

APPENDIX

INLAND
RAIL 

L

Matters of National Environmental Significance Technical Report

Part 1 of 4

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Inland Rail Border to Gowrie EIS

Appendix L – Matters of National
Environmental Significance
Technical Report

**Australian Rail Track
Corporation**

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Contents

1	Introduction	1
1.1	Project overview	1
1.2	Project objectives.....	1
1.3	The proponent	2
1.4	Scope and purpose	3
1.4.1	Environmental impact assessment process	3
1.4.2	This report.....	3
1.4.3	Impact assessment area	3
1.5	Terms of reference	5
1.6	Project location and existing land use	10
1.7	Project alternatives	13
1.7.1	Alternative locations and route options for Inland Rail Program	13
1.7.2	Alternative locations and route options for the Project.....	13
1.8	Project description	22
1.9	Reference design.....	24
1.9.1	Rail corridor	24
1.9.2	Crossing loops	24
1.9.3	Turnouts.....	24
1.9.4	Bridges.....	25
1.9.5	Drainage infrastructure	25
1.9.6	Road-rail interfaces	26
1.9.7	Fencing	27
1.10	Construction.....	29
1.10.1	Access roads	29
1.10.2	Bulk earthworks	30
1.10.3	Borrow pits.....	31
1.10.4	Non-resident workforce accommodation	32
1.10.5	Construction water requirements.....	33
1.10.6	Indicative construction schedule.....	36
1.10.7	Construction workforce	36
1.10.8	Hours of work.....	36
1.11	Operation	37
1.11.1	Hours of operation	37
1.11.2	Workforce	37
1.11.3	Train operations.....	37
1.11.4	Operational maintenance	37
1.12	Decommissioning	38
1.13	Social and economic benefits.....	38
1.14	Stakeholder engagement	39
1.14.1	Identification of stakeholders	39
1.14.2	Consultation approach.....	43
1.14.3	Consultation themes	44
1.15	Principles of ecologically sustainable development	46
1.15.1	Precautionary principle	47
1.15.2	Intergenerational equity	47
1.15.3	Conservation of biological diversity and ecological integrity	48
1.15.4	Improved valuation, pricing and incentive mechanisms	49

2	Legislation, policies and guidelines	50
3	Methodology of assessment	54
3.1	Overview.....	54
3.2	Desktop study	56
3.2.1	Database review	56
3.2.2	Review of existing literature and other studies.....	57
3.2.3	Assessment of the likelihood of occurrence of threatened species	58
3.2.4	Predictive habitat modelling for conservation significant species	59
3.2.5	Mapping of threatened ecological communities	62
3.3	Field assessments.....	62
3.3.1	Terrestrial ecology surveys.....	69
3.3.2	Aquatic surveys	81
3.3.3	Permits to conduct works	82
3.3.4	Quality assurance/quality control.....	82
3.3.5	Nomenclature	83
3.4	Impact assessment methodology	83
3.4.1	Magnitude of impacts	84
3.4.2	Sensitivity of receptor	84
3.4.3	Significance of impact.....	85
3.4.4	Assessment of the significance of impact against the matters of national environmental significance significant impact guidelines	86
3.5	Cumulative impact assessment methodology	87
3.5.1	Project selection	87
3.5.2	Approach	88
3.5.3	Assessment matrix	93
4	Description of environmental values.....	94
4.1	Regional and local context	94
4.2	Results of desktop study	96
4.2.1	Flora.....	97
4.2.2	Fauna.....	105
4.3	Existing environment	112
4.3.1	Flora.....	112
4.3.2	Fauna.....	116
4.3.3	Predicted habitat for threatened flora and fauna species.....	123
4.3.4	Flora and fauna habitat within the impact assessment area	127
4.4	Summary of matters of national environmental significance values	142
5	Potential impacts	145
5.1	Project activities.....	145
5.2	Description of potential impacts.....	146
5.2.1	Potential impacts to matters of national environmental significance	147
5.2.2	Potential impacts to matters of national environmental significance associated with air quality, surface water and hydrology, groundwater, noise and vibration	170
6	Mitigation measures	174
6.1	Mitigation through the reference design phase	174
6.2	Proposed mitigation measures	176
7	Impact assessment.....	201
7.1	Quantification of potential magnitude of direct impacts.....	201
7.2	Initial significance assessment	205

8	Significant residual impact assessment	213
8.1	Significant residual impact assessment for threatened ecological communities	213
8.2	Significant residual impact assessment for threatened flora	220
8.2.1	Critically endangered and endangered flora species	223
8.2.2	Vulnerable flora species populations	239
8.2.3	Significant impact assessment – Vulnerable flora	248
8.3	Significant residual impact assessment for threatened fauna	261
8.3.1	Critically endangered and endangered fauna species	263
8.3.2	Vulnerable fauna species populations	290
8.3.3	Significant impact assessment - Vulnerable fauna species	297
9	Biodiversity offsets	331
10	Commitments	333
11	Cumulative impact assessment	334
12	Conclusion	343
13	References	347

Appendices

Appendix A

Predictive habitat modelling methodology

Appendix B

Species and Community Profiles

Appendix C

Herbarium confirmation letter

Appendix D

Database Search Results

Appendix E

Flora Species List

Appendix F

Fauna Species List

Appendix G

Flora Assessment Proformas

Appendix H

Fauna Habitat Assessment Proformas

Appendix I

Predicted Habitat Mapping

Figures

Figure 1.1 Location of the Project and impact assessment area

Figure 1.2a-d Location of alternative routes assessed under corridor options assessment (including 2016 survey sites)

Figure 1.3 Standard fauna exclusion fence over channel

Figure 3.1	Assessment methodology
Figure 3.2a-d	Location of areas sampled as part of historic and concurrent works
Figure 3.3a-d	Location of sampling locations within the impact assessment area
Figure 3.4	Location of projects that have been included in the cumulative impacts assessment area
Figure 4.1a-d	Location of specimen backed records of MNES significant flora species derived from desktop assessments
Figure 4.2a-d	Location of specimen backed records of MNES significant fauna species derived from desktop assessments
Figure 4.3a-b	Locations of observed MNES significant flora and fauna species within the impact assessment area
Figure 4.4a-d	Extent and distribution of TECs within the impact assessment area
Figure 4.5a-d	Location of habitat types contained within the impact assessment area
Figure 6.1a-d	Location of proposed fauna crossings
Figure 6.2a-d	Location of indicative fencing including of fauna crossing solutions

Tables

Table 1.1	Quantification of anticipated significant residual impacts ('worst-case' scenario) to matters of national environmental significance
Table 1.1	Terms of reference compliance table
Table 1.2	Existing land use within the Project footprint
Table 1.3	Land use within the Project footprint located outside of the existing rail corridors
Table 1.4	Key features of the Project
Table 1.5	Turnouts to existing Queensland Rail sidings and loops
Table 1.6	Summary of bridge structures for the Project
Table 1.7	Summary of public road interfaces in the reference design for the Project
Table 1.8	Summary of road-rail interface treatments in the reference design, by asset manager
Table 1.9	Locations for non-resident workforce accommodation
Table 1.10	Estimated water requirements for construction activities
Table 1.11	Stakeholders informed or consulted during development of the reference design and draft Environmental Impact Statement
Table 1.12	Summary of key engagement themes, issues and opportunities
Table 2.1	Commonwealth legislation and policies relevant to the Project
Table 3.1	Database review summary
Table 3.2	Previous assessment and reports associated with ecological values of the Project
Table 3.3	EPBC Act listed threatened ecological community assumptions used to map areas of occurrence within the impact assessment area
Table 3.4	Timing of field investigations undertaken associated with the Project used to supplement the results of the current study
Table 3.5	Field survey sites and date of assessment (excluding opportunistic survey locations)
Table 3.6	Criteria for magnitude
Table 3.7	Timeframes for predicted Project activity impact duration
Table 3.8	Sensitivity criteria for values/matters of national environmental significance within the impact assessment area
Table 3.9	Significance assessment matrix
Table 3.10	Significance classifications
Table 3.11	Projects to be included in cumulative assessment
Table 3.12	Assessment matrix
Table 3.13	Impact significance
Table 4.1	Threatened flora species identified from database searches
Table 4.2	Threatened ecological communities identified within the impact assessment area based on desktop mapping
Table 4.3	Threatened fauna species identified from database searches
Table 4.4	Predicted habitat for threatened (EPBC Act) flora and fauna species within the impact assessment area and Project footprint

Table 4.5	Extent of fauna habitat located within the impact assessment area and Project footprint
Table 4.6	Summary of groundwater dependent ecosystem springs
Table 4.7	Identified matters of national environmental significance within the impact assessment area
Table 5.1	Summary of Project related activities associated with construction, commissioning and reinstatement and operation
Table 5.2	Summary of impact processes and matters of national environmental significance receptors likely to be impacted
Table 5.3	Construction activities and proposed equipment
Table 5.4	Potential construction and operation impacts to water quality and impacting processes
Table 5.5	Flood impact objectives and outcomes
Table 5.6	Potential impacts on groundwater
Table 5.7	Potential indirect impact to susceptible sensitive environmental receptors under non-mitigated flooding scenarios
Table 5.8	Assessment of potential impacts related to air quality, surface water and hydrology, groundwater, and noise and vibration upon matters of national environmental significance
Table 6.1	Project impact mitigation measures
Table 6.2	Project impact mitigation measures specific to matters of national environmental significance
Table 7.1	Estimation of potential magnitude of disturbance for each of the matters of national environmental significance identified for the Project
Table 7.2	Initial impact assessment of the Project upon identified matters of national environmental significance – Threatened ecological communities
Table 7.3	Initial impact assessment of the Project upon identified matters of national environmental significance – threatened flora
Table 7.4	Initial impact assessment of the Project upon identified matters of national environmental significance – threatened fauna
Table 8.1	Assessment of the Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC
Table 8.2	Assessment of the Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC
Table 8.3	Assessment of the Weeping Myall Woodlands TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC
Table 8.4	Assessment of the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland) TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC
Table 8.5	Assessment of the Poplar Box Grassy Woodland on Alluvial Plains TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC
Table 8.6	Summary of the results of the significant impact assessment for matters of national environmental significance flora species
Table 8.7	Assessment against the significant impact criteria: King blue-grass (<i>Dichanthium queenslandicum</i>)
Table 8.8	Assessment against the significant impact criteria: Winged peppercress (<i>Lepidium monoplocoides</i>)
Table 8.9	Assessment against the significant impact criteria: Wandering pepper-cress (<i>Lepidium peregrinum</i>)
Table 8.10	Assessment against the significant impact criteria: Coolmunda leucopogon (<i>Leucopogon</i> sp. Coolmunda) (<i>D. Halford Q 1635</i>)-
Table 8.11	Assessment against the significant impact criteria: Slender tylophora (<i>Tylophora linearis</i>)
Table 8.12	Assessment against the significant impact criteria: Xerothamnella herbacea
Table 8.13	Assessment of status of vulnerable flora species population against Guideline criteria
Table 8.14	Assessment against the significant impact criteria: Shiny-leaved ironbark
Table 8.15	Assessment against the significant impact criteria: Belson's panic (<i>Homopholis belsonii</i>)

Table 8.16	Assessment against the significant impact criteria: <i>Macrozamia machinii</i>
Table 8.17	Assessment against the significant impact criteria: Hawkweed (<i>Picris evae</i>)
Table 8.18	Assessment against the significant impact criteria: <i>Rhaponticum australe</i>
Table 8.19	Summary of the results of the significant impact assessment for matters of national environmental significance fauna species
Table 8.20	Assessment against the significant impact criteria: Brigalow woodland snail
Table 8.21	Assessment against the significant impact criteria: Regent honeyeater
Table 8.22	Assessment against the significant impact criteria: Australasian bittern
Table 8.23	Assessment against the significant impact criteria: Curlew sandpiper
Table 8.24	Assessment against the significant impact criteria: Swift parrot
Table 8.25	Assessment against the significant impact criteria: Australian painted snipe
Table 8.26	Assessment against the significant impact criteria: Spotted-tail quoll
Table 8.27	Assessment against the significant impact criteria: Condamine earless dragon
Table 8.28	Assessment of status of vulnerable fauna species population against Guideline criteria
Table 8.29	Assessment against the significant impact criteria: Collared delma
Table 8.30	Assessment against the significant impact criteria: Yakka skink
Table 8.31	Assessment against the significant impact criteria: Dunmall's snake
Table 8.32	Assessment against the significant impact criteria: Squatter pigeon (southern)
Table 8.33	Assessment against the significant impact criteria: Painted honeyeater
Table 8.34	Assessment against the significant impact criteria: Murray cod
Table 8.35	Assessment against the significant impact criteria: South-eastern long-eared bat
Table 8.36	Assessment against the significant impact criteria: Greater glider
Table 8.37	Koala habitat assessment tool (DoE 2014) - Project footprint
Table 8.38	Assessment against the significant impact criteria: Koala
Table 8.39	Assessment against the significant impact criteria: Five-clawed worm-skink
Table 9.1	Quantification of anticipated significant residual impacts to matters of national environmental significance
Table 11.1	Cumulative impact assessment of magnitude for matters of national environmental significance cumulative impact assessment area
Table 11.2	Significance assessment of cumulative impacts within the cumulative impact assessment area

Abbreviations

Abbreviation	Explanation
AoLA	Atlas of Living Australia
ARTC	Australian Rail Track Corporation Limited
AUSRIVAS	Australian River Assessment System
B2G	Border to Gowrie Project
BAMM	Biodiversity Assessment and Mapping Methodology
BPA	Biodiversity Planning Assessment
CE	Critically Endangered
CEMP	Construction Environmental Management Plan
Cth	Commonwealth
DAF	Department of Agriculture and Fisheries
DAWE	Department of Agriculture, Water and the Environment
DDMRB	Darling Downs Moreton Rabbit Board
DES	Department of Environment and Science
DNRME	Department of Natural Resource Management and Energy
DotEE	Department of the Environment and Energy
DSITI	Department of Science, Information Technology and Innovation
DTMR	Department of Transport and Main Roads
E	Endangered
EHP	Department of Environment and Heritage Protection (former)
EIS	Environmental Impact Statement
EP Act	<i>Environmental Protection Act 1994 (Qld)</i>
Cth	Commonwealth
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Cth)</i>
EX	Extinct
FFJV	Future Freight Joint Venture
G2H	Gowrie to Helidon
GDE	Groundwater dependent ecosystem
GIS	Geographic information system
ha	hectare
HES	High Ecological Significance
HVR	High Value Regrowth
Inland Rail	Melbourne to Brisbane Inland Rail
kg/m	kilogram/metre
km	kilometre
LC	Least concern
LGA	Local government area
m	metre
MCA	multi-criteria analysis
mm	millimetre
MNES	matters of national environmental significance

Abbreviation	Explanation
MSES	Matters of State environmental significance
NS2B	North Star to NSW/QLD Border
NRM	Natural Resource Management
NSW	New South Wales
OC	Of concern
PMST	Protected Matters Search Tool
Project	Border to Gowrie Project
Qld	Queensland
QLD	Queensland
QR	Queensland Rail
QWQG	Queensland Water Quality Guidelines 2009
RE	Regional Ecosystem
SDPWO Act	<i>State Development and Public Works Organisation Act 1971 (Qld)</i>
SPP	State Planning Policy 2017 (Qld)
SPRAT	Species Profile and Threats Database (EPBC Act)
T	Tree (canopy) stratum
tal	Total axle load
Threatened	Critically endangered, Endangered and Vulnerable
TEC	Threatened ecological community
ToR	Terms of Reference
V	Vulnerable
VM Act	<i>Vegetation Management Act 1999 (Qld)</i>
WQO	Water Quality Objectives

Glossary

Term	Explanation
Adverse impact	Adverse impacts are defined as those impacts that result in an unwanted and unanticipated result of taking a particular action. In an environmental context, an adverse impact means any change in the physical or biological conditions of the natural environment that results in a detrimental effect upon flora, fauna, air, water, minerals or other natural characteristic of the area.
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: - Genetic diversity – the variety of genes (or units of heredity) in any population - Species diversity – the variety of species - Ecosystem diversity – the variety of communities or ecosystems.
Biodiversity Planning Assessments (QLD) (BPAs)	BPAs have been prepared for each of Queensland's bioregions based on the methodology outlined in the Biodiversity Assessment and Mapping Methodology (BAMM) (Queensland Government 2002a). The BPAs draw upon the Department of Environment and Science (DES) certified Regional Ecosystem (RE) mapping, database information, and expert panel reports and incorporate information about threatened ecosystems and/or species, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, as well as buffers to wetlands or other types of important areas for ecological processes. There are three biodiversity significance levels to which an area can be assigned: - State significance – areas assessed as being significant for biodiversity at the bioregional or State scales - Regional significance – areas assessed as being significant for biodiversity at the sub-bioregional scale - Local significance and or other values – local values that are of significance at the local government scale All remnant vegetation will qualify into one of the above three categories.
Bioregion	A bioregion as defined in An Interim Biographic Regionalisation of Australia (Thackway and Cresswell (1995)). The region subject to this report is the Brigalow Belt South bioregion.
Biosecurity Act 2014 (QLD) (Biosecurity Act)	The Biosecurity Act lists declared plants and animals that have, or could have, serious economic, environmental or social impacts and are targeted for control. There are legal obligations associated with the control supply, sale, keeping and transport of declared species. Where these exotic pests and weeds are encountered, landholders have an obligation under the Biosecurity Act to control the declared weeds and pest animals, in accordance with relevant guidelines and local government area pest management plans. There are seven categories for restricted matter defined in the Biosecurity Act: - Categories 1 and 2 are restricted matters that have specific urgent reporting requirements - Categories 3, 4, 5, 6 and 7 relate to restricted matter that is in a person's possession, under their control and is also about not feeding restricted matter Several restriction categories apply to some restricted matter. In such cases, you would need to follow the requirements of all restriction categories for these restricted matter listings.
Conservation significant	A collective term used with reference to species that are listed as Critically endangered, Endangered or Vulnerable under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth) (EPBC Act) (refer EPBC Act conservation significance for more details)).
Critical habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered ecological community that is critical to the survival of the species, population or ecological community. Critical habitat is listed under the EPBC Act.
Critically endangered	Designated as Critically endangered under the EPBC Act. Refer to definition of EPBC Act conservation status for meaning of Critically endangered under the Act.
Cumulative impacts	The impacts that result from the incremental impact of an activity when it is added to past, present, and reasonably foreseeable future activities. Cumulative impacts arise when several developments that may have insignificant effects but when taken together have a significant effect.

Term	Explanation
Direct impacts	Impacts that result from a direct interaction between integral Project activities and identified Matters of National Environmental Significance (MNES) (e.g. land clearing resulting in vegetation and habitat loss).
Ecological community	An assemblage of species occupying a particular area.
Ecological MNES	An ecological value or group of ecological values that has the potential to be adversely impacted by Project related activities.
Ecologically sustainable development	Using, conserving and enhancing the community's resources so that ecological processes are maintained and the total quality of life, both now and in the future, can be increased.
Endangered	Designated as Endangered under the EPBC Act. Refer to definitions of EPBC Act conservation status for meaning of Endangered.
EPBC Act conservation status	Under the EPBC Act, listed species and threatened ecological communities are assigned a conservation status of Extinct in the wild, Critically endangered, Endangered or Vulnerable. Definitions of these terms under the Act are as follows: Extinct in the wild - It is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range or - It has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a timeframe appropriate to its lifecycle and form Critically Endangered - It is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria Endangered - It is not Critically Endangered - It is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria Vulnerable - It is not Critically Endangered or Endangered - It is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Habitat	An area or areas permanently, periodically or occasionally occupied by a species, population or ecological community, including any and all biotic and abiotic features of the area or areas occupied.
High constraint area	The environmental value is at risk from the Project activity. The activity will only be allowed with a specific set of stringent mitigation measures.
High value regrowth	According to the DNRME (2018), regulated regrowth vegetation includes vegetation that falls into one of the following categories: - Vegetation identified on a regulated vegetation map as High Value Regrowth vegetation (Category C; light blue) - Vegetation located within 50 m of watercourses in priority reef catchment areas (Category R; yellow) - Vegetation that is a Least concern, Of concern or Endangered RE High value regrowth vegetation is mature native vegetation that has not been cleared in the last 15 years.
Impact assessment area	This includes the B2G Project footprint plus a nominal 1 km buffer area. Where multiple options were identified, a 1 km buffer was maintained from the edge of each option, resulting in areas that are wider in some locations.
Indirect impacts	Impacts that are not a direct result of project activities but are encouraged to occur away from the original impact area via a complex pathway (e.g. soil disturbance during construction promoting weed and/or pest invasion that reduces habitat quality). Indirect impacts include the following: Downstream or downwind impacts, such as impact on wetlands or ocean reefs from sediment, fertilisers or chemical which are washed or discharged into river systems

Term	Explanation
	- Upstream impacts such as impacts associated with the extraction of raw materials and other inputs which are used to undertake the action - Facilitated impacts which result from further actions (including actions by third parties) which are made possible or facilitated by the action.
Matters of national environmental significance (MNES)	The nine matters of national environmental significance protected under the EPBC Act are: - World heritage properties - National heritage places - Wetlands of International Importance (listed under the Ramsar Convention) - Listed threatened species and ecological communities - Migratory species protected under international agreements - Commonwealth marine areas - The Great Barrier Reef Marine Park - Nuclear actions (including uranium mines) - A water resource, in relation to coal seam gas development and large coal mining development.
Microchiropteran bats	This report uses the term Microchiropteran bats to refer to small mostly insectivorous bats that use echolocation to navigate and find food.
Migratory	Species listed as Migratory under the EPBC Act.
Naturalness and ecological condition	The apparent naturalness or health/condition of an ecological community, as assessed against the following criteria: - Disturbance — described in terms of its cause (natural or human), its degree or severity, its extent and distribution within the community - Weed content — description of species abundance, horizontal and vertical distribution of each species - Ecological viability — measure of a community's ability to survive in the longer term - Ecological health — measure of regeneration, size, structure and number of dead or dying plants within a community - Ecological relationships — the sequential relationship of one community to another, such as diurnal systems.
Negative impact	An impact that is considered to result in an unfavourable or adverse change to the MNES.
Non-remnant vegetation	Vegetation that is not mapped as remnant vegetation by DES and/or which fails to meet DESs criteria for remnant vegetation (see definition of remnant vegetation, below). This includes regrowth, heavily thinned or logged vegetation and significantly disturbed vegetation that fails to meet the structural and/or floristic characteristics of remnant vegetation. It also includes urban and cropping land. Non-remnant vegetation may retain significant biodiversity values (Neldner <i>et al.</i> 2017).
Permanent impact	The impact will last in excess of 21 years.
Precautionary principle	The precautionary principle stipulates that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Project cumulative impact area	The Inland Rail Project cumulative impact area encompasses the Inland Rail Project footprint and extends 50 km beyond the Project footprint boundary.
Project footprint	The project footprint is the Project footprint (both temporary and permanent) associated with the Project. The project footprint is the areas subject to direct disturbance.
Rare	Defined as “not occurring very often”.
Regional ecosystem (RE)	A vegetation community, within a bioregion, that is consistently associated with a particular combination of geology, landform and soil (Young <i>et al.</i> 1999). REs are classified under schedules 1 to 3 of the Vegetation Management Regulation as Endangered, Of concern or Least concern. Refer to VM Act conservation status for meaning of Endangered, Of concern and Least concern under the Act. These terms in reference to REs in this report refers to the RE status under the VM Act.
Regrowth vegetation	As defined under the VM Act, regrowth is any vegetation that is not 70% of height of an equivalent community of undisturbed vegetation or 50% of what would be undisturbed foliage cover and a mix of species represented in undisturbed communities.

Term	Explanation
Remnant vegetation	Remnant woody vegetation is defined as vegetation where the dominant canopy has >70% of the height and >50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy (Neldner et al. 2012).
Significant impact	In accordance with the intent of the EPBC Act, a significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.
Spatial extent	Impacts are considered with respect to the biologically meaningful spatial extents of local, regional, State, and national/international.
Threatened	A collective term used with reference to species that are listed as Critically endangered, Endangered or Vulnerable under the provisions of the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth) (EPBC Act) (refer EPBC Act conservation significance for more details)
VM Act conservation status	Under the VM Act, REs may be classified as either Endangered, Of concern or Least concern. Definitions of these terms under the Act are provided below Endangered - Less than 10% of pre-clearing extent of remnant vegetation (refer following definition) exists in the bioregion, or 10% to 30% of pre-clearing extent remains and the remnant vegetation is less than 10,000 ha Of concern 10% to 30% of pre-clearing extent of remnant vegetation exists in the bioregion, or more than 30% of pre-clearing extent remains and the remnant vegetation is less than 10,000 ha Least concern - More than 30% of pre-clearing extent of remnant vegetation exists in the bioregion, and it is greater than 10,000 ha. In addition, for biodiversity planning purposes DES also classifies a RE as No concern at present if the degradation criteria listed above for Endangered or Of concern REs are not met.
Vulnerable	Designated as Vulnerable under the EPBC Act. Refer to definitions of EPBC Act conservation status for meaning of Vulnerable under this Act.
Weeds of National Environmental Significance (WoNS)	Thirty-two (32) species of weeds are declared to be weeds of national significance, based on their invasiveness, potential for spread and environmental, social and economic impacts. The State Government is responsible for the legislation and administration of WoNS in Queensland and landholders are responsible for managing WoNS. The Australian Weeds Strategy provides a framework for establishing consistency between all stakeholders and identifies priorities for national weed management with the aim of minimizing the environmental, social and economic impacts of weeds. A National Management Group has been established for each of the WoNS to manage the implementation of the respective National Strategic Plans.

Executive summary

The Australian Government has committed to delivering Inland Rail, an interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland (QLD). Inland Rail is a significant piece of national transport infrastructure which will enhance Australia's existing rail network and serve the interstate freight market.

The Inland Rail route, which is approximately 1,700 kilometres (km) long and is divided into 13 sections to assist with the delivery of the Inland Rail Program, will provide a safe and sustainable solution to Australia's freight challenge. The Program will also provide significant social and economic benefits and opportunities, while implementing mitigation, management and offset measures that result in acceptable environmental, social and economic outcomes.

The Australian Rail Track Corporation Limited (ARTC), the proponent, proposes to construct and operate the Border to Gowrie Project ('the Project') which is proposed to be approximately 216.2 km of single-track railway between the QLD and NSW border near Kurumbul, 15 km east of Goondiwindi, and will connect to the proposed Gowrie to Helidon (G2H) Project (Inland Rail) at Gowrie Junction, situated on the north-eastern outskirts of Kingsthorpe.

The Project has been aligned to maximise the usage of existing rail corridors, wherever possible. As a consequence, approximately one third of the length of the Project (71.2 km) is positioned within existing rail corridor. The other two thirds of the alignment (145.0 km) are regarded as 'greenfield' alignment, requiring new rail corridor to be established. A large proportion of the greenfield alignment extends through agricultural lands which have been subject to extensive historical land management practices, including clearing and grazing.

The corridor will be of sufficient width to accommodate future possible upgrades of the track, including a future possible requirement to accommodate trains up to 3,600 m in length. The land requirement for the Project will comprise a corridor with minimum width of 40 m, widened to accommodate earthworks, drainage structures, rail infrastructure, access tracks and fencing.

On 16 March 2018, the Project was declared a coordinated project for which an Environmental Impact Statement (EIS) is required under the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act). This declaration initiated the statutory environmental impact assessment procedure detailed in Part 4 of the SDPWO Act, which requires a proponent to prepare an EIS for the Project in accordance with the *Terms of Reference for an environmental impact statement: Inland Rail - Border to Gowrie project* for the Project (ToR), issued in November 2018 by the Coordinator-General.

The Project was referred to the Department of the Environment and Energy (now called the Department of Agriculture, Water and the Environment (DAWE)) in February 2018 (EPBC 2018/8165) for determination under s75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Minister for the Environment determined the Project a 'controlled action' on 9 April 2018, requiring assessment and approval under the EPBC Act. The controlling provision for the controlled action is 'Listed threatened species and communities'.

The SDPWO Act EIS process has been accredited under the Queensland and Commonwealth governments EPBC Act assessment bilateral agreement for the assessment of the Project under the EPBC Act. The Project will be assessed under the terms of this bilateral agreement.

This Matters of National Environmental Significance (MNES) Technical Report has been prepared to address the matters set out in section 11 of the ToR.

The Project is situated within the Brigalow Belt South bioregion, which has experienced a long history of clearing and disturbance as a result of agriculture, forestry and grazing practices, resource development and community infrastructure development. At a regional level, most remaining areas of vegetation are now fragmented, occurring on the rockier hilly areas of ranges, as roadside vegetation, or as relatively small isolated remnants. Larger tracts of remnant vegetation in the region generally occur in State forests and are subject to periodic timber harvesting.

The Project footprint provides habitat for a number of threatened species listed under the EPBC Act and their associated habitat.

There is one Threatened Ecological Community (TECs) listed under the EPBC Act confirmed as present within the Project footprint and a further two TECs may potentially occur.

Based on literature review, database searches, and field surveys supporting habitat modelling, habitat for 41 threatened flora (18 species) and fauna (23 species) have been confirmed within the Project footprint. This includes significant habitat associated with the State forest areas north of Inglewood and critical habitat for a several species including King blue-grass (*Dichanthium queenslandicum*), Winged peppercress (*Lepidium monoplocoides*), Hawkweed (*Picris euae*), Australian painted snipe (*Rostratula australis*), Condamine earless dragon (*Tympanocryptis condaminensis*) and Koala (*Phascolarctos cinereus*).

An assessment of potential impacts from Project activities upon the identified MNES was undertaken, informed by the outcomes of desktop analysis, including habitat mapping, and multiple ecological field surveys.

The construction and operation of the Project has the potential to impact on MNES via the following mechanisms (predominantly associated with the construction phase):

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species by invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light impacts
- Increase in litter (waste)
- Aquatic habitat degradation
- Erosion and sedimentation
- Flooding.

To determine the significance of potential impacts of the Project upon the identified MNES, sensitivity categories were applied to each of the MNES. The sensitivity of the MNES was grouped into three distinct categories: high, moderate and low. These groupings were based on factors including, but not limited to, legislative status, resilience and representation in the broader landscape.

In addition to sensitivity, the magnitude of each potential impact was assigned based on the extent, duration and resultant change to the MNES. The magnitude of impact was grouped into five categories: major, high, moderate, low and negligible.

Development of the reference design has progressed in parallel with the impact assessment process. As a consequence, design solutions for avoiding, minimising or mitigating impacts have been incorporated into the reference design as appropriate and where possible. Understanding of the mitigations and controls incorporated into the reference design process was combined with the sensitivity of a MNES and the magnitude of the potential impact to determine the significance of a potential impact as a consequence of the Project.

In addition to reference design phase mitigation, measures have been identified for adoption or implementation through future phases of Project delivery. These addition mitigation measures have been considered in order to determine the ultimate 'post-mitigation' significance of the potential impacts upon the listed threatened species and communities (or 'residual significance').

Project mitigation measures included (but were not limited to):

- Reducing the Project footprint as far as reasonably practical through refinement of the detail design
- Development and implementation of a Biodiversity Management Sub-plan as a component of the Construction Environmental Management Plan (CEMP) for the Project
- Development and implementation of a Biosecurity Management Sub-plan as a component of the CEMP
- Development and implementation of a Soil Management Sub-plan, including erosion and sedimentation controls, as a component of the CEMP
- Identification and implementation of fauna movement features to reduce barrier effects associated with the Project and enable fauna passage
- Development and implementation of a Rehabilitation and Landscaping Management Sub-plan.

Impact assessment concluded that the magnitude of residual impacts to the MNES were generally reduced following the implementation of an additional mitigation measures and management plans. A key reason for disturbance to MNES is expected to be the potential loss of habitat, through clearing to establish the Project footprint. The Project may also result in permanent barrier effects and habitat fragmentation. The loss of habitat from vegetation clearing/removal upon most of the terrestrial MNES is not expected to significantly reduce in magnitude of impact following the implementation of Project mitigation measures. The assessment also found that, whilst measures will be implemented to reduce impacts due to fragmentation associated with barrier effects (e.g. the provision of crossing structures to facilitate fauna passage), terrestrial species such as Koala (*Phascolarctos cinereus*) are still likely to be subject to adverse impacts.

Based on assessment against the Significant Impact Guidelines for MNES, a significant residual impact is likely to occur to the threatened species and communities listed in Table 1.1.

Table 1.1 Quantification of anticipated significant residual impacts ('worst-case' scenario) to matters of national environmental significance

Sensitive environmental receptor (MNES)	Identified significant residual impact ¹
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) TEC	62.89 ha – potential extent
Weeping Myall Woodlands TEC	81.92 ha – potential extent
Poplar Box Grassy Woodland on Alluvial Plains TEC	81.92 ha – potential extent
King blue-grass (<i>Dichanthium queenslandicum</i>)	5.29 ha
Winged peppercress (<i>Lepidium monoplacoides</i>)	40.91 ha
Belson's panic (<i>Homopholis belsonii</i>)	3.19 ha
Hawkweed (<i>Picris evae</i>)	18.68 ha
Austral cornflower (<i>Rhaponticum australe</i>)	2.29 ha
Spotted-tail quoll (mainland) (<i>Dasyurus maculatus maculatus</i>)	15.49 ha
Condamine earless dragon (<i>Tympanocryptis condaminensis</i>)	17.93 ha
Five-clawed worm-skink (<i>Anomalopus mackayi</i>)	16.68 ha
Collared delma (<i>Delma torquata</i>)	295.76 ha
Dunmall's snake (<i>Furina dunmalli</i>)	298.85 ha
Swift parrot (<i>Lathamus discolor</i>)	243.54 ha
Koala (<i>Phascolarctos cinereus</i>)	481.15 ha

Table note:

- 1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

Impact assessment has been undertaken on the potential “worst case scenario”, which is based on a conservative Project footprint established for the reference design. The Project footprint will be refined during the detail design phase of the Project to reflect the final Project design and the land required to accommodate the Principal Contractor’s adopted construction methodology (e.g. only one of the two allocated concrete batching facility locations provided in the Project footprint is expected to be used). This process is expected to result in a reduction in the total Project footprint area and subsequent impacts to ecological receptors (including MNES).

A cumulative impact assessment was carried out including all relevant projects within a 50 km radius of the current Project footprint. The significance of the predicted cumulative impact as a result of the Project and other similar projects are likely to be higher on the following ecological MNES flora and fauna species:

- Weeping Myall woodlands TEC
- Poplar box grassy woodlands TEC
- Belson’s panic (*Homopholis belsonii*)
- Wandering pepper-cress (*Lepidium peregrinum*)
- Coolmunda Leucopogon (*Leucopogon* sp. Coolmunda)
- Painted honeyeater (*Grantiella picta*)
- South-eastern long-eared bat (*Nyctophilus corbeni*)
- Greater glider (*Petauroides Volans*)
- Five-clawed worm-skink (*Anomalopus mackayi*)
- Yakka skink (*Egernia rugosa*)
- Condamine earless dragon (*Tympanocryptis condaminensis*).

MNES identified through the impact assessment will be subject to further investigations and surveys throughout detail design. This will refine the current proposed works and determine whether these species actually occur and if so, the magnitude of the significant residual impacts upon the listed threatened species and communities. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable.

The Project will result in significant residual adverse impact on MNES, even after the implementation of all mitigation measures, including rehabilitation. Therefore, it is expected that environmental offsets will be required for the Project. Offsets will need to be provided in accordance with requirements of the EPBC Act, *Environmental Offsets Act 2014* and relevant policies.

A Project offset plan will be developed to provide for the staged delivery of offsets, where appropriate, ahead of relevant clearing works being undertaken and finalised in consultation with relevant Australian Government and State regulatory agencies.

1 Introduction

1.1 Project overview

The Australian Government has committed to delivering Inland Rail, an interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland (QLD). Inland Rail is a significant piece of national transport infrastructure which will enhance Australia's existing rail network and serve the interstate freight market.

The Inland Rail route, which is approximately 1,700 kilometres (km) long, will involve:

- Using the existing interstate rail corridor through Victoria and southern NSW
- Upgrading approximately 400 km of existing corridor, mainly in western NSW
- Providing approximately 600 km of new corridor in northern NSW and South East Queensland (SEQ).

Inland Rail has been divided in 13 sections to assist with the delivery of the Inland Rail Program of works.

The Australian Rail Track Corporation (ARTC) proposes to construct and operate the Border to Gowrie section ('the Project') of the Inland Rail Program. This section consists of 216.2 km of single track railway with five crossing loops. It will ultimately accommodate trains up to 3,600 metres (m) long based on business needs but will be initially constructed to accommodate 1,800 m long double stack freight trains. The Project will utilise a combination of existing rail corridors and new rail corridor.

The Project design responds to key environmental and social constraints and has been developed in line with engineering standards to produce a feasible rail design (the reference design) that will achieve the performance specifications for Inland Rail and the Project.

1.2 Project objectives

The objectives of the Project are to:

- Provide upgraded rail infrastructure that meets the Inland Rail Program specifications, to enable trains using the Inland Rail corridor to travel from the NSW/QLD border to Gowrie, connecting with other sections of Inland Rail to the north and south
- Provide connectivity at points of interface with the existing Queensland Rail (QR) network, thereby enabling trains operating on the regional network to use sections of Inland Rail
- Minimise the potential for environmental and community impacts by maximising use of existing rail corridor.
- Provide a rail link between Melbourne and Brisbane that is interoperable with train operations to Perth, Adelaide and other locations on the standard gauge rail network, to serve future rail freight demand and stimulate growth for inter-capital and regional/bulk rail freight
- Provide an increase in productivity that will benefit consumers through lower freight transport costs
- Provide a step-change improvement in rail service quality in the Melbourne to Brisbane corridor and deliver a freight rail service that is competitive with road
- Improve road safety, congestion and reduce environmental impacts by moving freight from road to rail
- Bypass bottlenecks within the existing metropolitan rail networks and free up train paths for other services along the coastal routes
- Act as an enabler for regional economic developments along the Inland Rail corridor

1.3 The proponent

The ARTC was created in 1997 after the Australian and State governments agreed to the formation of a 'one stop shop' for all operators seeking to access the national interstate rail network.

Since its formation, ARTC has focussed on infrastructure investment and the modernisation of the rail network. This has extended to building and upgrade of existing track to allow for the capacity that the market requires.

Today, ARTC plays a critical role in the transport supply chain and in the overall economic development of Australia. The ARTC network supports industries and businesses that are vital to the nation's economy by facilitating the movement of a range of commodities including general freight, coal, iron ore, other bulk minerals and agricultural products.

Across the network, ARTC is responsible for:

- Selling access to train operators
- Developing new business
- Capital investment in the network
- Managing the network
- Infrastructure maintenance.

As the operator and manager of Australia's national rail freight network, ARTC has successfully delivered more than \$5 billion in capital upgrades to the national rail freight network. Having emerged from this period of significant investment and network growth, ARTC has now been tasked with developing a program to deliver Inland Rail under the guidance of the Department of Infrastructure, Regional Development and Cities.

ARTC have incurred two penalties in NSW relating to minor environmental incidents including:

- NSW Environmental Protection Authority Penalty Notice to ARTC dated 29 May 2012 for discharge of sediment-laden water at Allandale (Maitland to Minimbah Third Track Project) = \$1,500
- NSW Environmental Protection Authority Penalty Notice to Transport Express Joint Venture (operating under ARTC Environment Protection Licence) dated 5 March 2012 for sediment and erosion control issues at Sawtell = \$1,500.

ARTC have not incurred any other environmental prosecutions within the last 10 years.

ARTC has also previously entered into a Voluntary Enforceable Undertaking with the Commonwealth Department of the Environment and Energy (DotEE) under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act), in 2011.

Contact details for the Inland Rail Program are as follows:

Australian Rail Track Corporation
ABN: 75 081 455 754
Level 16, 180 Ann Street
PO Box 2462 Queen Street
Brisbane QLD 4001
Telephone: 1800 732 761

Further information on ARTC can be found at: <http://www.artc.com.au>.

1.4 Scope and purpose

1.4.1 Environmental impact assessment process

This EIS supports an application for approval of the Project under Section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act). It addresses the *Terms of reference for an environmental impact statement: Inland Rail—Border to Gowrie project* dated November 2018 (the ToR) (refer Appendix B: Terms of reference compliance table of the Border to Gowrie Project EIS (the EIS)). The Project is also a controlled action requiring assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) (reference number EPBC 2018/8165). The controlling provision under the EPBC Act is listed threatened species and communities (sections 18 and 18A).

Assessment of the Project against the requirements of the EPBC Act will occur in accordance with the bilateral agreement with the State of Queensland. To enable this, the draft EIS must address the controlling provision for the Project and describe the particular aspects of the environment and the Project that are subject to the controlled action decision.

A principal purpose of the EIS is to provide sufficient information to enable the Coordinator-General (State Government) and the Commonwealth Minister for the Environment (Commonwealth Government) to evaluate and assess the Project under the SDPWO Act and EPBC Act respectively, and to state conditions and make recommendations regarding approvals required by the Project under other legislation.

At the conclusion of the SDPWO Act EIS process, the Commonwealth Minister for the Environment will receive a copy of the Coordinator-General's Evaluation Report and will take the Coordinator-General's Evaluation Report into account when making a decision under the EPBC Act. The Commonwealth Minister for the Environment will decide on whether to approve the Project with or without conditions.

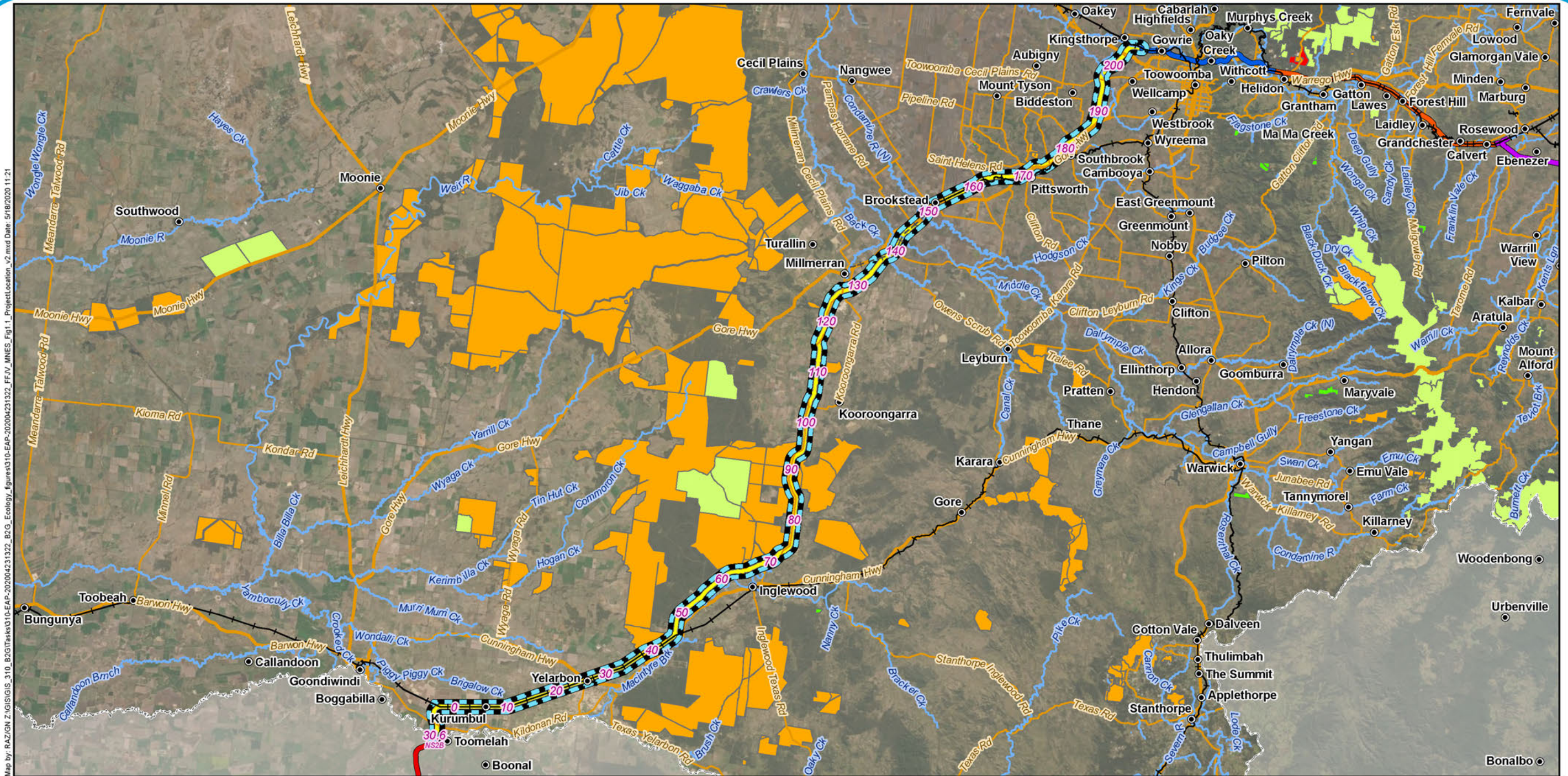
ARTC will obtain all other development approvals from local government authorities (e.g. for a material change of use) and Queensland Government departments (e.g. an environmental authority under the *Environmental Protection Act 1994* (EP Act) (Qld)), where applicable.

1.4.2 This report

This MNES technical report has been prepared to address Sections 11.1 to 11.35 of the ToR. It has been prepared as a “stand-alone” document that assesses potential impacts on listed threatened species and communities under the EPBC Act during construction and operation of the Project. Furthermore, this report draws on other impact assessments completed for the EIS as relevant to listed threatened species and communities, including air quality, surface water and hydrology, groundwater, and noise and vibration.

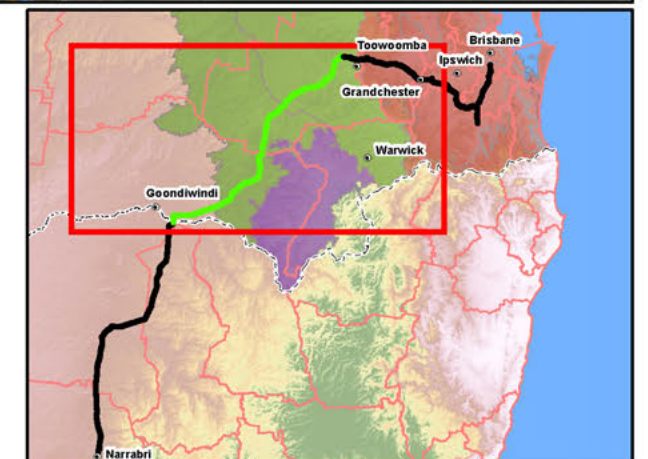
1.4.3 Impact assessment area

For the purpose of this report, the assessment of potential impacts has focussed on the Project footprint and impact assessment area presented in Figure 1.1. The impact assessment area for this technical report is based on a 1 km buffer of the Project footprint, increasing in buffer extent where multiple design options were identified and explored during development of the reference design. The Project footprint has been established to encompass all permanent infrastructure required for the Project. Permanent infrastructure features include the new rail track, bridges and drainage structures, level crossings, road realignments, possible upgrades to adjacent roads and infrastructure, rail maintenance access roads (RMAR), fencing and signage.



Legend

- | | | | |
|--|------------------------|-------------------|--------------------------|
| 5 Chainage (km) | Major roads | Protected areas | Bioregions |
| Localities | Minor roads | Conservation Park | Brigalow Belt South |
| North Star to NSW/QLD border alignment | Watercourses | National Park | Nandewar |
| Gowrie to Helidon alignment | NSW/QLD border | Resources Reserve | South Eastern Queensland |
| Helidon to Calvert alignment | Project footprint | State Forest | |
| Calvert to Kagaru alignment | Impact assessment area | | |
| Existing rail (operational) | | | |
| Existing rail (non-operational) | | | |



A3 scale: 1:800,000

0 10 20 30 40 50 km



Future Freight
Integrating Community, Environment and Engineering

Issue date: 30/04/2020 Version: 2
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 1.1: Location of the Project and impact assessment area

1.5 Terms of reference

This report addresses the ToR for the Project, as summarised in Table 1.1. Compliance of the EIS against the full ToR is documented in EIS Appendix B: Terms of Reference compliance table.

Ecological matters associated with sections 11.94 to 11.106 of the ToR have been addressed separately in EIS Appendix J: Terrestrial Ecology Technical Report, EIS Appendix K: Aquatic Ecology Technical Report and EIS Chapter 10: Flora and fauna.

Table 1.1 Terms of reference compliance table

Terms of reference requirement		Report section
Matters of national environmental significance – background and context		
11.1	This section should provide a stand-alone description and detailed assessment of the impacts of the project on the controlling provision for the project under the EPBC Act inclusive of any avoidance, mitigation and offset measures.	This report
11.2	The Commonwealth Minister for the Environment and Energy (the Commonwealth Minister) has determined that the project (EPBC 2017/7944) is likely to impact upon listed threatened species and communities (sections 18 and 18A of the EPBC Act).	Section 1.4.1
11.3	The EIS must be prepared in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland relating to environmental assessment. This will enable the EIS to meet the impact assessment requirements under both Commonwealth and Queensland legislation.	Section 1.4.1
11.4	The statutory obligations for conduct of the EIS process under the bilateral agreement are set out in Part 13 of the State Development and Public Works Organisation Regulation 2010.	Section 1.4.1
11.5	Once the draft EIS has been prepared to the satisfaction of the Coordinator-General and MNES addressed to the satisfaction of the Australian Government Department of the Environment and Energy, the draft EIS will be made available for public comment.	Is not required to be addressed by the draft EIS
11.6	The proponent may be required by the Coordinator-General or the Department of the Environment and Energy to provide additional material to address matters raised in submissions on the EIS	Is not required to be addressed by the draft EIS
11.7	At the conclusion of the environmental assessment process, the Coordinator-General will provide a copy of the report evaluating the environmental impacts of the project to the Commonwealth Minister.	Is not required to be addressed by the draft EIS
11.8	After receiving the evaluation report and sufficient information about the relevant impacts of the action, the Commonwealth Minister for the Environment and Energy has 30 business days to consider whether the impacts of the proposal are acceptable, or not, and to decide whether or not to approve each controlling provision.	Is not required to be addressed by the draft EIS
11.9	The Commonwealth Minister's decision under Part 9 of the EPBC Act is separate to the approval decisions made by Queensland state agencies and other agencies with jurisdiction on state matters.	Is not required to be addressed by the draft EIS
Information Requirements		
11.10	Consideration must be given to any relevant policy statements available from www.environment.gov.au , including: a) Matters of National Environmental Significance: Significant impact guidelines 1.1 b) <i>Environment Protection and Biodiversity Conservation Act 1999</i> Environmental Offsets Policy and c) any approved conservation advice, recovery plans and threat abatement plans (as relevant) for listed threatened species and ecological communities.	Guidelines and plans – Sections 8, 8.2 and 8.3 and Appendix B Offsets – Section 9 and EIS Appendix N: Environmental Offset Delivery Strategy - QLD

Terms of reference requirement		Report section
11.11	The EIS must: a) assess all the relevant impacts that the action has, will have or is likely to have, including on receiving environments of the project b) provide enough information about the action and its relevant impacts to allow the Commonwealth Minister to make an informed decision on whether or not to approve the action c) address the matters set out in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth) (EPBC Regulations).	Project description – Section 1.8 and EIS Chapter 5: Project Description Impacts – Section 5.2 Mitigations – Sections 6 and 7.2 EIS Appendix J: Terrestrial Ecology Technical Report EIS Chapter 3: Legislation and project approvals process Environmental record - EIS Chapter 1: Introduction Information sources – Appendix B and Section 9
11.12	The MNES section of the EIS should bring together assessments of impacts from other chapters and produce a stand-alone assessment in a format suited for assessment under the EPBC Act.	Throughout document EIS Appendix J: Terrestrial Ecology Technical Report
11.13	The project should initially be assessed in its own right followed by an assessment of the cumulative impacts related to existing major projects and/or development that is progressing through a publicly available planning and approval process. Cumulative impacts not solely related to the project development should also be described.	Sections 3.5 and 10 EIS Chapter 21: Cumulative impacts
11.14	Predictions of the extent of threat (risk), impact and the benefits of any mitigation measures proposed, should be based on sound science and quantified where possible. All sources of information relied upon should be referenced.	Mitigations – Sections 6 and 7.2 Information sources – Appendix B and Section 9
11.15	An estimate of the reliability of any predictions should be provided.	Appendix A
11.16	Any positive impacts of the Project should be identified and evaluated.	Section 1.13 EIS Chapter 2: Project rationale EIS Chapter 15: Social
11.17	The extent of any new field work, modelling or testing should be commensurate with risk and should be such that when used in conjunction with existing information, provides sufficient confidence in predictions that well-informed decisions can be made.	Sections 3.2 and 0
11.18	In accordance with Schedule 4 of the EPBC Regulations, feasible project alternatives must be discussed, including: (a) if relevant, the alternative of taking no action (b) a comparative description of the impacts of each alternative on the triggered MNES protected by the controlling provision (c) sufficient detail to make clear why any alternative or option is preferred to another.	Section 1.7 EIS Chapter 2: Project rationale
11.19	Short, medium and long-term advantages and disadvantages of the alternatives or options must be discussed.	Section 1.7 EIS Chapter 2: Project rationale
11.20	The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: (a) the person proposing to take the action (b) for an action for which a person has applied for a permit, the person making the application. If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must also be included.	EIS Chapter 1: Introduction

Terms of reference requirement		Report section
11.21	The economic and social impacts of the action, both positive and negative, must be summarised. Matters of interest should include: (a) consideration at the local, regional and national levels (b) any public consultation activities undertaken, and their outcomes (c) any consultation with indigenous stakeholders (d) identification of affected parties and communities that may be affected and a description of the views of those parties and communities (e) project economic costs and benefits of the project and project alternatives, including the basis for their estimation through cost/benefit analysis or similar studies; and (f) employment and other opportunities expected to be generated by the project in each of the construction and operational phases.	Section 1.13 EIS Chapter 15: Social
11.22	The EIS must provide background to the action and describe in detail all components of the action for example (but not limited to), the construction, operation and (if relevant) decommissioning components of the action. This must include the location of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Sections 1.8 and 1.9 EIS Chapter 5: Project description
11.23	The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.	Sections 1.8 and 1.9 EIS Chapter 5 – Project Description
11.24	The EIS must also provide details on the current state of groundwater and surface water in the region as well as any use of these resources.	Sections 5.2.1.13 and 5.2.2 EIS Chapter 12: Surface Water and Hydrology EIS Chapter 13: Groundwater
Listed threatened species and communities		
11.25	The EIS must describe the listed threatened species and ecological communities identified below (including EPBC Act status, distribution, life history and habitat).	
11.26	The EIS must consider and assess the impacts to the listed threatened species and ecological communities identified in section 11.29 and 11.31 (including EPBC Act status, distribution, life history and habitat and any others that are found to be or may potentially be present in areas that may be impacted by the project. Impacts from each component of the project of relevance to each listed threatened species or ecological community should be identified. Impacts may result from: (a) a decrease in the size of a population or a long-term adverse effect on an ecological community (b) reduction in the area of occupancy of the species or extent of occurrence of the ecological community (c) fragmentation of an existing population or ecological community (d) disturbance or destruction of habitat critical to the survival of the species or ecological community (e) disruption of the breeding cycle of a population (f) modification, destruction, removal, isolation or reduction of the availability or quality of habitat to the extent that the species is likely to decline (g) modification or destruction of abiotic (non-living) factors (such as water, nutrients or soil) necessary for the ecological community's survival (h) the introduction of invasive species that are harmful to the species or (i) ecological community becoming established (j) interference with the recovery of the species or ecological community.	Sections 8, 8.2 and 8.3 and Appendix B

Terms of reference requirement		Report section
11.27	The EIS should describe any mitigation measures proposed to reduce the impact on the listed threatened species and ecological communities and proposed mitigation measures. Supporting evidence should be provided to demonstrate the appropriateness of mitigation measures proposed. Where the likely success of mitigation measures cannot be supported by evidence, identify contingencies in the event the mitigation is not successful.	Sections 6 and 7.2
11.28	The EIS should describe any offsets proposed to compensate for residual impacts.	Section 9 and EIS Appendix N: Environmental Offset Delivery Strategy - QLD
List of potential listed threatened species and their status		
11.29	The EIS must address impacts on, but not limited to, the following listed threatened species for the proposed action: Flora (a) Mt. Berryman phebalium (<i>Phebalium distans</i>) – critically endangered; (b) king blue-grass (<i>Dichanthium queenslandicum</i>) – endangered; (c) finger panic grass (<i>Digitaria porrecta</i>) – endangered; (d) <i>Lepidium monoplacoides</i> – endangered; (e) <i>Lepidium peregrinum</i> – endangered; (f) <i>Tylophora linearis</i> – endangered; (g) <i>Xerothamnella herbacea</i> – endangered; (h) <i>Leucopogon</i> sp. (Coolmunda D.Halford Q1635) – endangered; (i) <i>Microcarpaea agonis</i> – endangered; (j) <i>Homopholis belsonii</i> – vulnerable; (k) hawkweed (<i>Picris evae</i>) – vulnerable; (l) <i>Macrozamia machinii</i> – vulnerable; (m) austral cornflower, native thistle (<i>Rhaponticum australe</i>) – vulnerable; (n) brush sophora (<i>Sophora fraseri</i>) – vulnerable; (o) tara Wattle (<i>Acacia lauta</i>) – vulnerable; (p) <i>Bertya opposens</i> – vulnerable; (q) satin-top grass (<i>Bothriochloa bunyensis</i>) – vulnerable; (r) <i>Dichanthium setosum</i> – vulnerable; (s) <i>Philotheca sporadica</i> – vulnerable; (t) <i>Prostanthera</i> sp. (Dunmore D.M.Gordon 8A) – vulnerable; (u) toadflax (<i>Thesium australe</i>) – vulnerable; (v) hairy-joint grass (<i>Arthraxon hispidus</i>) – vulnerable; (w) Ooline (<i>Cadellia pentastylis</i>) – vulnerable; (x) stream clematis (<i>Clematis fawcettii</i>) – vulnerable; (y) shiny-leaved ironbark (<i>Eucalyptus virens</i>) – vulnerable; (z) <i>Macrozamia conferta</i> – vulnerable; (aa) <i>Westringia parvifolia</i> – vulnerable; (bb) tall velvet sea-berry (<i>Haloragis exalata</i> subsp. <i>Velutina</i>) – vulnerable; (cc) macadamia nut (<i>Macadamia integrifolia</i>) – vulnerable; (dd) <i>Sarcochilus hartmannii</i> – vulnerable; (ee) blotched sarcochilus (<i>Sarcochilus weinthalii</i>) – vulnerable; (ff) miniature moss-orchid (<i>Bulbophyllum globuliforme</i>) – vulnerable; (gg) durikai mallee (<i>Eucalyptus infera</i>) – vulnerable (a) regent honeyeater (<i>Anthochaera phrygia</i>) – critically endangered; (b) curlew sandpiper (<i>Actitis hypoleucos</i>) – critically endangered; (c) swift parrot (<i>Lathamus discolor</i>) – critically endangered; (d) silver perch (<i>Bidyanus bidyanus</i>) – critically endangered;	EIS also covers additional threatened fauna and flora species as identified during the desktop review process (e.g. Grey falcon (<i>Falco hypoleucos</i>)). Species relevance to Project - Sections 4.2 and 4.3 Impacts relevant to species – Sections 5.2 and 7.2 EIS Appendix J: Terrestrial Ecology Technical Report (migratory species were not deemed a controlling provision under the EPBC Act and are not assessed here)

Terms of reference requirement	Report section
(e) spot-tailed quoll, tiger quoll (<i>Dasyurus maculatus maculatus</i>) – endangered; (f) brigalow woodland snail (<i>Adclarkia cameroni</i>) – endangered; (g) Australian painted snipe (<i>Rostratula australis</i>) – endangered; (h) dulacca woodland snail (<i>Adclarkia Dulacca</i>) – endangered; (i) Australasian bittern (<i>Botaurus poiciloptilus</i>) – endangered; (j) black-throated finch (southern) (<i>Poephila cincta cincta</i>) – endangered; (k) Condamine (Darling Downs) earless dragon (<i>Tympanocryptis condaminensis</i>) – endangered; (l) northern quoll/digul (<i>Dasyurus hallucatus</i>) – endangered; (m) koala (<i>Phascolarctos cinereus</i>) – vulnerable; (n) red goshawk (<i>Erythrorchis radiatus</i>) – vulnerable; (o) squatter pigeon (Southern Subspecies) (<i>Geophaps scripta scripta</i>) – vulnerable; (p) painted honeyeater (<i>Grantiella picta</i>) – vulnerable; (q) south-eastern long-eared bat (<i>Nyctophilus corbeni</i>) – vulnerable; (r) greater glider (<i>Petauroides volans</i>) – vulnerable; (s) grey-headed flying-fox (<i>Pteropus poliocephalus</i>) – vulnerable; (t) Murray cod (<i>Maccullochella peelii</i>) – vulnerable; (u) five-clawed worm-skink, Five-clawed worm skink (<i>Anomalopus mackayi</i>) – vulnerable; (v) collared delma (<i>Delma torquate</i>) – vulnerable; (w) yakka skink (<i>Egernia rugosa</i>) – vulnerable; (x) Dunmall's snake (<i>Furina dunmalli</i>) – vulnerable; (y) black-breasted button-quail (<i>Turnix melanogaster</i>) – vulnerable; (z) large-eared pied bat (<i>Chalinolobus dwyeri</i>) – vulnerable; (aa) brush-tailed rock-wallaby (<i>Petrogale penicillate</i>) – vulnerable; (bb) long-nosed potoroo (<i>Potorous tridactylus tridactylus</i>) – vulnerable; (cc) new holland mouse (<i>Pseudomys novaehollandiae</i>) – vulnerable; (dd) border thick-tailed gecko (<i>Uvidicolus sphyrurus</i>) – vulnerable; (ee) Bell's turtle (<i>Wollumbinia belli</i>) – vulnerable; (ff) sharp-tailed sandpiper (<i>Calidris acuminata</i>) – migratory; (gg) white-throated needletail (<i>Hirundapus caudacutus</i>) – migratory; (hh) satin flycatcher (<i>Myiagra cyano-leuca</i>) – migratory; (ii) fork-tailed swift (<i>Apus pacificus</i>) – migratory; (jj) common sandpiper (<i>Actitis hypoleucos</i>) – migratory; (kk) pectoral sandpiper (<i>Calidris melanotos</i>) – migratory; (ll) oriental cuckoo (<i>Cuculus optatus</i>) – migratory; (mm) Latham's snipe, Japanese snipe (<i>Gallinago hardwickii</i>) – migratory; (nn) black-faced monarch (<i>Monarcha melanopsis</i>) – migratory; (oo) eastern osprey (<i>Pandion cristatus</i>) – migratory; (pp) osprey (<i>Pandion haliaetus</i>) – migratory; (qq) rufous fantail (<i>Rhipidura rufifrons</i>) – migratory; (rr) common greenshank (<i>Tringa nebularia</i>) – migratory; (ss) spectacled monarch (<i>Monarcha trivirgatus</i>) – migratory; (tt) yellow wagtail (<i>Motacilla flava</i>) – migratory	
11.30 The EIS must address how the impacts to each of the listed species is not inconsistent with relevant recovery plans, threat abatement plans and conservation advices.	Sections 8.2 and 8.3

Terms of reference requirement		Report section
List of potential listed threatened communities		
11.31	The EIS must address impacts on the following listed threatened ecological communities for the proposed action: (a) Lowland Rainforest of Subtropical Australia – critically endangered (b) Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland – critically endangered (c) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland) – critically endangered (d) Brigalow (<i>Acacia harpophylla</i> dominant and codominant) – endangered (e) Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions – endangered (f) Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions - endangered (g) Weeping Myall Woodlands – endangered.	TEC relevance to Project – Sections 4.2.1.2 and 4.3.1.3 Impacts relevant to TEC – Sections 5.2 and 7.2
11.32	The EIS must address how the impacts to each of the listed communities is not inconsistent with relevant recovery plans, threat abatement plans and conservation advices.	Section 8
Offsets		
11.33	The EIS must describe any significant adverse residual impacts of the action for each relevant matter protected by the EPBC Act, after all proposed avoidance and mitigation measures are considered.	Sections 8, 8.2 and 8.3 Section 9
11.34	The EIS must propose offsets for all residual impacts to matters protected by the EPBC Act consistent with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy.	Section 9 and EIS Appendix N: Environmental Offset Delivery Strategy - QLD
Conclusion		
11.35	The EIS must include an overall conclusion for the action describing the acceptability of the impact of undertaking the action in the manner proposed on the protected matters, in the context of: (a) the requirements of the EPBC Act; (b) the principles of ecologically sustainable development and the precautionary principle; and (c) the proposed avoidance, mitigation measures, and if relevant, offsets (d) measures proposed to address any residual impacts.	Section 12

1.6 Project location and existing land use

The location of the Project and impact assessment area is shown Figure 1.1. The Project is located within the Goondiwindi Regional Council and Toowoomba Regional Council local government areas (LGAs) in the Brigalow-belt (BB) and Southeast Queensland (SEQ) bioregions.

The Project starts at the NSW/QLD border, the median line of the Macintyre River, approximately 18 km to the south-east of Goondiwindi, near Kurumbul. The Project ends in Gowrie, before the Inland Rail tie in to Queensland Rail's (QR) West Moreton Line on the south-eastern outskirts of Kingsthorpe.

The Project provides a link between the adjacent Inland Rail projects of:

- North Star to NSW/QLD border in the south at the Macintyre River
- Gowrie to Helidon project in the north, which connects into QR's West Moreton Line.

Further information about the location and description of the Project is detailed in EIS Chapter 5: Project description.

The impact assessment area includes extensive areas of agricultural land and State forest areas within the Darling Downs region and as such, has been subject to extensive disturbance throughout the alignment. In the western part of the impact assessment area, between Goondiwindi and Inglewood, the landscape is dominated by dryland cropping, irrigated agriculture and intensive animal production on the fertile soils and floodplains associated with the Macintyre River, Dumaresq River and Macintyre Brook.

North of Inglewood, the Project passes through the undulating and densely forested landscapes of Whetstone and Bringalily State forests. The Project then traverses the gently undulating agricultural areas near Millmerran before crossing the extensive Condamine River floodplain. The rail alignment deviates from the existing railway line north of Yarranlea to pass through the hilly landscapes surrounding Pittsworth, Southbrook and Athol before crossing Westbrook Creek near Toowoomba Wellcamp Airport and joining the Gowrie to Helidon section of Inland Rail near Gowrie Junction.

Within the impact assessment area, large areas of land have been subject to clearing and land disturbance for agriculture, grazing, mining, industry and transport (road and rail corridors). Land use within the Project footprint is predominately grazing land. The next most common land uses are also predominately of an agricultural nature including cropping and irrigated cropping. Other land use which exceeds one per cent of the Project footprint includes land classified as other minimal use (consisting of areas of land that are largely unused, for example, residual native cover or land reserved for stock routes), production forestry and transport and communication (which includes transportation infrastructure and commercial services).

Table 1.2 provides a summary of the land use within the Project footprint, broken down into the permanent and temporary footprints. The Project footprints will utilise the existing South Western Line and Millmerran Branch Line rail corridors for approximately 33 per cent of the total length of the Project. Although land use within this existing rail corridor is mapped as the adjoining land use under Queensland Land Use Mapping Program (QLUMP), it is not utilised for grazing, agricultural, residential or other non-infrastructure related uses.

Table 1.2 Existing land use within the Project footprint

Land use ¹	Permanent footprint		Temporary footprint	
	Area (ha)	% of land	Area (ha)	% of land
Grazing native vegetation	1,359.7	51.2	252.6	45.9
Cropping	827.0	31.2	173.5	31.5
Production forestry	125.2	4.7	16.8	3.0
Other minimal use	114.3	4.3	31.2	5.7
Irrigated cropping	74.0	2.8	15.0	2.7
Irrigated cropping - cotton	42.1	1.6	28.8	5.2
Transport and communication	35.6	1.3	17.8	3.2
Residential	23.3	0.9	4.9	0.9
Nature conservation	16.1	0.6	2.8	0.5
Grazing modified pastures	8.9	0.3	0.9	0.2
Intensive animal production	8.2	0.3	0.7	0.1
Irrigated perennial horticulture	8.0	0.3	0.9	0.2
Services	4.4	0.2	1.8	0.3
Land in transition	3.0	0.1	0.5	0.1
Manufacturing and industrial	1.5	0.1	1.0	0.2
Mining	1.4	0.1	0.6	0.1
Reservoir/dam	0.6	Less than 0.1	0.4	0.1

Land use ¹	Permanent footprint		Temporary footprint	
	Area (ha)	% of land	Area (ha)	% of land
River	0.1	Less than 0.1	0.0	Less than 0.1
Waste treatment and disposal	0.1	Less than 0.1	0.1	Less than 0.1
Total	2,653.2	100.0	550.2	100.0

Table note:

1 Land use as per the QLUMP. This dataset has not been modified where localised inaccuracies are known to occur.

Table 1.3 provides a summary of land use within the permanent and temporary footprints that are located outside of the existing rail and road corridors.

For the areas of the permanent footprint outside of the existing rail corridors, land use is mapped as being predominately grazing land (50 per cent) or cropping land (36 per cent). The temporary disturbance footprint outside of existing rail corridors is also primarily mapped as grazing land (41 per cent) or cropping (39 per cent). Other land use includes production forestry, other minimal use, irrigated cropping and transport and communication. For areas of the permanent footprint outside the existing rail corridors, land use is mapped as predominately grazing or cropping land.

Table 1.3 Land use within the Project footprint located outside of the existing rail corridors

Land use ¹	Permanent footprint		Temporary footprint	
	Area (ha)	% of permanent footprint, outside of existing rail corridor	Area (ha)	% of temporary footprint, outside of existing rail corridor
Grazing native vegetation	1,025.3	49.7	176.5	41.5
Cropping	750.7	36.4	164.5	38.7
Production forestry	111.5	5.4	13.1	3.1
Irrigated cropping	68.5	3.3	12.6	3.0
Irrigated cropping - cotton	32.1	1.6	27.8	6.5
Residential	15.1	0.7	3.8	0.9
Other minimal use	14.9	0.7	17.4	4.1
Nature conservation	10.5	0.5	2.5	0.6
Grazing modified pastures	8.9	0.4	0.9	0.2
Irrigated perennial horticulture	8.0	0.4	0.9	0.2
Intensive animal production	7.7	0.4	0.6	0.1
Transport and communication	4.9	0.2	2.2	0.5
Services	2.6	0.1	1.3	0.3
Reservoir/dam	0.5	0.0	0.3	0.1
Manufacturing and industrial	0.2	0.0	0.7	0.2
Mining	-	-	0.3	0.1
River	-	-	0.0	Less than 0.1
Waste treatment and disposal	-	-	0.1	Less than 0.1
Total	2,061.5	100.0	425.4	100.0

Table note:

1 Land use as per the QLUMP. This dataset has not been modified where localised inaccuracies are known to occur.

Where the Project is positioned within the existing South Western Line rail corridor and the Millmerran Branch Line rail corridor, the tenure of that existing rail corridor is lands lease, leased by the State to Queensland Rail. Where the Project deviates from or extends outside of the existing rail corridors, the tenure of land is predominately freehold, traversing some parcels of reserve and State land tenure.

1.7 Project alternatives

1.7.1 Alternative locations and route options for Inland Rail Program

The development of an inland railway between Melbourne and Brisbane has been considered for more than a hundred years, first being formally considered in 1902 (ARTC 2015). The current Inland Rail Program was initiated in 2006, as a safe, sustainable solution to the freight challenge that will transform the way freight is moved around the country. The history of Project's development is documented in the *Inland Rail route history 2006-2019* (ARTC 2020) (available at: <https://inlandrail.artc.com.au/documents>).

Since 2006, two major studies have been commissioned in relation to the development of an inland rail route between Melbourne and Brisbane. The first study, the *North-South Rail Corridor Study* (Department of Transport and Regional Services 2006) examined the adequacy of the existing Melbourne to Sydney to Brisbane rail corridor to meet future freight demand. The study also examined different options for an enhanced, existing coastal route or alternative inland routes. Key issues identified in the study included infrastructure links, engineering, environmental, urban and regional planning issues. A financial and economic analysis was also undertaken on each of the route options. The study identified the 'far western corridor' through Parkes as the preferred corridor.

The purpose of the second study, the *Melbourne-Brisbane Inland Rail Alignment Study* (ARTC 2010), was to determine the optimum alignment, the economic benefits and likely commercial success of a new standard gauge inland railway between Melbourne and Brisbane. The terms of reference for the study required evaluation of route options within the 'far western sub-corridor'. Two key criteria – capital cost and journey time – were used to establish a shortlist of route options between Melbourne and Parkes, Parkes and Moree, and Moree and Brisbane. The shortlist of route options was then subject detailed to technical, financial and economic assessment, focussing on:

- Environmental and land issues
- Railway operations considerations
- Engineering assessments
- Capital cost estimates.

The preferred alignment for Inland Rail, between South Dynon in Melbourne and Acacia Ridge in Brisbane, incorporated:

- Melbourne to Parkes – 670 km of existing track and 37 km of new track on a greenfield alignment from Illabo to Stockinbingal, bypassing Cootamundra and the Bethungra spiral
- Parkes to North Star – 307 km of upgraded track, and 291 km of new track on a greenfield alignment from Narramine to Narrabri
- North Star to Acacia Ridge – 271 km of new track on a greenfield alignment, 119 km of existing track upgraded from narrow gauge to dual gauge, and 36 km of the existing coastal route.

This alignment for Inland Rail was endorsed by the Inland Rail Implementation Group as the base case alignment.

More detail on alternative locations and route options for Inland Rail, between Melbourne and Brisbane, is available in EIS Chapter 2: Project rationale.

1.7.2 Alternative locations and route options for the Project

This section provides background on the alternative routes considered during the concept assessment phase (from early 2016 to late 2017) of the Project.

In all instances, the guiding principles of ecologically sustainable development have been factored into the assessment and selection of corridor and alignment options for the Project. These guiding principles, as established in the National Strategy for Ecologically Sustainable Development (Ecologically Sustainable Development Steering Committee 1992), are as follows:

- Decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations
- Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- The global dimension of environmental impacts of actions and policies should be recognised and considered
- The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised
- The need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised
- Cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms
- Decisions and actions should provide for broad community involvement on issues which affect them.

During the concept assessment phase, the NSW/QLD border to Yelarbon section of the Project was assessed separately to the Yelarbon to Gowrie section. Therefore, these sections are discussed separately.

1.7.2.1 New South Wales/Queensland border to Yelarbon

This section discusses the corridor and alignment options considered for the section of the Project that is located from the NSW/QLD border, on the Macintyre River, to Yelarbon.

Corridor selection

The base case for Inland Rail was proposed to cross the NSW/QLD border to the south of Yelarbon. However, subsequent concept studies and discussions with local stakeholders led to the identification of four alternative route options, with different border crossing locations. These route options are described as follows:

- Base case alignment
- Option 1 – 73 km (38 km of new track constructed in abandoned rail corridor or greenfield construction), via Bibilah, Mungle, Wearne and Kildonan (QLD)
- Option 2 – 90 km (46 km of new track constructed in abandoned rail corridor or greenfield construction), via Bibilah, Mungle, Wearne, Boggabilla and Moorobie (QLD)
- Option 3 – 65 km greenfield alignment, crossing the NSW/QLD border south of Yelarbon
- Option 4 – 65 km greenfield alignment, crossing the NSW/QLD border south of Yelarbon.

These options were comparatively assessed using a multi-criteria analysis (MCA), which considered:

- Technical viability
- Safety
- Operational constraints
- Constructability and schedule
- Environmental constraints (including MNES)
- Community and property issues
- Approvals and stakeholder concerns.

The MCA was documented in the 2016 Verified Alignment Development Report (ARTC 2016) and concluded that:

- The base case alignment performed comparatively worse than the other route options due to hydrological challenges and interaction with the environmentally sensitive Yelarbon desert
- The projected journey time for Option 2 was not compatible with the objective total journey time for Inland Rail
- Option 3 resulted in greater land impacts than Option 4
- Option 1 and Option 4 could not be separated by the MCA required more detailed comparative assessment.

Further comparative assessment of Option 1 and Option 4, and variants of each, was undertaken by MCA based upon the outcomes of additional stakeholder and community engagement, geotechnical site investigation, flood modelling and more detailed quantity estimation and costing. This assessment identified a 6 km corridor around the western route option, Option 1, to be the preferred investigation corridor for the next phase of the Project as it scored favourably in regard to community and property issues, environmental constraints and approvals and stakeholder concerns (WSP | Parsons Brinckerhoff 2017).

Alignment selection

The preferred study area for this section of the Project was announced in 2017 by the then Federal Minister for Infrastructure and Transport. After the preferred study area was announced, additional work was undertaken to refine the 6 km corridor around the proposed Macintyre River crossing to a 2 km wide corridor. This refinement work included:

- Additional flood studies
- Consultation with key stakeholders, including potentially affected landowners, elected representatives, industry groups and government agencies.

Consequently, six greenfield alignment options for crossing the Macintyre River between Mooroobie and Kurumbul and tying into the South Western Line were developed and assessed through an MCA. The MCA considered:

- Technical viability
- Safety
- Operational constraints
- Constructability and schedule
- Environmental constraints (including MNES)
- Community and property issues
- Approvals and stakeholder concerns.

The MCA identified '*Option D st 1D*' to be the preferred alignment due to:

- Reduced impacts on environment (including MNES), utilities, land use and property
- Improved hydrological and flooding outcomes in the vicinity of Whalan Creek and the Macintyre River
- Improved safety outcomes for road users due to a reduction in the number of road-rail interfaces
- Opportunities to connect with regional transport and freight hubs in northern NSW.

As a consequence, alignment option '*Option D st 1D*' has formed the basis for the reference design for this Project between the NSW/QLD border and the existing QR South Western Line.

1.7.2.2 Yelarbon to Gowrie

This section discusses the corridor and alignment options considered for the section of the Project that is located from Yelarbon to Gowrie.

Review of the base case alignment

In 2016, ARTC revisited the base case alignment previously established in the *Melbourne-Brisbane Inland Rail Alignment Study* (ARTC 2010) to confirm the technical viability of the alignment and to undertake localised route optioneering. This review resulted in localised modifications to the alignment to achieve a route that was optimal in regards to engineering, environmental, social and economic constraints. The revised alignment was named the Base Case Modified alignment.

As a component of this review, route options were considered that extended north from Whetstone, through the Whetstone State Forest, thereby bypassing to the west of Inglewood. In total six State forest route options were identified and assessed against the base case. These six options were as follows:

- **Option 3124:** North through Whetstone State Forest along the transmission line easement, across the Gore Highway and passing to the north of Millmerran, via Captains Mountain
- **Option 3125:** North through Whetstone State Forest along the transmission line easement, across the Gore Highway and extending to Commodore Mine, via Captains Mountain
- **Option 3126:** North through Whetstone State Forest along the transmission line easement, then extending east in parallel to the Gore Highway to Commodore Mine
- **Option 3127:** North through Whetstone State Forest along the transmission line easement, then extending east in parallel to the Gore Highway to the north of Millmerran
- **Option 3128:** North through Whetstone State Forest along the transmission line easement, then northeast to the western side of Millmerran Downs and parallel to the Gore Highway to Commodore Mine
- **Option 3129:** North through Whetstone State Forest along the transmission line easement, then northeast to the eastern side of Millmerran Downs and parallel to the Gore Highway to Commodore Mine.

The options were considered in a like-for-like manner against the Base Case Modified option, with consideration for the following factors:

- Alignment length
- Journey time
- Property impacts
- Environmental constraints (including MNES)
- Impacts with existing infrastructure
- Hydrological constraints
- Earthwork volumes
- Maximum vertical gradients.

This comparative assessment concluded that the Base Case Modified alignment performed better than the six alternative alignment options as it:

- Was between 10 km and 28 km shorter than the alternative alignment options
- Had a journey time between 3 and 18 minutes faster than the alternative alignment options
- Required substantially less earthworks than the alternative alignment options
- Avoided the steep vertical grades that were otherwise encountered by the State forest options
- Required between 19 and 37 fewer private access severances than the alternative alignment options
- Had fewer watercourse crossings than the alternative alignment options.

The *Concept Assessment Report – Yelarbon to Gowrie* (AECOM 2017) was developed as an output of this review and defined departures from the 2010 base case route.

Corridor options assessment

In late 2016 the Australian Government directed ARTC to investigate and comparatively assess three additional corridor options, between Inglewood and Gowrie, against the Base Case Modified option. The opening of the Toowoomba Wellcamp Airport in November 2014 was one of the key drivers for this request, due to the economic growth opportunities that the airport introduced for the region.

The four options that were assessed were:

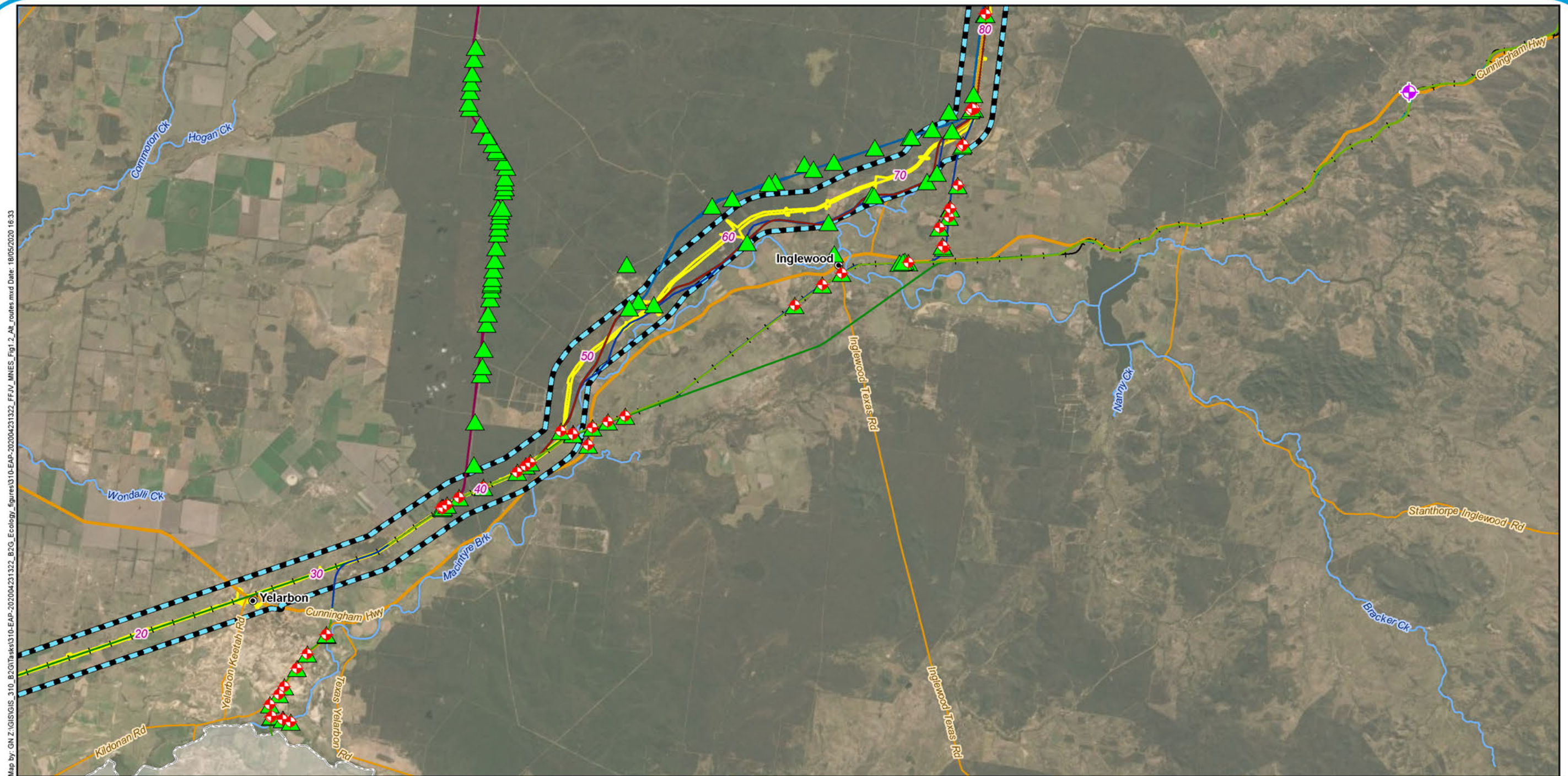
- **Corridor 1: Base Case Modified option.** This option followed Millmerran-Inglewood Road to Millmerran, and then extended through or close to Brookstead, Mount Tyson, Aubigny and Kingsthorpe. The corridor had a length of 181.3 km
- **Corridor 2: Wellcamp-Charlton option.** This option followed Millmerran-Inglewood Road to Millmerran, and then extended through or close to Brookstead, Pittsworth, Southbrook and Wellcamp. The corridor had a length of 168.1 km
- **Corridor 3: Karara/Leyburn option.** This option followed the existing South Western Line until Karara. It then extended through or close to Leyburn, Southbrook and Wellcamp. The corridor had a length of 171.9 km
- **Corridor 4: Warwick option.** This option followed the existing South Western Line to approximately 20 km west of Warwick. The option then extended north through or close to Elinthorp, Clifton, Nobby, Wyreema and Wellcamp. The corridor had a length of 208.3 km.

The alternative corridor assessment process was conducted by independent consultants and overseen by the Yelarbon to Gowrie Project Reference Group, a group of stakeholder representatives specifically formed for the task. Figure 1.2 shows the location of the corridor options including sites surveyed for environmental constraints during 2016 surveys.

The corridor assessment process involved comparing the three alternative corridors against the Base Case Modified alignment on a like-for-like basis, involving the following steps:

1. MCA of the four routes, considering:
 - Technical criteria
 - Technical viability
 - Safety
 - Operational constraints
 - Constructability and schedule
 - Non-technical criteria
 - Environmental constraints (including MNES)
 - Community and property issues
 - Approvals and stakeholder concerns
2. Comparative construction cost estimates
3. Community consultation and validation of the transparency of the assessment process.

Once each alignment had been developed and refined to comply with ARTC's design standards, each was assessed by a multi-disciplinary team to determine key metrics and values that would provide differentiators for the MCA and cost estimate.



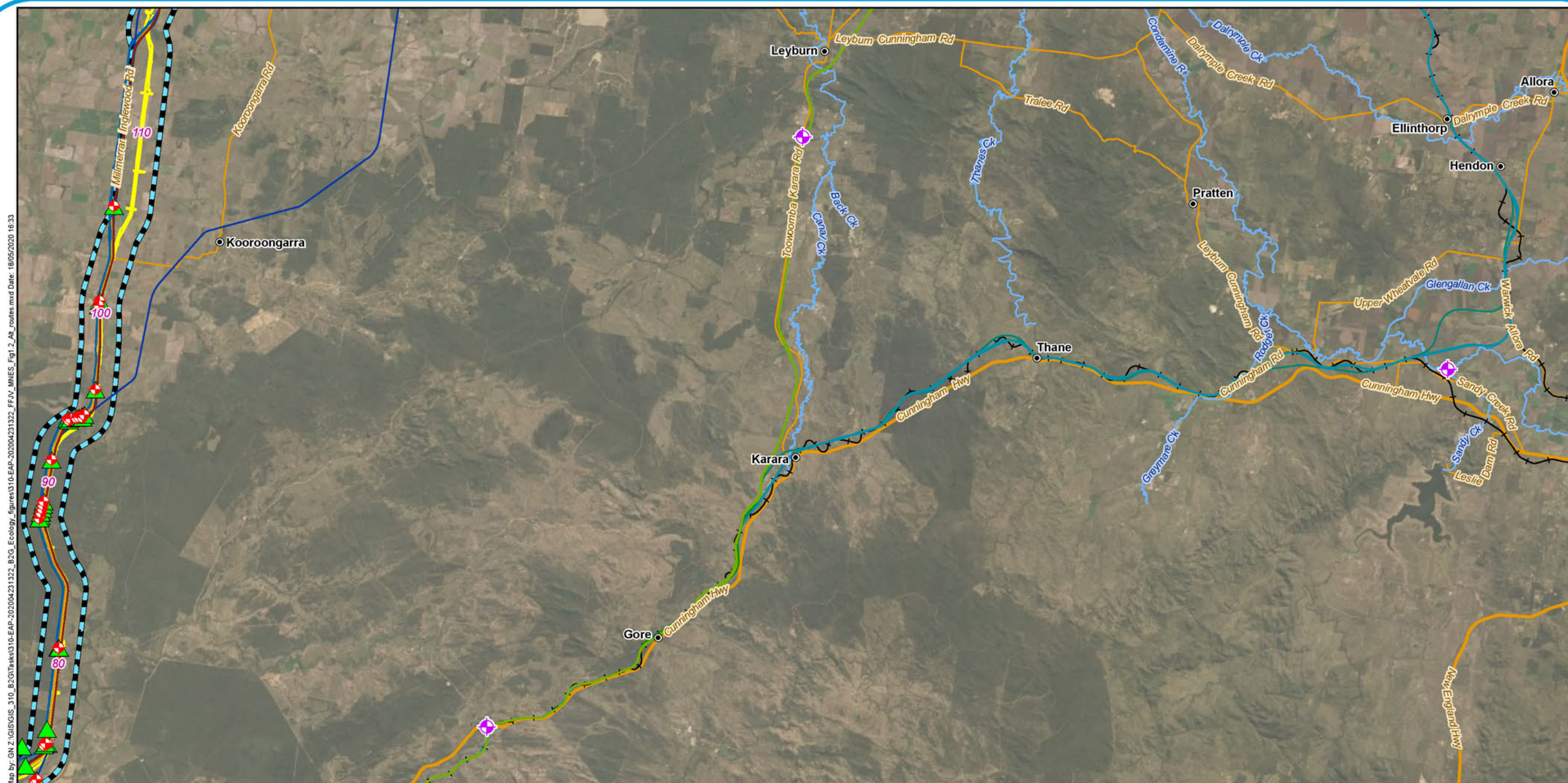
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area
- Sampling locations**
- ◆ Eco logical survey sites 05/09/2016
- ▲ Eco logical survey sites 30/09/2016
- ◆ Anabat site



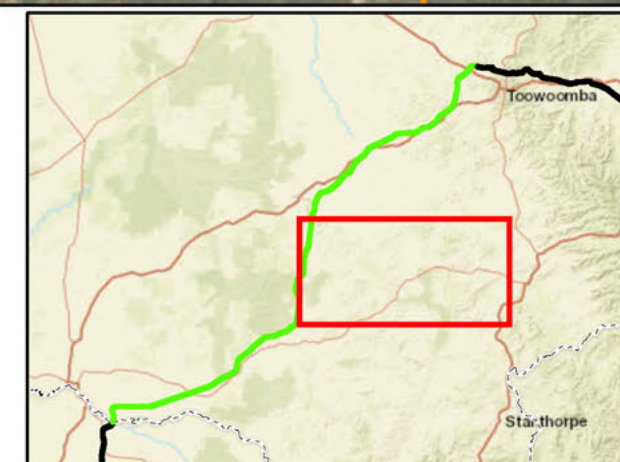
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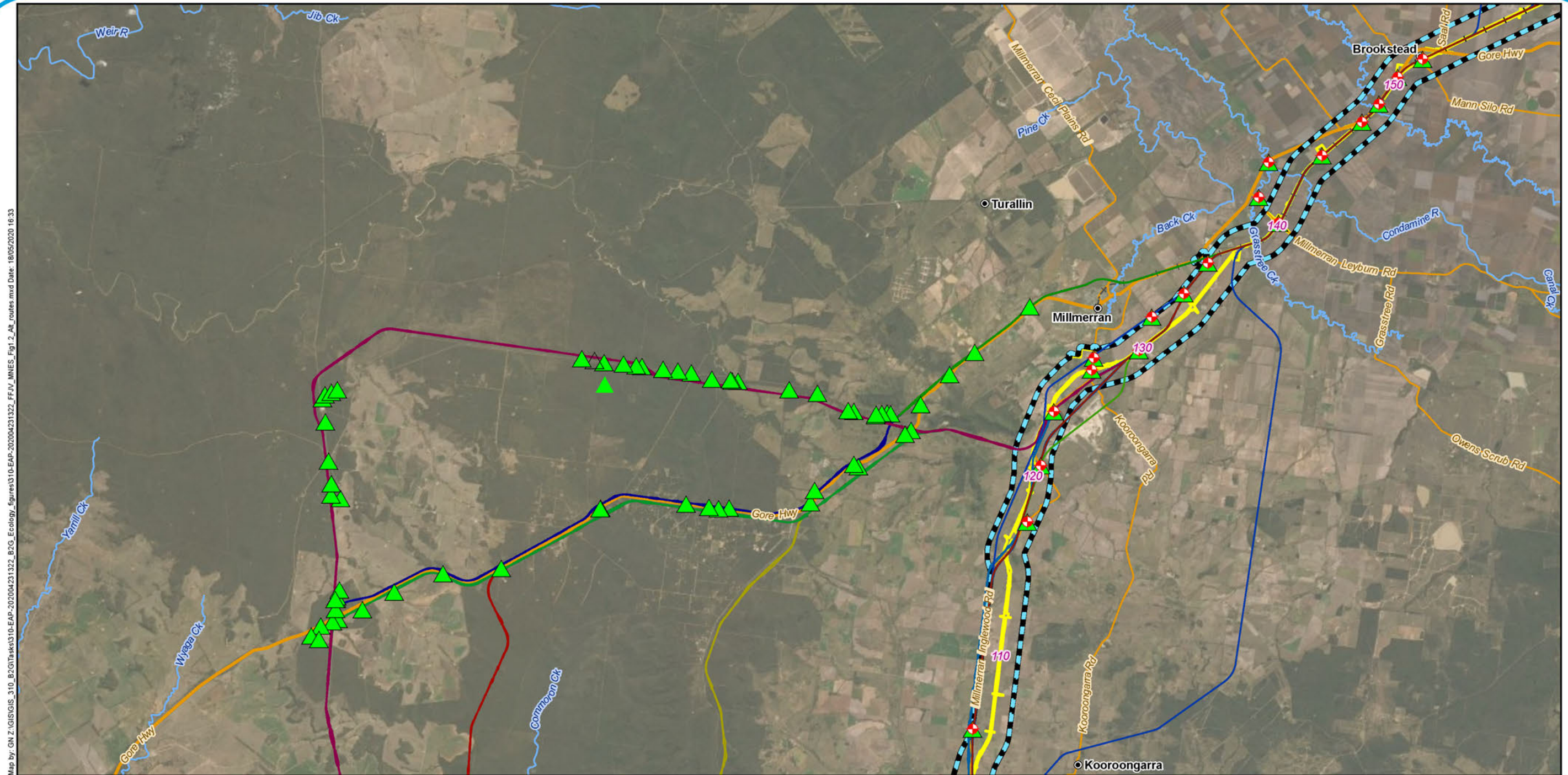
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Sampling locations**
- Eco logical survey sites 05/09/2016
- Eco logical survey sites 30/09/2016
- Anabat site



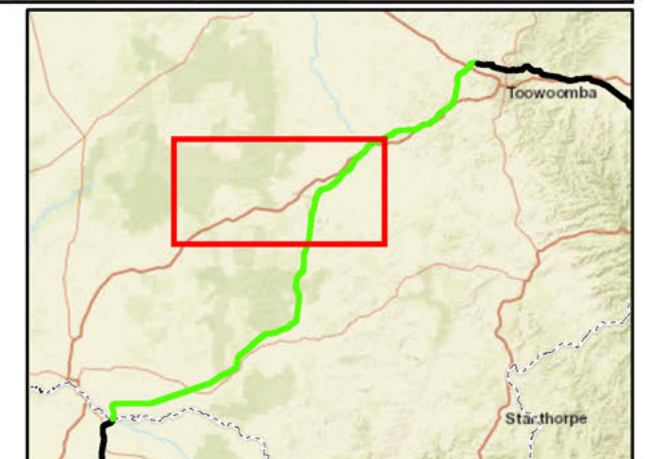
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0 5 10 15 km



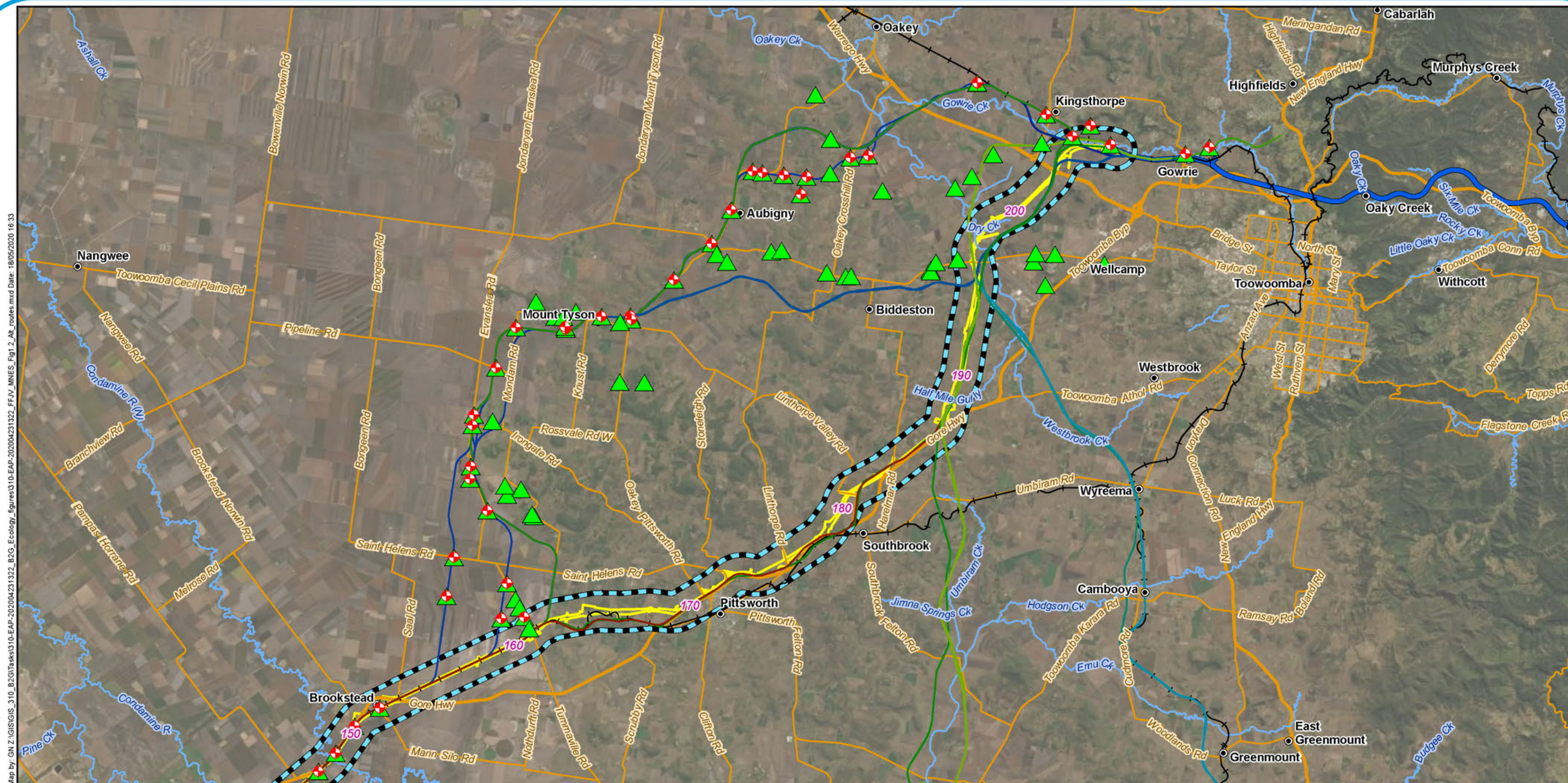
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Sampling locations**
- ◆ Eco logical survey sites 05/09/2016
- ▲ Eco logical survey sites 30/09/2016



A3 scale: 1:225,000





Legend

5 Chainage (km)

● Localities

— Gowrie to Helidon alignment

— Existing rail (operational)

--- Existing rail (non-operational)

— Major roads

— Minor roads

— Watercourses

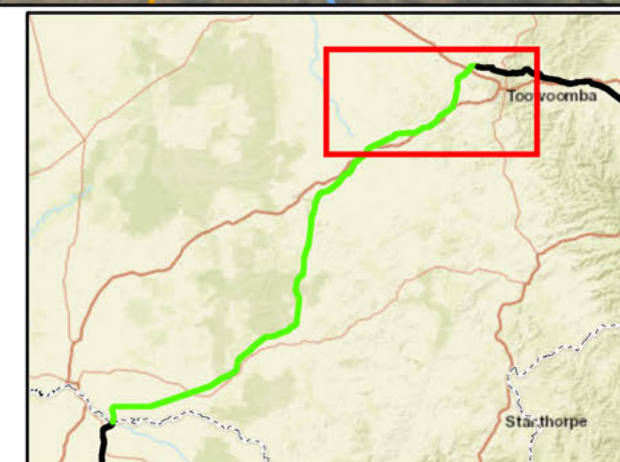
Project footprint

Impact assessment area

Sampling locations

◆ Eco logical survey sites 05/09/2016

▲ Eco logical survey sites 30/09/2016



A3 scale: 1:225,000

0 5 10 15 km

The results of the MCA indicated that two of the alternative options scored closely to the Base Case Modified option, these being the Wellcamp-Charlton route (Corridor 2) and the Karara-Leyburn route (Corridor 3). The third alternative option the Warwick route (Corridor 4) did not score as closely and scored negatively when compared to the Base Case Modified route. This negative score was a function of the extra length of the alignment, the interfaces with more local communities and sensitive receptors and the requirement to modify the existing alignment to meet the ARTC design standards.

The outcomes of the MCA were documented in the Corridor Options Report (AECOM 2017). The report, in combination with the cost estimate for each option, was provided by ARTC to the then Commonwealth Minister for Infrastructure and Transport for consideration.

Forestry route, via Cecil Plains

In April 2017 an alternative route option was presented to ARTC by a representative of the Yelarbon to Gowrie Project Reference Group which was referred to as the "Forestry route, via Cecil Plains". This alternative route extended north from Whetstone through Bringalily State Forest to Cecil Plains, then followed an existing rail corridor (the Cecil Plains Branch line) to Mount Tyson and then to near Oakey where it joined with QR's West Moreton Line to Gowrie.

Following receipt of the alternative route option, ARTC undertook a key criteria comparative assessment between the Forestry route, via Cecil Plains, and the Base Case Modified option. This comparative assessment concluded the Forestry route to be 15 km longer than the Base Case Modified option, resulting in an additional journey time of approximately 12 minutes (at an average speed of 84.08 km/hr). The Forestry route was also reliant on using an alignment through the State forest that traversed unfavourable topography, resulting in substantially greater earthworks and non-optimal operating gradients. Based on these findings, it was concluded that the Forestry route performed less favourably than the Base Case Modified option in achieving the Inland Rail service offering and that the corridor assessment process documented in the Corridor Options Report (AECOM 2017) did not need to be revisited.

Selection of preferred corridor

On 21 September 2017, the Australian Government announced the Wellcamp-Charlton corridor via Brookstead, Pittsworth and Wellcamp (Corridor 2) to be the preferred corridor to take forward into the formal planning and approvals process.

1.8 Project description

The Project consists of the key permanent and temporary features listed in Table 1.4. Key features of the Project are also shown in EIS Volume 3: Design drawings.

Further information on the features of the Project is provided in EIS Chapter 5: Project description.

Table 1.4 Key features of the Project

Aspect	Description
Permanent features	
New track	■ Approximately 216.2 km of new single track railway, consisting of: – 7.0 km of standard gauge rail (1,435 millimetres (mm)) – 209.2 km of dual gauge rail (standard (1,435 mm) and narrow (1,067 mm) gauge). ■ Railway infrastructure and the corridor will initially be constructed for 1,800 m long trains, and future- proofed for operation of 3,600 m trains.

Aspect	Description
Rail corridor	- Establishment of approximately 145.0 km of new rail corridor and use of approximately 71.2 km of existing rail corridor. - The rail corridor is generally a minimum width of 40 m. There is one exception to this where the Project utilises the existing rail corridor for the South Western Line parallel to Yelarbon-Kurumbul Road from Ch 7.5 km to Ch 10.0 km. The rail corridor may be as narrow as 25 m through that section to minimise impacts to Yelarbon-Kurumbul Road, adjoining land uses and their access arrangements. - The rail corridor would extend out to a maximum of 230 m. Wider sections of corridor are required to accommodate earthworks, drainage structures, rail infrastructure, access tracks and fencing. - The rail corridor will be of sufficient width to accommodate all proposed railway infrastructure, including the crossing loops, as well as future expansion to accommodate the potential for 3,600 m long trains.
Crossing loops and turnouts	- Crossing loops are places on a single-line track where trains in opposing directions can pass each other. Five crossing loops will be constructed as part of the Project, at a minimum of 2,200 m in length for each loop. - Turnouts allow the train to be guided from one section of track to another. Turnouts that connect in to crossing loops and QR's existing South Western Line, Millmerran Branch Line and sidings have been incorporated into the reference design.
Bridges	Bridges to accommodate topographical variation, crossings of waterways or other infrastructure.
Drainage	- Cross-drainage is provided by reinforced concrete pipe culverts and reinforced concrete-box culverts. - Scour protection measures will be installed around culverts and abutments to prevent erosion.
Rail crossings	Rail crossings, including level crossings, grade separated crossings (rail or road overbridges) and occupational/private crossings.
Ancillary works	- The construction of associated railway infrastructure, including maintenance sidings and signalling infrastructure to support Advanced Train Management Systems (ATMS). - Ancillary works, including works to level crossings, signalling and communications, signage and fencing, drainage works, and installation or modification of services and utilities within the rail corridor.
Construction features (temporary)	
Land	- Temporary access tracks will be used to access construction sites. Where possible, access tracks will be retained to serve as RMAR during the operation of the Project. - Land requirements for construction will include temporary workspaces, site offices and laydown facilities. These requirements are encompassed within the nominated temporary construction footprint for the Project. - Laydown areas will be located approximately every 5 km (avoiding one per cent annual exceedance probability (AEP) floodplains, where possible). Larger sites will be located approximately every 2 km.
Embankments and cuttings	Embankments and cuttings will be required along the length of the rail alignment.
Borrow pits	Identification, establishment and lawful use of borrow pits for the sourcing of construction materials for the Project. This does not include existing borrow pits owned by third parties. Borrow pits are not included in the Project footprint as approval to establish and use borrow pits will be sought separately to the EIS approval process.
Non-residence accommodation facilities	Construction, use and decommissioning of up to three temporary non-resident workforce accommodation facilities. These facilities are not included in the Project footprint as approval to establish and operate non-resident workforce accommodation facilities will be sought separately to the EIS approval process.

Subject to obtaining all the necessary environmental approvals for the Project, early works for the Project are planned to start in 2021, with construction estimated to be completed by the beginning of 2026. Inland Rail, and the Project, are estimated to be operational in 2026.

1.9 Reference design

1.9.1 Rail corridor

The Project requires establishment of approximately 145 km of new rail corridor (greenfield) and utilisation of approximately 71.2 km of existing rail corridor (brownfield), specifically the South Western Line and the Millmerran Branch Line which are components of QR's South Western System. The Millmerran Branch Line is currently non-operational south of Brookstead as a consequence of damage sustained in the 2010/11 flood events.

Brownfield corridor refers to locations where the Project is generally coincident with existing rail corridors. This does not mean that the railway is located wholly within the existing rail corridor. Corridor widening and/or curve easing is generally required to meet the requirements of the ARTC Basis of Design, resulting in some works outside the extent of the existing rail corridors.

The land required for the Project comprises a rail corridor that is generally a minimum width of 40 m. There is one localised exception to this, where the rail corridor may be as narrow as 25 m to accommodate existing infrastructure. The rail corridor would extend out to a maximum of 230 m. Wider sections of corridor are required to accommodate earthworks, drainage structures, rail infrastructure, access tracks and fencing.

The rail corridor will be of sufficient width to accommodate the infrastructure currently proposed for construction, including the crossing loops, as well as future expansion to accommodate the potential for 3,600 m trains.

1.9.2 Crossing loops

Crossing loops are places on a single line track where trains in opposing directions can pass each other. These are double ended and connected to the main track at both ends. Crossing loops are typically a little longer than any of the trains that might need to cross at that point. In operation, one train enters a crossing loop through one of the turnouts and idles at the other end, while the opposing train continues along the mainline track to pass the now stationary train.

The Project includes five new crossing loops. The selection of crossing loop locations was informed by operational modelling for the Inland Rail Program and has taken into consideration proximity to sensitive receptors, interferences with existing infrastructure and flexibility for future extension. The proposed locations for the crossing loops are:

- Yelarbon – Ch 16.3 km to Ch 18.5 km (future-proofed to Ch 20.3 km to accommodate 3,600 m trains)
- Inglewood – Ch 50.2 km to Ch 52.4 km (future-proofed to Ch 54.2 km to accommodate 3,600 m trains)
- Kooroongarra – Ch 89.2 km to Ch 91.4 km (future-proofed to Ch 93.2 km to accommodate 3,600 m trains)
- Yandilla – Ch 129.8 km to Ch 132.0 km (future-proofed to Ch 129.3 km and to Ch 133.3 km to accommodate 3,600 m trains)
- Broxburn – Ch 174.9 km to Ch 177.1 km (future-proofed to Ch 178.9 km to accommodate 3,600 m trains).

The loops would be constructed as new sections of track roughly parallel to the existing track. They would each be 2,200 m long to initially accommodate 1,800 m trains. Crossing loops have been positioned to enable future extension to accommodate 3,600 m trains.

1.9.3 Turnouts

Turnouts are switches that allow a train to be guided from one section of track to another. The anticipated locations for turnouts are detailed in Table 1.5.

Table 1.5 Turnouts to existing Queensland Rail sidings and loops

Location	Description	Turnout type
Ch 6.1 km	Kurumbul Loop	Dual to narrow gauge
Ch 6.6 km	Kurumbul Siding	Dual to narrow gauge
Ch 6.9 km	Kurumbul Loop	Dual to narrow gauge
Ch 26.1 km	Yelarbon Loop	Dual to narrow gauge
Ch 26.5 km	Yelarbon Siding	Dual to narrow gauge
Ch 27.0 km	Yelarbon Loop	Dual to narrow gauge
Ch 152.9 km	Brookstead Siding East	Not provided as this siding is not currently used for rail operations, and may cause conflict with the proposed GrainCorp access road A future turnout is possible but would need to consider interaction with the GrainCorp access road
Ch 153.1 km	Brookstead Siding West	Dual to narrow gauge

1.9.4 Bridges

Bridge structures are required so that water, vehicles and, in some cases, stock and pedestrians may cross the proposed rail corridor. Bridge structures may either be rail-over-watercourse or road, or road-over-rail, depending on local topology and rail or road alignment requirements.

The Project involves the construction of 34 new bridge structures. These structures are summarised in Table 1.6. The Project does not involve the reinstatement or reconstruction of any existing bridge structures.

Table 1.6 Summary of bridge structures for the Project

Crossing type	Number
Rail-over-road	11
Rail-over-watercourse	20 ¹
Road-over-rail	3

Table note:

1 Includes one bridge that also goes over a road

The type of bridge proposed for a location depends on a range of factors, including the local topography, road usership, rail and road alignments at the crossing point and access requirements. Bridges have been provided at all major watercourse crossings along the Project alignment to minimise impacts to flow regimes and to avoid having to divert watercourses.

The new bridge structures are typically founded on piled foundations supporting in situ reinforced concrete substructures. Bridge superstructures are typically formed from pre-stressed concrete (PSC) girders (either PSC slabs or PSC Super-T) with in situ concrete decks incorporating walkways, guardrails and barriers as appropriate. The bridges are of various lengths and spans to suit the alignment and topography.

1.9.5 Drainage infrastructure

1.9.5.1 Cross-drainage

Cross-drainage structures have been incorporated into the reference design where the Project intercepts existing drainage lines and watercourses. The type of cross-drainage structure in the design depends on various factors such as the natural topography, rail formation levels, design flow and soil type. Bridges are proposed at all major waterway crossings to avoid disturbance to the existing flow regime. In some instances, bridges are provided in locations which may have multiple drainage features passing under the rail corridor, such as across the Condamine River floodplain.

Culverts are structures that allow water, whether in a watercourse or drainage line, to pass under the rail alignment. Culverts are incorporated into the design as a component of the cross-drainage solution to ensure that no additional permanently ponded areas will be created upstream of the Project.

Cross-drainage structures, including culverts, have been incorporated into the design to enable the Project to achieve the flood immunity specified in the design criteria of a 1% AEP event. The design and location of culverts will be refined, if required, during the detail design phase to reflect design changes through that process.

Culverts incorporated into the design are a mix of reinforced concrete pipe culverts and reinforced concrete box culverts, as follows:

- Reinforced concrete box culverts: 961 cells in 121 locations
- Reinforced concrete pipes: 1,934 pipes in 222 locations

Scour protection measures have been included around culvert entrances and exits, on disturbed stream banks and on land bound by a watercourse to avoid erosion.

1.9.5.2 Longitudinal drainage

The purpose of longitudinal or track drainage is to remove water that has percolated through the track ballast, and to divert surface runoff to the nearest bridge or culvert location before it reaches the subgrade. Without adequate track drainage, the subgrade may become saturated leading to weakening and subsequent failure of the subgrade.

Two types of track drainage are proposed:

- Embankment drains – longitudinal drains adjacent to the track in embankment conditions
- Catch drains – longitudinal drains on the uphill side of cuttings.

Track drainage is proposed at specific locations along the alignment where the gradient is steep enough to divert surface runoff to the nearest bridge or culvert location. As with culverts, the design and location of track drainage will be refined, if required, during the detail design phase.

1.9.6 Road-rail interfaces

Road-rail interfaces are points at which the rail alignment intersects a public road. The Project requires the crossing of State-controlled roads and local government (GRC and TRC) roads. A summary of the number of interfaces with each public road type is presented in Table 1.7.

Table 1.7 Summary of public road interfaces in the reference design for the Project

Road type	Number of interfaces ¹
State-controlled	9
Goondiwindi Regional Council	18
Toowoomba Regional Council	26

Table note:

- 1 Only includes locations where a crossing solution is provided. Excludes interface locations where no crossing is provided in the reference design.

A summary of the road-rail interface treatments provided in the reference design, by asset manager, is provided in Table 1.8.

Table 1.8 Summary of road-rail interface treatments in the reference design, by asset manager

Asset manager and interface design treatment	Number in the reference design
Department of Transport and Main Roads	
■ Active level crossing	2
■ Grade separation: rail-over-road	5
■ Grade separation: road-over-rail	2
Goondiwindi Regional Council	
■ Passive level crossing	8
■ Active level crossing	8
■ Grade separation: rail-over-road	2
■ Grade separation: road-over-rail	0
Toowoomba Regional Council	
■ Passive level crossing	12
■ Active level crossing	7
■ Grade separation: rail-over-road	6
■ Grade separation: road-over-rail	1

1.9.7 Fencing

1.9.7.1 General approach

Fencing will be provided for the majority of the rail corridor and its primary purpose is to limit access to the railway. The fencing approach has been detailed in EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy. Fencing will act to protect adjoining lands from trespass and to prevent stock on such adjoining land from gaining access to the railway. Fencing is to extend between the corridor and lands of owners or occupiers adjoining the railway, with any specific requirements to be designed in consultation with the adjoining land owner.

As the Project comprises substantial greenfield works in rural agricultural and grazing areas, standard rural fencing will typically be provided according to ARTC fencing procedure, Boundary Fencing ETM-17-02 (available on the ARTC Extranet). Where superior fencing is required (for example where tracks are in close proximity to roads and/or communities, or where trespass is anticipated to occur) a 1.8 m chain link boundary fence may be provided.

Fencing will not be provided across flood-prone areas due to the risk of debris being caught in the fencing during flood events. Instead, guide posts will be used to demarcate the extent of the rail corridor across the floodplain. The track is positioned on top of elevated embankment or bridge structure where guide posts will be used. The track elevation through these areas will therefore be a deterrent to trespass or livestock access to the railway.

Gates will be provided at suitable corridor entry/exit locations to allow convenient access to infrastructure for maintenance purposes, and at private level crossings and stock crossings.

Fencing returns are required to bridge abutments and drainage or fauna crossing culverts. Fencing across small waterways is to be designed to avoid storm damage and to retain effective stock control.

1.9.7.2 Fauna fencing and crossings

Maintaining effective fauna movement across the rail corridor has been an important design consideration for the Project. A preliminary fauna movement provision and fencing strategy has been prepared for the Project and is included in EIS Appendix J: Terrestrial Ecology Technical Report. The purpose of the strategy is to identify fauna corridor locations in proximity to the Project and to nominate the optimal locations for fauna crossings and associated fencing.

The intent of this strategy is to identify fauna movement and fencing opportunities that are to be investigated further during the detail design phase of the Project to confirm the appropriateness of each solution at the nominated location. Fauna movement opportunities that have been identified for the Project are classified as follows:

- At grade crossing, via track crossing
- Overpass, via canopy bridge
- Underpass at rail bridge location.

The opportunity to provide fauna exclusion fencing in association with the above-mentioned fauna crossings has been identified. This fencing would guide animals towards the preferred fauna crossing structure or passage, whilst reducing their potential to be struck by vehicles or trains. A 3 m buffer clear of vegetation on the habitat side of the fauna exclusion fence would be required to ensure that species cannot use vegetation to climb onto the exclusion fencing.

The confirmation of suitability for each fauna connectivity opportunity will be reliant upon:

- Consultation with adjoining landholders to confirm the acceptability of the proposed connectivity or fencing approach at each nominated location,
- Assessment of each opportunity for compatibility with detail design
- Consideration for maintenance constraints that a fauna connectivity or fencing opportunity may introduce.

Where practical, the strategy provides recommendations for conceptual fauna crossing design types and associated fencing with consideration of the DTMR Fauna Sensitive Road Design Manual – Volume 2 (2010). The manual provides general guidance and examples of fauna movement strategies for linear infrastructure, and the guidance is readily adapted to rail corridors. Additional expert guidance in relation to specific design features will be sought during the detail design process.

1.9.7.3 Pest exclusion fencing

There are three types of barrier fences that are identified in the *Biosecurity Act 2014* for the management of pest animals. These are the wild dog barrier fence, wild dog check fence and the rabbit fence. The Project intersects the wild dog check fence and the rabbit fence.

Wild dog check fences protect areas of grazing and cropping land in southern Queensland from wild dogs. Wild dog check fences do not physically link up to the wild dog barrier fence, however they play an important role in wild dog control in southern Queensland. GRC is responsible for the ongoing maintenance of approximately 283 km of the wild dog check fence.

The rail alignment runs parallel to the existing wild dog check fence from Ch 26.8 km to 43.5 km, it then intersects the wild dog check fence at four locations, Ch 50.1 km, Ch 51.2 km, Ch 54.9 km and Ch 56.0 km. The wild dog check fence will need to be reinstated on the northwest side of the rail corridor boundary in six locations as rectification for severance of this fence, as shown in Figure 1.3.

ARTC have commenced consultation with the GRC to determine fencing requirements at these locations. Detail design drawings of ARTC's nominated fencing solution for reinstatement of the wild dog check fence will be submitted to GRC for acceptance prior to works commencing.

The details of ARTC's standard fauna exclusion fence, which will be used as a basis for designing the reinstatement for the wild dog check fence, are shown in Figure 1.3.

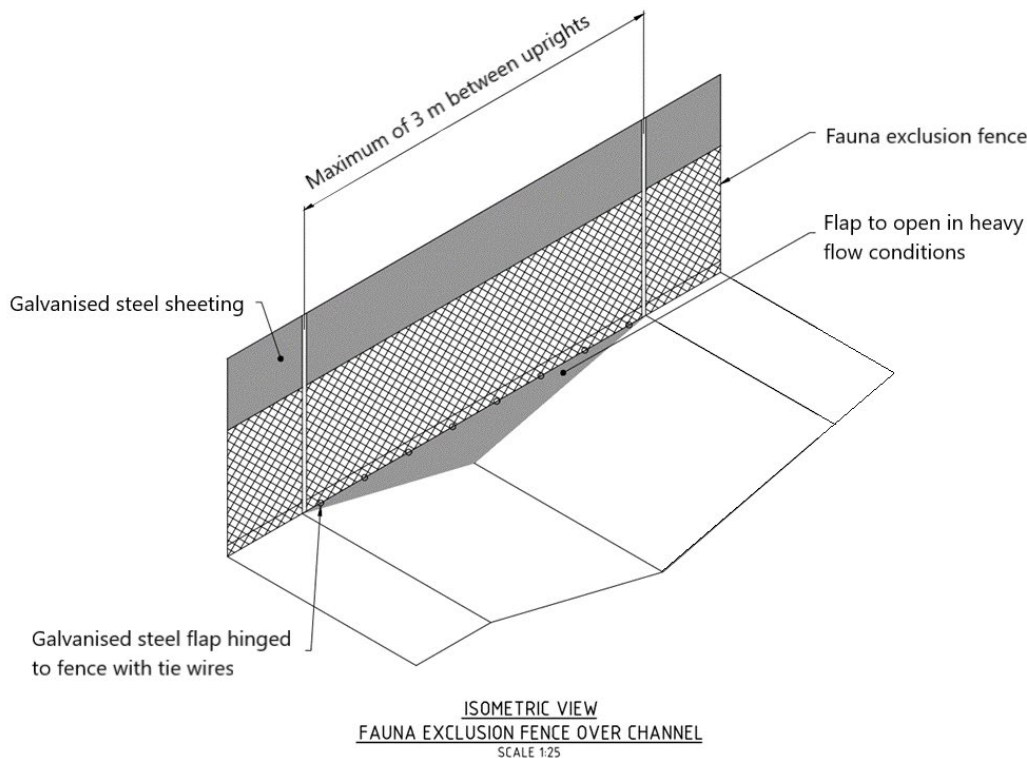


Figure 1.3 Standard fauna exclusion fence over channel

The Darling Downs-Moreton Rabbit Board (DDMRB) fence is a 555 km long rabbit-proof fence. The fence is managed and maintained by the DDMRB, stretching from Lamington National Park in the east, to Goombi in the southwest, where it connects to the wild dog barrier fence. The Project intersects the DDMRB fence when traversing through the locality of Clontarf, at approximately Ch 120.2 km. In addition, a rabbit trap will be set up in this location.

ARTC have commenced consultation with the DDMRB to determine fencing requirements at this location. Detail design drawings of ARTC's nominated fencing solution at Ch 120.2 km will be submitted to DDMRB for acceptance prior to works construction commencing.

1.10 Construction

1.10.1 Access roads

Access roads will be required along the rail corridor to allow construction crews to access work fronts. Access roads to the alignment will be designed and constructed, or upgraded if existing tracks are to be used, with appropriate consideration to minimising disruption to landholders and public infrastructure.

Construction access is proposed to be provided adjacent to all working fronts along the rail corridor and will be sized to allow free flow and unhindered access for all construction and support traffic vehicles. During this phase materials including rail, sleepers, ballast, concrete, culverts, fill material (general and structural) and construction water will be delivered and stockpiled/stored in designated construction laydown areas. In general, the access roads will also cater for the movement of:

- Construction equipment and vehicles
- Personnel transport for staff and labour to access work fronts
- Maintenance vehicles
- Material deliveries
- Servicing temporary construction facilities along the route.

Several access roads will be developed to facilitate access to the laydown and construction sites located along the length of the Project. These access roads will be designed and constructed with consideration for:

- Vehicle numbers
- Vehicle lengths
- Vehicle weights
- Separation requirements
- One-way or two-way vehicle movements
- Overtaking requirements.

Access routes will, in the first instance, be located within the rail corridor and use the future RMAR footprint. This will be in preference to creating new tracks that will require restoration once the construction work has been completed.

When planning for the location of access roads and haul routes, an assessment will be made of above and underground services that may be affected by oversized loads or weights. This assessment will also consider the asset owners' maintenance access requirements.

1.10.2 Bulk earthworks

The construction of the foundation of the railway line will require earthworks and engineering fill to provide a stable platform designed accommodate an operational freight railway. The earthworks will mostly involve the construction of embankments and excavation of cuttings. This work will be carried out using heavy earthmoving plant and equipment.

1.10.2.1 Embankments

The initial phase in embankment construction is the preparation of the subgrade. Subgrade inspection and testing shall be carried out as embankment foundations are exposed, following which the appropriate treatments will be specified. Three broad treatment strategies to prepare the subgrade are anticipated:

- Compact existing subgrade, if deemed suitable
- Dig out and replace unsuitable materials with suitable fill, which is then compacted
- Lime treatment. Spreading lime, mixing material into the soil with a reclaimer/stabilizer, compacting lime treated subgrade, rolling of subgrade.

Embankment construction will follow the preparation of the subgrade. The embankment will be constructed in layers, with zones designated for:

- Placement of material directly via scrapers or trucks, or spread from stockpiles via bulldozers and graders
- Compaction of material with roller compactors, and plate compactors for confined working
- Rolling and grading to final level and finish.

Embankment fill material will be laid out in the maximum lift depths by a grader or dozers prior to compaction. The moisture conditioning required for compaction will be determined by further geotechnical investigations. The compacting effort required for the fill material will be determined so that compaction equipment can be effectively matched to requirements.

Access ramps onto the embankment shall be located at regular intervals to facilitate concurrent activities of placement and compaction and continued delivery of materials.

1.10.2.2 Cuttings

Cuttings in the existing ground profile will be needed where the final design level is lower than the surrounding land. Excavation will progress depending on the in-situ material types. If the material is of sufficient quality, is rippable, and does not contain oversized rocks, then dozers and scrapers will move the material along the alignment to locations of embankment construction. If the material contains a high percentage of rock, it may be necessary to use excavators and trucks to move the material. This material may require some processing prior to use in embankment construction, dependent upon meeting the necessary earthworks specifications.

Non-rippable rock (rock that is not able to be broken down using mechanical means) will be broken via drill and blast or by hydraulic rock-breakers. Broken rock will be loaded onto trucks by front-end loaders and excavators for placement at its required location.

Significant volumes of non-rippable rock are anticipated within some of the cuttings along the rail corridor, particularly in the northern part of the alignment; the extent to which drilling and blasting will be required is subject to further geotechnical investigation. Based on the preliminary geotechnical information, it is anticipated that blasting may be required for the cuttings between:

- Ch 164.4 km and Ch 165.8 km
- Ch 174.4 km and Ch 175.5 km
- Ch 177.0 km and Ch 179.3 km
- Ch 188.8 km and Ch 190.4 km.

Where drilling and blasting is to be undertaken, a Blasting Contractor will be engaged to perform blasting activities. The Blasting Contractor will need to maintain a Security Management System and prepare a Blast Management Plan for the task to ensure that potential impacts are properly assessed and managed.

The Blasting Contractor will be responsible for the security of the explosives for the entire duration of the task, including the segregation of incompatible products.

Further details on the potential impacts of blasting and the necessary controls are presented in EIS Chapter 14: Noise and vibration and EIS Chapter 19: Hazard and risk.

1.10.2.3 Structural fill and capping

Capping material is currently planned to be transported by existing road network from commercial quarries.

In the first instance, structural fill will be sourced from cuts within the rail corridor. If there is a lack of suitable structural fill material from cuts, then this material may be sourced from borrow pits.

The following are the key strategies with regards to transport, handling, and placement for structural fill and capping material:

- Suitable material will be transported to the corridor and delivered directly to the alignment or stockpiled within the nominated laydown areas of the corridor
- The materials will be moisture conditioned and tipped directly on the formation in suitable volumes to deliver the required thicknesses for compaction
- Spreading and compaction of the material will be undertaken using graders and compactors
- Final trimming and profiling will be undertaken to allow rail construction.

1.10.3 Borrow pits

Nineteen possible material source locations have been identified by ARTC as potentially suitable for use during construction activities. These sites consist of seven operational licensed quarries and 12 potential borrow pit sites. The viability and feasibility of accessing material from these locations will be confirmed during the detail design phase of the Project (post-EIS).

The potential borrow pit locations have been identified based on the following factors:

- Proximity to rail alignment
- Proximity to road access/accessibility
- Desktop environmental assessment
- Presence/size of existing borrow pit.

Standard earthmoving equipment such as trucks and bulldozers will be used to extract material from borrow pits and quarries. If required, mechanical screens will be used to screen and grade material. The material will then be transported to construction sites using the public road network and tipped directly onto the formation. Prior to commencing works within borrow pits, the necessary approvals and licences will be obtained by the construction contractor.

1.10.4 Non-resident workforce accommodation

The accommodation requirements for workforce in the northern extent of the Project is expected to be sufficiently met by existing accommodation available in Toowoomba, and surrounding towns such as Southbrook and Pittsworth. Existing accommodation is less readily available south of Pittsworth. To compensate for this shortage in accommodation, the Project includes allowance for three non-resident workforce accommodation to accommodate the construction workforce. Each facility will be required to hold 300 staff during the peak between weeks 50 and 70. The average occupancy of the facilities outside of the peak period will be approximately 150 people per facility.

An initial assessment of workforce demand and safe commutable distances has identified a potential need for non-resident workforce accommodation in the vicinity of Yelarbon, Inglewood and Millmerran. Locations for non-resident workforce accommodation in proximity to these townships have been identified with consideration for:

- The proximity of the facility to likely construction sites, for fatigue management purposes (maximum desirable commute 30 minutes)
- Land tenure and ownership of the site
- Available land area
- Proximity to supporting infrastructure and services, such as water and electricity
- Likelihood of noise, vibration and air quality impacts originating from the facility
- Likelihood of disturbing significant vegetation communities, threatened species or heritage sites
- Road access
- Potential for planned future developments to impact on the non-resident workforce accommodation facility, or vice versa.

Based on these criteria, three properties have been identified as suitable for the establishment of non-resident workforce accommodation. ARTC have consulted with the landowners of the three properties, each of whom are receptive to having a non-resident workforce accommodation facility being located on their property.

Table 1.9 **Locations for non-resident workforce accommodation**

Lot and plan	Address
Lot 30 MH721	Cunningham Highway, Yelarbon
Lot 5 MH75	Millmerran-Inglewood Road, Inglewood
Lot 135 DY1033	553 Turallin Road, Turallin

At a minimum, each non-resident workforce accommodation facility will accommodate up to 300 persons and be self-contained and will include accommodation units with kitchen, dining, ablution, laundry facilities. Supporting and additional infrastructure associated with each facility will include:

- Potable water storage – approximately 0.51 megalitre (ML) of water per five-day week of operation during peak occupancy, based on average usage of 340 litres (L) per person, per day
- Water and wastewater treatment and collection facilities, including temporary package sewage treatment (estimated capacity of 300 equivalent population)
- Power generation (if not connected to the local electricity grid) by diesel powered generators, in combination with solar panels where appropriate
- Solid waste collection facilities
- Recreational facilities
- Paramedic and first aid facilities
- Offices
- Car parking and gatehouse/security.

1.10.5 Construction water requirements

Significant volumes of water will be required for various activities associated with construction of the Project, including for earthworks, concrete production, track works and the operation of non-resident accommodation facilities. A summary of the estimated water requirements for elements of the Project construction is presented in the following sections and in more detail in EIS Chapter 5: Project Description.

1.10.5.1 Earthworks

The greatest water demand for the Project will be for earthworks, which predominantly includes conditioning of fill material, haul road and laydown pad maintenance and dust suppression. The rates of water application for earthworks activities have been adopted based on the rates used during earthworks for a previous transport infrastructure project in the region and are as follows:

- Material conditioning is expected to consume approximately 100 L/m³ of fill, however this is variable, dependent upon material properties.
- General dust suppression across the site will be a constant activity. An allowance of 50 L/m³ of fill has been made. This allowance also covers the water required to re-establish vegetation on disturbed surfaces following the completion of works.
- Haul road and laydown area maintenance will also require water. An allowance of 40 L/m³ of fill has been made.

Based on these rates of application and the volume of fill required for the reference design, a total of 2,536 ML of water that is not quality dependent is estimated to be required for earthworks during construction.

1.10.5.2 Concrete batching

The Project is expected to rely on a combination of existing commercial concrete batching plants and a temporary plant for the batching and precast of concrete, established to service the Project.

Concrete batching has specific water quality requirements in order to achieve structural integrity and asset life objectives. Established plants are connected into mains water supply, so the quality and uninterrupted supply of water is not an issue for existing commercial facilities. Therefore, the water requirement for concrete supplied by existing concrete/precast concrete suppliers does not contribute to the Project's direct water requirement.

Locations for two temporary plants, with combined concrete batching and precast function, have been nominated in the Toowoomba LGA to service the Project, one at Ch 137.0 km (Yandilla) and another at Ch 150.5 km (Dieckmann Road). The demand for an on-site temporary batching and precast plant is driven by the large number and scale of concrete structural elements that are included in the design solution for the crossing of the Condamine River floodplain. Whilst two locations have been nominated, only one plant is expected to be necessary to supplement the supply of concrete from established commercial operators.

If a temporary batching and precast plant is established, a dedicated water supply sourced from mains water will be required. A temporary concrete batching and precast plant would be established with on-site water storage tanks, which would be filled by water trucks drawing water from mains connections in local towns, being Brookstead and Millmerran, if capacity is available. Alternatively, water would be sourced from further afield.

A water requirement of 200 L/m³ has been estimated for the on-site batching of concrete (wet and precast). Using this rate, the water requirement for on-site concrete batching activities is estimated to be 15 ML. The availability of mains water for the use in a temporary batching facility would be discussed with TRC as the construction approach is refined during the detail design process. In the planning of water access, maintaining the uninterrupted supply of potable water to existing residential and commercial users will be the priority.

1.10.5.3 Track works

The predominant requirement for construction water during track works is for dust suppression relating to ballasting works, in particular ballast dropping and ballast regulating works during track tamping activities. Based on previous rail project experiences, a conservative allowance of 6 L per track metre has been assumed for dust suppression during ballast dropping and 4 L per track metre for dust suppression during tamping and regulating activities.

For 216.2 km of rail alignment, track works is estimated to require a total of 2.16 ML of water that is not quality dependent.

1.10.5.4 Non-resident workforce accommodation facilities

The total daily water usage on non-resident workforce accommodation facilities is a factor of a facilities occupancy numbers and includes water used for the following purposes: toilets, showers, laundry, food preparation and cleaning.

The average daily water use per person recorded by TRC in February 2020 was 120 L per person per day (L/p/d), with a maximum of 322 L/p/d and a minimum of 44 L/p/d. Based on this data, a conservative daily volume of 340 L/p/d has been adopted to estimate the water usage for non-resident workforce accommodation facilities. For three non-resident workforce accommodation facilities operation at full capacity (300 beds) over a 58 month period, a total water usage of 540 ML is estimated.

The overall estimated water requirements for construction of the Project is summarised in Table 1.10.

Table 1.10 Estimated water requirements for construction activities

Construction activity	Total volume (ML)
<i>Earthworks - rail</i>	
Material conditioning	1,225
Dust suppression ¹	613
Haul road and laydown area maintenance	490

Construction activity	Total volume (ML)
<i>Earthworks - roads</i>	
Material conditioning	110
Dust suppression	55
Haul road and laydown area maintenance	44
Total (earthworks)	2,536
<i>Concrete product</i>	
Precast	4.8
Wet (bulk)	10.2
Total (concrete)	15.0
<i>Track works activity</i>	
Dust suppression during ballast dropping	1.30
Dust suppression during tamping and regulating	0.86
Total (track works)	2.16
Total (accommodation facilities)	540.09
Total estimated water usage	3,093.25

1.10.5.5 Water sourcing

ARTC recognises water sourcing and availability is critical to supporting the construction program for the Project. Sources of construction water will be finalised as the construction approach is refined during the detail design phase of the Project (post-EIS). Through this process detailed water demand planning will be undertaken, including detailed contingency options in the event that protracted dry seasonal conditions prevail and water supply options become unavailable.

The ultimate water sourcing strategy for the Project will be documented in a Construction Water Plan and be dependent on:

- Climatic conditions in the lead up to construction
- Confirmation of private water sources made available to the Project by landholders under private agreement
- Confirmation of access agreements with local governments for sourcing of mains water.

Options for the sourcing of construction water, subject to availability, are anticipated to be as follows:

- Commercial, licensed water supplies where capacity exists
- Public surface water storages, i.e. dams and weirs
- Permanently (perennial) flowing watercourses
- Privately held water storages, i.e. dams or ring tanks, under private agreement
- Existing registered and licensed bores
- Treated water, e.g. from waste water treatment plants
- New bores established to service the Project under appropriate water licence or entitlement (least preferred option).

An assessment of the suitability of each source will need to be made for each construction activity requiring water, based on the following considerations:

- Legal access

- Volumetric requirement for the activity
- Water quality requirement for the activity, e.g. facilities will need potable water
- Source location relative to the location of need.

A summary of the considerations for accessing water from each potential surface water source is presented EIS Chapter 5: Project Description.

1.10.6 Indicative construction schedule

Construction of the Project will commence once the detail design is complete and all the necessary approvals have been obtained. The following broad milestone dates for construction are proposed at this stage:

- Contract award end of 2020
- Pre-construction activities and early works commence in 2021
- Target completion of construction by the beginning of 2026
- Six months testing and commissioning phase.

The broad milestone dates for construction are indicative only and are subject to change during the detail design and construction phases as a result of:

- Weather conditions
- Changes to construction methods and materials
- Unexpected finds, such as threatened biodiversity species or cultural heritage values
- Community interest in the Project or issues that need to be addressed.

If the duration and timing of construction were to change, work will be rescheduled, considering site-specific environmental and engineering constraints. The schedule of environmental controls, including traffic management and noise controls, would also be adjusted.

1.10.7 Construction workforce

The Project is part of a larger Inland Rail Program of works. It is anticipated that 16,000 jobs will be required program-wide at the peak of construction, with an average of 800 jobs per annum over the 10 year construction period. An average of 700 additional jobs per annum is anticipated over 50 years of operation (2024 to 2074).

Workforce on site for the Project is estimated to peak at 950 full-time equivalents between weeks 50 and 70 of construction. The average number of full-time equivalent workforce on site across the full construction period is over 400 people.

Workforce recruitment will be the responsibility of the construction contractor engaged by ARTC to construct the Project. Local resident and Indigenous workforce targets will be established by ARTC and passed on to the construction contractor.

1.10.8 Hours of work

The construction program will generally be based on the following worksite hours:

- General construction activities:
 - Monday to Friday – 6.30 am to 6.00 pm
 - Saturday – 6.30 am to 1.00 pm
 - No work planned on Sundays or public holiday
- Track possessions may occur on a 7 day/24 hour calendar basis, subject to agreement with QR.

Track possession of QR's assets will generally be allocated over weekend periods, with extended track possession occurring over holiday periods.

There may be circumstances where work outside the above standard hours, including night works, will be required, for example, the delivery of materials. Work outside standard hours will only be undertaken where consultation with the local community has been undertaken.

1.11 Operation

Operation phase activities will include the use of the railway for freight purposes, operation and maintenance of safety systems, signalling, and general track and infrastructure maintenance.

1.11.1 Hours of operation

The hours of operation are anticipated to be on a 24 hour/7 day calendar.

1.11.2 Workforce

It is anticipated that the ongoing operation and maintenance of the Project will require a workforce of approximately 10 to 15 full-time equivalents. The operational workforce will be based at provisioning centres outside the immediate vicinity of the Project.

1.11.3 Train operations

Train control will be managed via ARTC's existing control centres. Train services will be provided by a variety of operators. Trains will be a mix of grain, bulk freight and other general transport. Inland Rail as a whole will be operational once all 13 sections are complete, which is estimated to be in 2026.

The Project will involve operation of a single rail track with crossing loops, initially to accommodate double stacked freight trains 1,800 m long and 6.5 m high. Train speeds will vary according to axle loads and track geometry, and range from 80 to 115 km/hr.

It is estimated that once operational, the Project will involve an annual average of about 14 train services per day in 2026. This is likely to increase to an average of 20 trains per day in 2040, and up to 25 per day during peak operational periods. Annual freight tonnages will increase in parallel, from approximately 14 million tonnes per year in 2026 to 19 million tonnes per year in 2040.

Electricity supply will be needed for points, signalling and other infrastructure. It is anticipated that the supply of these services will be delivered by relevant providers under the terms of their respective approvals and/or assessment exemptions.

1.11.4 Operational maintenance

Standard ARTC maintenance activities will be undertaken during operations. Typically, these activities include:

- Minor maintenance works, such as:
 - Bridge inspections
 - Culvert cleanout
 - Sleeper replacement
 - Rail welding
 - Rail grinding
 - Ballast profile management

- Track tamping
- Clearing/slashing vegetation within the rail corridor.
- Major periodic maintenance, such as:
 - Ballast cleaning
 - Formation work
 - Reconditioning of track
 - Adjustment
 - Turnout replacement
 - Correction of track level and line
 - Maintenance of structures including waterproofing, jointing etc.

These activities will occur on a scheduled basis, in addition to being in response to unplanned requirements, e.g. maintenance following adverse weather events.

1.12 Decommissioning

The Project is expected to be operational for in excess of 100 years. The design life of structures is 100 years to support this operational objective. The decommissioning of the Project cannot be foreseen at this point in time and is therefore not considered further as a Project phase in this EIS.

If the Project, or elements of it, were subject to plans for decommissioning it is envisaged that the works would be undertaken in accordance with a Decommissioning Environmental Management Plan, which would be developed in consultation with relevant stakeholders and regulatory authorities.

1.13 Social and economic benefits

Development of the Project would result in social and economic benefits, primarily in relation to employment, training and business supply opportunities. Local benefits as a result of the Project include:

- **Employment** - the construction workforce is expected to be drawn primarily from communities within the Project region and nearby LGAs, and therefore employment and training benefits would extend to construction industry workers across the region. The availability of long periods of employment in project construction is likely to be a strong positive opportunity for those personnel and their families.
- **Employment opportunities** in the Project region during the construction stage will have positive mental health benefits for the individuals employed, particularly if they are exiting a period of unemployment or commencing their career. This would be particularly important in communities with high levels of unemployment, and for particular population groups where unemployment rates are high (such as Indigenous people and young people).
- **Business opportunities** - local and regional businesses will benefit from the construction phase. Opportunities to supply the Project may include supply of fuels, equipment, borrow and quarried material, and services including fencing, electrical installation, rehabilitation, landscaping, maintenance and trades services.
 - Local transport or logistics businesses may also have significant opportunities to service the construction phase
 - The Project's local supply arrangements will provide an opportunity to develop and grow local businesses, with some possible benefits in nearby communities, but with regional benefits of greater significance.

- The expansion in construction activity in the vicinity of the Project will support additional flow-on demand and additional spending by the construction workforce, and therefore business trading levels in the region
- The Project will improve the connection between local produce such as bulk grain, containerised cotton and other agricultural products, and markets; through to both domestic markets in cities and international markets via the Port of Brisbane.
- **Crash reduction** - Crash cost savings represent the reduced costs associated with fatal and serious injuries resulting from both road and rail incidents.
- **Environmental externalities** - Reduced environmental externality costs represent reductions in air pollution and greenhouse gas emissions due to the Project. The majority of these benefits can be attributed to the mode shift from road freight to rail freight.
- **Road decongestion benefits** - As the Project encourages greater movement of freight by rail, the reduced truck movements that are projected upon completion of the Project result in reduced congestion in urban areas.

More information on social and economic benefits is provided in EIS Chapter 15: Social and Chapter 16: Economics.

1.14 Stakeholder engagement

1.14.1 Identification of stakeholders

Stakeholders in both Queensland and NSW were identified for the Project and included Federal, State and local government representatives, potentially affected landowners, local businesses, industry bodies, environmental groups, community groups, education and training providers, media and nearby communities. The stakeholders informed or consulted for the Project are detailed in Table 1.11.

Table 1.11 Stakeholders informed or consulted during development of the reference design and draft Environmental Impact Statement

Group	Stakeholder
Federal Government - elected representatives	■ Deputy Prime Minister and Minister for Infrastructure, Transport and Regional Development Michael McCormack (from 21 December 2017) ■ Minister for Infrastructure, Darren Chester (until 20 December 2017) ■ Members for Groom, John McVeigh ■ Member for Maranoa, David Littleproud MP; Minister for Water Resources, Drought, Rural Finance, Natural Disaster and Emergency Management ■ Hon Mathias Cormann, Minister for Finance, Senator for WA; and Vice-President of the Executive Council
Federal Government departments and agencies	■ Department of Infrastructure, Transport, Cities and Regional Development (DITCRD) ■ Department of Agriculture, Water and the Environment ■ Regional Development Australia ■ National Transport Commission
Queensland Government – elected representatives	■ Member for Condamine, Pat Weir ■ Member for Southern Downs, Lawrence Springborg (until December 2017) ■ James Lister (from December 2017)
New South Wales Government – elected representatives	■ Adam Marshall MP, State Member for Northern Tablelands (NS2B project). ■ Royal Francis Butler MP, Member for Barwon (Boggabilla).

Group	Stakeholder
Queensland Government departments and agencies	- Office of the Coordinator-General (OCG) - Department of Transport and Main Roads (DTMR) - Department of Natural Resources, Mines and Energy (DNRME) - Department of Environment and Science (DES) - Department of Agriculture and Fisheries (DAF) - Queensland Rail (QR) - Department of Education - Biosecurity Queensland - Emergency Services - Queensland Health
New South Wales Government departments and agencies	- Transport for NSW, Roads and Maritime Services, Department of Trade and Regional Investment - Office of Environment and Heritage (now DPIE) - NSW Environment Protection Authority - National Parks and Wildlife Office - Department of Planning, Industry and Environment NSW - Department of Primary Industries - Local Land Services - TAFE NSW - Department of Education
Local Government	- Toowoomba Regional Council (TRC) Mayor, Cr Paul Antonio - Goondiwindi Regional Council (GRC) Mayor, Cr Graeme Scheu - TRC Councillors - GRC Councillors - TRC officers and technical staff - GRC officers and technical staff - Moree Plains Shire Council (MPSC) Mayor, Cr Katrina Humphries - Gwydir Shire Council (GSC) Mayor, Cr Mark Coulton - MPSC Councillors - GSC Councillors - MPSC officers and technical staff - GSC officers and technical staff
Chambers of Commerce	- Toowoomba and Surat Basin Enterprise - Toowoomba Chamber of Commerce - Pittsworth Alliance - Goondiwindi Chamber of Commerce - Millmerran Commerce and Progress Association
Peak bodies	- National Road Transport Association - Queensland Transport and Logistics Council - Australian Trucking Association - Toowoomba and Surat Basin Enterprise - Southern QLD Country Tourism - QLD Farmers Federation - National Farmers Federation - Agforce - Cotton Australia - Growcom, Heavy Vehicle Industry Australia - Queensland Resources Council

Group	Stakeholder
Industry (New South Wales)	■ NSW Farmers ■ Cotton Australia ■ Namoi Cotton ■ GrainCorp ■ Carrington Cotton
Environmental and other community groups	■ Gowrie Junction Progress Group ■ Kingsthorpe and District Progress Group ■ Southern Downs Protection Group ■ Southern QLD NRM QLD Murray Darling committee ■ Millwood Farmers Group ■ Inglewood Community Advisory Group ■ Yelarbon Community Consultative Committee ■ Macintyre Brook Irrigators Association ■ Australia Koala Foundation ■ Australian Wildlife Conservancy ■ SQ Landscapes ■ Darling Downs Regional Organisation of Councils ■ Friends of the Escarpment Parks Toowoomba Inc. ■ Goondiwindi and District Historical Society ■ Highfields and District Business Connection Incorporated ■ History Pittsworth ■ Hope Australia (links to Condamine Catchments) ■ Inglewood and Texas Landcare Association Inc ■ Macintyre Valley Cotton Growers Association Inc. ■ Millmerran Commerce and Progress Inc. ■ Murray Darling Association ■ Murray-Darling Basin Authority ■ North East Downs Landcare ■ Pittsworth Landcare ■ Queensland Conservation Council Queensland Murray-Darling Committee ■ Rotary Club of Toowoomba North ■ RSPCA Queensland The Wilderness Society ■ Toowoomba Bird Observers ■ Waggamba Landcare Group Inc. ■ Wildlife Preservation Society of Queensland ■ Wildlife's Welfare Carers Inc. ■ Wylahra Grove Progress Association ■ Regional Landcare New England Northwest ■ Northern Slopes Landcare Association ■ Macintyre Brook Irrigators Association
Traditional owners and Indigenous groups	■ Western Wakka ■ Bigumbul ■ Goomeroi ■ Toomelah Local Aboriginal Land Council
Community action groups	■ Inner Downs Inland Rail Action Group (also known as RAIL – Residents Against Inland Rail Line) ■ Millmerran Rail Group
Community consultative committees (CCC)	■ Inner Darling Downs ■ Southern Darling Downs

Group	Stakeholder
Community and social services (New South Wales)	■ Rural Financial Counselling Service of NSW—Northern Regions Vincent de Paul Society ■ North Star CWA ■ Australian Centre for Agricultural Health and Safety ■ Centrelink ■ Anglican Counselling Service ■ Homeless Accommodation Support Team ■ Youth Accommodation Team ■ Meals on Wheels ■ North West Rural Counselling Service ■ Service ■ Salvation Army ■ Red Cross ■ North Star Public School ■ Yetman Public School ■ Boggabilla Central School ■ Toomelah Public School ■ The University of Sydney New England Area Health Service ■ Moree District Hospital ■ Hunter New England Local Health District—Regional Head Office ■ Home and Community Care (Yetman) ■ Anglicare Northern Inland Counselling ■ Inverell and District Health Service Social Worker ■ Police (Local Area Command New England—Armidale) ■ Police Yetman Station ■ Rural Fire Service—Moree Plains Local Government Area ■ SES—North West Region ■ Ambulance NSW—Western Sector Administrative Office ■ North Star & North Star East Rural Fire Brigade (RFS) ■ Boggabilla Rural Fire Brigade (RFS)
Landowners (directly impacted)	■ Landowners directly affected by the Project final rail corridor (nominal 100-metre wide corridor)
Landowners (study area)	■ Landowners in the two-kilometre-wide Project study area
Community (general)	■ Landowners, businesses and residents in the towns/localities of: – Kurumbul – Yelarbon – Inglewood – Millwood – Millmerran – Pampas – Brookstead – Southbrook – Pittsworth – Southbrook – Athol – Wellcamp – Charlton – Kingsthorpe – Gowrie Mountain – Gowrie Junction

Group	Stakeholder
Media	■ Toowoomba Chronicle ■ Pittsworth Sentinel ■ Macintyre Gazette ■ Goondiwindi Argus ■ Highfields Herald ■ ABC Southern Downs ■ WIN ■ Channel 7 ■ Print: Wialda Standard, Bingara Advocate, The Land, Border News ■ Radio: ABC ■ Television (out of other centres) ■ ABC ■ WIN ■ PRIME
Utilities/engineering infrastructure	■ Telstra ■ Millmerran Power ■ Energex ■ Ergon Energy ■ Essential Energy ■ Pipelines ■ SEQwater ■ Queensland Urban Utilities ■ NBN ■ Goondiwindi Regional Council and Toowoomba Regional Council communications, water, sewer and stormwater ■ Optus Utility Network ■ MPSC

1.14.2 Consultation approach

ARTC Inland Rail maintains a secure stakeholder management database (Consultation Manager) to record all consultation undertaken as a part of the EIS consultation process. The database was established in mid-2014 and will be maintained throughout the remainder of EIS process and into project construction and operation. This central database is used to record stakeholder consultation and monitor and report on enquiries, issues and team responses across all ARTC operations and Inland Rail projects.

In accordance with Section 3.1 of the ToR, a consultation plan was developed to guide effective and timely delivery of EIS consultation activities. The plan included:

- The types of activities to be undertaken
- Timing of activities
- How key stakeholder and community representatives will be targeted
- Integration with other EIS activities and the Project development process
- Consultation responsibilities
- Communication protocols
- Reporting and feedback arrangements
- How results of consultation will be considered by the proponent and integrated into the EIS process.

The consultation approach for the Project has been guided by the International Association of Public Participation (IAP2) Core Principles.

The IAP2 Spectrum identifies five levels at which stakeholders can participate in decision making – inform, consult, involve, collaborate and empower. The level of stakeholder participation for the Project depended on the stakeholder group and technical constraints and included the inform, consult, involve and collaborate levels of the spectrum.

ARTC Inland Rail **informed** stakeholders via presentations to community and industry groups and by using a range of communication tools, including community update newsletters, electronic newsletters (e-news), letters, project website, fact sheets, flyers and posters.

Stakeholders were **consulted** via numerous one-on-one and small group meetings, information sessions, pop-up consultation stands, and a community survey. This was supported by feedback mechanisms including an interactive map on the Project website, 1800 telephone line, email address, and feedback forms.

ARTC Inland Rail **involved** stakeholders in the design and EIS development through the community consultative committees, one-on-one and small group with landowners that enabled a two-way exchange of information.

In a number of situations, such as alignment development in some sections and when designing the road/rail interfaces, ARTC Inland Rail **collaborated** with stakeholders through workshops and meetings with landowners and key stakeholders.

1.14.3 Consultation themes

During the engagement process, participants identified a range of potential social, environmental and economic impacts and benefits of the Project. Although feedback has differed between localities and stakeholder groups, a number of consistent themes emerged, as follows:

- Further investigation of alternative routes
- Property impacts, acquisition and compensation
- Flooding impacts
- Train operations
- Engineering design
- EIS process
- Local roads
- Noise
- Liveability and wellbeing impacts
- Environmental impacts
- Social and economic benefits.

Each theme is summarised below as expressed by stakeholders at government meetings and consultation sessions. This summary provides a high-level snapshot of community/stakeholder perceptions in response to the Project, rather than a technical assessment of impact or benefit. Furthermore, the themes are presented without any particular priority order or ranking.

Table 1.12 presents the major themes and issues as identified by different stakeholder groups during consultation. This information is based on feedback received from selected stakeholders (who participated in consultation activities), and is not intended to be representative of all stakeholders listed in Table 1.11.

Table 1.12 Summary of key engagement themes, issues and opportunities

Issue themes	Issue description	EIS response
Further investigation of alternative routes	■ Ongoing requests from landowners and communities to move the study area.	■ Inland Rail sought to minimise impacts by where possible aligning the rail corridor with existing infrastructure and property boundaries. ■ Inland Rail worked collaboratively with DIRDC to share information about the study area selection ■ Community understand the study area was chosen by the Australian Government rather than ARTC
Property impacts, acquisition and compensation	■ Landowners wanting to know more about the acquisition process, how compensation will be determined and if compensation will be fair. ■ Landowners wanting more information about how impacts to dams, bores and water will be compensated and reinstated ■ Landowners are concerned about perceived loss of value to the property through the EIS process due to the potential construction and operation of the Project ■ Potential impacts on properties (physical infrastructure, fencing, access and operability of farming operations) has also been raised by the community. ■ Adjacent communities concerned how they will be affected and if they will receive any compensation.	■ Inland Rail developed and distributed information about the acquisition process via the website, fact sheet, CCC, information sessions and landowner meetings. ■ Inland Rail kept the community informed of the alignment development and actively sought feedback about individual requirements in relation to irrigation, water licences, livestock movements, local road usage, private crossing requirements, hydrology, existing infrastructure and land use. This information was considered in the design process where possible to minimise impacts. ■ Inland Rail promoted the DTMR acquisition fact sheet to assist educate potentially affected landowners. ■ Inland Rail assessed early acquisition requested in line with the Inland Rail Early Acquisition policy.
Flooding impacts	■ Flooding impacts of building Inland Rail continue to be a significant issue, particularly in relation to crossing of the Condamine River floodplain. Community is also requesting information about Westbrook Creek and Dry Creek flooding.	■ Inland Rail run specialised engagement campaigns about the hydrology modelling. ■ These campaigns involved seeking information from the community to confirm the modelling findings. ■ Inland Rail will continue to work with landowners concerned with hydrology throughout the detail design, construction and operational phases of the Project.
Train operations	■ Community continuing to seek clarity about the planned operations of trains. This includes asking about train length, frequency, what will be transported, how trains will cope with winds, potential spur lines and how emergencies will be dealt with. ■ The community and business operators are interested in opportunities to transport grain and other goods, as well as the potential for local employment for maintenance and operations and potential sidings and planned future intermodal developments.	■ ARTC recruited a Business Development Manager based in Toowoomba to identify potential opportunities for the community and business operators who are interested in potentially transporting grains and other goods. ■ Information about the service offering including length and frequency of trains was publicly available and promoted.
Engineering design	■ The technical engineering feasibility of the proposed rail line across the Condamine River floodplain is regularly raised as a concern of the communities. ■ Landowners are concerned about the potential impacts of earthworks and cuttings on surface and groundwater resources.	■ Inland Rail held workshops, technical briefings and landowner meetings about the technical engineering feasibility of the proposed rail line across the Condamine River floodplain. ■ An independent technical assessment was undertaken at the request of the Southern Darling Downs CCC to verify the Condamine flood modelling and solution.

Issue themes	Issue description	EIS response
EIS process	- The formal (EIS) and approvals process is of interest to the community. - Communities are keen to understand what is included in the EIS and have their say throughout the EIS process.	The EIS process including how to provide feedback will be publicly advertised and a fact sheet will be developed to assist people to have their say on the EIS.
Local roads	Maintaining access for emergency services and to properties is a concern to the community. The community is sharing information about how they currently use the existing road network and where they currently experience safety concerns.	- An extensive information gathering campaign was undertaken to for the public road crossings. - The local roads design took into account feedback from the local community and users of the wider road network where topography, legislation, safety and costings permitted.
Noise	- Potential noise impacts, the estimated number of train movements and potential mitigation measures have been raised. - Adjacent communities concerned they will not be considered.	- Noise monitoring and modelling were carried out as part of the EIS development. - The results of the modelling and potential mitigation strategies were shared with sensitive receptors prior to the final draft of the EIS. - Inland Rail will continue to engage with the community about noise and noise mitigation throughout the detail design, construction and operational phases of the Project in line with the recommendations in EIS Chapter 14: Noise and vibration.
Liveability and wellbeing impacts	- Amenity impacts, liveability and well-being of the small rural communities have been raised by the community - Concerns about the heights of the track and what landowners will see from their property - Adjacent communities concerned how they will be affected, if they will be considered and if they will receive any compensation/ mitigation	Visualisations were developed and made publicly available to assist the community understand the visual impact of the Project.
Environment	Concerns about wildlife (koalas) and also about erosion caused by culverts	Inland Rail has developed the fauna movement and fencing strategy. A copy of the strategy is provided as EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy.
Social and economic benefits	Strong feedback that 'local' opportunities mean opportunities for the towns within the Project impact assessment area, not only a nearby regional centre such as Toowoomba	Refer EIS Appendix U: Social Impact Assessment Report.

1.15 Principles of ecologically sustainable development

Ecologically sustainable development refers to using, conserving and enhancing the community's resources so that ecological processes are maintained and the total quality of life, both now and in the future, can be increased. There are four principles of ecologically sustainable development:

- Precautionary principle
- Principle of inter-generational equity
- Conservation of biological diversity and ecological integrity
- Improved valuation and pricing of environmental resources.

It is impossible to construct major transport infrastructure, such as this Project, without causing environmental, social and/or economic impacts (positive and negative). During Project development, the four principles of ecologically sustainable development were used as a guide to identify potential impacts and develop mitigation measures that afford equal weighting to environmental, social, economic and engineering opportunities and constraints.

1.15.1 Precautionary principle

The precautionary principle stipulates that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In applying the precautionary principle, decisions should be guided by:

- Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment
- An assessment of the risk-weighted consequences of various options.

The Project is aligned with the precautionary principle in the following ways:

- The assessment of potential impacts is based on best practice, using the best available information. The assessment has involved key stakeholders and the relevant government agencies.
- The impact assessment considered the maximum area of disturbance
- Since 2005, the Inland Rail has been the subject of numerous desktop and field surveys, as well as wide-reaching stakeholder consultation. Knowledge gained over this period will ensure that the Project is designed, constructed and operated in a way that minimises potential impacts.
- The draft EIS draws attention to aspects of the Project that may cause serious and/or irreversible environmental damage, especially if the nature and extent of the damage is uncertain. Where environmental damage cannot be avoided, mitigation and management measures to protect the receiving environment are proposed. This includes securing offsets for impacts to biodiversity values.
- Lack of full scientific certainty has not been used as a reason for postponing measures to prevent environmental damage. For example, threatened species that could potentially occur but were not observed within the ecology impact assessment area during field surveys are still assumed present (rather than absent). Measures to avoid and/or mitigate impacts on threatened species are proposed, on the basis that these threatened species could be present within the impact assessment area.

The detail design will aim to further minimise impacts and site and species-specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable and the significant residual impacts are offset.

- During development of the Project, the alignment has been refined to:
 - Avoid sensitive vegetation, areas with known threatened flora and fauna communities, and key habitat areas
 - Avoid known items/areas of cultural heritage significance
 - Minimise flooding impacts
 - Minimise impacts on existing agricultural land and infrastructure, while also considering potential future land uses.

1.15.2 Intergenerational equity

The principle of intergenerational equity is that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

The Project is aligned with the principle of intergenerational equity in the following ways:

- When developing the proposed alignment, minimising potential environmental impacts was a key consideration. This will ensure that environmental values (hydrological regimes, water quality, habitat connectivity, cultural heritage sites, etc.) are conserved for existing and future generations.
- Climate change projections were factored into flood modelling for the Project, and climate change-specific mitigation measures are proposed
- A Sustainability Management Plan will be developed prior to commencement of construction and sustainability initiatives will be incorporated into the Outline Environmental Management Plan (Outline EMP) for the Project which will include engaging meaningfully with stakeholders, promoting long-term economic benefits and training and development opportunities for locals.

The need for Inland Rail is well documented. As part of the wider inland Rail Program, the Project would benefit existing and future generations by providing a safer, more efficient, means of transporting freight between Melbourne and Brisbane.

Conversely, should the Project (and therefore Inland Rail) not proceed, the principle of intergenerational equity may be compromised. Future generations would experience increasingly worse safety and environmental impacts due to continued growth in road transport between Melbourne and Brisbane, particularly along the Newell Highway.

1.15.3 Conservation of biological diversity and ecological integrity

A broad range of sustainability initiatives were identified and incorporated into the Project during the development of feasibility design which included protecting the environment by minimising the environmental footprint.

Impacts on biological diversity and ecological integrity have been avoided to the greatest extent possible. For example, surveys were conducted to verify the presence of threatened species and ecological communities within the impact assessment area. The results were used to inform the development of the reference design and location of opportunities for fauna crossings, fauna exclusion fencing, and landscaping, revegetation and rehabilitation works.

Consideration by the Project of biological diversity and ecological integrity include:

- A crossing structure hierarchy was adopted during design development. Preference was given to bridges over culverts as, on the whole, bridges result in less severe impacts to fauna passage.
- Fauna crossing opportunities for species such as Koala, Condamine earless dragon and Greater glider have been co-located with waterway crossing structures to maintain habitat connectivity across the rail corridor. Where possible, these align with regional, state and locally significant fauna movement corridors or areas of important fauna habitat
- Cross drainage structures have been designed with consideration for Department of Agriculture and Fisheries' (DAF) *Accepted development requirements for operational work that is constructing or raising waterway barrier works* when designing bridges and culverts across mapped Queensland Waterways for Waterway Barriers Works
- A Rehabilitation and Landscaping Management Sub-plan will be developed to guide the approach to rehabilitating disturbed areas. Rehabilitation will occur progressively throughout the construction phase.
- Other plans that will be developed to minimise potential impacts on biodiversity during the construction phase include a Biodiversity Management Sub-plan, Biosecurity Management Sub-plan and a Soil Management Sub-plan as components of the Construction Environmental Management Plan (CEMP).

Where impacts cannot be avoided (e.g. clearing of Regional Ecosystems (RE) and essential habitat), mitigation and management measures will be implemented. Where required, biodiversity offsets will be secured. An Environmental Offset Delivery Strategy (Qld) (included as EIS Appendix N: Draft Offset Strategy) for the Project has been prepared in consultation with the QLD and Australian Governments and will inform the delivery of offsets in relation to significant residual impact upon environmental matters.

1.15.4 Improved valuation, pricing and incentive mechanisms

The principle of improved valuation, pricing and incentive mechanisms requires that environmental factors should be included in the valuation of assets and services, such as:

- Polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement
- The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste
- Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

It is difficult to place a monetary value on the Project's environmental impacts. However, the value placed on environmental resources within and surrounding the alignment is apparent in the breadth and depth of environmental investigations undertaken to inform the Project design and mitigation measures.

The costs associated with environmental design and mitigation measures have been built into the overall Project cost. For example:

- Where required, offsets will be secured to ensure a neutral or net beneficial biodiversity outcome for the region is achieved
- A range of mitigation measures will be implemented to ensure that, during construction and operation, waste is avoided, reused or recycled wherever possible. Waste mitigation measures will be documented in a Waste Management Sub-plan to the CEMP, including:
 - The management of waste activities associated with the Project will be underpinned by the 2018 *National Waste Policy* and *Waste Reduction and Recycling Act 2011* (Qld) waste and resource management hierarchy, as listed below in the preferred order to be considered:
 - Avoid or reduce
 - Reuse
 - Recycle
 - Recover energy
 - Treat
 - Dispose.
- Increased economic growth and reduced freight transport costs as a result of Inland Rail have been recognised. As stated in EIS Chapter 17: Economics, Inland Rail is expected to increase Australia's GDP by \$16 billion during construction and the first 50 years of operation, while decreasing freight transport costs by an estimated \$10 per tonne.

2 Legislation, policies and guidelines

The legislation, policy and management framework for the Project, as applicable to the assessment of MNES at the Commonwealth level, is summarised in Table 2.1.

The threatened species guidelines applicable to MNES of relevance to the Project and referenced for this assessment have been introduced, as applicable, in Section 3.2 and Section 3.3. These guidelines are as follows:

- Draft referral guidelines for the nationally listed Brigalow Belt reptiles (DSEWPaC 2011e)
- Draft referral guideline for 14 birds listed as migratory species under the EPBC Act (DotE 2015a)
- EPBC Act Referral Guidelines for the vulnerable koala (combined populations of QLD, New South Wales and the Australian Capital Territory), (DotE 2014a)
- Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011c)
- Survey guidelines for Australia's threatened birds (DEWHA 2010b)
- Survey guidelines for Australia's threatened bats (DEWHA 2010a)
- Survey guidelines for Australia's threatened mammals (DSEWPaC 2011b)
- Referral guideline for management actions in grey-headed and spectacled flying-fox camps (DotE 2015b).

Table 2.1 Commonwealth legislation and policies relevant to the Project

Legislation/ policy/plans	Legislative jurisdiction	Intent	Applicability
Commonwealth			
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth)	Australia and its Territories. Specifically, projects that involve or have the potential to impact upon nationally and internationally important flora, fauna, ecological communities and heritage places – defined under the Act as MNES.	The EPBC Act is the Australian Government's central piece of environmental legislation and provides the legal basis for the management and protection of nationally and internationally important flora, fauna, ecological communities and heritage places. Under Section 45 of the EPBC Act, the Australian Government and Queensland Government have implemented a bilateral agreement relating to environmental assessment. This agreement allows the Commonwealth Minister for the Environment and Department of the Environment and Energy (DotEE) to rely on specified environmental impact assessment processes of Queensland in assessing actions under the EPBC Act. The bilateral agreement specifically aims to achieve the following objectives: - Protect the environment in accordance with the requirements of the EPBC Act - Promote the conservation and sustainable use of natural resources - Ensure an efficient, timely and effective process for environmental assessment and approval of actions.	ARTC submitted an EPBC Act referral to the DotEE in February 2018 (EPBC 2017/7944) The Minister for the Environment declared the Project a 'controlled action' on 9 April 2018 to be requiring the preparation of an EIS. The controlling provisions for the controlled action are: Listed threatened species and communities. The EPBC Act controlled action will be assessed under the bilateral agreement with the Queensland Governments
<i>EPBC Act Environmental Offsets Policy (2012)</i> (EPBC Act Offsets Policy)	Areas subject to the EPBC Act	Developed to support the management and protection of MNES under the EPBC Act and outlines the Australian Government's approach to the use of environmental offsets for impacts to MNES. Eight principles for the use of environmental offset under the EPBC Act have been developed by DotEE. These principles are used to assess any proposed environmental offset for MNES to ensure consistency, transparency and equity under the Act. The Australian Government's position is that environmental offsets must: <i>Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action</i> <i>Be built around direct offsets but may include other compensatory measures</i> <i>Be in proportion to the level of statutory protection that applies to the protected matter</i> <i>Be of a size and scale proportionate to the residual impacts on the protected matter</i>	The Project will implement avoidance and mitigation measures to minimise the significant adverse residual impacts on the MNES. implementing mitigation measures including offsets will be consistent across the Inland Rail Program. Offsets provided for under the policy include direct offsets, and other compensatory methods (or indirect offsets). It is likely that a combination of methods will be applicable to the Project, based on the extent of the significant adverse residual impacts on MNES. The Project will comply with the EPBC Act Offsets Policy for any significant adverse residual impacts to MNES. It is proposed a Detailed Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction commencement subject to the approval under the EPBC Act.

Legislation/ policy/plans	Legislative jurisdiction	Intent	Applicability
		- Effectively account for and manage the risks of the offset not succeeding - Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of State or territory offsets that may be suitable as offsets under the Act for the same action) - Be efficient, effective, timely, transparent, scientifically robust and reasonable - Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced (Australian Government 2012). The Australian Government defines offsets as measures that compensate for the significant residual impacts of an action on the environment (Australian Government 2012).	
Significant impact guidelines 1.1 – Matters of National Environmental Significance: Environment Protection and Biodiversity Conservation Act 1999 (DEWHA 2013) (MNES Guidelines)	MNES	The purpose of the MNES Guidelines are to assist any person who proposes to take an action to decide whether or not they should submit a referral to the DotEE for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the EPBC Act. The MNES Guidelines outlines a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required. Important terms and phrases are explained.	Assessment of MNES against the MNES Guidelines will facilitate the determination of a significant residual impact to MNES. This has been undertaken in Sections 8, 8.2 and 8.3).
Species recovery plans	MNES	Recovery plans for listed threatened species and ecological communities have been made or adopted under the EPBC Act. These plans remain in force until and unless the species is removed from the threatened list. A recovery plan is a document stating the research and management actions necessary to stop the decline, support the recovery and enhance the chance of long-term survival in the wild, of a protected community, animal or plant species.	Species recovery plans for the following MNES relevant to this Project have been considered as part of this assessment: - Winged peppercreep (<i>Lepidium monoplacoides</i>)- endangered - Murray cod (<i>Maccullochella peelii peelii</i>) - vulnerable - Regent honeyeater (<i>Anthochaera phrygia</i>) – critically endangered - Red goshawk (<i>Erythrotriorchis radiatus</i>) - Swift parrot (<i>Lathamus discolor</i>) – critically endangered - Black-breasted button-quail (<i>Turnix melanogaster</i>) - Large-eared pied bat (<i>Chalinolobus dwyeri</i>) - Spotted-tail quoll (mainland) (<i>Dasyurus maculatus maculatus</i>) – endangered

Legislation/ policy/plans	Legislative jurisdiction	Intent	Applicability
			■ Brush-tailed Rock-wallaby (<i>Petrogale penicillata</i>) ■ Condamine earless dragon (<i>Tympanocryptis condaminensis</i>) – endangered Draft recovery plans awaiting adoption under the EPBC Act and utilised for this report include the following species: ■ Australian lungfish (<i>Neoceratodus forsteri</i>) ■ Australian painted snipe (<i>Rostratula australis</i>) ■ Australasian bittern (<i>Botaurus poiciloptilus</i>) ■ Grey-headed flying-fox (<i>Pteropus poliocephalus</i>) These recovery plans were used to guide the predictive habitat mapping for each relevant species (refer Section 3.2.4), impact assessment in relation to the MNES Guidelines (refer Section 8), and the development of mitigations measures (refer Section 6.2).
Threat abatement plans	MNES	Threat abatement plans provide for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on native species and ecological communities. Implementing the plan should assist the long-term survival in the wild of affected native species or ecological communities	Threat abatement plans relevant to MNES associated with the Project include: ■ Threat abatement plan for disease in natural ecosystems caused by <i>Phytophthora cinnamomi</i> ■ Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by Cane toads (<i>Rhinella marina</i>) ■ Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral Pigs (<i>Sus scrofa</i>) ■ Threats identified in the Threat abatement plan for competition and land degradation by rabbits ■ Threat abatement plan for predation by feral cats ■ Threat abatement plan for predation by the European red fox ■ Threat abatement plan for competition and land degradation by unmanaged goats. These threat abatement plans were used to guide the impact assessment in relation to the Matters of National Environmental Significance: Significant impact guidelines 1.1 – Environmental Protection and Biodiversity Conservation Act 1999 (refer Section 8), and the development of mitigations measures (refer Section 6.2).

3 Methodology of assessment

3.1 Overview

The initial step of the assessment was to identify the MNES (e.g. EPBC Act listed species and threatened ecological communities (TECs)) relevant to the Project. This was undertaken using a combination of desktop-based datasets and validation of predictive, species-specific mapping, which was supplemented by targeted field surveys at defined locations (refer Section 3.3).

Predictive habitat modelling for each of the MNES (refer Section 3.2.4, as well as Appendix A) was developed. It is noted the survey guidelines for EPBC Act threatened fauna species state:

“...Alternatives to a dedicated survey may also be appropriate. For example, a desktop analysis of historic data may indicate that a significant impact is not likely. Similarly, a regional habitat analysis may be used to determine the importance of a site to the listed birds. Proponents should also consider the proposals impact in the context of the species’ national, regional, district and site importance to establish the most effective survey technique(s)...”

Detailed onsite surveys for threatened species have not necessarily been undertaken as per the relevant Commonwealth survey guidelines. Where there are no Commonwealth guidelines (e.g. for threatened flora), surveys have been carried out following State guidelines (e.g. Department of Environment and Heritage Protection (DEHP) 2016).

Nevertheless, a range of various ecological survey methods have been carried out over a number of years and seasons. In combination with the conservative predictive habitat modelling developed for the Project, these survey methods are considered appropriate for assessing the potential presence of MNES along a 216 km Project alignment. More importantly, the surveys have provided information regarding assessment of the habitat values occurring along the Project alignment and its ability to potentially support MNES species. Section 3.3.1 outlines the methods used during Project-associated surveys as they apply to MNES fauna species.

The threatened species habitat modelling used in this assessment was based on a conservative approach to mapping habitat. That is, habitat for threatened species has been assumed to be present unless there is sufficient and robust scientific information to support a species being excluded from the assessment. The approach is also conservative given the quality of habitat or the carrying capacity of the habitat has been excluded from the assessment. Although this information has been referred to in determining whether a significant impact is likely when assessed against the MNES significant impact guidelines (refer Sections 8, 8.2 and 8.3). Assumptions that were adopted in developing the predictive habitat models are discussed in Section 3.2.4.

The predictive habitat modelling along with relevant scientific information was used to inform the significant impact assessment (direct and indirect) and where applicable measures to avoid, minimise and mitigate impacts. As part of this assessment the maximum potential area of disturbance was determined for each MNES using the predictive habitat modelling (i.e. the total extent of habitat to be cleared irrespective of habitat type and quality).

A key outcome of the significant impact assessment is the determination as to whether the Project will have a significant residual impact on each of the MNES under the MNES Guidelines (refer Sections 8, 8.2 and 8.3). The impact assessment has been undertaken on the potential “worst case scenario”, which is based on a conservative Project footprint established for the reference design. The Project footprint will be refined during the detail design phase of the Project to reflect the final Project design and the land required to accommodate the Principal Contractor’s adopted construction methodology. This process is expected to result in a reduction in the total Project footprint area and subsequent impacts to ecological receptors (including MNES).

The interaction of each stage of the assessment process is represented schematically in Figure 3.1. Further information regarding the development of predictive habitat mapping to support the assessment process provided in Appendix A.

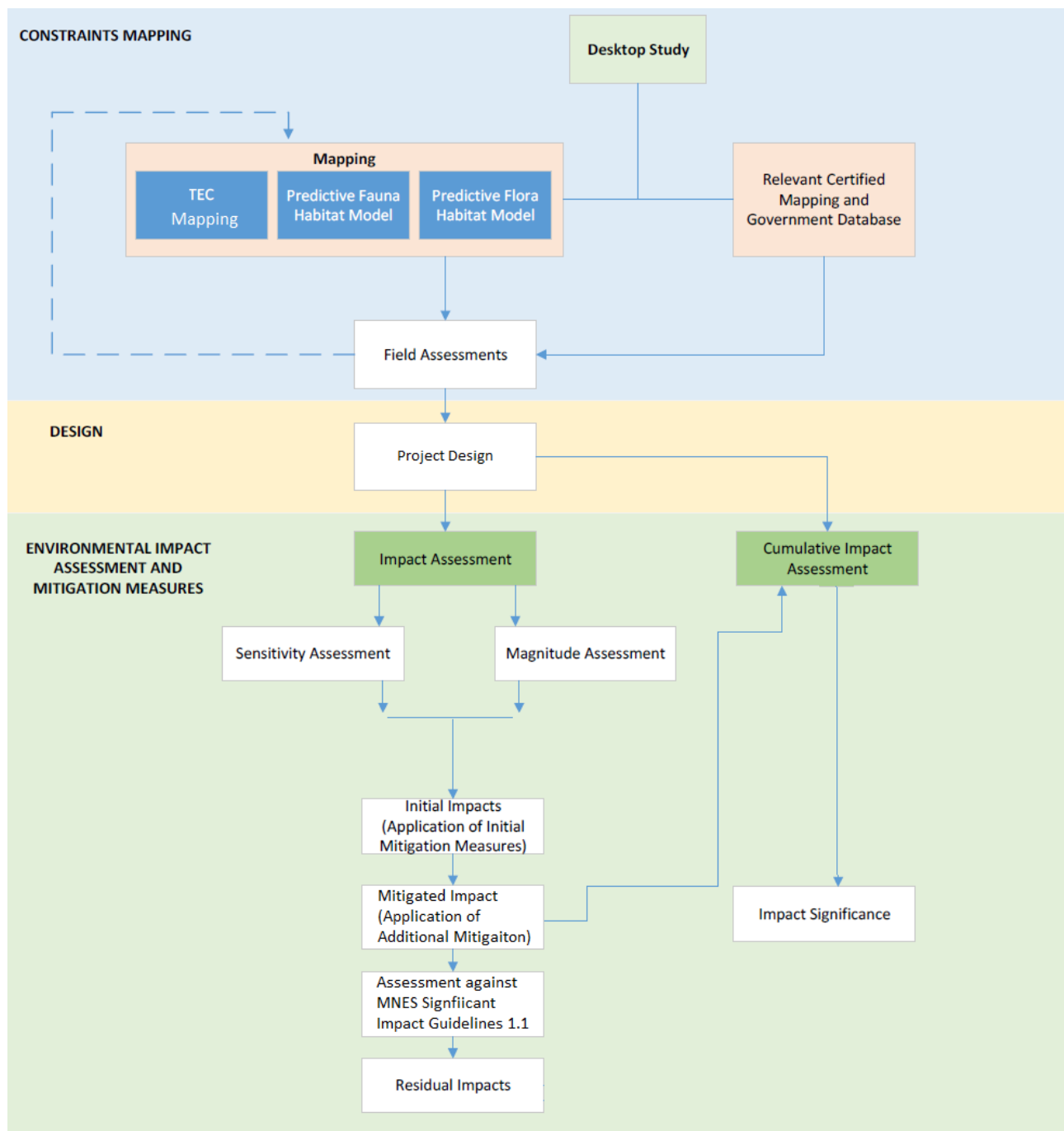


Figure 3.1 Assessment methodology

The approach outlined in Figure 3.1 and documented in this report, is the initial step in the determination of the extent of impacts associated with the Project upon MNES. That is, during the detail design, the design and construction methodology will be refined (in particular the Project footprint) with due consideration to the Project's impacts and mitigation measures, approval conditions and additional information on the ecological values of the Project (e.g. additional ecological surveys in accordance with Commonwealth threatened species survey guidelines). As such the significance of the impacts on MNES will also change. All of which will be done in consultation with the DAWE, relevant stakeholders and where applicable the community.

The approach adopted for this assessment is designed to be dynamic and will evolve in response to changes to the design and footprint, along with additional ecological information gained from Project activities (e.g. pre-clearing surveys or protected plant surveys in accordance with the relevant flora survey guidelines (i.e. DEHP 2016) and changes to species status. This flexibility also has benefits such that during the construction stage, it allows management and monitoring of compliance with disturbance limits and environmental offset requirements. That is, the predictive mapping models along with other Project inputs (e.g. fauna 'breeding places' identified during pre-clearing surveys) can be used to identify temporary and permanent no-go zones and track clearing extents against relevant disturbance limits and where applicable inform additional specific mitigation measures.

3.2 Desktop study

This section details the desktop analysis undertaken to identify MNES located within the impact assessment area, and existing gaps in datasets. This analysis included a review of existing field data collected prior to the commencement of the impact assessment and field data collected during the field component of the impact assessment. In addition, this section provides details related to the creation of predictive GIS models which specifically identify areas of habitat capable of supporting species listed under the EPBC Act and communities within the impact assessment area.

3.2.1 Database review

A database review was initially undertaken in 2017 prior to field investigations to identify MNES that were known or likely to be present within the impact assessment area. However, to ensure that the most recent data was obtained, searches were re-run to ensure that any relevant updates, or additional species observations were incorporated into the assessment. Details of the relevant database sources, the most recent search dates, search area parameters and type of information considered for the desktop study are summarised in Table 3.1.

Table 3.1 Database review summary

Database/data source name	Database search date	Database search areas	Data type
Atlas of Living Australia	11/05/2020	Impact assessment area	Ongoing inspection of records of flora and fauna, including threatened species listed under the EPBC Act.
Flying Fox Monitoring Program	24/04/2020	Impact assessment area	Show the location of flying-fox roosts in Queensland recorded by the department and include monitoring data of continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Birds Australia	29/03/2019	Impact assessment area	Records of avian fauna, including threatened species listed under the EPBC Act
Wetland <i>Info</i> database (DES 2019)	26/02/2020	Impact assessment area	Provides interactive maps, species records, case studies and legislation associated with Queensland wetlands
EPBC Act Protected Matters Search Tool (PMST) (Australian Government)	26/02/2020	Impact assessment area	Provides a "predictive" account of MNES identified within a specific area. Includes MNES such as world heritage properties, national heritage places or wetlands of international importance and threatened/migratory species.
Regulated Vegetation Management Map (DESv2020)	26/02/2020	Regional extent	Mapping of REs and High Value Regrowth that provide habitat for TECs and threatened species under the EPBC Act.

Database/data source name	Database search date	Database search areas	Data type
Matters of State Environmental Significance (MSES) Wildlife habitat mapping (Queensland Government 2019)	26/02/2020	Regional extent	Provides interactive maps, species records, case studies and legislation associated with Queensland wetlands.
Wildlife Online database (Queensland Government)	26/02/2020	Impact assessment area	Records of flora and vertebrate fauna including conservation significant species listed under the EPBC Act
Matters of national environmental significance (DAWE 2020)	26/02/2020	Impact assessment area	Location of MNES, including: - Conservation significant species as listed under the EPBC Act - TECs listed under the EPBC Act - Critical habitats - World Heritage Properties - National Heritage Places - Wetlands of International Importance (i.e. Ramsar) - Great Barrier Reef Marine Park - Commonwealth Marine Area - Nuclear Areas.

Specifically, data from the sources identified above were used to establish the likely presence or absence of the following MNES within the impact assessment area:

- EPBC Act listed threatened species and ecological communities (controlling provision)
- EPBC Act listed migratory species
- World Heritage Properties
- National Heritage Places
- Wetlands of International Importance (i.e. Ramsar)
- Great Barrier Reef Marine Park
- Commonwealth Marine environment.

3.2.2 Review of existing literature and other studies

Previous assessments and reports of relevance to the region were identified to enable an analysis of existing ecological field data associated with the impact assessment area. Previous assessments and reports of relevance to the Project, including survey timing and survey activities, are listed in Table 3.2.

Seasonal variation was also captured in the modelling approach (refer Section 3.2.4) which utilised government datasets and historic records that were developed across multiple seasons/years. The results of the modelling and subsequent mapping output provide a measure of the amount of suitable habitat that is present regardless of season as it collates essential habitat components required by the species (e.g. vegetation structure, geological feature, presence of specific hydrology regimes). In addition to the material identified in Table 3.1, site specific database queries as identified in Table 3.1, have been accessed to produce the predictive habitat mapping related to MNES flora and fauna to align with that prescribed by relevant recovery plans and conservation advices (refer Section 3.2.4 and Appendix A). Whilst it is acknowledged that previous investigations have been limited, the analysis of existing database records, additional survey work (refer Section 3.3) and the formulation of the predictive habitat models are considered to adequately account for seasonal variation and detectability related to threatened species.

Surveys locations of previous assessments are shown in Figure 3.2a to Figure 3.2d. The findings of each of the studies listed in Table 3.2 were used to supplement gaps identified from database searches, particularly in relation to the MNES matters.

Table 3.2 Previous assessment and reports associated with ecological values of the Project

Document/ investigation title	Timing of supporting surveys	Summary of significant findings related to MNES used to verify inputs to this assessment
Australian Rail Track Corporation Limited/Transport - Land/Multiple lots/ Queensland/Inland Rail Border to Gowrie project, QLD (EPBC referral 2018/8165) (ARTC 2018j) ¹	26-29 April 2016 12-15 September 2016 25-28 October 2016	Provides initial details on how the Project is likely to impact upon MNES. This includes, identification of the potential presence of threatened species. Identified the likely presence of the following species: - Confirmation of Brigalow (<i>Acacia harpophylla</i> dominant and codominant) TEC - Confirmation of Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions TEC - South-eastern long-eared bat (<i>Nyctophilus corbeni</i>) considered potentially present based on call analysis and location (Canning Creek)
Aurecon investigations undertaken as part of the Toowoomba Bypass (Toowoomba Second Range Crossing) Project	October 2015 – June 2018	Identified the presence of the following sensitive environment MNES to the east of the Project footprint: - Collared delma (<i>Delma torquata</i>) - Austral toadflax (<i>Thesium australe</i>) - Hawkweed (<i>Picris evae</i>) - Austral cornflower (<i>Rhaponticum australe</i>)
Initial Advice Statement: Inland Rail – Border to Gowrie (ARTC 2018a) ²	Nil	Provides initial details on how the Project is likely to impact upon MNES. This includes, identification of the potential presence of threatened species and TECs.

Table notes:

- 1 Available from: <http://epbcnotices.environment.gov.au/portal/modal-form-template-path/a71d58ad-4cba-48b6-8dab-f3091fc31cd5?id=c01afbcd-e912-e811-9fee-005056ba00a7&entityformid=c2c88dfd-64a4-49bf-84fb-49edb9186137&languagecode=1033#>
- 2 Available from: <http://eisdocs.dsdip.qld.gov.au/Inland%20Rail%20Border%20to%20Gowrie/IAS/final-initial-advice-statement.pdf>

Not all of the surveys conducted to inform the assessments in Table 3.2 were undertaken within the impact assessment area. However, observations from the surveys were still of use in confirming the presence of species, vegetation communities and other habitat types in proximity to the Project. The potential for MNES to occur within the impact assessment area was not discounted based on any of the findings of assessments in Table 3.2. Instead, they were used to reinforce understandings already obtained from other sources (refer Section 3.2.1). This information was of use in evaluating regional ecological habitats and developing the predictive habitat modelling for conservation significant species (refer Section 3.2.4) and the mapping of TECs (refer Section 3.2.5), specifically for informing assessment of the likelihood of occurrence of MNES within the impact assessment area.

3.2.3 Assessment of the likelihood of occurrence of threatened species

The likelihood of threatened species listed under the EPBC Act to occur within the impact assessment area was determined based on the results of the desktop study and review of existing literature (refer Appendix B), which was later supplemented with data derived from field assessments (refer Section 4.3, Appendix E and Appendix F) and used to refine the predictive habitat mapping (refer Figure 3.1 and Appendix A). The likelihood of occurrence assessment was central to determining which conservation significant species were identified as MNES for the Project and were subsequently subject to predictive habitat modelling (refer Section 3.2.4 and Appendix A).

Threatened species considered **possible** or **likely** to occur, or which were identified in the impact assessment area during Project-associated field assessments (grouped under **likely**), were assessed as **MNES applicable to the Project**. Threatened species, which were considered **unlikely** to occur within the impact assessment area, were not considered further as part of the impact assessment.

This process allowed for the identification of species that are most likely to be at risk from the Project impacts.

The likelihood of occurrence assessment was based on records collected during the impact assessment field assessments, historic datasets and consideration of a species current (known) distribution range and the presence and condition of suitable habitat in the impact assessment area.

Species considered **unlikely** to occur include species that fit one or more of the following criteria:

- The impact assessment area is beyond the current distributional limits
- Use specific habitat types or resources that are known not to be present in the impact assessment area (e.g. highland eucalypt open forest habitats with a dense understorey - Long-nosed potoroo (*Potorous tridactylus tridactylus*))
- Are considered locally extinct (e.g. Southern Black throated finch (*Poephila cincta cincta*), Northern quoll/digul (*Dasyurus hallucatus*)).

Species considered to **possibly** occur include species that fit one or more of the following criteria:

- Have infrequently been recorded previously in the impact assessment area (i.e. sporadic records with no recent sightings within the past 10 years within 20 km of the impact assessment area)
- Use habitat types or resources that are present in the impact assessment area, although generally in a poor or modified condition
- Are unlikely to maintain sedentary populations, however may seasonally utilise resources within the impact assessment area opportunistically during variable seasons or migration (e.g. Swift parrot (*Lathamus discolor*)). Note that species that can be identified as sporadically utilising areas of the impact assessment area (e.g. Grey-headed flying-fox (*Pteropus poliocephalus*)) are assigned to the “likely” category.

Species considered **likely** to occur include species that fit one or more of the following criteria:

- Have been recently recorded in the impact assessment area (i.e. sightings within the past 10 years within 20 km of the impact assessment area)
- Use habitat types or resources that are present in the impact assessment area, which are in good condition (with condition based on based desktop works, literature review and, where available and possible, supplementary field assessments)
- Are likely to maintain sedentary populations within the impact assessment area.

Information related to ecology, habitat requirements, threatening processes, threat abatement and recovery plans and distribution for each of the conservation significant species and communities identified from the desktop component is provided in Section 8.2 and Sections 8.3 and Appendix B.

3.2.4 Predictive habitat modelling for conservation significant species

3.2.4.1 Overview

Predictive habitat modelling was undertaken to identify and map areas that were determined as having the potential to provide habitat for conservation significant species listed under the EPBC Act in accordance with the ToR.

Whilst this technical report deals with MNES, State-based GIS layer datasets were used as habitat delineators and were incorporated into the predictive habitat model where applicable for each species. For example, regional ecosystems associated with remnant and high value regrowth vegetation, geological datasets, drainage feature mapping and cadastral boundaries were used to identify road reserves (where grazing pressures would be excluded) that may provide important habitat for species such as Austral toadflax (*Thesium australe*).

In addition, to adequately capture known records of threatened species (e.g. historic records and those identified during field assessment), all areas (regardless of existing vegetation communities) within a 1 km radius of the record were “automatically” identified as providing habitat for the specific species to which the record belonged. This distance adequately accounts for the potential movement and dispersal for the relevant species and would also mitigate potential issues associated with record precision. In some instances (e.g. habitat mapped for the Koala (*Phascolarctos cinereus*)), the mapped habitat contained areas of agricultural land, grassland, open forest/woodland habitat, as well as scattered trees that may provide habitat connectivity to larger forest patches. Habitat comprising scattered trees may be considered ‘critical to the survival of the species’ when referring to Koala. These habitat areas will be refined further during the detailed design phase of the Project through targeted fieldwork for threatened species and associated habitat values.

The model was designed to recognise specific requirements of each threatened species, which were identified through the broader desktop analysis. Where available this information was derived from species/community recovery plans, DAWE approved conservation advice for species/community, and relevant scientific studies. This approach to habitat mapping represents a highly conservative methodology and applies the precautionary principle (i.e. where doubt exists, habitat is included rather than excluded in addition to the inclusion of some areas of habitat that are not considered essential to the survival of the species) so as not to underestimate potential habitat for threatened species.

Databases and other information that were used to feed into the predictive GIS based model are identified in Table 3.1 (refer Section 3.2.1), Appendix A and Appendix B. In addition to database information, fauna and flora species data collected during field based assessments (such as species records) (refer Section 3.3) was used to verify and ‘fine-tune’ model outputs (refer Figure 3.1).

The habitat in the predictive threatened species habitat model was categorised as Habitat critical to the survival of the species, Important habitat and Potential habitat using current scientific knowledge and pre-existing data derived from historic surveys, state based mapping and scientific publications and industry recognised experts. The specific habitat assumptions for each species are provided in Appendix A.

The predictive habitat modelling provides greater certainty in predicting the likelihood of a listed threatened species (EPBC Act controlling provisions) occurring within the MNES study area, when compared to limited and or sporadic field investigations.

As with any modelling, assumptions have had to be made in determining the inputs to the assessment. Where assumptions have been necessary, a conservative, precautionary approach has been adopted to ensure that potential impacts are not underestimated. Assumptions adopted in developing the predictive habitat modelling are provided in Appendix A. The species-specific assumptions allowed the following areas to be identified for each threatened species:

- Unlikely habitat
- Potential habitat
- Important habitat (where applicable)
- Habitat critical to the survival of the species (where applicable).

These habitat categories are defined in Section 3.2.4.2 to 3.2.4.5. The use of these habitat categories aligns with DAWE’s habitat definitions for species protected under the EPBC Act where they are defined under relevant recovery plans and/or referral guidelines.

The predictive habitat modelling provides greater certainty in predicting the likelihood of a threatened flora and fauna species (EPBC Act) occurring within the impact assessment area, when compared to limited and or sporadic field investigations.

3.2.4.2 Unlikely habitat

Unlikely habitat consists of areas that do not contain specimen backed records of the particular species (i.e. no point data derived from the positive identification/confirmation of a species in the field) and contain no evidence of habitat values to support the presence or existence of resident individuals or populations of the species. However, it is acknowledged that these areas may provide temporary habitat for species during exceptional circumstances. It is considered that occurrences of the subject species within these areas is an anomaly as these areas are not likely to support the species in the long-term.

3.2.4.3 Potential habitat

Potential habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as Important habitat or Habitat critical to the survival of the species (i.e. records of the species are considered anomalies as general microhabitat features are not considered to be present from a desktop perspective). Potential habitat also includes suitable habitat that is available to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records and where this does not completely address the relevant criteria to be mapped as Habitat critical to the survival of the species or Important habitat. Potential habitat may include areas of suboptimal habitat for a species. Species specific assumptions that define the Potential habitat category are identified in Appendix A. Impacts to Potential habitat (where no habitat critical to the survival of the species occurs) are generally not considered to contribute towards significant residual impacts to an MNES.

3.2.4.4 Important habitat

In line with DAWE's guidelines, areas of Important habitat are regarded as a surrogate for important populations of Brigalow belt reptiles, which are known to occur within the impact assessment area. The following species are classified as Brigalow Belt reptiles and, where relevant, Important habitat for these species has been mapped as defined in Section 5 of the *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e):

- Collared delma (*Delma torquata*)
- Dunmall's snake (*Furina dunmalli*)
- Five-clawed worm-skink (*Anomalopus mackayi*)
- Yakka skink (*Egernia rugosa*).

In addition to the species identified above, the Important habitat has been used to capture "Priority habitat areas" for the Swift parrot as identified in the *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Saunders and Tzaros 2011).

Species specific assumptions that define the Important habitat category for the abovementioned species are provided in Appendix A. Impacts to Important habitat are considered to contribute towards significant residual impacts to an MNES

3.2.4.5 Habitat critical to the survival of the species

In line with DAWE's guidelines Habitat critical to the survival of the species represents habitat with the greatest value for relevant MNES species. This habitat category identifies areas that align with "Habitat critical to the survival" of a listed threatened species is identified in an approved Recovery Plan for the relevant MNES. However, in instances where there are no Recovery Plans for a specific species, and in line with the precautionary approach, the presence of a specimen backed record (i.e. derived from field investigations or previous database records with low location error information and from within the last 30 years) is considered to align with this category where breeding and foraging habitat is potentially present. For these species, elevation of habitat to this level adequately accounts for the significance of such areas regardless of the absence of a Recovery Plan. Species specific assumptions associated with the mapping of Habitat critical to the survival of the species are detailed in Appendix A. Impacts to Habitat critical to the survival of the species are considered to contribute towards significant residual impacts to an MNES.

3.2.5 Mapping of threatened ecological communities

TECs were identified by extrapolation using the relevant DAWE conservation listing advice available on the Species Profile and Threats Database (SPRAT), including analogous regional ecosystems (REs) for each TEC identified during the desktop review phase. Analogous vegetation communities (i.e. remnant and regrowth REs as mapped by the Queensland Government) as regulated by the VM Act were identified which were then used to spatially map out the extent of each of the identified TECs. Identified TECs and the analogous REs (both remnant and high value regrowth) were used to map each of the TECs is presented in Table 3.3.

It is acknowledged the State-based RE mapping may be inaccurate and therefore may not identify the true extent of potential TECs within the Project footprint (e.g. smaller patches of potential TEC vegetation may not be mapped as remnant or high-value regrowth communities under State-based mapping). Where targeted field investigations (refer Section 3.3.1 for survey locations) confirmed or rejected the presence of the TEC, these results were incorporated into the final TEC mapping for the Project footprint. This process of mapping refinement will continue as more detailed surveys are undertaken for the Project. Impacts to any areas containing a TEC has the potential to contribute toward significant residual impacts to the relevant TEC.

The majority of the TECs potentially occurring within the MNES study area are analogous with an RE and as such can be readily identifiable from the current State-based vegetation mapping.

3.3 Field assessments

Following the formulation of the predictive habitat model and review of other GIS layers associated with Sensitive environmental receptors, field-based assessments were used to validate modelled habitat and desktop based mapping where applicable. In addition, field-based investigations were undertaken to identify baseline conditions to inform the feasibility stage of the Project and to inform constraints assessment process of the Project.

At each terrestrial sampling location, a vegetation survey, a fauna habitat assessment, active searches for cryptic fauna and opportunistic observations were undertaken as a minimum.

Opportunistic site investigations associated with pre-clearance work for geotechnical investigations were used to supplement the desktop-based datasets and validate predictive, species-specific mapping. Surveys undertaken at opportunistic survey locations were undertaken in accordance with the methodology prescribed in the *Flora Survey Guidelines – Protected Plants Nature Conservation Act 1992* (DEHP 2016). Whilst it is acknowledged that this is a Queensland based guidelines, it prescribes intensive investigation regimes that are considered adequate to identify MNES flora species.

This section outlines the field assessment methodologies adopted in recognition of relevant departmental guidelines or policies (i.e. survey guidelines, guidelines for EPBC Act listed species or communities, species recovery plans and the MNES Guidelines). Surveys were undertaken in accordance with the following:

- Methodology for survey and mapping of REs and vegetation communities in Queensland (Neldner et al 2017)
- Terrestrial vertebrate fauna guidelines for Queensland (Eyre et al 2018)
- Flora survey guidelines - protected plants, *Nature Conservation Act 1992* (DEHP 2016).

Whilst it is acknowledged that detailed surveys for threatened fauna have not been undertaken in full accordance with the relevant Commonwealth survey guidelines, a range of various ecological survey methods have been used over a number of years and seasons. In combination with the conservative predictive habitat modelling developed for the Project, these survey methods are considered appropriate for detecting the potential presence of MNES along a 216.2 km Project alignment. The information within this document is based on desktop information and targeted field-based information from limited surveys. The approach to assessing threatened species presence and habitat modelling for threatened species has adopted a conservative approach in order to avoid underestimating the available habitat potentially present within the Disturbance footprint. As such, it is considered this maintains the intent of the various guidelines. Further ecological surveys will be undertaken during the detail design phase of the Project as the Project footprint is refined to reflect the detail design and adopted construction methodology.

The location of terrestrial and aquatic survey sites was dictated by land access agreements with landholders which was provided on a voluntary basis. This significantly reduced the areas that were accessible to ecological investigations.

The extent of fieldwork and predictive flora and fauna modelling undertaken for the Project, when used in conjunction with existing information (refer Figure 3.2) are considered sufficient to provide confidence in predictions of potential impacts to MNES in accordance with the ToR.

BioCondition assessments were omitted from the surveys, this method would likely have yielded results not representative to the typical habitat values due to drought conditions.

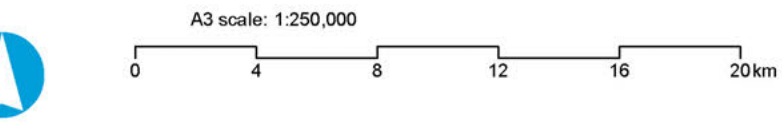
Detailed ecological surveys of the Project footprint will be undertaken in parallel to the development of the detail design. Data obtained from these surveys will be used to refine the quantification of ecological impacts and revise the calculation of offset requirements for the Project.

Table 3.3 EPBC Act listed threatened ecological community assumptions used to map areas of occurrence within the impact assessment area

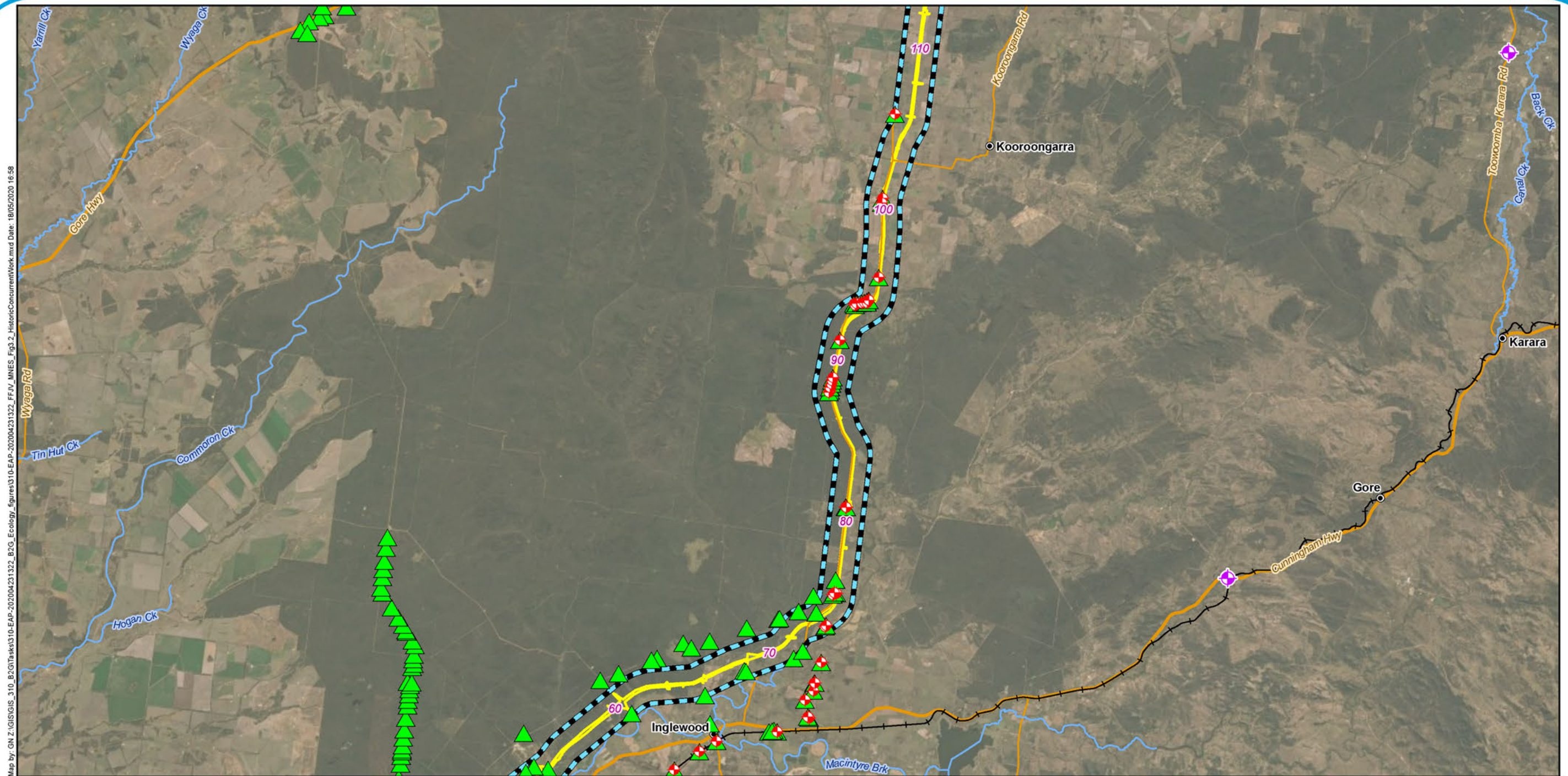
TEC name	EPBC Act status	Habitat requirements or analogous REs ¹
Brigalow (<i>Acacia harpophylla</i> dominant and co dominant) ecological community	Endangered	The following REs are analogous to this TEC: 6.4.2, 11.3.1, 11.3.1a, 11.3.1b, 11.3.1d, 11.4.3, 11.4.3a, 11.4.3b, 11.4.7, 11.4.8, 11.4.8a, 11.4.9, 11.4.9a, 11.4.9b, 11.4.10, 11.5.16, 11.5.16a, 11.9.1, 11.9.5, 11.9.5a, 11.9.6a, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6 and 12.12.26.
Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	The following REs are analogous to this TEC: 11.3.3, 11.3.3a, 11.3.3b, 11.3.3x1, 11.3.3c, 11.3.15a, 11.3.15, 11.3.16, 11.3.28, 11.3.37
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	The following REs are analogous to this TEC: 11.3.21, 11.3.24
Lowland Rainforest of Subtropical Australia (Note: within Qld, only identified as occurring within Bioregion 12: South-east Qld)	Critically Endangered	The following REs are analogous to this TEC: 12.3.1, 12.5.13, 12.8.3, 12.8.4, 12.8.13, 12.11.1, 12.11.10, 12.12.1, 12.12.16
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	The following REs are analogous to this TEC: 11.2.3, 11.3.11, 11.4.1, 11.5.15, 11.8.13, 11.9.4, 11.9.8, 11.11.18, 11.8.3, 11.8.6, 11.3.11x1, 11.9.4a, 11.9.4c, 11.10.8, 11.11.5, 11.11.21, 11.12.4
Weeping Myall Woodlands	Endangered	The following REs are analogous to this TEC: 11.3.2, 11.3.28, 11.3.2a, 11.3.2b, 11.3.2c
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland)	Critically Endangered	The following REs are analogous to this TEC: 11.8.2a, 11.8.8, 11.9.9a, 13.3.1, 13.11.8, 13.12.8, 13.12.9, 11.3.23, 12.8.16 (west of bioregion) 13.3.4, 13.11.3 and 13.11.4
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	The following REs are analogous to this TEC: 11.3.2, 11.3.2a, 11.3.2b, 11.3.2c, 11.3.17, 11.4.7, 11.4.12

Table note:

1 As regulated under the Queensland *Vegetation Management Act 1999*. Obtained from conservation listing advice contained within SPRAT

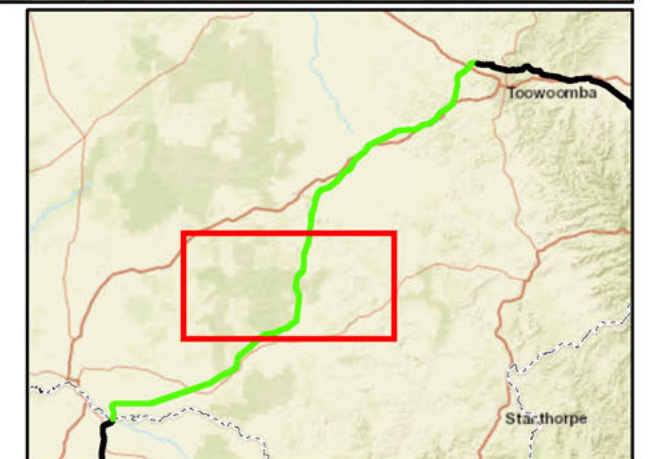


Border to Gowrie
Figure 3.2a: Location of areas sampled as part of historic and concurrent works



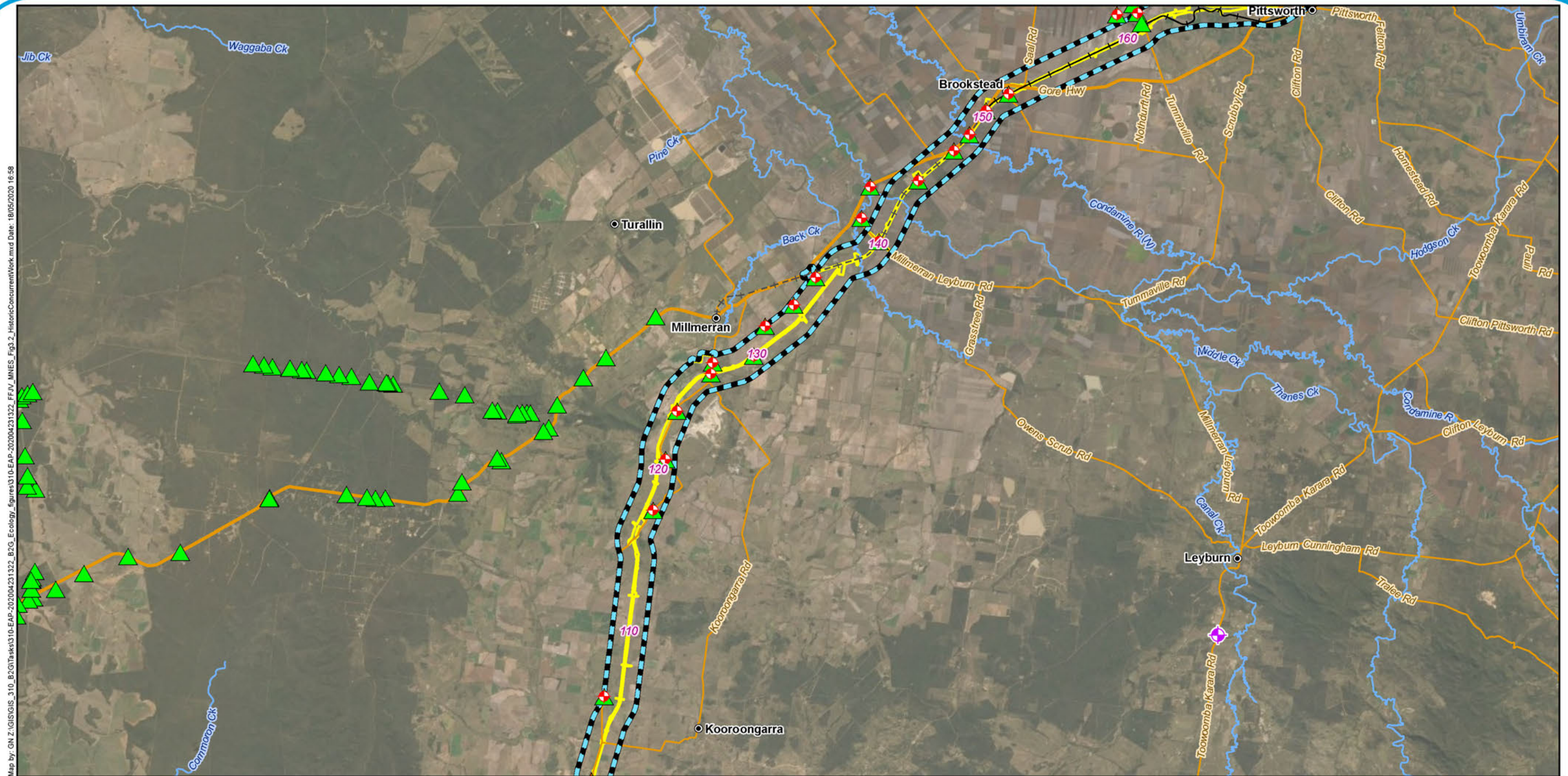
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Sampling locations**
- ◻ Eco logical survey sites 05/09/2016
- ▲ Eco logical survey sites 30/09/2016
- ◆ Anabat site



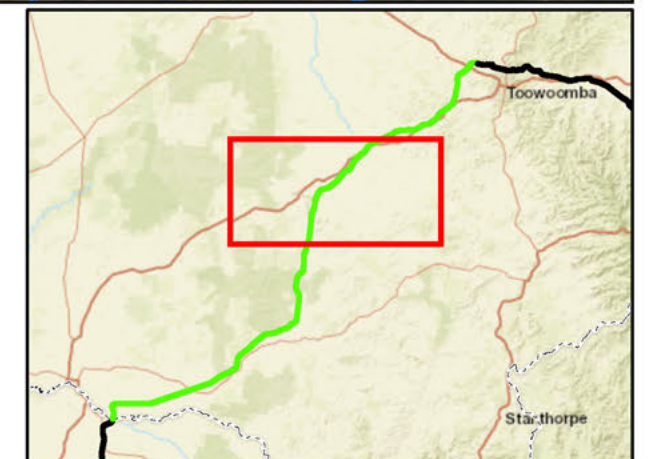
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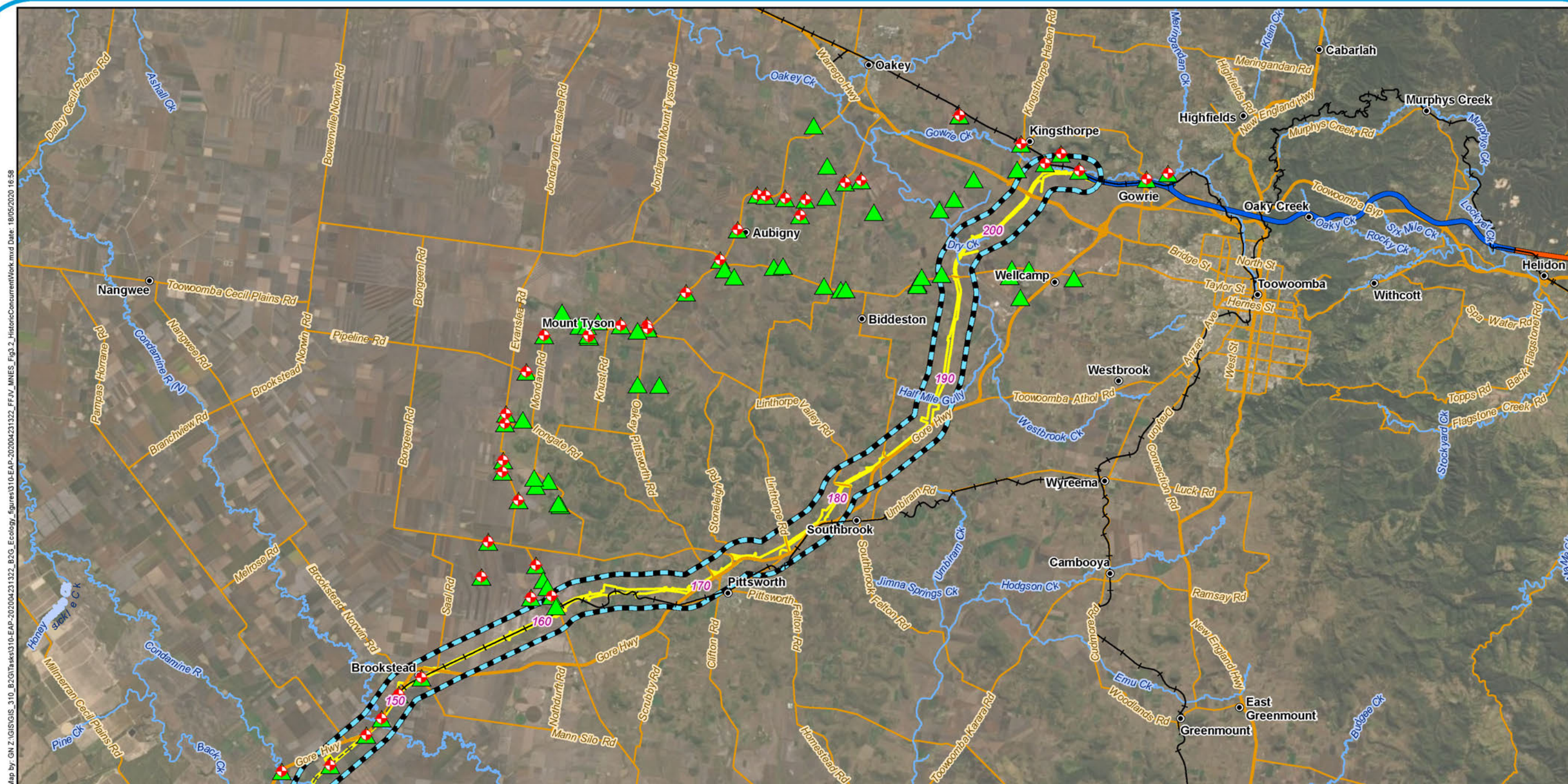
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- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Sampling locations**
- ♦ Eco logical survey sites 05/09/2016
- ▲ Eco logical survey sites 30/09/2016
- ◆ Anabat site



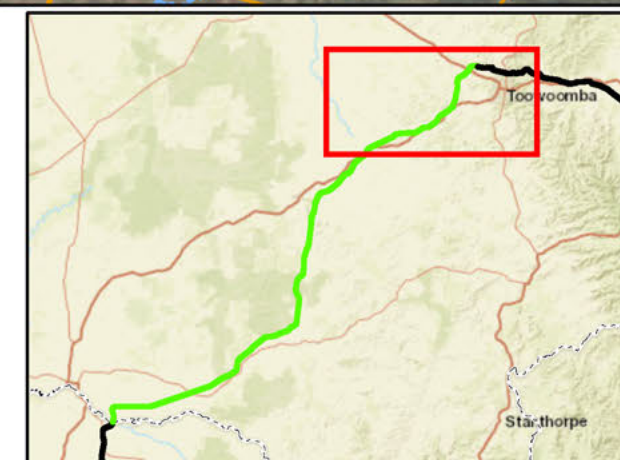
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Legend

- 5 Chainage (km)
- Localities
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- ▨ Impact assessment area
- ◆ Eco logical survey sites 05/09/2016
- ▲ Eco logical survey sites 30/09/2016



A3 scale: 1:250,000



3.3.1 Terrestrial ecology surveys

3.3.1.1 Field assessment locations and timing

A representative sampling approach was employed as part of the field sampling methodology. Seasonal sampling (i.e. Spring (mid-September to mid-December) and Autumn (late February to April)) are recommended for the Brigalow Belt South bioregion (Eyre et al. 2014). The use of publicly available datasets fulfils this seasonal requirement. These timings are considered adequate to measure taxa diversity and their repetition throughout the impact assessment area. In addition, when combined with the predictive habitat modelling (refer Section 3.2.4) which has been supplemented with field-based datasets, a highly conservative approach has been adopted to the assessment of Sensitive environmental receptors.

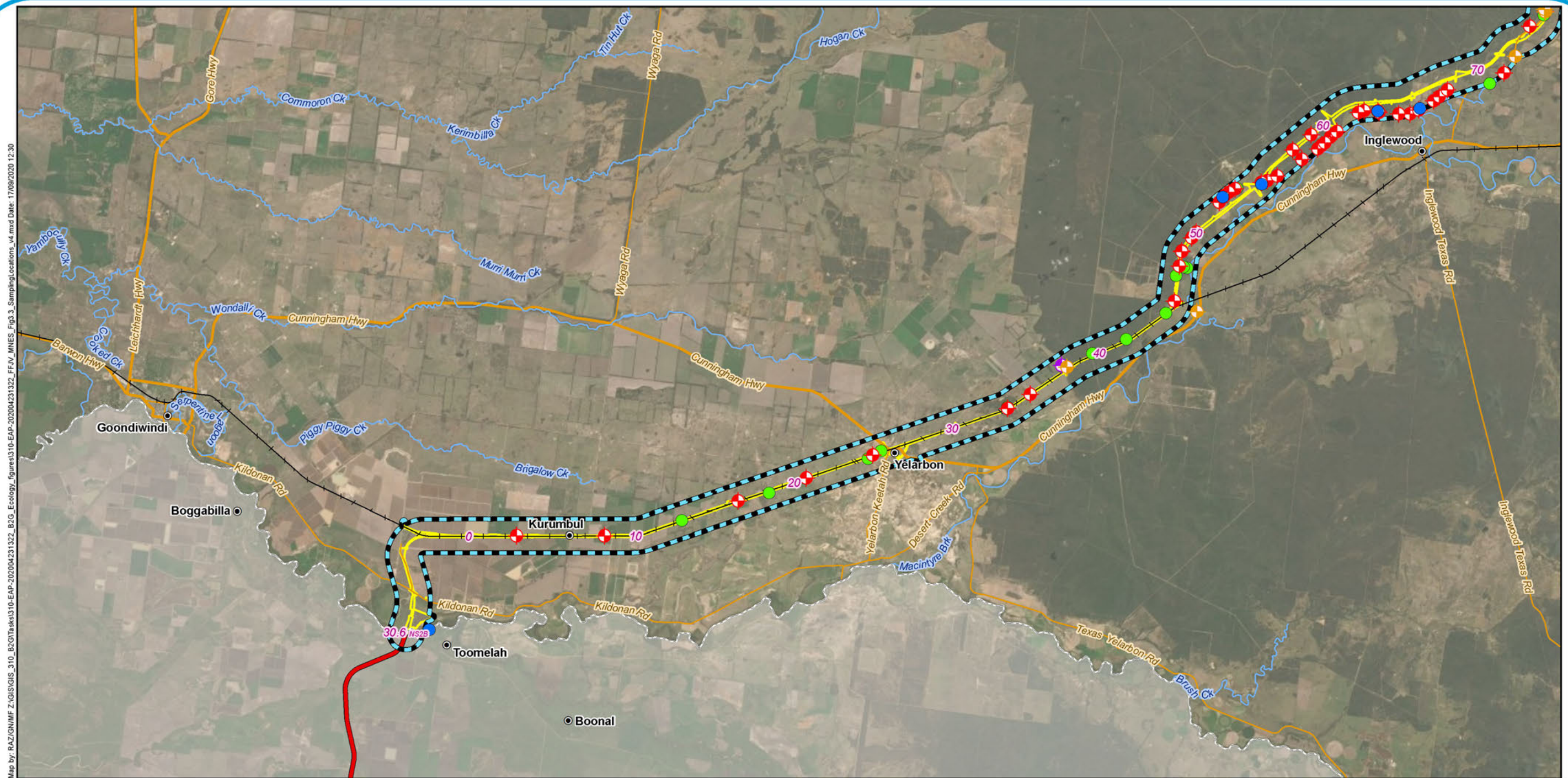
Previous and concurrent ecological surveys for Project

Previous ecological investigations undertaken within the impact assessment area have been undertaken by Eco Logical in 2016. This work was used to inform the final advice statement for the EIS process and has been considered for the Project. Table 3.4 presents the survey timing and survey activities associated with previous Project associated ecological investigations. It is noted that the Project footprint has changed somewhat since the surveys carried out by Eco Logical in 2016. Note, there is some overlap in the location of surveys undertaken during programs presented Table 3.4 with those undertaken as part of targeted surveys associated with the EIS in 2017 (refer Figure 3.3), allowing for seasonal data assessments of the same areas. The targeted surveys for the EIS have also captured areas within the alignment not subject to assessment elsewhere such that most of the Project footprint has been subject to ecological assessment.

Table 3.4 Timing of field investigations undertaken associated with the Project used to supplement the results of the current study

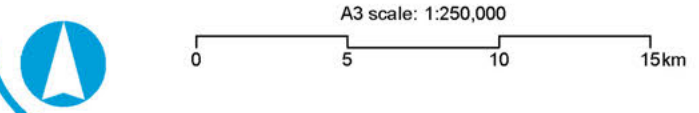
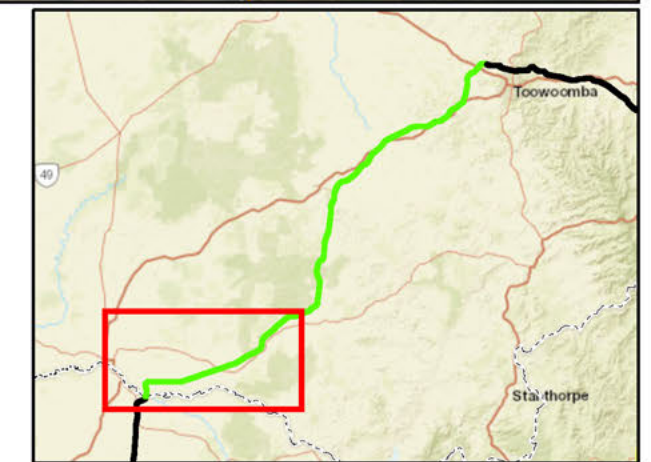
Study/investigation	Consultant/year	Timing of investigations	Season	Methodologies and notes
Border to Gowrie summary of ecological constraints to inform the EIS (total of 134 sites across the impact assessment area over three surveys)	Eco Logical (2016)	26-29 April 2016	Autumn	- Survey of alignment and corridor options - Identification of vegetation communities (i.e. REs) and TECs - Opportunistic searches for threatened flora species - Fauna habitat assessments - Anabat deployment at three sites
		12-15 September 2016	Spring	- Survey of further corridor options - Identification of vegetation communities (i.e. REs) and TECs - Opportunistic searches for threatened flora species - Fauna habitat assessments - Anabat deployment at two sites
		25-28 October 2016	Spring	- Survey of further corridor options - Identification of REs and TECs - Opportunistic searches for threatened flora species - Fauna habitat assessments
Inland Rail (Border to Gowrie) Aquatic Ecology Technical Report)	Eco Logical (2020)	June and November 2018 May 2019	Winter, Spring and Autumn	Aquatic ecology surveys (34 sites) including targeted fish surveys (12 sites)
Protected Plant surveys associated with geotechnical investigations – identified as opportunistic surveys throughout this technical report (total of 91 sites across along alignment over two survey periods)	FFJV (2018)	April (2018)	Autumn (2018)	- Protected plant surveys (meander surveys – minimum 30 minutes) throughout alignment - Habitat surveys - Confirmation of vegetation communities
	FFJV (2019)	April (2019)	Autumn (2019)	- Protected plant surveys (meander surveys – minimum 30 minutes) throughout alignment - Habitat surveys - Confirmation of vegetation communities

Study/investigation	Consultant/year	Timing of investigations	Season	Methodologies and notes
Australian Rail Track Corporation Limited/Transport - Land/Multiple lots/Queensland/Inland Rail Border to Gowrie project, QLD (EPBC referral 2018/8165)	AECOM (2018)			Provides initial details on how the Project is likely to impact upon MNES. This includes, identification of the potential presence of threatened species. Identified the likely presence of the following migratory species: - Confirmation of Brigalow (<i>Acacia harpophylla</i> dominant and codominant) TEC - Confirmation of Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions TEC - South-eastern long-eared bat (<i>Nyctophilus corbeni</i>) considered potentially present based on call and location (Canning Creek).
Aurecon investigations undertaken as part of the Toowoomba Bypass (Toowoomba Second Range Crossing (TSRC)) Project	Aurecon (2018)	October 2015 – June 2018		Identified the presence of the following Sensitive environment receptors to the east of the Project footprint: - Collared delma (<i>Delma torquata</i>) - Austral toadflax (<i>Thesium australe</i>) - Hawkweed (<i>Picris evae</i>) - Austral cornflower (<i>Rhaponticum australe</i>)

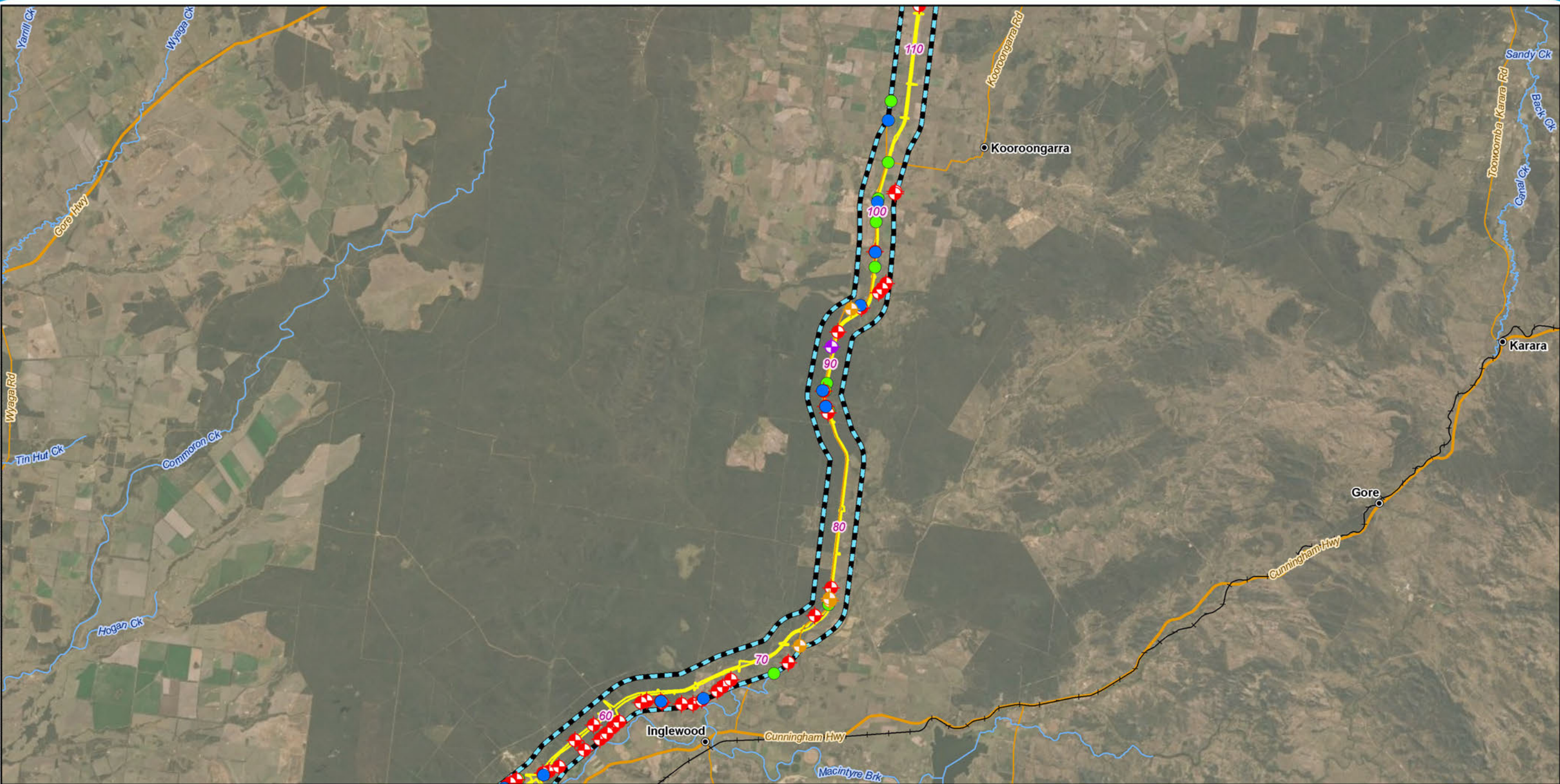


Legend

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| ● Localities | — Major roads | □ Project footprint |
| 5 Chainage (km) | — Minor roads | ▨ Impact assessment area |
| ★ Anabat survey location | — North Star to NSW/QLD border alignment | |
| ● Aquatic sampling sites | — Existing rail (operational) | |
| ★ Camera trap survey location | — Watercourses | |
| ◆ Opportunistic survey locations | --- NSW/QLD border | |
| ● Terrestrial sampling sites | | |

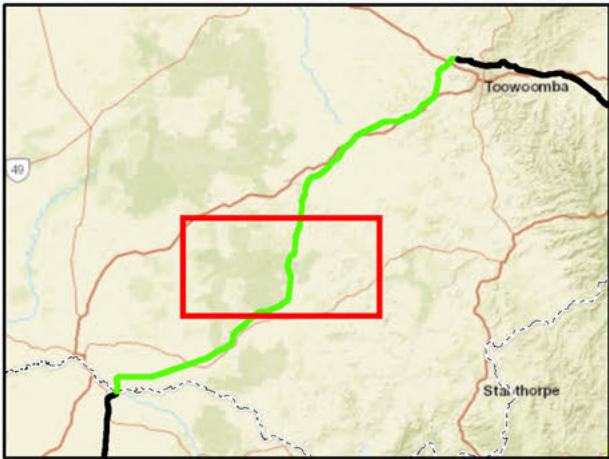


Border to Gowrie
Figure 3.3a: Location of sampling locations within the impact assessment area



Legend

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| ● Localities | — Major roads | □ Project footprint |
| 5 Chainage (km) | — Minor roads | ▨ Impact assessment area |
| ✦ Anabat survey location | — Existing rail (operational) | |
| ● Aquatic sampling sites | — Watercourses | |
| ✦ Camera trap survey location | | |
| ✦ Opportunistic survey locations | | |
| ● Terrestrial sampling sites | | |



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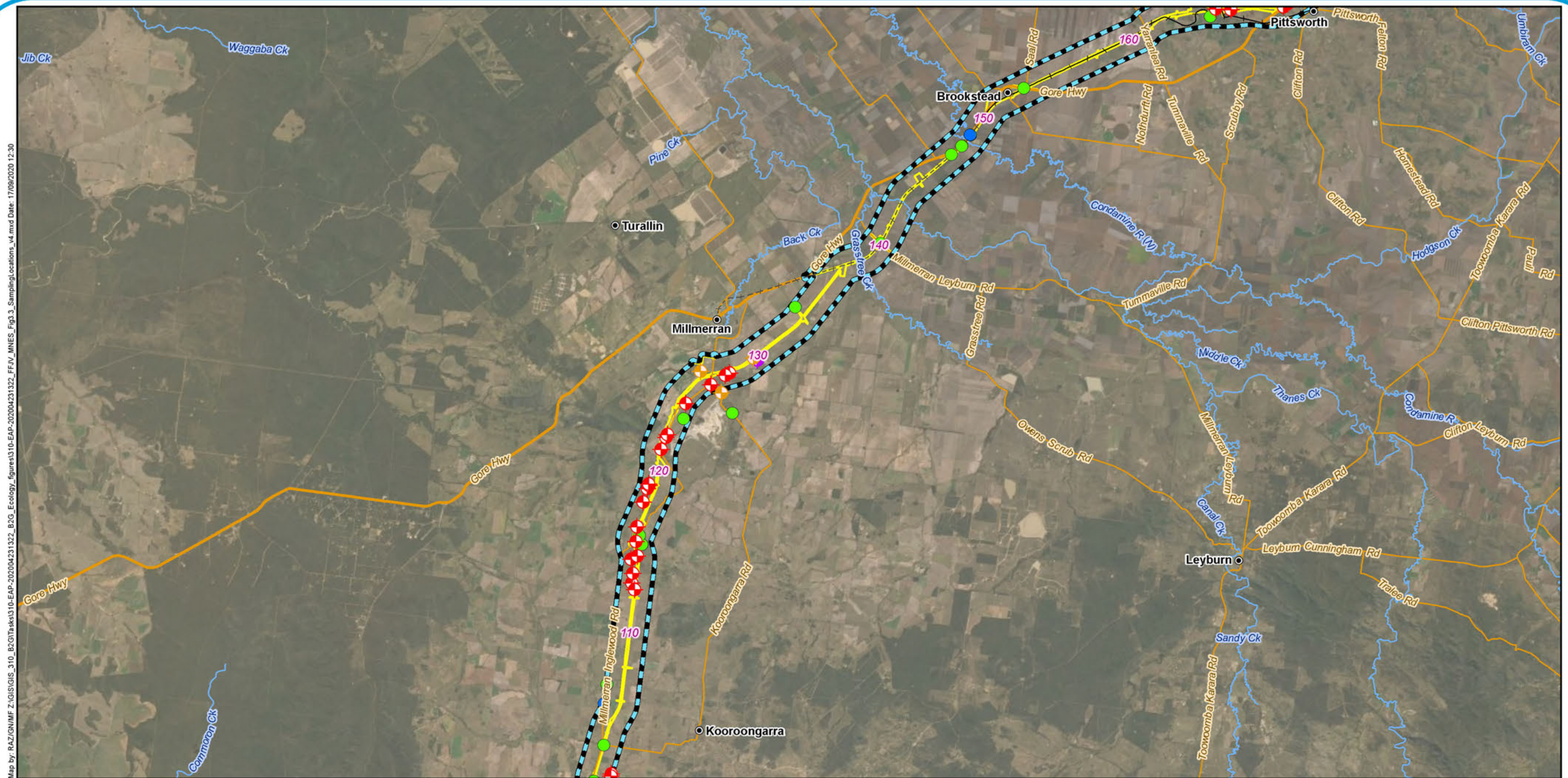


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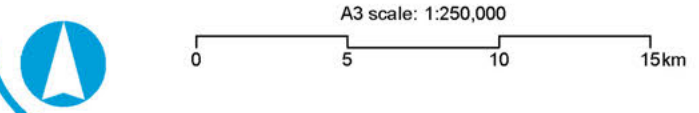
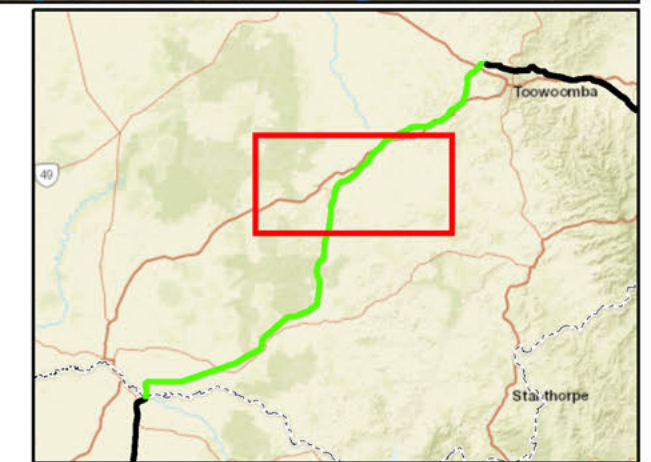
Border to Gowrie

Figure 3.3b: Location of sampling locations within the impact assessment area

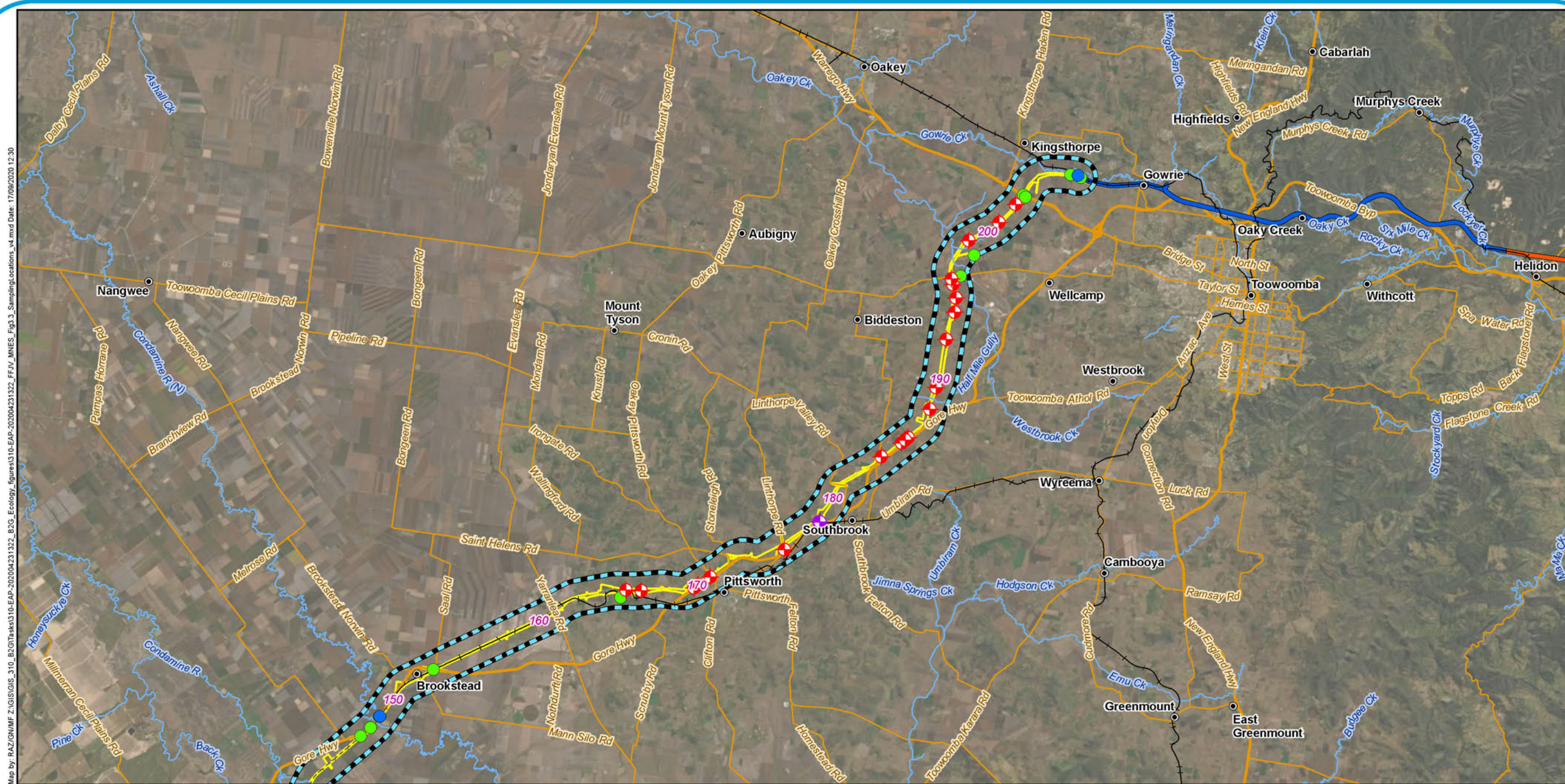


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|----------------------------------|---------------------------------------|--------------------------|
| ● Localities | — Major roads | □ Project footprint |
| 5 Chainage (km) | — Minor roads | ▨ Impact assessment area |
| ✦ Anabat survey location | — Existing rail (operational) | |
| ● Aquatic sampling sites | - - - Existing rail (non-operational) | |
| ✦ Camera trap survey location | — Watercourses | |
| ✦ Opportunistic survey locations | | |
| ● Terrestrial sampling sites | | |

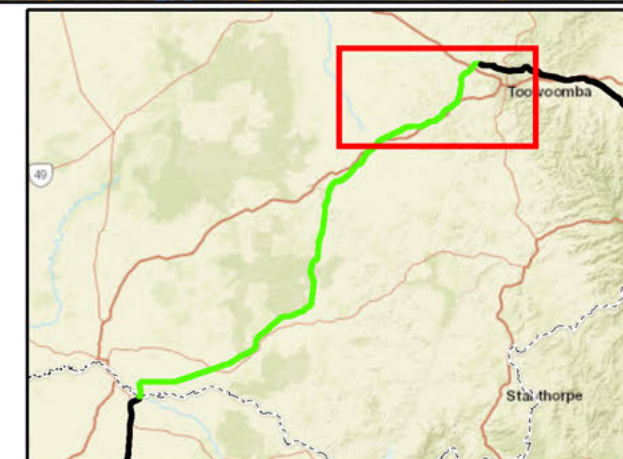


Border to Gowrie
Figure 3.3c: Location of sampling locations within the impact assessment area



Legend

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|----------------------------------|-----------------------------------|--------------------------|
| ● Localities | — Major roads | □ Project footprint |
| 5 Chainage (km) | — Minor roads | ▣ Impact assessment area |
| ✦ Anabat survey location | — Gowrie to Helidon alignment | |
| ● Aquatic sampling sites | — Helidon to Calvert alignment | |
| ✦ Opportunistic survey locations | — Existing rail (operational) | |
| ● Terrestrial sampling sites | — Existing rail (non-operational) | |
| | — Watercourses | |



A3 scale: 1:250,000
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Border to Gowrie

Figure 3.3d: Location of sampling locations within the impact assessment area

Terrestrial ecology survey locations

Following initial surveys by Eco Logical Australia in 2016, the Project alignment was revised and finalised. This alignment was subject to further targeted assessments as part of the EIS surveys. Additional protected plant surveys to support geotechnical investigations (i.e. April 2018 and April 2019) were also undertaken along the finalised alignment.

Following the desktop component, sites were selected which were specifically identified as containing features of interest. The 44 survey locations included:

- Areas containing a representative example of a distinct vegetation community (i.e. areas contained within mapped remnant vegetation, regrowth vegetation, and non-remnant vegetation areas)
- Areas containing landscape features that were considered likely to support conservation significant species when viewed from aerial photography (i.e. gilgai areas, wetlands and escarpments)
- Areas known or predicted to support conservation significant species
- Waterways which will be potentially impacted by the Project
- Areas that have not been subject to previous ecological investigations.

At each terrestrial sampling location, a vegetation survey, a fauna habitat assessment, active searches for cryptic fauna and opportunistic observations were undertaken as a minimum. In instances where wetland indicators were present (e.g. macrophytes, topography consistent with wetlands or areas mapped as a wetland), an assessment of the potential of the area to be a wetland was undertaken, recording site-based attributes as required.

The location of survey sites within the impact assessment area, and the date of assessment, are presented in Table 3.5 and shown in Figure 3.3. In addition, opportunistic fauna sampling locations are provided in Figure 3.3. The location of aquatic ecology survey sites is depicted in EIS Appendix K: Aquatic Ecology Technical Report.

Table 3.5 Field survey sites and date of assessment (excluding opportunistic survey locations)

Site ID	Site location (GDA94)			Assessment date
	Zone	Easting (m E)	Northing (m S)	
T1	56J	267600	6833087	16 April 2018
T2	56J	272818	6834722	16 April 2018
T3	56J	279535	6837249	16 April 2018
T4	56J	278742	6836780	17 April 2018
T9	56J	287093	6839863	17 April 2018
T10	56J	290392	6842292	4 September 2018
T11	56J	290667	6842246	5 September 2018
T12	56J	294210	6843939	5 September 2018
T13	56J	292177	6843089	5 September 2018
T14	56J	296588	6845507	17 April 2018
T15	56J	297206	6847737	18 April 2018
T16	56J	297857	6848212	18 April 2018
T17	56J	297647	6848269	18 April 2018
T18	56J	300835	6852989	18 April 2018
T19	56J	315986	6859251	19 April 2018
T20	56J	319229	6863353	19 April 2018
T24	56J	319244	6874797	6 September 2018
T25	56J	319119	6876446	7 September 2018

Site ID	Site location (GDA94)			Assessment date
	Zone	Easting (m E)	Northing (m S)	
T26	56J	319034	6876002	7 September 2018
T27	56J	320574	6880824	19 April 2018, 8 September 2018
T28	56J	321988	6883344	8 September 2018
T29	56J	322048	6886042	19 April 2018
T30	56J	322163	6887416	20 April 2018
T31	56J	322758	6889565	20 April 2018
T32	56J	322945	6893212	20 April 2018
T35	56J	325031	6901588	10 September 2018
T36	56J	324895	6902122	21 April 2018
T37	56J	327539	6909079	9 September 2018
T38	56J	330457	6909418	9 September 2018
T39	56J	331835	6912739	22 April 2018
T40	56J	334208	6915773	22 April 2018
T41	56J	339306	6919607	22 April 2018
T42	56J	343559	6924919	22 April 2018
T43	56J	344169	6925429	22 April 2018
T44	56J	344693	6926087	22 April 2018
T45	56J	347904	6928906	22 April 2018
T47	56J	359083	6933186	10 September 2018
T50	56J	379353	6952354	7 September 2018
T51	56J	386534	6958232	6 September 2018
T52	56J	385925	6958407	23 April 2018, 6 September 2018
T53	56J	383102	6957203	23 April 2018, 8 September 2018
T54	56J	383239	6957062	23 April 2018, 10 September 2018
T55	56J	380159	6953590	23 April 2018, 9 September 2018
Site X	56J	331980	6912679	21 April 2018

3.3.1.2 Flora field assessment

The location of terrestrial survey sites was dictated by land access agreements with landholders which was provided on a voluntary basis. This reduced the areas that were accessible for environmental investigations. However, adoption of the precautionary principle and the modelling approach suitably accounted for deficiencies in accessible land.

At each target terrestrial survey site, a list of all flora species encountered, were recorded and documented. In addition, opportunistic observations across the impact assessment area were used to supplement site specific datasets. MNES flora species that were not previously encountered, or species that were unidentifiable in the field (when sampling occurred), were collected and lodged at the Queensland Herbarium for formal identification. As per Aurecon's current Scientific Purposes Permit requirements, no more than two samples per species were taken at each survey location when sampling was required for identification purposes.

Verification via ecological assessment of a representation of distinctly different vegetation communities identified during the desktop component was undertaken in the field. The following approach to sampling was applied:

- Within a representative of each different vegetation community, as determined from aerial imagery, an intensive survey occurred, which included an assessment of the relative species density and diversity within the emergent (E), canopy (T1, T2, T3), shrub (S1, S2, S3) and ground (G) strata layers when they were present. Methodologies used were consistent with the tertiary level as described by Neldner *et al.* (2019). Survey transects approximated 100 m in length and 20 m in width
- Once a full vegetation survey was complete for each representative of the specific vegetation community, verification of the remaining map units of the same type was undertaken at the quaternary level as described by Neldner *et al.* (2019).

A representation of the predictive flora habitat modelling (refer Section 3.2.4) was verified where applicable during field investigations throughout the impact assessment area. This information was used to iterate the predictive modelling and refined the model inputs to increase modelling accuracy (refer Figure 3.1).

Field verification of predictive habitat modelling for flora and mapping associated with TECs was undertaken by comparing the species-specific habitat assumptions derived from the desktop phase (refer Appendix A), to characteristics observed in the field. Where site-based field observations significantly deviated from the desktop derived habitat assumptions, these areas were amended in the predictive habitat mapping. Alternatively, where a MNES species was observed, these areas were elevated in status to either general habitat (for areas that were not currently mapped as potential/Habitat critical to the survival of the species), or Habitat critical to the survival of the species (for locations that were already included within the Potential habitat mapping layer) (refer Section 3.2.4 for further detailed information).

Protected plant surveys

The random meander survey method was also employed at sites within and adjacent to the Project footprint associated with vegetation clearing for geotechnical works (largely boreholes and access tracks). Surveys were carried out regardless of their inclusion/exclusion from “High Risk” areas identified in the Queensland Government Protected Plants flora survey trigger map) to specifically target threatened species. At each site, the random meander survey was undertaken [as per the QLD Protected plants survey guidelines (DES 2019)] until no new flora species were identified for 30 minutes following the recording of the last identified flora species. As per the guidelines, surveys were carried out within the targeted clearing area with an additional 100 m buffer area applied (providing a substantial survey area at each site). Surveys were undertaken for a minimum of 30 minutes at each site but may have extended well beyond this search timeframe where new species were encountered. Samples of all MNES flora species encountered were submitted with the Queensland Herbarium for incorporation into the HERBRECS database, and all flora survey records were submitted to DES as part of FFJV’s scientific purposes licencing commitments.

3.3.1.3 Fauna field assessment

Terrestrial fauna and habitat assessments were conducted using the following methods as described in the survey guidelines identified at the beginning of this Section:

- A general habitat assessment and a record of all fauna encountered (i.e. observed/heard) was undertaken at every vegetation assessment survey site during different seasons (Eyre et al 2018)
- Localised validation of the predictive habitat mapping was undertaken, where possible
- Use of specific techniques to identify conservation significant species (e.g. identification of scats, specific scratch marks and diggings).

In addition to the techniques identified above, the use of existing datasets, historic records and the formulation of the predictive habitat models provided a comprehensive and conservative assessment of the fauna contained within the impact assessment area.

Field based methodologies are further described in the sections below. A list of species encountered at each site was recorded.

Fauna habitat assessments

At each vegetation assessment location (refer 'terrestrial sampling sites' in Figure 3.3a-d), an assessment of fauna habitat features, and a record of all fauna species encountered was undertaken (a total of 41 sites). Fauna habitat assessments were also undertaken within the impact assessment area and surrounds by Ecological Australia (2016) (a total of 134 sites). Fauna habitat features recorded included, but was not limited to:

- Level of disturbance (scale of 0 – nil and 3 – severe) relating to the following:
 - Fire
 - Grazing
 - Clearing
 - Erosion
- List of conservation significant fauna species that are likely to utilise the area based on available habitat types (based on database search results and predictive habitat mapping)
- Abundance of tree hollows present in the following categories:
 - >30 cm diameter
 - >15 cm but <30 cm diameter
 - >10 cm but <15 cm diameter
 - >5 cm but <10 cm diameter
 - < 5 cm diameter
- Abundance of fallen logs (>10 cm diameter)
- Abundance of coarse woody debris (<10 cm diameter)
- Abundance of trees with decorticated bark
- Percentage of groundcover containing the following:
 - Leaf litter
 - Bare ground
 - Grasses
 - Soil cracks
 - Surface rocks
 - Non-native flora species (e.g. weeds)
- Presence of:
 - Soil banks (e.g. river beds/road cuttings)
 - Bounders
 - Wetlands/drainage features
- Abundance of the following:
 - Flowers
 - Fruit.

All species of fauna observed were identified to the species level where possible (refer Appendix H for site fauna habitat assessment datasheets).

Targeted fauna survey methods

Where areas were identified as containing habitat considered likely to support threatened species (i.e. both within vegetation assessment areas and at opportunistic locations), specific techniques were employed to increase the likelihood of detecting these species. Location selection was optimised to maximise fauna detection by selecting sites along drainage lines and fauna pathways within bushland. Specific techniques adopted as part of the ecological assessments (including survey effort where applicable) and their relevance to target fauna species include the following:

- Anabat devices (Microchiropteran bats) were deployed by FFJV (EIS studies) at 5 sites (overnight) for a total survey effort of seven detector nights and by Eco Logical Australia (2016) at five sites along the alignment for a total of five nights (total of 12 nights of survey effort) (refer Figure 3.2 and Figure 3.3 for locations)
- Standardised surveys for birds at all EIS assessment sites comprising recording birds by observation or calls for 20 minutes over a 2 hectare (ha) survey area. These used the Birds Australia census technique described by Loyn (1986) for the EIS studies (refer 'terrestrial sampling site' in Figure 3.3 for locations).
- Active searches for Koala (*Phascolarctos cinereus*), their pellets and tree scratches were undertaken at all assessment sites (refer 'terrestrial sampling site' in Figure 3.3 for locations) where food trees were present, during the EIS studies
- Active searches for reptiles at all EIS assessment sites. This involved 20 minutes of searching by two people over 1 ha within suitable microhabitats. This involved searching within suitable microhabitats, particularly beneath rocks and fallen logs and amongst leaf litter and woody debris. Carried out for the EIS studies (refer Figure 3.3 for locations).
- Spotlighting and night driving for species such as Dunmall's snake (*Furina dunmalli*), along with other amphibians, reptiles, birds and mammals – outside of formalised survey locations. Carried out for the EIS studies.

Other species encountered during these works were recorded, along with opportunistic observations (all fauna species), refer Appendix H for more details. Remote sensing techniques were used to ensure maximum chances of detecting threatened species, without increasing the species risk of harm or placing stress upon the animal (i.e. animals sampled ethically and humanely). This included:

- Infra-red remote motion-sensing cameras (overnight) at watering points and/or at baited feeding stations (mammals and birds) – 9 sites (refer Figure 3.3).

Whilst the use of non-invasive techniques such as remote sensing data and habitat assessments in lieu of trapping deviates from the techniques recommended by DAWE and DES, the use of such techniques, when combined with the predictive habitat mapping assists in providing information to suitably inform the impact assessment process in instances of site inaccessibility or deficiencies of existing information. The methodology employed is scientifically robust, defensible and repeatable.

Pre-clearance habitat surveys

In addition to the fauna survey methods employed for the EIS studies identified above a large number of 'preclearance surveys' associated with vegetation clearing for geotechnical works (largely boreholes and access tracks) have been undertaken by FFJV personnel during 2018 and 2019. These surveys were carried out to further inform the Project EIS studies and as part of requirements under QLD legislation. Surveys were carried out at 91 locations throughout the Project disturbance footprint.

The surveys included the following methods:

- Searches for potential breeding habitat for threatened species such as:
 - Recording of all burrows/dens, logs, rocks, caves and suitable leaf litter that may contain breeding habitat for threatened species
 - Recording of hollow bearing trees noting hollow attributes such as size, angle, height in the tree and orientation it was facing
 - Recording of bird nests and potential for active nesting
- Habitat suitability assessments for threatened species with key habitat types recorded
- Incidental fauna observations recorded.

3.3.1.4 Survey effort

In addition to the targeted EIS study survey locations identified in Figure 3.3 (44 sites within the impact assessment area) 92 opportunistic surveys associated with geotechnical investigations were undertaken by FFJV personnel, specifically targeting areas within the disturbance footprint. The location of opportunistic surveys is shown in Figure 3.3. With regard to survey effort, a total area of approximately 427 ha was assessed by FFJV as part of the EIS investigations (i.e. 138 ha associated with targeted surveys and 289 ha associated with opportunistic investigations). This represents approximately 13.33 per cent of the Disturbance footprint.

3.3.2 Aquatic surveys

3.3.2.1 Aquatic habitat assessment

Aquatic ecology surveys were carried out on three discrete survey events by Eco Logical Australia (2020): June 2018, November-December 2018 and May 2019. Assessments were carried out at 34 sites across the three survey events (refer Figure 3.2 for locations and EIS Appendix K: Aquatic Ecology Technical Report for detailed site information). The aquatic habitat assessments described the environmental values of targeted watercourses (to assess existing environmental condition proximal to, and where the Project alignment intersects watercourses) within the impact assessment area. The Australian River Assessment System (AUSRIVAS) Physical Assessment Protocol (Parsons et al. 2002) was used in the field assessment of the drainage systems.

At each aquatic ecology sampling location, an AUSRIVAS physical assessment protocol was completed to assess the existing physical habitat values of the waterway. A detailed list of the habitat variables recorded is provided in EIS Appendix K: Aquatic Ecology Technical Report for detailed information. Where water was present, a surface water quality sample was collected. The habitat value of each aquatic ecology assessment site was assessed to predict the nature of faunal assemblages utilising the watercourse. The information collected was used to inform an assessment of the suitability of aquatic habitats for key species of interest, such as the Murray cod, Silver perch and Bell's turtle. General site observations and photographs of aquatic habitats were also recorded.

In addition, surface water quality sampling was conducted at aquatic habitat assessment sites (where water was present at the time of survey). Four discrete water sampling events were carried out: winter (June 2018); spring/summer (November 2018 and February 2019) and an autumn assessment (April 2019) Eco Logical Australia (2020). Watercourse flow was limited; however, this was consistent with the highly seasonal, and sporadic flow regimes throughout the impact assessment area. Noting the seasonal flow regimes of the watercourses, timing of the assessments was chosen in order to capture dry or wet condition water quality samples.

In-situ water quality field data was collected during each monitoring round in addition to samples collected for laboratory analysis. Sampling could not be undertaken at all assessment sites on each occasion due to a lack of adequate water (i.e. dry conditions) and land access at the time of the water quality assessments. The results of the water quality sampling assessments are provided in detail in EIS Appendix P: Surface Water Quality Technical Report.

3.3.2.2 Aquatic fauna surveys

Freshwater macroinvertebrate sampling was undertaken to gain an improved understanding of the aquatic values, watercourse health and trophic interactions occurring at each site. Macroinvertebrate sampling was undertaken in November 2018 and May 2019. Macroinvertebrate samples were collected in accordance with the Queensland AUSRIVAS assessment manual (DNRM 2001). Samples were collected from aquatic ecology survey sites that exhibited wetted habitat at the time of assessment. Due to dry conditions, this was limited to two sites in November 2018, and five sites in May 2019.

For the June 2018 field trip, a limited fish survey was implemented involving the deployment of baited box traps and dip-netting, targeting small fish at sites containing water. At each site, up to seven baited box traps were deployed for approximately one hour, followed by dip-netting watercourse edge habitats for a period of approximately 10 minutes with an Environet®.

For subsequent field trips in December 2018 and May 2019, the scope of works was expanded, and a range of additional survey techniques were applied to assess fish assemblages at aquatic ecology sites that were suitable. Targeted fish survey methods were selected from the *Survey Guidelines for Australia's Threatened Fish* (DSEWPAC 2011a), and included backpack electrofishing (where water depth was <0.5 m), seine netting (2 to 5 mm mesh) and use of fyke nets. Where fyke nets were used, two nets were deployed overnight (one 3 mm stretched mesh and one 4 mm stretched mesh). Nets were dual wing in design, with each wing 4 m in length with a 0.6 m drop. The survey methods were adapted to suit the local conditions of the watercourse, with the primary considerations being the depth of water and presence of woody debris which may foul nets.

A representation of predictive fauna habitat mapping for EPBC Act listed species was undertaken by comparing the species-specific habitat assumptions derived from the desktop phase, to characteristics observed in the field. Where site-based field observations significantly deviate from the desktop derived habitat assumptions, these areas were removed from the predictive habitat mapping (refer Section 3.2.4 and Appendix A for further details).

3.3.3 Permits to conduct works

The terrestrial ecological field surveys reported in this document were conducted under the provisions of Aurecon's Scientific Purposes Permit (WISP14453114) and Animal Ethics approval for General Terrestrial Surveys (CA 2015/03/846). Aurecon is one of two partner organisations that, with AECOM, form the FFJV.

Aquatic surveys were undertaken under Ethics CA2018/07/1214) and DPM Envirosiences (General Fisheries Permit 192554 and Animal Ethics CA2017/03/1043).

3.3.4 Quality assurance/quality control

Quality control/assurance in relation to field results occurred through the following processes:

- At least one suitably qualified person in accordance with Section 4.2.1 of the Queensland Flora Survey Guidelines – Protected Plants (DEHP 2016) was present within each survey team
- All flora samples to be submitted to the Queensland Herbarium were stored in a field press to ensure their integrity. Samples were stored in a cool/dry environment and were submitted to the Queensland Herbarium within nine days of collection
- A portion of any conservation significant flora species encountered, or species that could not be confidently identified during field recognisance, was submitted to the Queensland Herbarium for verification/identification

- A senior and/or principal level aquatic ecologist was present at all field surveys, which were led by an aquatic ecologist accredited in Queensland under the AUSRIVAS assessment method
- Scats that were collected in the field were taken to the Queensland Museum for species confirmation
- Any conservation significant fauna species required consensus between both members of a field team in order to constitute a confirmed record. Where applicable/possible, proof (e.g. photograph (e.g. captured fish, scat or other evidence) was collected
- Surface water quality sampling was conducted in accordance with industry-accepted standards and quality assured procedures. Field quality control included rigorous sample collection, decontamination procedures (where appropriate), and sample documentation. As each sample was collected it was labelled with a unique sample identifier, the initials of the sampler, the date and the project number. All sample jars were filled leaving no headspace and placed immediately into ice-filled cooler boxes. All samples were transported in ice-filled coolers to prevent degradation of organic compounds. Chain of Custody documentation was completed, with data including sample identification, date sampled, matrix type, preservation method, analyses required and name of sampler. Field data monitoring equipment was fully serviced and calibrated prior to use.

3.3.5 Nomenclature

3.3.5.1 Flora

The source of nomenclature for the flora sections of this report is the Census of the Queensland Flora (Queensland Government 2016). The botanical names comply with the rules of the current International Code of Botanical Nomenclature (ICBN) (McNeill et al. 2006) and the International Code of Nomenclature for Cultivated Plants (Brickell et al. 2016). Author abbreviations follow Brummitt and Powell (1992).

3.3.5.2 Fauna

The sources of nomenclature for the fauna sections of this report are as follows:

- Ingram, McDonald and Nattrass (2002) for frogs
- Wilson and Swan (2010) for reptiles
- Pizzey and Knight (2012) for birds
- Menkhorst and Knight (2011) for mammals
- Duncan et al. Action Plan for Australian Bats (1999) for microbats
- Pusey, Kennard and Arthington (2004) for freshwater fish.

3.4 Impact assessment methodology

The MNES assessment of the Project uses a significance-based impact assessment framework to identify and assess potential Project related impacts in relation to MNES. Initial impact assessment was undertaken to identify MNES where they may be subject to significant impacts (refer Section 3.4.3). Where impacts were identified as significant, these were subject to assessment against the MNES guidelines (refer Sections 8, 8.2 and 8.3).

For the purpose of assessment, the MNES assessment was undertaken both quantitatively (e.g. measurable assessment of vegetation community (RE) attributes) and qualitatively (e.g. visual evaluation of fauna habitat values). For the purpose of assessment, a significant impact depends upon the sensitivity of the MNES, the quality of the environment, which is impacted, and the magnitude of the potential impact. Determination of the sensitivity or vulnerability of the MNES and the magnitude of the potential impacts facilitate the assessment of the significance of total potential project impacts.

The sections below discuss and define impact magnitudes, MNES sensitivity and impact significance.

3.4.1 Magnitude of impacts

The magnitude of a potential impact as a result of Project activities is essential to the determination of its level of significance on sensitive values/MNES. For the purposes of this assessment, impact magnitude is defined as being comprised of the nature and extent of the potential impacts, including direct and indirect impacts. The impact magnitude is divided into five categories (refer Table 3.6). The magnitude of impacts is determined using techniques and tools that facilitate an estimation of the **extent**, **duration** (refer Table 3.7) and **frequency** of the impacts.

Table 3.6 Criteria for magnitude

Magnitude	Description
Major	An impact that is widespread, permanent and results in substantial irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of environmental management controls are required to address the impact. (e.g. greater than 50% of the habitat within the greater area disturbed).
High	An impact that is widespread, long lasting and results in substantial and possibly irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of site-specific environmental management controls are required to address the impact. (e.g. between 13-50% of the habitat within the greater area disturbed)
Moderate	An impact that extends beyond the area of disturbance to the surrounding area but is contained within the region where the Project is being developed. The impacts are short term and result in changes that can be ameliorated with specific environmental management controls. (e.g. between 2-13% of the habitat within the greater area disturbed).
Low	A localised impact that is temporary or short term and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls. (e.g. between 1-2% of the habitat within the greater area disturbed)
Negligible	An extremely localised impact that is barely discernible and is effectively mitigated through standard environmental management controls. (e.g. less than 1% of the habitat within the greater area disturbed)

The timeframes used to predict the duration of potential impacts on MNES (refer Table 3.7) has been derived using the approach described in the Environmental Assessment and Management Risk Management Framework as employed by the Great Barrier Reef Marine Park Authority (GBRMPA 2009). The Framework is designed to manage risk and help inform decisions regarding the construction and operational risks associated with Project activities on environmental values (in this case MNES).

Table 3.7 Timeframes for predicted Project activity impact duration

Duration term	Timeframe – to be defined for each MNES type if required
Temporary	Days to months (e.g. 1 to 2 seasons; 3 to 6 months)
Short term	Up to 2 year (i.e. 6 to 24 months)
Medium term	From 2 to 10 years ¹
Long term/long lasting	From 11 to 20 years ²
Permanent or irreversible	More than 21 years ³

Table notes:

1. Derived from the term 'moderate' EAM Risk Management Framework 2009 (GBRMPA 2009)
2. Derived from the term 'major' EAM Risk Management Framework 2009 (GBRMPA 2009)
3. Derived from the term 'catastrophic' EAM Risk Management Framework 2009 (GBRMPA 2009)

3.4.2 Sensitivity of receptor

Sensitivity categories are applied to each of the MNES to assess the significance of potential impacts on that receptor. The sensitivity categories are split into five discrete groups as described in Table 3.8. These groupings are based on qualitative assessments utilising information related to the sensitivity of the MNES, in addition to the potential of a sensitive MNES's occurrence within the receiving environment.

Through the determination of sensitivity categories for each of the values/MNES, the features are then able to be assessed through a matrix against the magnitude of the potential project impact type to indicate the level of significance for each of the impact types on the values/MNES.

Sensitive features are treated individually. In the case where there are conflicting classes, the "worst-case" is taken.

Table 3.8 Sensitivity criteria for values/matters of national environmental significance within the impact assessment area

Sensitivity	Description
Major	- The environmental value is listed on a recognised or statutory state, national or international register as being of conservation significance - The environmental value is entirely intact and wholly retains its intrinsic value - The environmental value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region, state, country or the world - It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the environmental value - Project activities would have an adverse effect on the environmental value.
High	- The environmental value is listed on a recognised or statutory state, national or international register as being of conservation significance - The environmental value is relatively intact and largely retains its intrinsic value - The environmental value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region - The environmental value has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the sensitive value - Project activities would have an adverse effect on the environmental value.
Moderate	- The environmental value is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers - The environmental value is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements - The environmental value is relatively well represented in the systems/areas in which it occurs, but its abundance and distribution are exposed to threatening processes - Threatening processes have reduced the environmental value's resilience to change. Consequently, changes resulting from Project activities may lead to degradation of the prescribed value - Replacement of unavoidable losses is possible due to its abundance and distribution.

3.4.3 Significance of impact

The significance of a potential impact is a function of an impacted MNES's **sensitivity** and the **magnitude** of the potential impact. Although the sensitivity of the value/MNES will not change (i.e. is generally determined qualitatively by the interaction of the MNES's condition, adaptive capacity and resilience), the **magnitude** of the potential impact is variable and may be categorised quantitatively to facilitate the prediction of the significance of the potential impact.

Once the sensitive value/MNES has been identified, and the **sensitivity** of the MNES and the **magnitude** of the potential impact have been determined, this will facilitate the assessment of the significance of the potential impact through use of a five by five matrix (refer Table 3.9).

Table 3.9 Significance assessment matrix

Magnitude of impact	Sensitivity				
	Major	High	Moderate	Low	Negligible
Major	Major	Major	High	Moderate	Low
High	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Low	Moderate	Moderate	Low	Negligible	Negligible
Negligible	Moderate	Low	Low	Negligible	Negligible

Table 3.10 **Significance classifications**

Significance rating	Description
Major	Arises when an impact will potentially cause irreversible or widespread harm to an MNES that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.
High	Occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the MNES. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.
Moderate	Results in degradation of the environmental value due to the scale of the impact or its susceptibility to further change even though it may be reasonably resilient to change. The abundance of the MNES ensures it is adequately represented in the region, and that replacement, if required, is achievable.
Low	Occurs where an MNES is of local importance and temporary or transient changes will not adversely affect its viability provided standard environmental management controls are implemented.
Negligible	Does not result in any noticeable change and hence the proposed activities will have negligible effect on environmental values. This typically occurs where the activities are located in already disturbed areas.

Significance ratings of Low, Moderate, High and Major constitute a potential significant residual impact to an MNES. These were subsequently assessed against the *MNES Significant impact guidelines 1.1* (DotE 2013) Guidelines to confirm the initial impact assessment results (refer Sections 8, 8.2 and 8.3).

Following the identification of the level of significance using initial impact mitigation measures, Project mitigation measures were then applied to the potential impacts to identify the residual (mitigated) impacts in a tabular form.

Initial assessment of the significance of impacts was undertaken for the following project phases:

- Construction
- Commissioning and reinstatement
- Operation.

Given the uncertainty associated with timeframe for decommissioning, this phase was not considered in the initial impact assessment.

3.4.4 **Assessment of the significance of impact against the matters of national environmental significance significant impact guidelines**

Assessment of residual significant impacts was undertaken after avoidance or mitigation of those impacts to each MNES. Only those MNES that returned an initial significance rating of Major, High, Moderate or Low were assessed for residual significant impacts.

MNES that returned a rating of Negligible, or those MNES for which habitat had not been identified within the impact assessment area, were omitted from assessment against the MNES Guidelines.

Relevant MNES were assessed against the following guidelines as applicable:

- Significant impact guidelines 1.1 – Matters of National Environmental Significance: *Environmental Protection and Biodiversity Conservation Act 1999* (DotE 2013)
- EPBC Act Referral Guidelines for the vulnerable koala (combined populations of QLD, New South Wales and the Australian Capital Territory), (DotE 2014a).

Assessment of MNES against the relevant criteria in the MNES Guidelines is presented in the following sections:

- TECs – Section 8
- Threatened flora species – Section 8.2
- Threatened fauna species – Section 8.3.

3.5 Cumulative impact assessment methodology

When numerous projects occur in a region they may result in cumulative impacts, which differ from those of an individual project when considered in isolation. Cumulative impacts may be positive or negative, and their severity and duration will depend on the Project size and timing overlap.

The following sections outline the selected projects and the method applied in the cumulative impact assessment.

3.5.1 Project selection

Projects for inclusion in the cumulative impact assessment (CIA) are all those within a 50 km radius of the Project (referred to as the 'cumulative impact area') including:

- Projects subject to assessment under the EP Act or SDPWO Act, with an Initial Advice Statement published by DES or Department of State Development, Tourism and Innovation (DSDTI)
- Projects listed in GRC and TRC development application databases
- Development within Priority Development Areas and State Development Areas
- Economic Development Queensland development projects
- Community Infrastructure Designation projects
- Projects within the public register of environmental authorities
- DTMR infrastructure projects
- Private infrastructure facilities
- Development in accordance with Regional Planning Interests
- The Inland Rail projects immediately adjacent to the Project, being the North Star to NSW/QLD Border and Gowrie to Helidon projects

Table 3.11 lists the projects that have been included in the CIA, and their associated selection criteria. The approximate location of these projects in relation to the Project is shown in Figure 3.4. The projects listed in Table 3.11 include infrastructure development projects located in proximity to the Project.

It is important to note that projects that fall into the following categories have been excluded from the CIA:

- Existing or historic projects within the Project cumulative impact area that are considered to constitute part of the baseline environment
- Projects that have not been developed to the point that their environmental assessment process has been made public.

Operational projects have been included in the assessment of ecological cumulative impacts due to the potential for such developments to continue to have an ongoing impact on ecological sensitive receptors and processes. For example, through the degradation of adjoining habitats or disturbance of species through noise, operational emissions, light, weed incursion etc.

Twenty three projects have been identified for preliminary consideration for their potential to contribute to cumulative impacts, in combination with the Project (refer Table 3.11).

3.5.2 Approach

The approach used to identify and assess potential cumulative impacts of this Project provided within this technical report is summarised below:

- A review of the potential impacts identified within the assessment. The environment at the time of the ToR is the baseline, prior impacts from past land use has not be considered.
- A preliminary list of projects for consideration in the cumulative impact assessment was collated with timelines to demonstrate the temporal relationship between projects.
- The preliminary list of projects was assessed to identify those that meet one of the following criteria:
 - Projects that have been approved but where construction has not commenced
 - Projects that have commenced construction subsequent to issuance of the ToR for the Project, but have potential for overlap in construction activities with the Border to Gowrie Project
 - Projects that have been completed subsequent to issuance of the ToR for the Project
 - Are operational developments that have future plans for expansion
- Projects that were excluded from further assessment were:
 - Existing projects, with no known plans for expansion. Such projects are typically considered part of the 'existing environment' and have been accounted for in the impact assessment of each specific matter.
 - Proposed projects that have not been developed to the point that details of their scale, size, location and core activities would be publicly available.
 - Where there is a potential overlap in impacts (either spatially or temporally), a cumulative impact assessment was undertaken to determine the nature of the cumulative impact. Where possible, the assessment method was quantitative in nature however qualitative assessment has also been undertaken.
- An assessment matrix method (further details within Section 3.5.3) has been used to determine the significance of cumulative impacts with respect to beneficial or detrimental effects.
- Where cumulative impacts are deemed to be of 'medium' or 'high' significance, additional mitigation measures are proposed, beyond those already proposed by the relevant technical impact assessments.

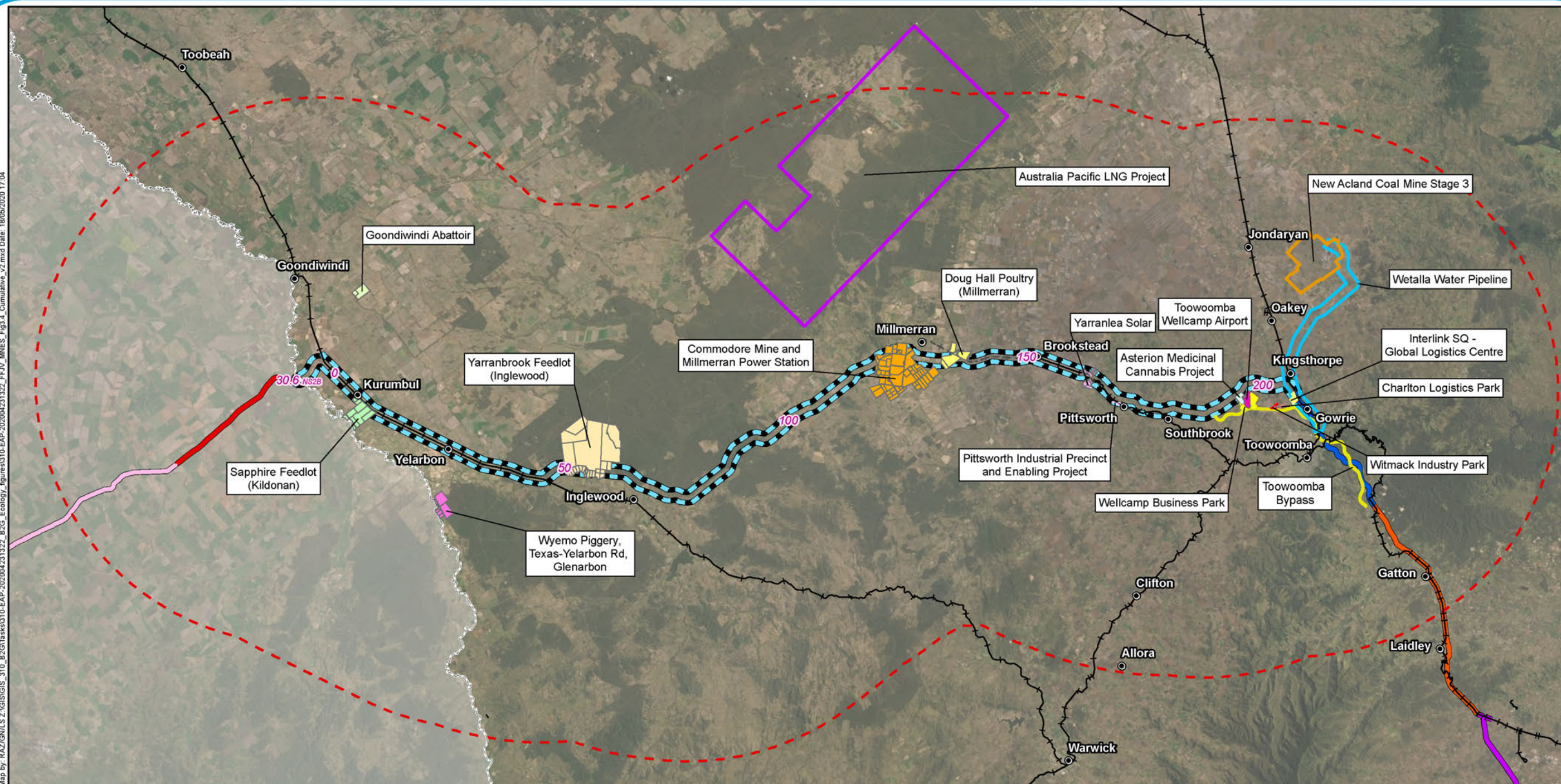
Table 3.11 Projects to be included in cumulative assessment

Projects	Location	Description	Status	Construction dates
Wetalla Water Pipeline	From the Wetalla Wastewater Reclamation Facility in Toowoomba to the New Acland coal mine, 35 km northwest of the city. Adjacent to north of the Project footprint	A 45 km underground water pipeline to supply up to 5,500 megalitres of treated wastewater to the New Acland coal mine.	EIS approved with conditions in 2008. The Wetalla Water Pipeline is completed.	2010-2013
New Acland Coal Mine Stage 3	35 km northwest of Toowoomba 18 km north of the Project footprint	Expansion of the existing New Acland open-cut coal mine to up to 7.5 Mtpa.	EIS approved with conditions in 2014.	2019-TBC
Australia Pacific LNG Project	Walloons gas fields (approximately 20 km west of Millmerran) 13 km west of the Project footprint	Integrated liquefied natural gas (LNG) project. The Walloons gas fields, located to the west of the Project, supplies Coal Seam Gas to support the LNG Facility on Curtis Island.	EIS approved with conditions in 2011	Construction began 2011
Toowoomba Bypass (formerly the Toowoomba Second Range Crossing)	The 41 km-long bypass route extends from the Warrego Highway at Helidon Spa in the east to the Gore Highway at Athol in the west, via Charlton. 1 km to south and east of the Project footprint	This bypass takes heavy vehicle through-traffic around the north of Toowoomba	Opened in September 2019	2015-2019
InterLinkSQ	13 km west of Toowoomba Adjacent to south of the Project footprint	A 200 ha transport, logistics and business hub. Located on the narrow gauge regional rail network and interstate network. Located at the junction of the Gore, Warrego and New England Highways.	Under construction	2018-TBC
Toowoomba Wellcamp Airport	Wellcamp, QLD 1 km east of the Project footprint	Airport servicing Toowoomba, promoting interstate, intrastate and international connection for the Darling Downs, Granite Belt, Surat Basin and Southern Downs regions.	Operational	2013-2014
Wellcamp Business Park	Wellcamp, QLD 1.5 km east of the Project footprint	A 500 ha industrial and commercial park that forms part of the Toowoomba Enterprise Hub. The Business Park is located in close proximity to the Toowoomba Wellcamp Airport and other major transportation infrastructure.	Operational	2013-2014
Witmack Industry Park and Charlton Logistics Park	Wellcamp, QLD 3 km south-east of the Project footprint (Witmack Industry Park) Charlton, QLD 3 km south of the Project footprint (Charlton Logistics Park)	The Witmack Industry Park is a large industrial land development that offers large size industrial land parcels. Businesses situated within the Witmack Industrial Park include the Toowoomba Pulse Data Centre. The Charlton Logistics Park is part of the Toowoomba Enterprise Hub and provides fully serviced 2 ha sites and is well situated for potential transport and logistics operators due to its proximity to transport infrastructure.	Operational	2016-2018

Projects	Location	Description	Status	Construction dates
Asterion Medicinal Cannabis Project	Wellcamp, QLD Adjoins the Project footprint 1 km south of Toowoomba-Cecil Plains Road	A high-tech medicinal cannabis cultivation, research and manufacturing facility. The project involves construction of a 40 ha glasshouse to produce 20,000 plants per day at full capacity. Medicinal grade cannabis grown at the facility will be manufactured into a range of medicinal products, including single patient packs, cannabis oils, gels, salts and related products, destined solely for the medicinal market. This facility is anticipated to be the largest facility of its kind in the world.	Construction	2020-2021
Commodore Mine and Millmerran Power Station	Domville, QLD Intersects the Project footprint, located primarily to east	The Commodore Mine is an open cut coal mine which provides coal for the 850 MW Millmerran Power Station (Mininglink, 2018). The Millmerran Power Station is a coal-fired power station that supplies enough electricity to power approximately 1.1 million homes (Power Technology, 2018)	Operational	2001-2003
Pittsworth Industrial Precinct and Enabling Project	Pittsworth, QLD 500 m to south of the Project footprint	Road and sewerage infrastructure upgrades at the Pittsworth Industrial Precinct to allow for industrial land for industries servicing agriculture and the wider region.	Under construction	2017-2019 (TBC)
Doug Hall Poultry	Millmerran, QLD Intersects the Project footprint, located primarily to north-west	Poultry farming operation with capacity of approximately 20,000 chickens. Operations include egg grading, a feedmill with output of 1,500 tonnes per week, piggery, cropping and solar farm.	Operational	N/A
Yarranbrook Feedlot	Whetstone, QLD Intersects the Project footprint, located predominantly to north	Cattle feedlot licenced for 25,000 head.	Operational	N/A
Sapphire Feedlot	Kildonan, QLD Adjacent to south of the Project footprint	Cattle feedlot which currently has a 6,000 head capacity, with plans to expand to 8,700 and in the future.	Operational	N/A
Wyemo Piggery	Glenarbon, QLD 8 km south of the Project footprint	Piggery with approval for 55,000 pig units.	Approved with conditions by Goondiwindi Regional Council	Not yet publicly released
Yarranlea Solar	Yarranlea, QLD Intersects the Project footprint, generally extends equally to north and south	Solar Farm which will have a generation capacity of up to 100 MW once completed.	Under construction	2018-2019
Goondiwindi Abattoir	Goondiwindi, QLD 13 km north of the Project footprint	A new beef Abattoir located on the outskirts of Goondiwindi with beef processing of up to 72,000 tonnes per year.	Approved with conditions by Goondiwindi Regional Council	Not yet publicly released

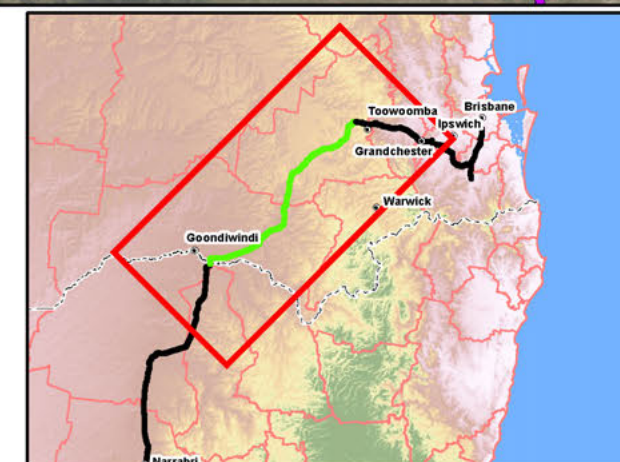
Projects	Location	Description	Status	Construction dates
North Star to NSW/QLD Border (Inland Rail)	Rail alignment from North Star, NSW to the NSW/QLD border Adjoins the Project footprint to south	New 37 km rail corridor to connect North Star (NSW) to the Queensland Rail South West Rail Line just over the NSW/QLD border.	Reference design and EIS	2021 to 2024
Gowrie to Helidon Project (Inland Rail)	Rail alignment from Gowrie to Helidon, QLD Adjoins the Project footprint to north	New 26 km dual gauge track between Gowrie (north-west of Toowoomba) and Helidon (east of Toowoomba), extending through the Local Government Areas of Toowoomba and Lockyer Valley. The project includes a 6.38 km tunnel to create an efficient route through the steep terrain of the Toowoomba Range.	Reference design and EIS	2021 to 2025
Helidon to Calvert (Inland Rail)	Rail alignment from Helidon to Calvert, QLD 26 km east of the Project footprint	New 47 km dual gauge rail line connecting Helidon (east of Toowoomba) with Calvert (near Ipswich), via Placid Hills, Gatton, Forest Hill, Laidley and Grandchester, extending through the Local Government Areas of Lockyer Valley and Ipswich City. The project includes a 1.1 km tunnel to create an efficient route through the steep terrain of the Little Liverpool Range.	Reference design and EIS	2021 to 2025

Map by: RAZ/GN/LS Z:\GIS\GIS_310_B2G\Task\310-EAP-202004231322_B2G_Ecology_Figure\310-EAP-202004231322_FFIV_MINES_Figs4_Cumulative_v2.mxd Date: 18/05/2020 17:04



Legend

- Localities
- 5 Chainage (km)
- North Star to NSW/QLD border alignment
- Narrabri to North Star alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Existing rail (operational)
- - - Existing rail (non-operational)
- - - NSW/QLD border
- Cumulative impact assessment area
- Impact assessment area



A3 scale: 1:800,000

0 10 20 30 40 50 km

3.5.3 Assessment matrix

Following the identification of each potential cumulative impact, a relevance factor scores of Low, Medium and High has been determined in consideration of the impacts, in accordance with the assessment matrix in Table 3.12.

The significance of the impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 3.12 and summing the relevance factors. The sum of the relevance factors determines the impact significance and consequence which are summarised in Table 3.13. For example, if a Project impact on an ecological value such as changed flood regimes was considered to have a probability of impact of 2, duration of impact of 3, magnitude /intensity of impact of 1 and a sensitivity of receiving environment of 1 the significance of impact would be $(2+3+1+1 = 7) = \text{Medium}$.

Table 3.12 Assessment matrix

Aspect	Relevance factor		
	Low	Medium	High
Probability of impact	1	2	3
Duration of impact	1	2	3
Magnitude/intensity of impact	1	2	3
Sensitivity of receiving environment	1	2	3

Table 3.13 Impact significance

Impact significance	Sum of relevant factors	Consequence
Low	1 to 6	Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general project monitoring programme.
Medium	7 to 9	Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring programme required, where appropriate.
High	10 to 12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring programme necessary, where appropriate.

4 Description of environmental values

This section describes the MNES values of the impact assessment area including the results of the desktop analysis, field surveys results and predictive habitat mapping. This section then defines the ecological values and MNES of the impact assessment area which will be the scope of the impact assessment presented in Section 5.

4.1 Regional and local context

The impact assessment area is located within the Brigalow Belt South bioregion. From west to east the Project is located within the Commoroon Creek Floodout subregion (NSW/QLD border to Yelarbon), Inglewood Sandstones subregion (from Yelarbon to Millmerran) and the Eastern Darling Downs subregion (from Millmerran north to Gowrie). The Brigalow Belt South bioregion is characterised by a dry subtropical climate with no pronounced dry season with rainfall increasing with proximity to the coast. The bioregion has experienced a long history of human disturbance as a result of agricultural practices and resource development. At a regional level, most remaining areas of vegetation are now fragmented, occurring on the rockier hilly areas of ranges, as part of State protected areas (State forests), as roadside vegetation, or as relatively small isolated remnants (refer Photograph 4.1 and Photograph 4.2).



Photograph 4.1 Example of mature trees retained within a road reserve, surrounded by anthropogenic disturbance within the Millmerran region (FFJV 2018)



Photograph 4.2 Example of mature trees retained within a road reserve, surrounded by anthropogenic disturbance south of Toowoomba (FFJV 2018)

The impact assessment area commences at the NSW/QLD border, the median line of the Macintyre River, approximately 18 km to the south-east of Goondiwindi near Kurumbul. The impact assessment area then extends for approximately 216 km in a north-northeast direction where it finishes between Leeson Road and Draper Road, on the south-eastern outskirts of Kingsthorpe (north of Toowoomba).

The impact assessment area includes extensive areas of agricultural land and State forest. The Project footprint has been subject to historical disturbance/clearing and approximately one third of its length is located within existing rail corridors (brownfield). The remaining greenfield portions of the Project alignment extend largely through areas subject to agricultural land uses (refer Photograph 4.3, Photograph 4.4, Photograph 4.5 and Photograph 4.6). Outside of the State Forests in the Inglewood area, the remaining patches of forest within the impact assessment area are highly fragmented in nature.



Photograph 4.3 Portion of the Project footprint on the Condamine floodplain (FFJV 2019)



Photograph 4.4 Project footprints north of the Condamine floodplain (FFJV 2019)

In the southern extent of the impact assessment area, between the NSW/QLD border and Inglewood, the landscape is dominated by dryland cropping, irrigated agriculture and intensive animal production on the fertile soils and floodplains associated with the Macintyre River, Dumaresq River and Macintyre Brook. North of Inglewood, the Project passes through the undulating and densely forested landscapes of Whetstone and Bringalily State forests. The Project then traverses the gently undulating agricultural areas near Millmerran before crossing the extensive Condamine River floodplain (refer Photograph 4.5 and Photograph 4.6). The rail alignment deviates from the existing railway line north of Yarranlea to pass through the hilly landscapes surrounding Pittsworth, Southbrook and Athol before crossing Westbrook Creek near Toowoomba Wellcamp Airport and joining the Gowrie to Helidon section of Inland Rail near Gowrie Junction.

Within the impact assessment area, the majority of lands are highly modified having been cleared for pasture, agricultural production (refer Photograph 4.6) and for rural, urban residential settlements. Other areas of planned future development include the Wellcamp Business Park, Witmack Industry Park and Charlton Logistics Park which will be subject to future infrastructure and industrial 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.



Photograph 4.5 Cabbage tree Creek on the Condamine floodplain, showing the narrow band of mature vegetation (FFJV 2019)



Photograph 4.6 Fertile soils of the Condamine floodplain are used extensively for cropping (FFJV 2019)

There are two State Forests that are intersected by the project:

- Bringalily State Forest (35,695 ha) (north of Inglewood)
- Whetstone State Forest (41,282 ha) (west of Inglewood).

One conservation park, the Irongate Conservation Park (29 ha), and the Mount Basalt Environmental Park are also located in the impact assessment area. These areas are dominated by eucalypt woodlands on sandy plains or shallow soils in areas of higher elevation. They are noted for a high diversity of terrestrial fauna including MNES species such as Dunmall's snake (*Furina dunmalli*), Greater glider (*Petauroides volans*) and Spotted-tail quoll (*Dasyurus maculatus maculatus*) (DES 2018).

There are a further five State Forests within the vicinity of the impact assessment area not intersected by the project. These are:

- McEwan State Forest (306 ha) – 1.25 km from impact assessment area
- Domville State Forest (228 ha) – 0.83 km from impact assessment area
- Millmerran State Forest (583 ha) – 1.3 km from impact assessment area
- Devine State Forest (4,665 ha) – 4.3 km from impact assessment area
- Yelarbon State Forest (30,772 ha) – 3.7 km from impact assessment area.

The Project alignment traverses two catchment areas, the Condamine and Border Rivers. The Condamine River catchment is one of the largest catchments in the Murray Darling Basin (Murray Darling Basin Authority 2018). The main rivers of the catchment, the Condamine and the Maranoa, rise in elevated country in Queensland. However, two-thirds of the catchment is flat floodplain country, with a complex system of rivers and creeks joining and breaking away from the Balonne River. The catchment's extensive floodplains provide habitat for a diverse range of plants and endangered plant communities (Murray Darling Basin Authority 2018). The region is significant for its agricultural diversity, with a wide range of winter and summer crops produced on the Darling Downs, as well as very large cotton production areas in the west (Murray-Darling Basin Authority 2018).

The Border Rivers catchment is one of the northern-most catchments in the Murray Darling Basin (Murray Darling Basin Authority 2018). It is made up of a group of rivers in a region straddling the NSW/QLD border. The rivers of the catchment rise on the western slopes of the Great Dividing Range and run westward, gradually merging with one another to become the Barwon River on the floodplains upstream of Mungindi (Murray Darling Basin Authority 2018). The catchment consists of approximately 450 km of rivers. The landscape of the Border Rivers catchment is diverse, containing tablelands and slopes as well as semi-arid plains (Murray Darling Basin Authority 2018).

In relation to MNES that are not identified as controlling provisions for the Project under the EPBC Act, there are no World heritage areas, National heritage areas, Ramsar Wetlands, Commonwealth marine areas or Great Barrier Reef Marine Park areas located within or near the impact assessment area. Therefore, these MNES are not discussed further in this document.

4.2 Results of desktop study

The following subsections provide a comprehensive description of the desktop study results within the impact assessment area and desktop search extents provided in Table 3.1. The desktop study results provide an understanding of the known and historical MNES from the impact assessment area in accordance with Section 11.96 of the *Terms of Reference for an environmental impact statement: Inland Rail – Border to Gowrie Project*. The results of the database searches are presented in full in Appendix D.

Results associated with previous surveys and surveys conducted concurrently with the targeted field investigations (i.e. additional ecological surveys associated with siting of geotechnical assessment locations) have been incorporated into the predictive habitat mapping and the relevant sections of this technical report and has informed the impact assessment section of this document where appropriate.

4.2.1 Flora

4.2.1.1 Threatened flora species

A total of 31 threatened flora species identified under the provisions of the EPBC Act are predicted or are known to occur within the impact assessment area (refer Table 4.1). Of these, two species have been identified exclusively from the EPBC Act PMST (DAWE 2020) which is a predictive search tool that does not rely on specimen backed records. The location of specimen-backed records for threatened flora species, derived from database sources (e.g. Wildlife Online and AoLA) is provided in Figure 4.1a-d.

A total of five MNES species are likely to occur within the impact assessment area based on the presence of suitable habitat. A total of 16 MNES species are considered possible to occur within the impact assessment area based on the presence of suitable habitat.

Ten MNES species are considered unlikely to occur within the impact assessment area based on the absence of specimen-backed records in the Wildlife Online and AoLA databases and/or the absence of suitable habitat.

Information related to the ecology, biology and distribution for species listed in Table 4.1 is provided in Appendix B.

Table 4.1 Threatened flora species identified from database searches

Family	Common name	Species name ¹	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife online	PMST	AoLA	ToR ²	
Acanthaceae	-	<i>Xerothamnella herbacea</i>	E		✓		✓	Possible
Apocynaceae	Slender tylophora	<i>Tylophora linearis</i>	E		✓		✓	Possible
Asteraceae	Hawkweed	<i>Picris evae</i>	V	✓	✓		✓	Likely
Asteraceae	Austral cornflower	<i>Rhaponticum australe</i>	V	✓	✓	✓	✓	Likely
Brassicaceae	Winged peppergrass	<i>Lepidium monoplacoides</i>	E	✓			✓	Likely
Brassicaceae	Wandering pepper-grass	<i>Lepidium peregrinum</i>	E		✓		✓	Possible
Ericaceae	Coolmunda leucopogon	<i>Leucopogon</i> sp. <i>Coolmunda</i> (D. Halford Q 1635)	E				✓	Possible
Euphorbiaceae	-	<i>Bertya opposens</i>	V				✓	Possible
Fabaceae	Tara wattle	<i>Acacia lauta</i>	V		✓		✓	Possible
Fabaceae	Brush sophora	<i>Sophora fraseri</i>	V	✓	✓		✓	Possible
Lamiaceae	Dunmore prostanthera	<i>Prostanthera</i> (sp. <i>Dunmore</i>)	V	✓			✓	Possible
Lamiaceae	Small-flowered westringia	<i>Westringia parvifolia</i>	V		✓	✓	✓	Possible
Malvaceae	-	<i>Androcalva procumbens</i>	V		✓			Unlikely, impact assessment area outside of recorded distribution - endemic to NSW

Family	Common name	Species name ¹	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife online	PMST	AoLA	ToR ²	
Myrtaceae	Durikai mallee	<i>Eucalyptus infera</i>	V				✓	Unlikely, impact assessment area outside of recorded distribution, near Warwick
Myrtaceae	Shiny-leaved ironbark	<i>Eucalyptus virens</i>	V		✓		✓	Possible
Orchidaceae	Miniature moss-orchid	<i>Bulbophyllum globuliforme</i>	V				✓	Unlikely, impact assessment area outside of the species known distribution and lack of naturally occurring host species (i.e. Hoop pine)
Orchidaceae	Waxy sarcochilus	<i>Sarcochilus hartmannii</i>	V				✓	Unlikely, impact assessment area located to the west of known distribution
Orchidaceae	Blotched sarcochilus	<i>Sarcochilus weinthalii</i>	V		✓		✓	Unlikely, impact assessment area located to the west of known distribution and suitable habitat unlikely to occur
Poaceae	Hairy-joint grass	<i>Arthraxon hispidus</i>	V				✓	Possible
Poaceae	Bunya Mountains bluegrass	<i>Bothriochloa bunyensis</i>	V				✓	Unlikely, impact assessment area north of Toowoomba Range is highly modified and very unlikely to be suitable for the species
Poaceae	King blue-grass	<i>Dichanthium queenslandicum</i>	E	✓	✓	✓	✓	Likely
Poaceae	Bluegrass	<i>Dichanthium setosum</i>	V		✓		✓	Possible
Poaceae	Belson's panic	<i>Homopholis belsonii</i>	V	✓	✓	✓		Likely
Proteaceae	Macadamia nut	<i>Macadamia integrifolia</i>	V				✓	Unlikely, outside of the species known coastal distribution
Ranunculaceae	Stream clematis	<i>Clematis fawcettii</i>	V		✓		✓	Possible
Rutaceae	Mt Berryman phebalium	<i>Phebalium distans</i>	CE				✓	Unlikely, outside of the species known distribution
Santalaceae	Austral toadflax	<i>Thesium australe</i>	V		✓		✓	Possible
Scrophulariaceae	-	<i>Microcarpaea agonis</i>	E				✓	Unlikely, species known from a single location over 50 km west of Project
Surianaceae	Ooline	<i>Cadellia pentastylis</i>	V				✓	Possible

Family	Common name	Species name ¹	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife online	PMST	AoLA	ToR ²	
Zamiaceae	-	<i>Macrozamia conferta</i>	V				✓	Unlikely, only known from very restricted small populations located outside the range of the Project
Zamiaceae	-	<i>Macrozamia machinii</i>	V		✓		✓	Possible

Table notes:

CE = Critically Endangered E = Endangered V = Vulnerable NT = Near threatened

1 Species present within database record within the impact assessment area

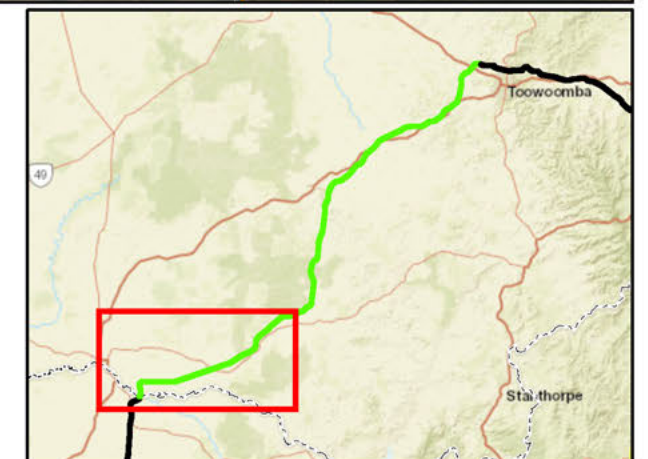
2 ToR = Terms of Reference



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area
- Species point observations**
- Winged pepper-cress (*Lepidium monoplacoides*)

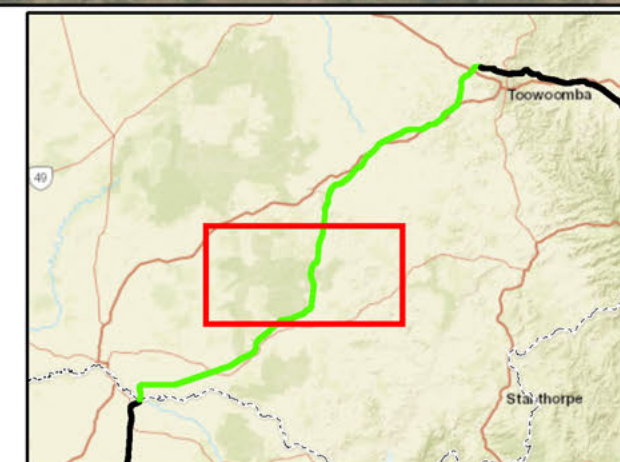
The impact assessment area for ecology extends into NSW. Mapping of ecological features and species habitats, as only relevant to Queensland legislation, is confined to Queensland sections of the impact assessment area.



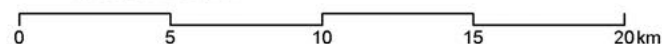


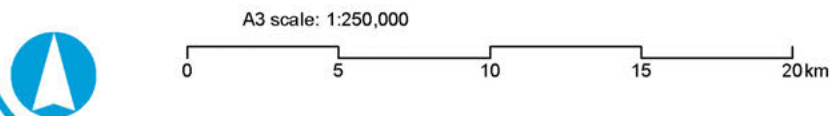
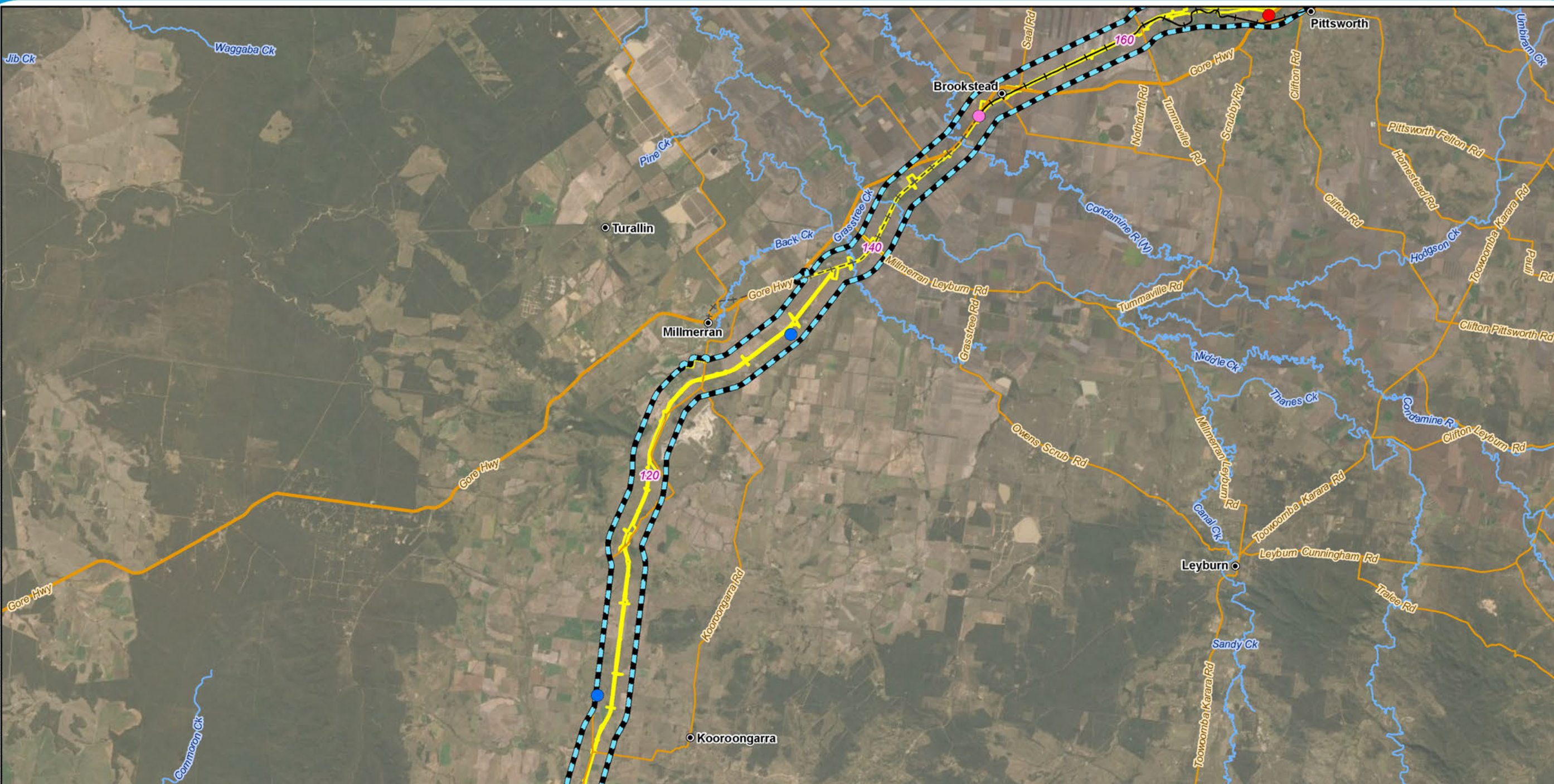
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Species point observations**
 - Belson's panic (*Homopholis belsonii*)

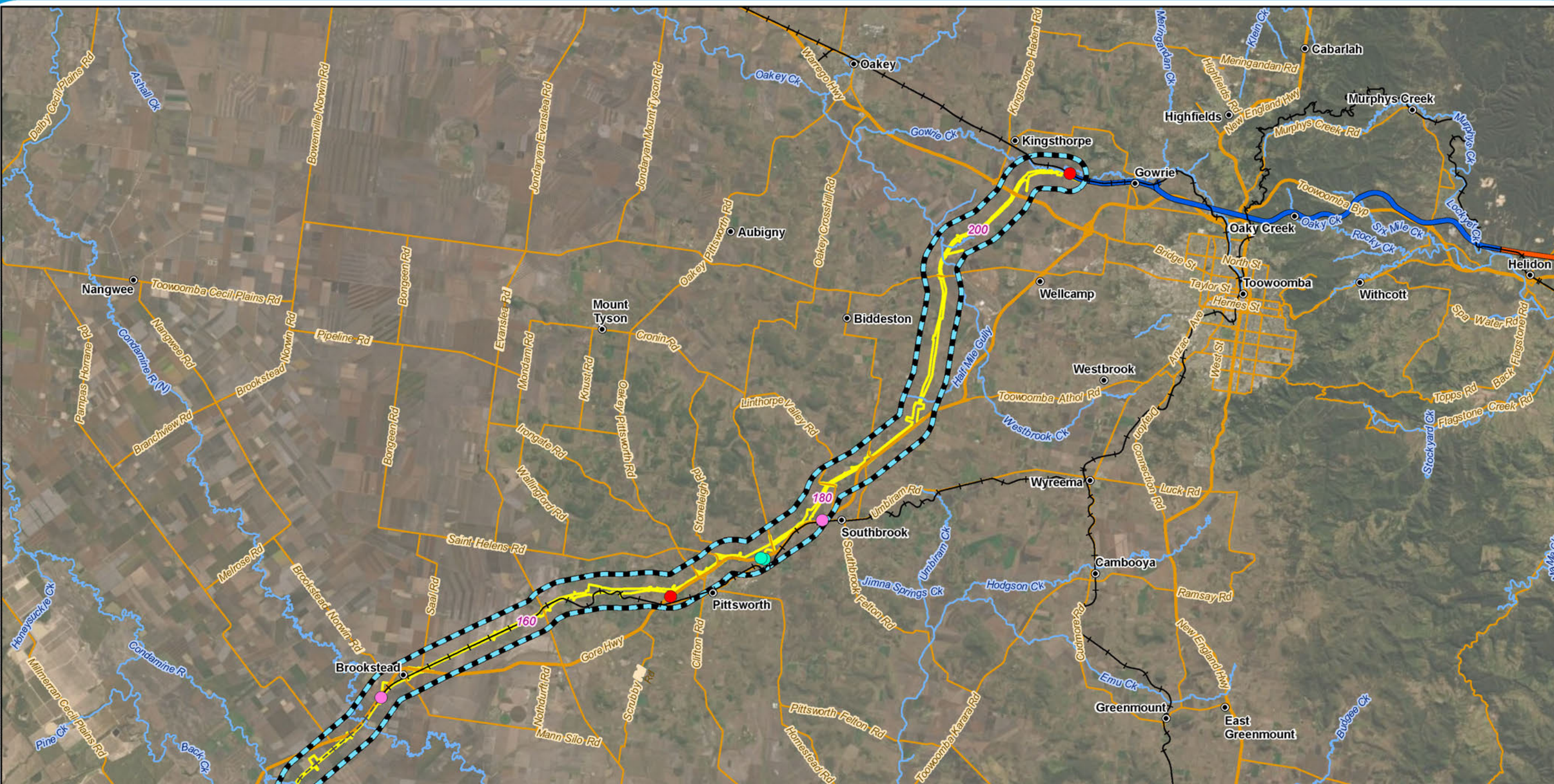


A3 scale: 1:250,000





Border to Gowrie
Figure 4.1c: Location of specimen backed records of MNES significant flora species derived from desktop assessments



Legend

5 Chainage (km)

● Localities

— Gowrie to Helidon alignment

— Helidon to Calvert alignment

— Existing rail (operational)

--- Existing rail (non-operational)

— Major roads

— Minor roads

— Watercourses

Project footprint

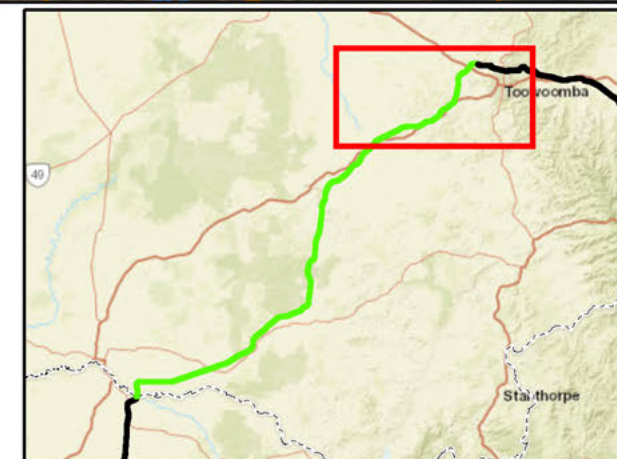
Impact assessment area

Species point observations

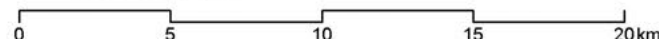
● King blue-grass (*Dichanthium queenslandicum*)

● A hawkweed (*Picris evae*)

● Austral cornflower (*Rhaphonticum australe*)



A3 scale: 1:250,000



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Issue date: 06/05/2020 Version: 2
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.1d: Location of specimen backed records of MNES significant flora species derived from desktop assessments

4.2.1.2 Threatened ecological communities

A total of eight MNES TECs identified under the provisions of the EPBC Act are predicted or are known to occur within the impact assessment area. Identified TECs consist of the following:

- Lowland Rainforest of Subtropical Australia – Critically Endangered
- Brigalow (*Acacia harpophylla* dominant and co-dominant) – Endangered
- Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions – Endangered
- Natural grassland on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland – Critically Endangered
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions - Endangered
- Weeping Myall Woodlands – Endangered
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland – Endangered
- Poplar Box Grassy Woodland on Alluvial Plains – Endangered.

Based on review of the RE mapping (i.e. current and pre-clearance), aerial imagery and previous surveys, there are four TECs likely to occur within the impact assessment area:

- Brigalow (*Acacia harpophylla* dominant and codominant) ecological community
- Natural Grasslands
- Weeping Myall Woodlands
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- Poplar Box Grassy Woodland on Alluvial Plains.

Profiles related to each of the TECs identified above, mapping produced by DAWE, Approved conservation advice, relevant threat abatement/recovery plans and threatening processes are provided in Appendix B.

The current State RE mapping indicates the presence of these communities within the following areas relevant to the Project:

- Brigalow remnants occur largely as fragments between Yelarbon and Millmerran. For the most part these occur as linear fragments associated with fence lines and road reserves. The Project footprint intersects part of a large tract of mixed woodland potentially comprising Brigalow woodland associated with Bringalily State Forest (north of Inglewood).
- Patches of Weeping Myall woodlands potentially occurs between the southern extent of the Project and Pittsworth, although are more prevalent in the Inglewood area. The Project footprint intersects a large tract of mixed woodlands potentially comprising Weeping Myall woodland associated with Whetstone State Forest (south-west of Inglewood).
- A small area of White Box-Yellow Box woodland occurs within the edge of impact assessment area to the south of Millmerran (does not occur within the Project footprint)
- A small patch of potential grassland TEC occurs within the impact assessment area between Millmerran and Pittsworth (does not occur within the Project footprint)
- Poplar box woodland overlaps substantially with REs that are analogous to Weeping Myall woodlands (RE 11.3.2) (refer Table 3.3). As such, the Project footprint intersects a large tract of mixed woodlands potentially comprising Poplar box woodlands associated with Whetstone State Forest.

These communities may provide habitat for a number of threatened flora and fauna species, including some of the species listed in Table 4.1 and Table 4.3.

The amount of each community occurring within the impact assessment area based on vegetation community mapping at a desktop level is detailed in Table 4.2. The DES vegetation (RE) mapping incorporates a number of mixed polygons thereby including more than one vegetation community as potentially present. The desktop mapping has not separated the predicted extent of TEC vegetation within these mapped polygons and may therefore over-estimate the potential extent of TEC based on the current State-based mapping.

It is also noted the current State RE mapping may be inaccurate and therefore may not identify the true extent of potential TECs within the Project footprint. Condition thresholds as outlined in the community-specific Approved conservation advice may be relatively small (e.g. 0.5 ha for the Brigalow and Natural Grasslands TECs) and may not reflect the community growth status (i.e. remnant or regrowth) of the State-based mapping.

As such, incorporation of the State-based mapping will likely not reflect the actual extent of the TECs on the ground (refer Section 4.3.1.3 for TEC mapping).

Table 4.2 **Threatened ecological communities identified within the impact assessment area based on desktop mapping**

TEC Name	EPBC Act status*	Extent (ha)	
		Impact assessment area	Project footprint
Lowland Rainforest of Subtropical Australia	CE	0.00	0.00
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	E	503.86	62.89
Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South	E	0.00	0.00
Natural grassland on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	CE	0.95	0.00
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	E	0.00	0.00
Weeping Myall Woodlands	E	1,632.72	81.92
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	E	36.31	0.00
Poplar Box Grassy Woodland on Alluvial Plains	E	1,632.72	81.92

4.2.2 Fauna

4.2.2.1 Threatened fauna species

A total of 33 threatened fauna species identified under the provisions of the EPBC Act are predicted or are known to occur within the impact assessment area (refer Table 4.3). Of these, 18 species have been identified exclusively from the EPBC Act protected matters search tool (DAWE 2020) which is a predictive search tool that does not rely on specimen backed records. The location of specimen backed records for threatened fauna species, derived from database sources (e.g. Birds Australia, Wildlife Online and AoLA) is provided in Figure 4.2a-d.

Of the threatened fauna species identified above seven are considered likely to occur within the impact assessment area based on the potential presence of suitable habitat and specimen-backed records in the Wildlife online and the AoLA databases and/or the presence of suitable habitat (refer Table 4.3).

Of the threatened species 18 are considered possible to occur within the impact assessment area based on the presence of suitable habitat (refer Table 4.3).

Of the threatened species eight are considered unlikely to occur within the impact assessment area based on the absence of specimen-backed records in the Wildlife Online and AoLA databases and/or the absence of suitable habitat.

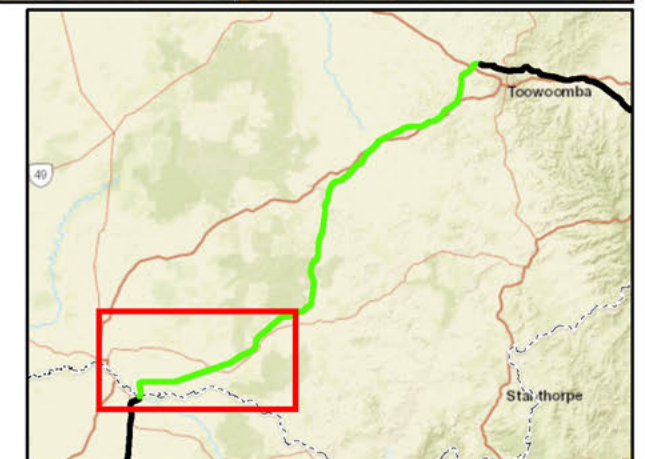
Map by: RAZ/IGN Z:\GIS\GIS_310_B2G\Tasks\310-EAP-202004231322_FF\N_MNES_Fig4.2_DeskFauna_v2.mxd Date: 18/05/2020 17:07



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area
- Species point observations**
- White-throated needletail (*Hirundapus caudacutus*)

The impact assessment area for ecology extends into NSW. Mapping of ecological features and species habitats, as only relevant to Queensland legislation, is confined to Queensland sections of the impact assessment area.



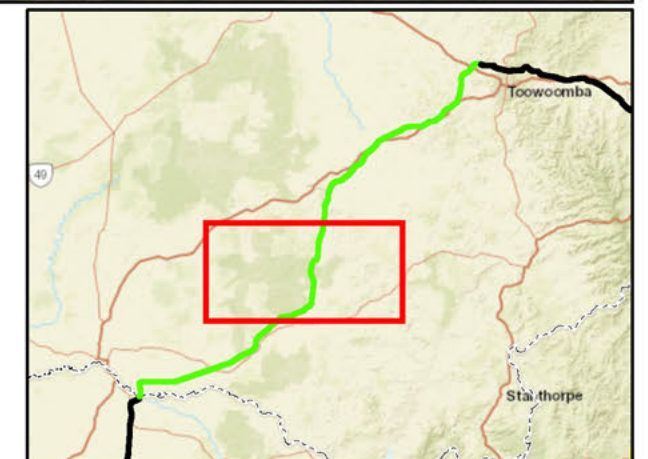
A3 scale: 1:250,000

0 5 10 15 20 km

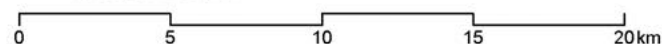


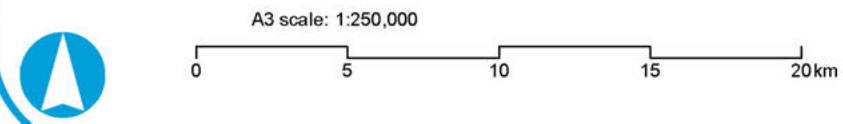
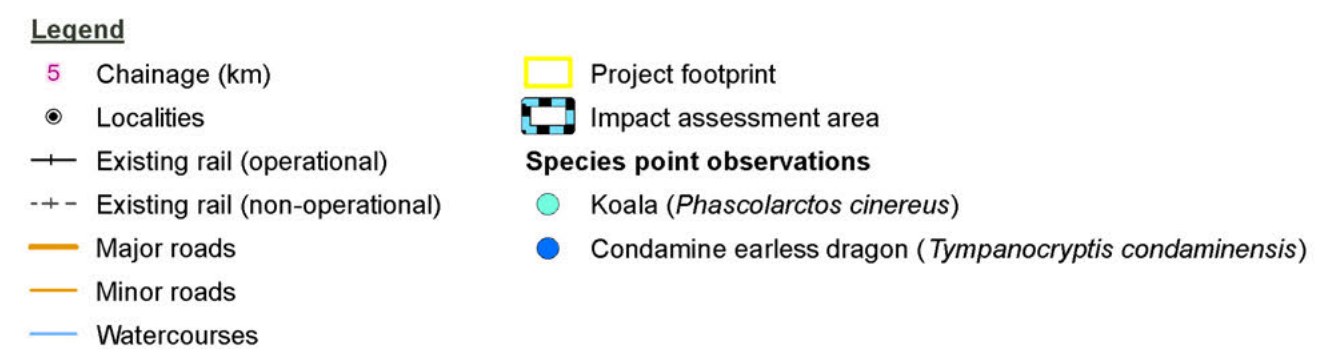
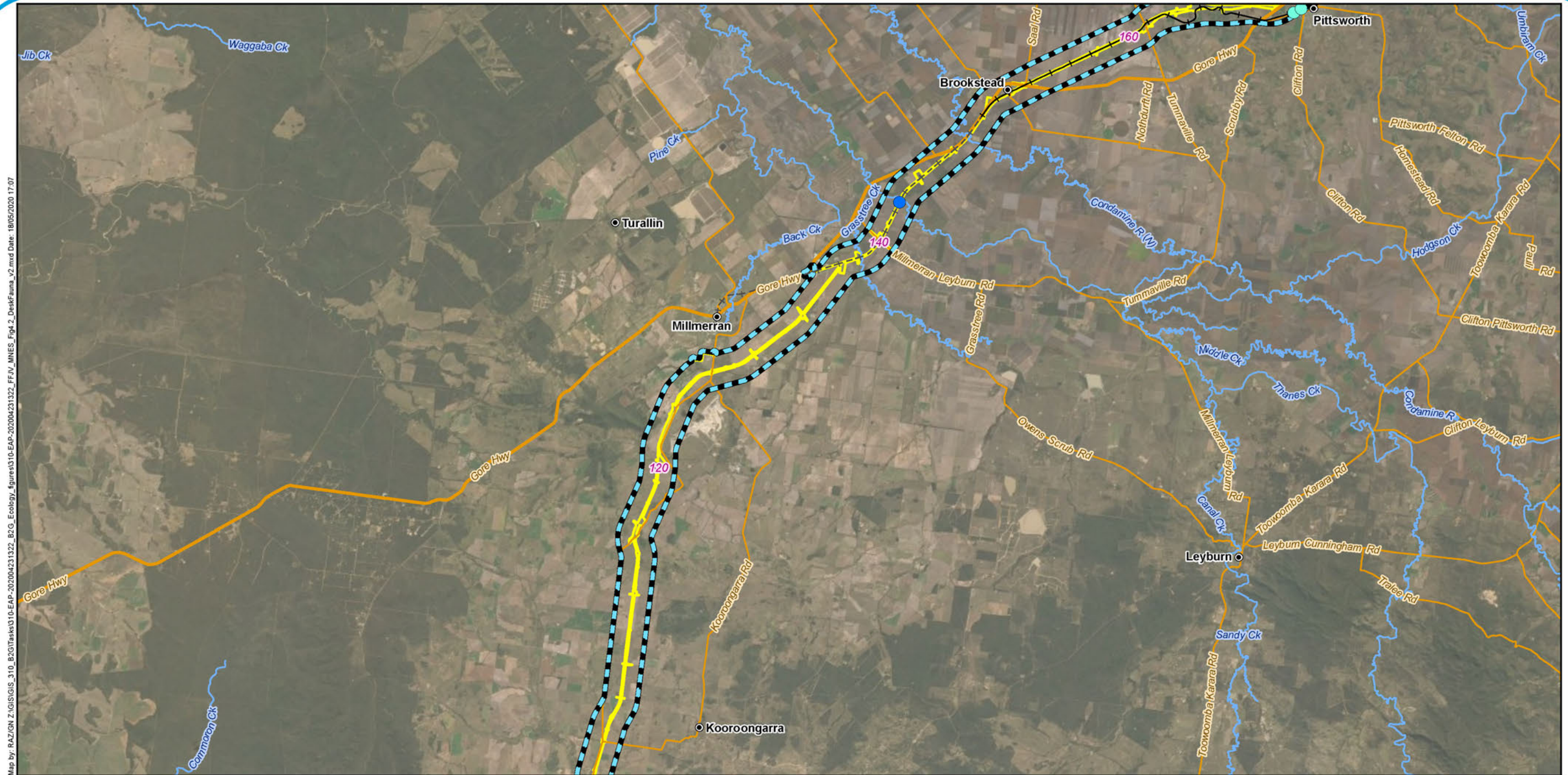
Legend

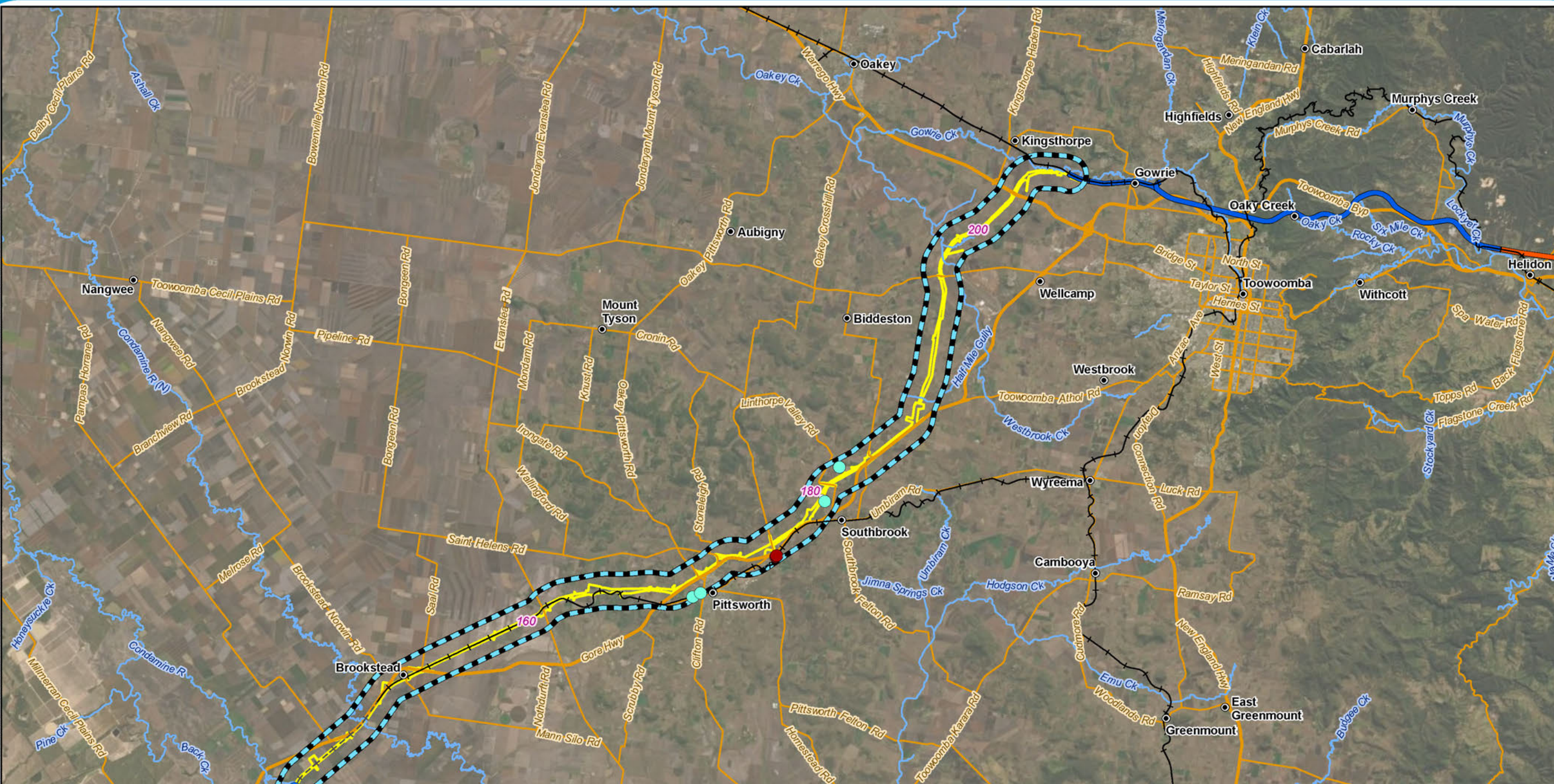
- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Species point observations**
 - Dunmall's snake (*Furina dunmalli*)
 - White-throated needletail (*Hirundapus caudacutus*)



A3 scale: 1:250,000

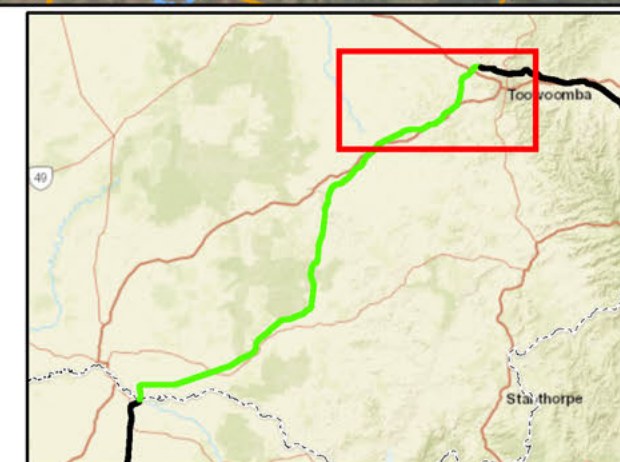




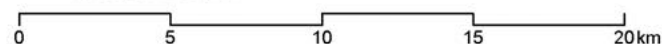


Legend

- 5 Chainage (km)
- Localities
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Species point observations**
 - Five-clawed worm-skink (*Anomalopus mackayi*)
 - Koala (*Phascolarctos cinereus*)
 - Condamine earless dragon (*Tympanocryptis condaminensis*)



A3 scale: 1:250,000



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Issue date: 06/05/2020 Version: 2
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.2d: Location of specimen backed records of MNES significant fauna species derived from desktop assessments

Information related to the ecology, biology and distribution for all species listed in Table 4.3 and is provided in Appendix B.

Table 4.3 Threatened fauna species identified from database searches

Family	Common name	Species name ¹	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife online	PMST	AoLA	ToR ²	
Birds								
Accipitridae	Red goshawk	<i>Erythrotriorchis radiatus</i>	V		✓		✓	Possible
Apodidae	White-throated needletail	<i>Hirundapus caudacutus</i>	V, M	✓	✓	✓	✓	Likely
Ardeidae	Australasian bittern	<i>Botaurus poiciloptilus</i>	E		✓		✓	Possible
Columbidae	Squatter pigeon - southern subspecies	<i>Geophaps scripta scripta</i>	V	✓	✓		✓	Possible
Falconidae	Grey falcon	<i>Falco hypoleucos</i>	V			✓		Possible
Meliphagidae	Regent honeyeater	<i>Anthochaera phrygia</i>	CE		✓		✓	Possible
Meliphagidae	Painted honeyeater	<i>Grantiella picta</i>	V	✓			✓	Possible
Passeridae	Southern black-throated finch	<i>Poephila cincta cincta</i>	E		✓		✓	Unlikely – considered to be locally extinct
Psittacidae	Swift parrot	<i>Lathamus discolor</i>	CE		✓		✓	Possible
Rostratulidae	Australian painted snipe	<i>Rostratula australis</i>	E		✓		✓	Possible
Scolopacidae	Curlew sandpiper	<i>Calidris ferruginea</i>	CE, M		✓		✓	Possible
Turnicidae	Black-breasted button-quail	<i>Turnix melanogaster</i>	V	✓	✓		✓	Possible
Fish								
Percichthyidae	Murray cod	<i>Maccullochella peelii</i>	V		✓		✓	Likely
Terapontidae	Silver perch	<i>Bidyanus bidyanus</i>	CE				✓	Unlikely – no suitable habitat present (refer EIS Appendix K: Aquatic Ecology Technical Report). Local Toowoomba records likely a result of fish stocking.
Mammals								
Dasyuridae	Northern quoll	<i>Dasyurus hallucatus</i>	E		✓			Unlikely – impact assessment area outside current distribution
Dasyuridae	Spotted-tail quoll	<i>Dasyurus maculatus maculatus</i>	E	✓			✓	Possible
Macropodidae	Brush-tailed rock-wallaby	<i>Petrogale penicillata</i>	V		✓		✓	Possible

Family	Common name	Species name ¹	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife online	PMST	AoLA	ToR ²	
Muridae	New Holland mouse	<i>Pseudomys novaehollandiae</i>	V		✓		✓	Unlikely – impact assessment area is located west of current distribution
Petauroidea	Greater glider	<i>Petauroides volans volans</i>	V		✓		✓	Possible
Phascolarctidae	Koala	<i>Phascolarctos cinereus</i>	V	✓	✓	✓	✓	Likely
Potoroidae	Long-nosed potoroo	<i>Potorous tridactylus tridactylus</i>	V				✓	Unlikely – impact assessment area is located west of known distribution and suitable habitat is unlikely to be present
Pteropodidae	Grey-headed flying-fox	<i>Pteropus poliocephalus</i>	V				✓	Likely
Vespertilionidae	Large-eared pied bat	<i>Chalinolobus dwyeri</i>	V		✓		✓	Possible
Vespertilionidae	South-eastern long-eared bat	<i>Nyctophilus corbeni</i>	V	✓	✓		✓	Possible
Reptiles								
Agamidae	Condamine earless dragon	<i>Tympanocryptis condaminensis</i>	E	✓	✓		✓	Likely
Chelidae	Bell's turtle	<i>Wollumbinia belli</i>	V				✓	Unlikely – impact assessment area is located outside of known distribution (ie. in south-east Queensland near Stanthorpe, at the headwaters of the Border Rivers catchment)
Elapidae	Dunmall's snake	<i>Furina dunmalli</i>	V	✓			✓	Likely
Gekkonidae	Border thick-tailed gecko	<i>Uvidicolus sphyrurus</i>	V		✓		✓	Unlikely – impact assessment area is located outside of known distribution
Pygopodidae	Collared delma	<i>Delma torquata</i>	V				✓	Possible
Scincidae	Five-clawed worm-skink	<i>Anomalopus mackayi</i>	V	✓	✓	✓	✓	Likely
Scincidae	Yakka skink	<i>Egernia rugosa</i>	V		✓		✓	Possible
Invertebrates								
Camaenidae	Brigalow woodland snail	<i>Adclarkia cameroni</i>	E		✓		✓	Possible
Camaenidae	Dulacca woodland snail	<i>Adclarkia dulacca</i>	E		✓		✓	Unlikely – impact assessment area is located outside of known distribution

Table notes:

- = Species not listed CE = Critically Endangered E = Endangered V = Vulnerable M= Migratory

1 Species present within database record within the impact assessment area

2 ToR = Terms of Reference

4.3 Existing environment

This section describes the existing ecological values of the impact assessment area, based on the results of the field surveys and with consideration of the desktop assessment. The results presented in this section detail the existing MNES flora and fauna species (including notes on weeds and pests), habitats, and TECs that may support MNES.

4.3.1 Flora

4.3.1.1 Species richness

A total of 404 plant species were identified within the impact assessment area during the field surveys, including 283 (70 per cent) native species and 121 (30 per cent) non-native species (refer Appendix E).

Non-native species were typically more abundant and diverse in areas of high anthropogenic disturbance when compared to those characterised by an intact canopy of native species such as identified as remnant vegetation/intact bushland.

4.3.1.2 Threatened flora species

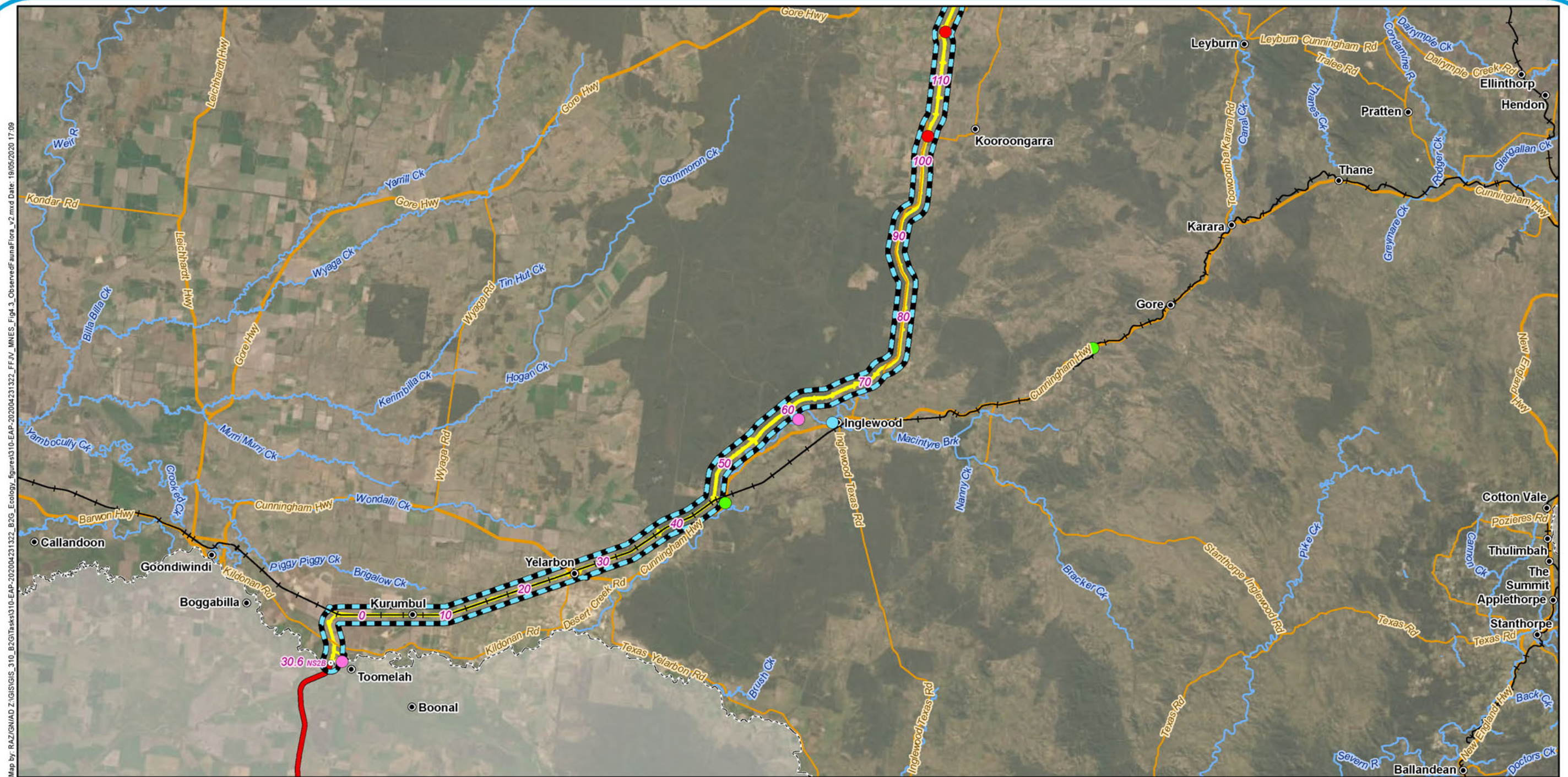
One conservation significant flora species listed under provisions of the EPBC Act was identified within the impact assessment area during field surveys. This species is Belson's panic (*Homopholis belsonii*) (listed as vulnerable under the EPBC Act) which was recorded at multiple locations to the south of Millmerran. The species was observed in road reserves adjacent to the Project footprint 3.2 km south of Millmerran, 13.5 km south of Millmerran (adjacent to the Millmerran-Inglewood Road) and 26.2 km south of Millmerran (adjacent to the Millmerran-Inglewood Road and Kooroongarra Road). Figure 4.3 illustrates the location of observed MNES flora species. An image of identified specimens and habitat of Belson's panic is provided in Photograph 4.7 and Photograph 4.8.



Photograph 4.7 Belson's panic recorded during Project surveys – Millmerran area (2018)

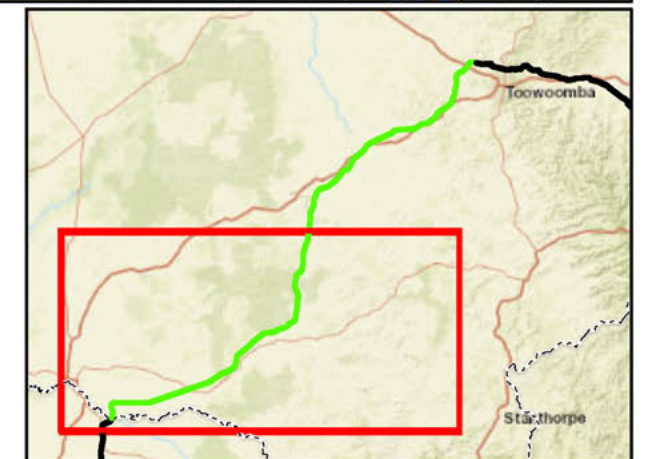


Photograph 4.8 Road reserve habitat of Belson's panic – Millmerran area (2018)



Legend

- | | | |
|--|------------------------|---|
| 5 Chainage (km) | Major roads | Flora records |
| Chainage point | Minor roads | ● Belson's panic (<i>Homopholis belsoni</i>) |
| Localities | Watercourses | Fauna records |
| North Star to NSW/QLD border alignment | NSW/QLD border | ● Grey-headed flying-fox (<i>Pteropus poliocephalus</i>) |
| Existing rail (operational) | Project footprint | ● Murray cod (<i>Maccullocheila peelii</i>) |
| | Impact assessment area | ● Potential South-eastern long-eared bat (<i>Nyctophilus corbeni</i>) |



A3 scale: 1:500,000

0 10 20 30 40 km

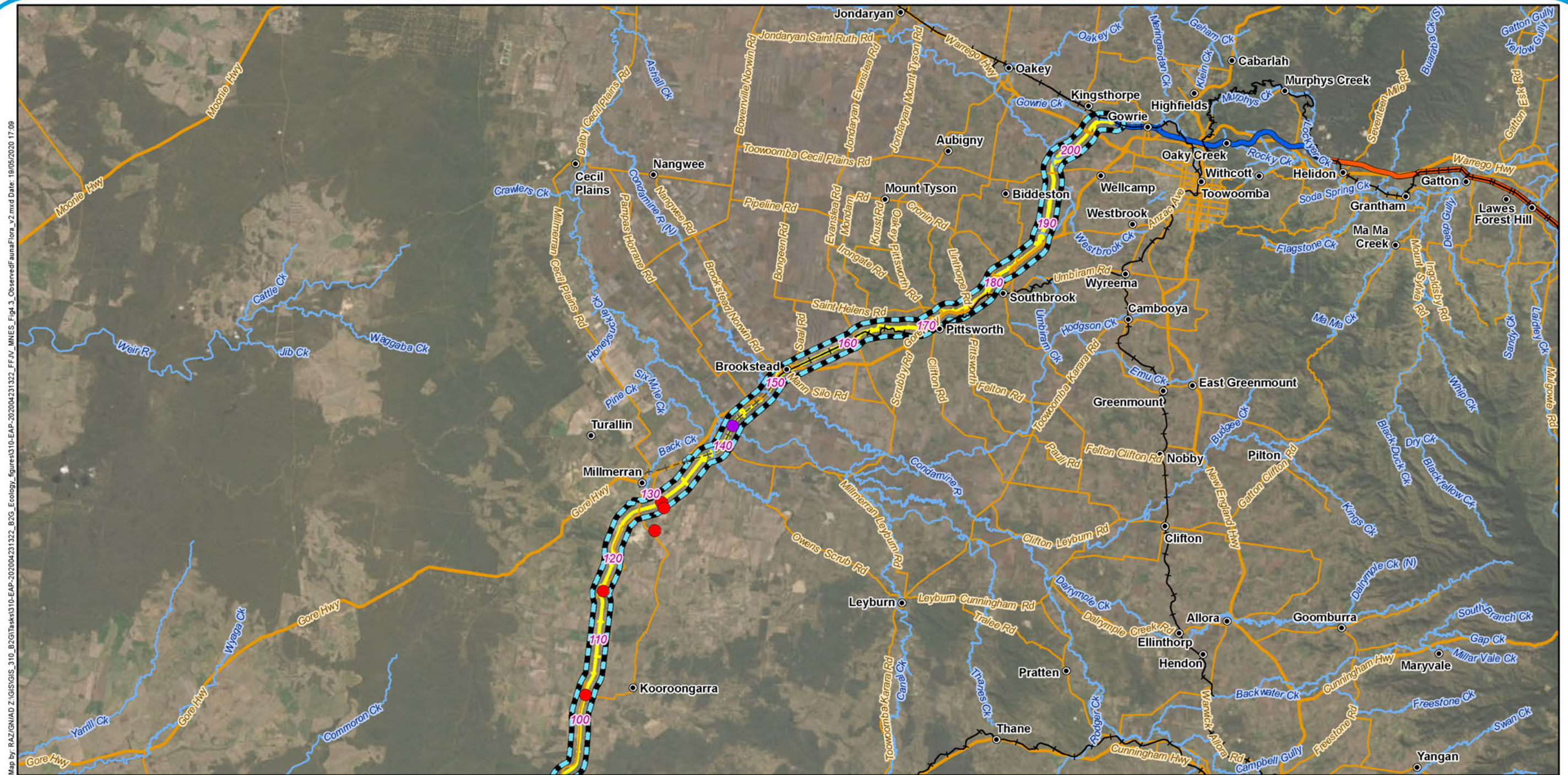


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Issue date: 19/05/2020 Version: 2
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Border to Gowrie

Figure 4.3a: Locations of observed MNES significant flora and fauna species within the impact assessment area



Legend

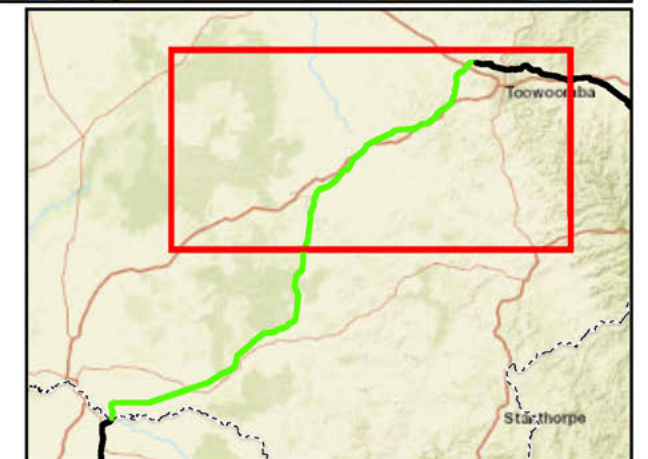
- 5 Chainage (km)
- Chainage point
- Localities
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area

Flora records

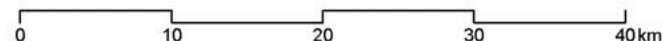
- Belson's panic (*Homopholis belsoni*)

Fauna records

- Condamine earless dragon (*Tympanocryptis condaminensis*)



A3 scale: 1:500,000



The field investigations also confirmed habitat for a number of other flora species within the impact assessment area including (but not restricted to) the following:

- Tara wattle (*Acacia lauta*) – woodlands in the Whetstone State Forest area
- King bluegrass (*Dichanthium queenslandicum*) – black clay soils on the Condamine River floodplain
- Shiny-leaved ironbark (*Eucalyptus virens*) - woodlands in the Whetstone State Forest area
- Hawkweed (*Picris evae*) – dark clay soils in the Millmerran area and north of Bringalily State Forest
- Austral cornflower (*Rhaponticum australe*) - dark clay soils in the Millmerran area, north of Bringalily State Forest and west of Toowoomba
- *Xerothamnella herbacea* – largely associated with Brigalow habitat in the south of the impact assessment area (to the south of Millmerran).

This information was used to inform the predictive habitat modelling for each of the MNES flora species. Predictive habitat mapping within the impact assessment area for those species considered to have habitat potentially impacted by the Project are presented in Appendix F. Potential habitat for threatened flora species is largely associated with remnant vegetation associated with the State forests located north of Inglewood, Brigalow habitat located south of Millmerran and the dark clay soils associated with the Condamine River floodplain.

It is noted that whilst all areas within the impact assessment areas were not accessible, information derived from previous surveys (refer Figure 3.2) was used to inform the predictive mapping for MNES flora species where applicable.

4.3.1.3 Threatened ecological communities

A single Endangered TEC identified in the desktop study (Brigalow (*Acacia harpophylla* dominant and co-dominant), has been confirmed as occurring approximately 20 km north of Inglewood within the impact assessment area (refer Photograph 4.9), as well as other locations further south-west in proximity to Yelarbon (refer Photograph 4.10).



Photograph 4.9 Brigalow TEC identified within the impact assessment area north of Inglewood (2018)



Photograph 4.10 Brigalow TEC identified within the impact assessment area in proximity to Yelarbon (2018)

Queensland RE mapping indicates that heterogeneous polygons including remnant RE 11.3.2 (analogous to the Weeping myall woodlands and Poplar box woodlands TECs) occur within the impact assessment area and Project footprint. The occurrence of these communities could not be confirmed due to a lack of property access at the time of Project surveys. The Natural Grassland TEC and White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC are indicated as occurring within the impact assessment area but not within the Project footprint. The location and extent of mapped TECs within the impact assessment area is presented in Figure 4.4 and Table 4.2.

As noted in Section 4.2.1.2 the current State-based mapping will likely not reflect the actual extent of the TECs on the ground. Detailed surveys throughout the Project footprint have not been carried out as yet. Detailed ecological surveys will be undertaken in parallel to the development of the detail design to identify the extent to which TEC vegetation actually occurs within the vicinity of the Project disturbance footprint, as confirmed through detail design. Surveys will assess the potential presence of TECs using the diagnostic criteria and condition thresholds detailed in the relevant Approved conservation advice for each community (refer Table 6.2 and Section 10).

4.3.2 Fauna

This section outlines the fauna species richness observed within the impact assessment area. This section also provides the conservation significant species listed under the provisions of the EPBC Act that were recorded within the impact assessment area.

4.3.2.1 Species richness

The Project field surveys have identified a total of 131 fauna species (refer Appendix F), including 120 (91.5 per cent) native species and 11 (8.5 per cent) non-native species. Recorded species consisted of 91 (70 per cent) birds, 27 (20 per cent) mammals, 10 (7.7 per cent) reptiles and three (2.3 per cent) amphibians.

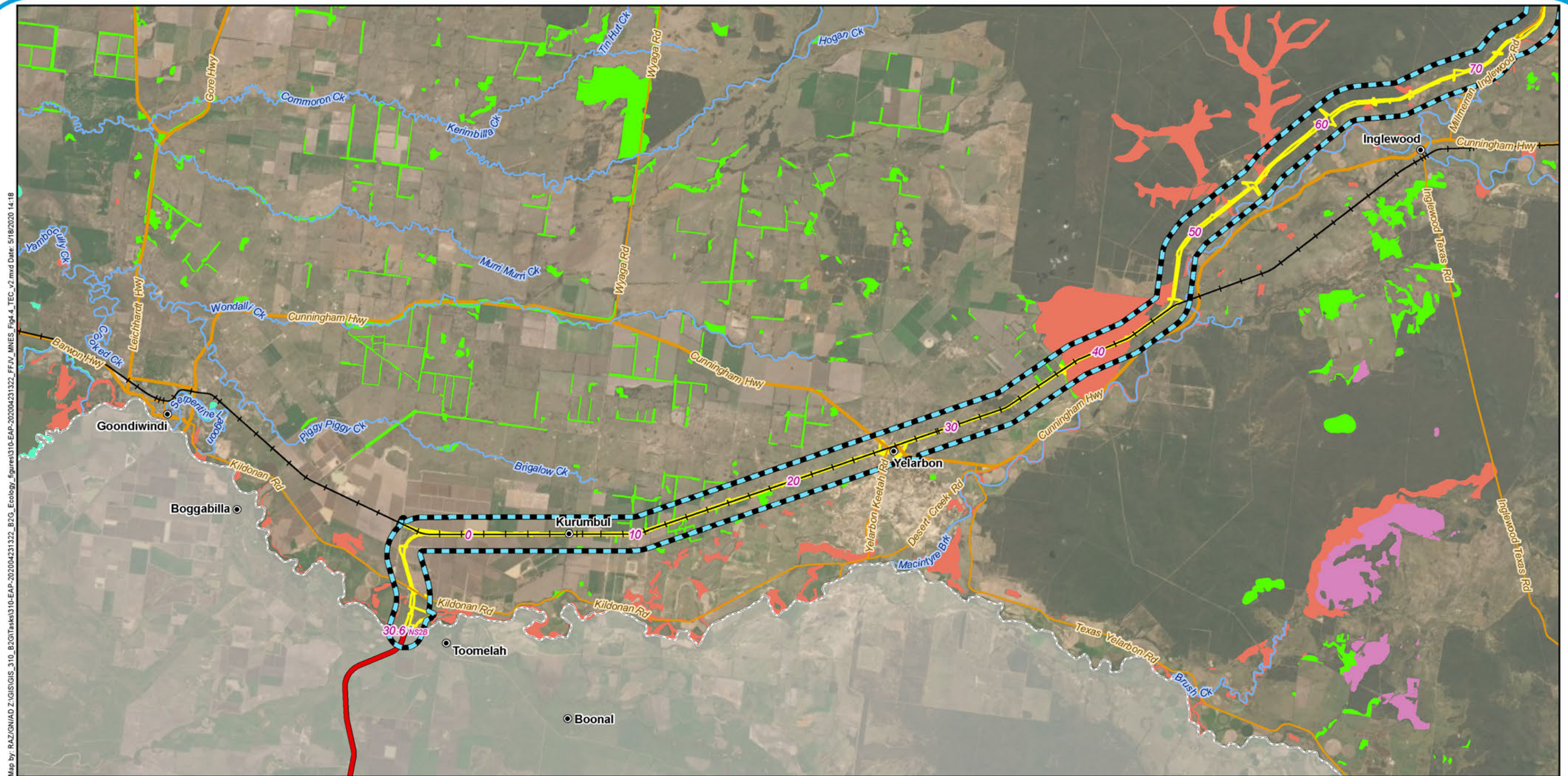
Given the fragmented nature of bushland areas within much of the impact assessment area, their vagile nature and ability to persist in fragmented landscapes, it is to be expected that birds would constitute the largest percentage of observed species. However, their dominance of the recorded species is also likely to be an artefact of their detectability when compared to more cryptic species such as amphibians and reptiles.

4.3.2.2 Threatened fauna species

As noted in Section 4.2.2.1, there is the potential for a number of threatened fauna species to occur throughout the impact assessment area.

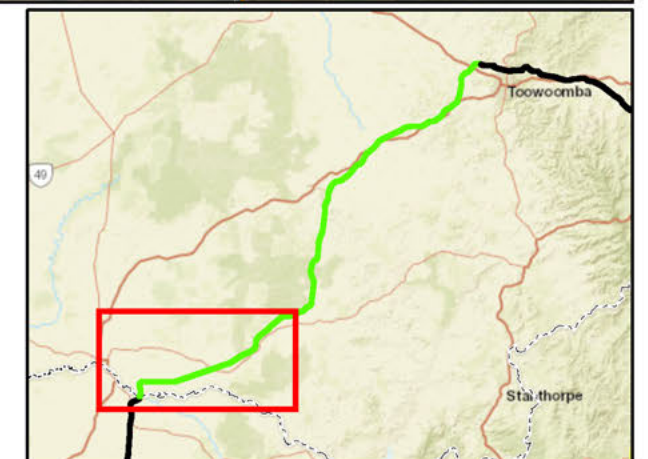
Three threatened fauna species were recorded within the impact assessment area during the field surveys:

- Grey-headed flying fox (*Pteropus poliocephalus*) was observed at a camp located on Macintyre Brook next to the township of Inglewood. This is a known flying-fox camp and approximately 200-300 individuals were present at the time.
- Condamine earless dragon (*Tympanocryptis condaminensis*) was identified in an existing rail reserve located between Millmerran and Brookstead (refer Photograph 4.11). Potential grassland on cracking clay habitat suitable for the species was identified throughout the area (refer Photograph 4.12).
- Murray cod (*Maccullochella peelii*) was recorded in the Macintyre River and Macintyre Brook during targeted surveys in 2019. Suitable habitat for the species was not identified as present on the waterways intersected by the Project within the Condamine River floodplain (refer Section 4.3.2.3).



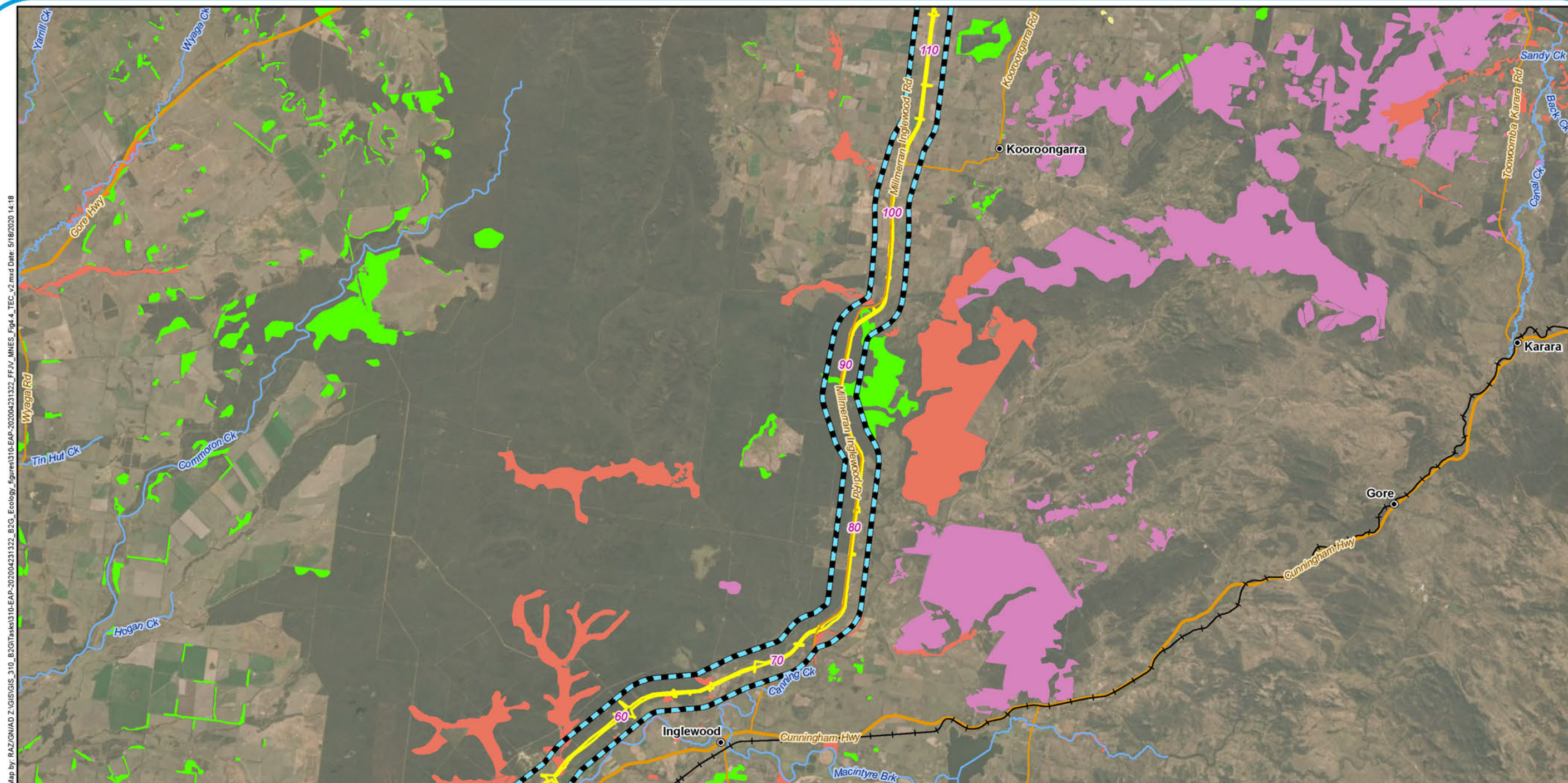
Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- ▨ Impact assessment area
- Brigalow Habitat
- Coolibah Habitat
- Weeping Myall Habitat
- White Box Habitat



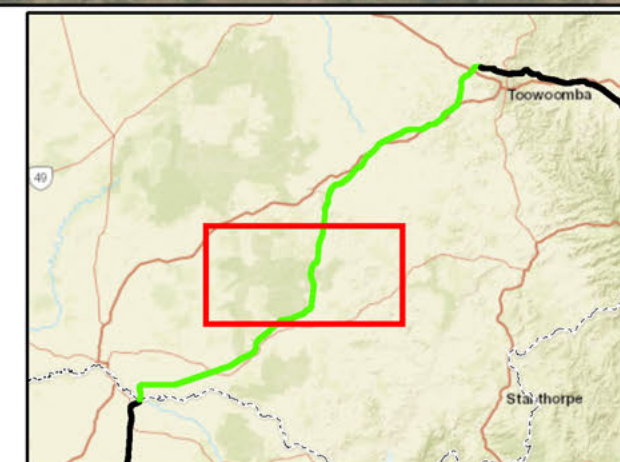
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0 5 10 15 20 km

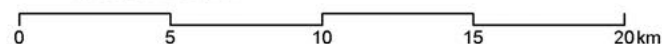


Legend

- | | |
|-----------------------------|------------------------|
| 5 Chainage (km) | Project footprint |
| Localities | Impact assessment area |
| Existing rail (operational) | Brigalow Habitat |
| Major roads | SEVT Habitat |
| Minor roads | Weeping Myall Habitat |
| Watercourses | White Box Habitat |



A3 scale: 1:250,000

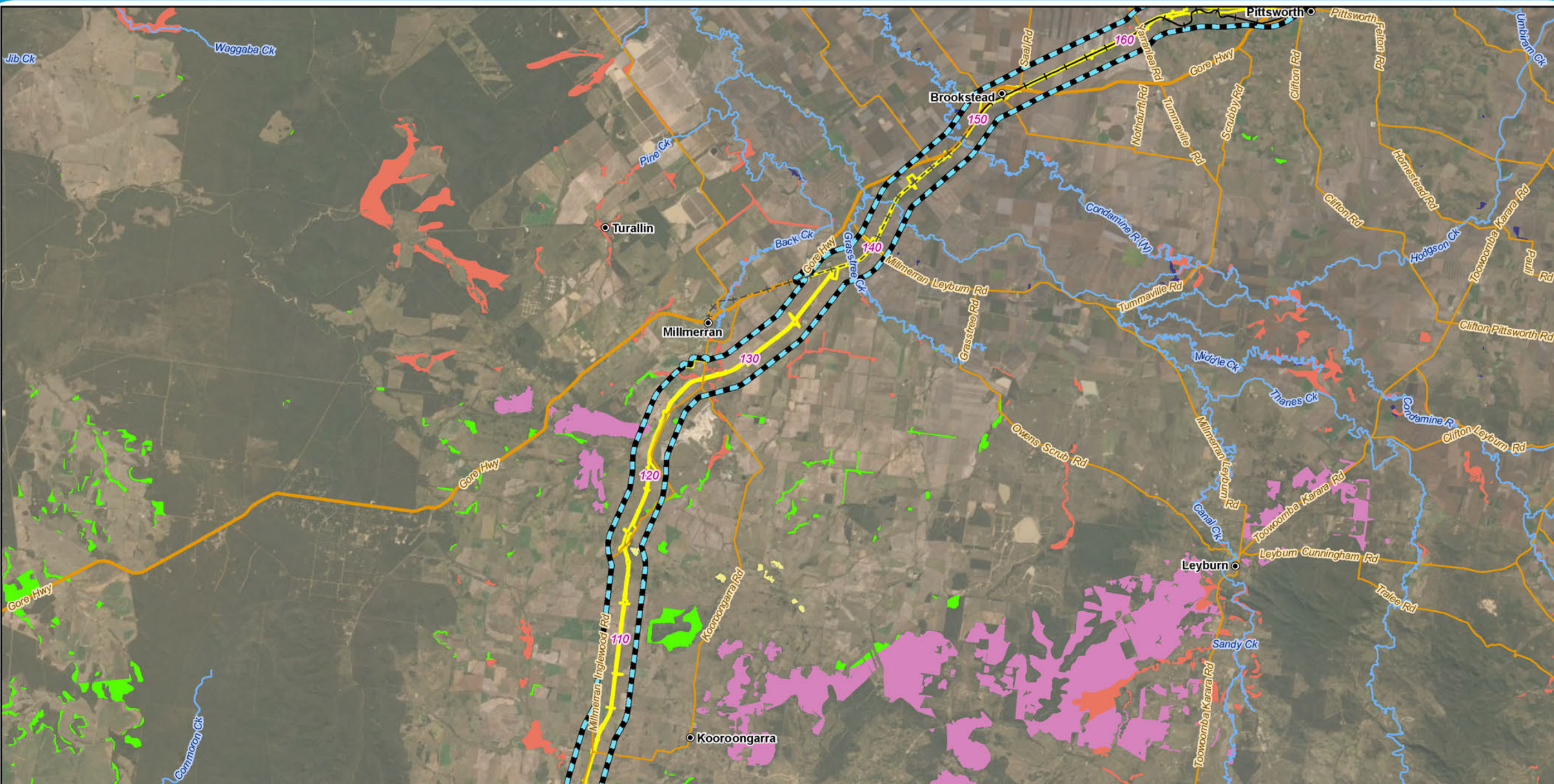


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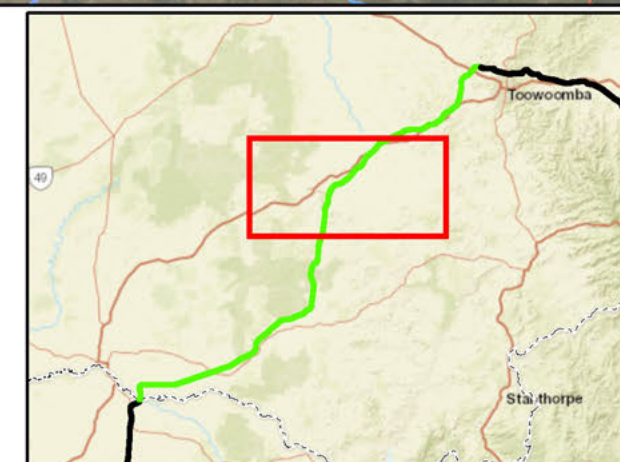
Border to Gowrie

Figure 4.4b: Extent and distribution of TECs within the impact assessment area

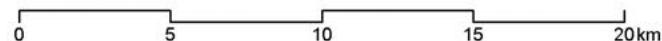


Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Brigalow Habitat
- Grass SQ Habitat
- Natural grasslands Habitat
- SEVT Habitat
- Weeping Myall Habitat
- White Box Habitat



A3 scale: 1:250,000



Future Freight
 Integrating Community, Environment and Engineering

Issue date: 14/05/2020 Version: 2
 Coordinate System: GDA 1994 MGA Zone 56

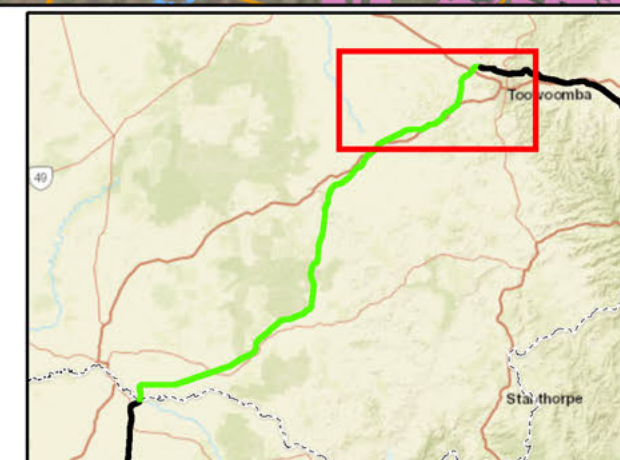
Border to Gowrie

Figure 4.4c: Extent and distribution of TECs within the impact assessment area

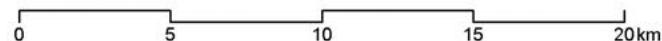


Legend

- | | |
|---------------------------------|----------------------------|
| 5 Chainage (km) | Project footprint |
| Localities | Impact assessment area |
| Gowrie to Helidon alignment | Brigalow Habitat |
| Helidon to Calvert alignment | Grass SQ Habitat |
| Existing rail (operational) | Natural grasslands Habitat |
| Existing rail (non-operational) | SEVT Habitat |
| Major roads | Weeping Myall Habitat |
| Minor roads | White Box Habitat |
| Watercourses | |



A3 scale: 1:250,000





Photograph 4.11 Modified habitat in which Condamine earless dragon was observed within Project footprint (2018)



Photograph 4.12 Grassland habitat suitable for Condamine earless dragon within Project footprint (2018)

Microchiropteran call detection (i.e. ANABAT) recorded a long-eared bat species from the genus *Nyctophilus* in proximity to the impact assessment area, near Whetstone State Forest. The species was also recorded as potentially occurring in the Canning Creek area (Bringalily State Forest) from the results of previous surveys for the Project (Eco Logical Australia 2016). As identification to a species level is not possible for this genus on call detection alone, the adoption of the precautionary approach and presence of suitable habitat within the local landscape (large tracts of woodlands with a relatively dense lower tree storey) lead to the assumption of presence for the South-eastern long-eared bat (*Nyctophilus corbeni*).

The locations of threatened fauna records are displayed in Figure 4.3.

Field investigations also confirmed the presence of suitable fauna habitat (foraging and breeding) including the following:

- Confirmed habitat (primarily in areas containing eucalypt open forest/woodland communities) for the following species:
 - Regent honeyeater (*Anthochaera phrygia*) - box-ironbark woodlands
 - Squatter pigeon (*Geophaps scripta scripta*) – grassy woodlands on sandy soils in the Inglewood area
 - Painted honeyeater (*Grantiella picta*) - eucalypt/*Acacia* woodlands
 - Large-eared pied bat (*Chalinolobus dwyeri*) – eucalypt woodlands in the Canning Creek area (in the vicinity of Wondul Range) and Gowrie Mountain
 - Yakka skink (*Egernia rugosa*) – eucalypt woodlands associated with the woodlands in State forests north of Inglewood
 - Five-clawed worm-skink (*Anomalopus mackayi*) – open woodlands and grasslands on cracking clays to the south of Millmerran and north-west of Toowoomba
 - Dunmall's snake (*Furina dunmali*) – largely associated with the woodlands in State forests north of Inglewood
 - Koala (*Phascolarctos cinereus*) - eucalypt woodlands throughout although preferentially in riparian habitat along drainage lines

The availability of habitat types and their relevance to MNES fauna and flora are discussed further in Section 4.3.4.

This information was used, in addition to that contained within relevant recovery plans and conservation listing advice, to inform the predictive habitat modelling for each of the MNES fauna species. Predictive habitat mapping within the impact assessment area for those species that have potential to occur in the impact assessment area are presented in Appendix G. Potential habitat for threatened fauna species is largely associated with remnant vegetation associated with the State forests (north of Inglewood), areas of watercourse vegetation, and the cracking clay plains of the Condamine River floodplain.

It is noted that whilst all areas of the Project footprint were not accessible, information derived from historic and concurrent surveys (refer Table 3.2) was used to inform the predictive mapping for MNES fauna species where applicable.

4.3.2.3 Threatened aquatic fauna species

As noted in Table 4.3, two threatened aquatic species (Murray cod (*Maccullochella peelii*) and Silver perch (*Bidyanus bidyanus*)) were considered to have potential to occur in the watercourses associated with the impact assessment area (based on the desktop review). Targeted fish surveys were undertaken in the Macintyre River and Macintyre Brook in both June 2018 and May 2019 (Eco Logical Australia 2020). Dry conditions during the 2018 survey resulted in neither species being captured. Habitat for the Murray cod was observed within the Macintyre River, Macintyre Brook and Condamine River systems (refer EIS Appendix K: Aquatic Ecology Technical Report). Subsequent surveys undertaken in 2019 captured Murray cod within both the Macintyre River and Macintyre Brook. Images of habitat associated with the Murray cod within the Macintyre River and Macintyre Brook are shown in Photograph 4.13.



Photograph 4.13 Captured Murray cod and associated habitat within the Macintyre River (top) and Macintyre Brook (bottom) within the impact assessment area

Aquatic surveys within river and creek systems associated with the Project did not capture Silver perch or identify habitat suitable for the species (species is thought to prefer faster-flowing waters (DoE 2013c)). In particular, waterways associated with the Condamine River floodplain do not offer suitable values for either species (refer Section 4.3.4.10). Silver perch was considered unlikely to occur (refer EIS Appendix K: Aquatic Ecology Technical Report) and is not considered as present (potentially or likely) in this assessment report.

4.3.3 Predicted habitat for threatened flora and fauna species

Predictive habitat mapping for conservation significant flora and fauna species (refer Section 3.2.4, and Appendix A) indicates that potential habitat exists for 43 threatened species (19 flora and 24 fauna) within the impact assessment area and 41 threatened species (18 flora and 23 fauna) within the Project footprint. The potential extent of habitat for each of these species is presented in Table 4.4 and mapped areas of habitat are provided in Appendix I.

The Project is a 216.2 km section of new single-track railway between the NSW/QLD border and Gowrie, in Queensland. The Project is comprised of 7 km of standard-gauge rail (1,435 mm) and 209.2 km of dual standard/ narrow-gauge rail (1,435 mm standard and 1,067 mm narrow). The new railway will be positioned within approximately 145 km of new rail corridor (greenfield) and approximately 71.2 km of existing rail corridor (brownfield), currently used by QR's South Western Line and Millmerran Branch Line. Land uses within the Project footprint, but outside of the existing rail corridors, is presented in Table 1.3.

The predictive habitat mapping is based on a range of considerations including desktop and ground-truthed vegetation mapping, database search results for species records and the results of field surveys for the Project. The Project footprint encompasses a total of 3,203.78 ha. Queensland Government (DNRME) vegetation mapping indicates that the Project footprint includes 563.3 ha of remnant vegetation and 34.6 ha of high-value regrowth vegetation (HVR) (refer EIS Appendix J: Terrestrial Ecology Report). The remaining 2,605.9 ha (81.3 per cent of the Project footprint and inclusive of existing rail corridors) has been subject to clearing and land disturbance for agriculture, grazing, mining, industry and transport (road and rail corridors) and is unlikely to provide habitat for most MNES fauna.

Nevertheless, cleared habitats, particularly associated cracking clay soils on the Condamine River floodplain may provide habitat for the Condamine earless dragon (*Tympanocryptis condaminensis*) and the Five-clawed worm-skink (*Anomalopus mackayi*), some threatened flora species (e.g. King bluegrass (*Dichanthium queenslandicum*) and as well as scattered ephemeral flooded areas following heavy rainfall events (for wetland birds).

The predictive estimation of habitat provided in Table 4.4 represents a highly conservative approach, accounting for MNES movement patterns, and where doubt existed regarding the potential of an area to provided habitat for a specific MNES, these areas were incorporated into the predicted estimation. The values provided in Table 4.4 are based on the presence of specific REs identified in the desktop review of vegetation mapping considered as suitable for each species. The State-based vegetation mapping includes large areas of mixed polygons (i.e. areas containing more than one vegetation community or RE). The estimates in Table 4.4 and in mapping in Appendix I includes the entirety of these mixed polygons including instances in which only a single RE may be applicable to a species. In addition, areas outside of mapped REs were also included in the mapping for some fauna species (refer habitat modelling assumptions in Appendix A), potentially encompassing lands with minimal woody vegetation present and which may be unsuitable for the species presence. As such, the estimates are considered to represent the upper limit of available habitat within the impact assessment area for each MNES.

Table 4.4 Predicted habitat for threatened (EPBC Act) flora and fauna species within the impact assessment area and Project footprint

Common name	Species name	EPBC Act status	Predicted habitat within the impact assessment area (ha) ² (43,560.56 ha)				Predicted habitat within the Project footprint (ha) ² (3,203.78 ha) ³			
			Potential habitat	Important habitat	Habitat critical to the survival of the species ⁴	Total Habitat ⁵	Potential habitat	Important habitat	Habitat critical to the survival of the species ⁴	Total Habitat ⁵
Flora (threatened)										
Tara wattle	<i>Acacia lauta</i>	V	5,510.32	N/A	0.00	5,510.32	295.85	N/A	0.00	295.85
Hairy-joint grass	<i>Arthraxon hispidus</i>	V	832.26	N/A	0.00	832.26	33.09	N/A	0.00	33.09
-	<i>Bertya opposens</i>	V	223.78	N/A	0.00	223.78	10.6	N/A	0.00	10.60
Ooline	<i>Cadellia pentastylis</i>	V	317.48	N/A	0.00	317.48	4.56	N/A	0.00	4.56
Stream clematis	<i>Clematis fawcettii</i>	V	0.00	N/A	0.00	0.00	0.00	N/A	0.00	0.00
King blue- grass	<i>Dichanthium queenslandicum</i>	E	989.56	N/A	23.77	1,013.33	116.65	N/A	5.29	121.94
Bluegrass	<i>Dichanthium setosum</i>	V	693.78	N/A	0.00	693.78	60.49	N/A	0.00	60.49
Shiny-leaved ironbark	<i>Eucalyptus virens</i>	V	5,110.00	N/A	0.00	5,110.00	292.55	N/A	0.00	292.55
Belson's panic	<i>Homopholis belsonii</i>	V	4,495.94	N/A	13.87	4,509.81	287.69	N/A	3.19	290.88
Winged peppercress	<i>Lepidium monoplacoides</i>	E	5,893.63	N/A	244.39	6,138.02	329.61	N/A	40.91	370.52
Wandering pepper-cress	<i>Lepidium peregrinum</i>	E	813.32	N/A	0.00	813.32	50.39	N/A	0.00	50.39
Coolmunda leaucopogon	<i>Leucopogon</i> sp. <i>Coolmunda</i> (D. Halford Q 1635)	E	653.20	N/A	0.00	653.20	48.20	N/A	0.00	48.20
-	<i>Macrozamia machinii</i>	V	1,495.06	N/A	0.00	1,495.06	77.72	N/A	0.00	77.72
Hawkweed	<i>Picris evae</i>	V	5,254.41	N/A	168.08	5,422.49	575.31	N/A	18.68	593.99
Dunmore prostanthera	<i>Prostanthera</i> (sp. <i>Dunmore</i>)	V	1,230.40	N/A	0.00	1,230.40	105.84	N/A	0.00	105.84
Austral cornflower	<i>Rhaponticum australe</i>	V	2,307.63	N/A	64.26	2,371.89	220.24	N/A	2.29	222.53
Brush sophora	<i>Sophora fraseri</i>	V	80.53	N/A	0.00	80.53	0.00	N/A	0.00	0.00
Austral toadflax	<i>Thesium australe</i>	V	2,196.20	N/A	0.00	2,196.20	202.59	N/A	0.00	202.59
Slender tylophora	<i>Tylophora linearis</i>	E	3,683.47	N/A	0.00	3,683.47	229.42	N/A	0.00	229.42

Common name	Species name	EPBC Act status	Predicted habitat within the impact assessment area (ha) ² (43,560.56 ha)				Predicted habitat within the Project footprint (ha) ² (3,203.78 ha) ³			
			Potential habitat	Important habitat	Habitat critical to the survival of the species ⁴	Total Habitat ⁵	Potential habitat	Important habitat	Habitat critical to the survival of the species ⁴	Total Habitat ⁵
Small-flowered westringia	<i>Westringia parvifolia</i>	V	0.00	N/A	0.00	0.00	0.00	N/A	0.00	0.00
-	<i>Xerothamnella herbacea</i>	E	616.40	N/A	0.00	616.40	66.97	N/A	0.00	66.97
Fauna (threatened)										
Birds¹										
Regent honeyeater	<i>Anthochaera phrygia</i>	CE	2,100.72	N/A	0.00	2,100.72	157.39	N/A	0.00	157.39
Australasian bittern	<i>Botaurus poiciloptilus</i>	E	924.20	N/A	0.00	924.20	44.98	N/A	0.00	44.98
Curlew sandpiper	<i>Calidris ferruginea</i>	CE, M	167.46	N/A	0.00	167.46	13.80	N/A	0.00	13.80
Red goshawk	<i>Erythroriorchis radiatus</i>	V	4,181.54	N/A	2,122.60	6,304.14	224.63	N/A	114.71	339.34
Grey falcon	<i>Falco hypoleucos</i>	V	13,359.20	N/A	0.00	13,359.20	838.71	N/A	0.00	838.71
Squatter pigeon (southern subspecies)	<i>Geophaps scripta scripta</i>	V	6,277.49	N/A	0.00	6,277.49	339.34	N/A	0.00	339.34
Painted honeyeater	<i>Grantiella picta</i>	V	7,236.05	N/A	0.00	7,236.05	432.99	N/A	0.00	432.99
White-throated needletail	<i>Hirundapus caudacutus</i>	V, M	34,509.5	9,051.08	0.00	43,560.58	2,605.9	597.89	0.00	3,203.8
Swift parrot	<i>Lathamus discolor</i>	CE	220.2	0.00	4,339.41	4,559.61	20.12	0.00	243.54	263.66
Australian painted snipe	<i>Rostratula australis</i>	E	0.00	N/A	924.20	924.20	0.00	N/A	44.98	44.98
Black-breasted button-quail	<i>Turnix melanogaster</i>	V	0.00	N/A	36.41	36.41	0.00	N/A	0.00	0.00
Fish										
Murray cod	<i>Maccullochella peelii</i>	V	186.58	N/A	162.32	348.90	7.76	N/A	5.06	12.82
Mammals										
Large-eared pied bat	<i>Chalinolobus dwyeri</i>	V	1,065.35	N/A	0.00	1,065.35	54.95	N/A	0.00	54.95
Spotted-tail quoll	<i>Dasyurus maculatus maculatus</i>	E	937.05	N/A	568.12	1,505.17	65.93	N/A	15.49	81.42
South-eastern long-eared bat	<i>Nyctophilus corbeni</i>	V	6,364.49	N/A	0.00	6,364.49	344.10	N/A	0.00	344.10

Common name	Species name	EPBC Act status	Predicted habitat within the impact assessment area (ha) ² (43,560.56 ha)				Predicted habitat within the Project footprint (ha) ² (3,203.78 ha) ³			
			Potential habitat	Important habitat	Habitat critical to the survival of the species ⁴	Total Habitat ⁵	Potential habitat	Important habitat	Habitat critical to the survival of the species ⁴	Total Habitat ⁵
Greater glider	<i>Petauroides volans volans</i>	V	2,680.33	N/A	0.00	2,680.33	198.42	N/A	0.00	198.42
Brush-tailed rock-wallaby	<i>Petrogale penicillata</i>	V	0.00	N/A	0.00	0.00	0.00	N/A	0.00	0.00
Koala	<i>Phascolarctos cinereus</i>	V	179.95	N/A	7,911.46	8,091.41	11.91	N/A	481.15	493.06
Grey-headed flying-fox	<i>Pteropus poliocephalus</i>	V	964.73	N/A	79.72	1,044.45	110.38	N/A	0.10	110.48
Reptiles										
Five-clawed worm-skink	<i>Anomalopus mackayi</i>	V	2,679.55	194.35	0.00	2,873.90	161.58	16.68	0.00	178.26
Collared delma	<i>Delma torquata</i>	V	0.00	4,700.10	0.00	4,700.10	0.00	295.76	0.00	295.76
Yakka skink	<i>Egernia rugosa</i>	V	7,071.21	N/A	0.00	7,071.21	364.47	N/A	0.00	364.47
Dunmall's snake	<i>Furina dunmalli</i>	V	0.00	5,633.89	0.00	5,633.89	0.00	298.85	0.00	298.85
Condamine earless dragon	<i>Tympanocryptis condaminensis</i>	E	3,037.01	N/A	227.66	3,264.67	227.66	N/A	17.93	245.59
Invertebrates										
Brigalow woodland snail	<i>Adclarkia cameroni</i>	E	1,313.25	N/A	0.00	1,313.25	131.46	N/A	0.00	131.46

Table notes:

CE = Critically endangered E = Endangered V = Vulnerable M = Migratory

- For aerial species, all "air-space" above the Project footprint may be considered habitat. However, these areas will not be impacted by the Project. Therefore aerial species have not been subject to impact assessment.
- No value (i.e. 0) represents areas where habitat modelling has indicated that no predicted habitat occurs. For species where no habitat is present within the impact assessment area, impact assessment has not been conducted. However, the habitat requirements and ecology of these species has been considered through the modelling process (refer Section 3.2.4 and Appendix A). This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to development of the detail design.
- This area includes 716.5 ha which is existing, cleared and maintained rail corridor.
- Only 'Potential habitat' has been identified in instances where there are no species records within the impact assessment area or the Project footprint, and when habitat conditions are not consistent with the definition of 'Habitat critical to the survival of the species', as presented in the MNES Guidelines (refer Section 3.2.4.5). In all instances, where Habitat critical to the survival of the species has not been identified, there is no indication that these species are present within the impact assessment area. Detailed ecological surveys of the Project footprint will be undertaken in parallel to the development of the detail design. These surveys will be in accordance with the relevant survey guidelines for nationally threatened species (refer Section 2). Data obtained from these detailed surveys will be used to refine the quantification of ecological impacts and revise the calculation of offset requirements for the Project.
- Total habitat = sum of 'potential', 'important' and 'habitat critical to the survival of the species'.

4.3.4 Flora and fauna habitat within the impact assessment area

A total of ten broad flora and fauna habitat types have been identified within the impact assessment area. The broad habitat types were delineated by grouping vegetation communities according to their vegetative structure, composition, and geomorphological characteristics. Where relevant, habitat types were corresponded to indicative REs however, not all communities corresponded to a particular RE. The condition of the various habitat types was derived from aerial photograph interpretation, vegetation mapping, relevant database searches, field reconnaissance and previous experience within the impact assessment area.

Discrete areas of remnant vegetation are scattered across the impact assessment area, however, most of the area is characterised by non-remnant vegetation, particularly cleared agricultural areas, which provide grassland habitat to fauna species. Grassland is the dominant land cover in the impact assessment area, other land cover types in order of decreasing extent include crops, forest/woodland, urban, and quarry.

The majority of remnant and non-remnant native vegetation occurs in the Inglewood region and is within protected areas (State forest). Extensive but fragmented remnant vegetation also exists in the northern portion of the impact assessment area around Gowrie Mountain.

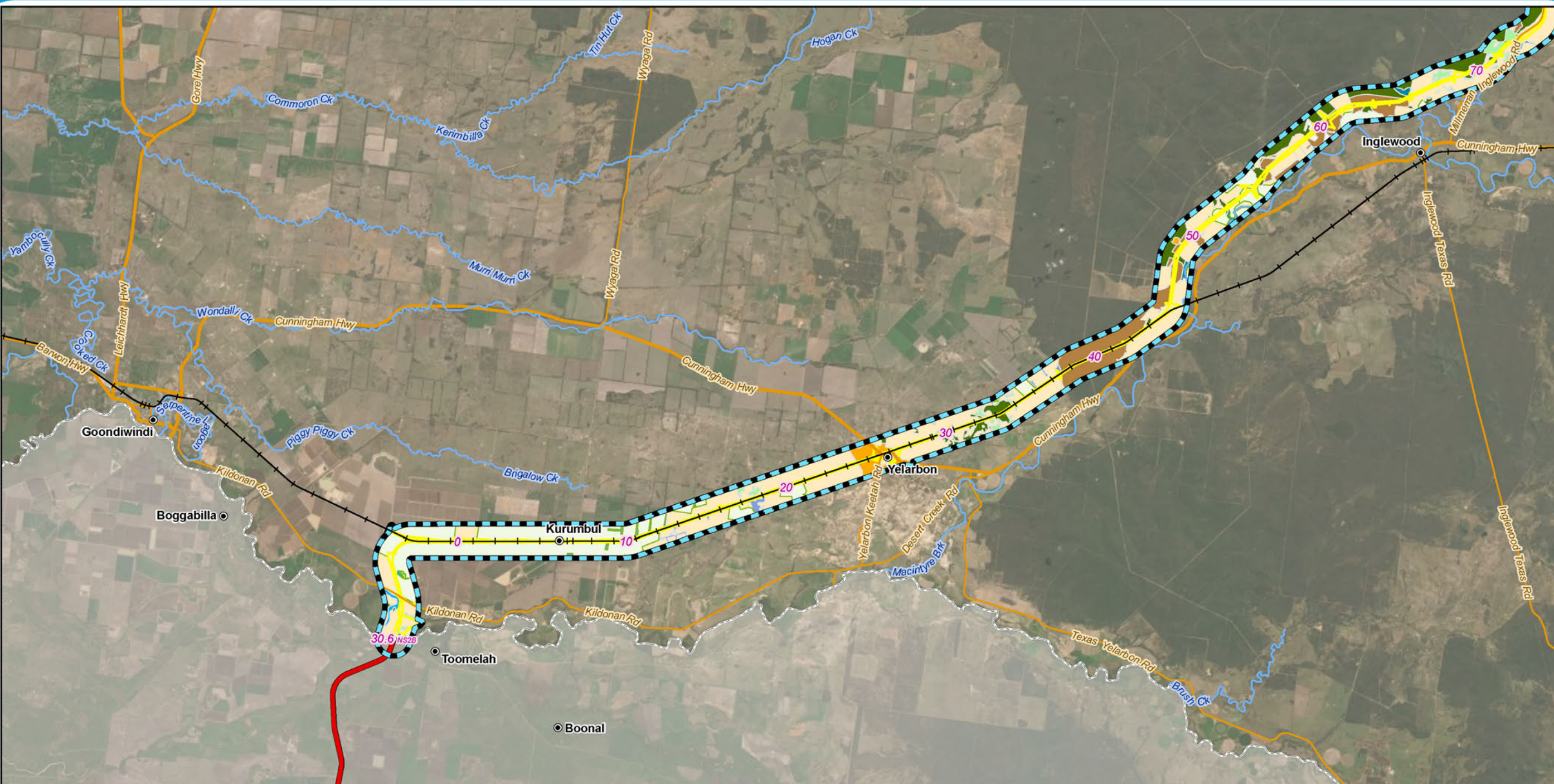
The Condamine River floodplain region is extensively cleared and highly modified for irrigated agriculture.

Non-remnant linear vegetation along roadsides and drainage lines, regrowth vegetation and isolated paddock trees form a variegated landscape mosaic in an otherwise fragmented environment.

Each broad habitat type is discussed in further detail below and shown in Figure 4.5a-d. An analysis of the quantity of fauna habitat contained within the impact assessment area and within the Project footprint is presented in Table 4.5.

Table 4.5 **Extent of fauna habitat located within the impact assessment area and Project footprint**

Fauna habitat type (refer Figure 4.5a-d)	Extent (ha)	
	Impact assessment area	Project footprint
Grassland	2,0021.51 (46.04% of impact assessment area)	1,641.53 (51.24% of Project footprint)
Cultivated land	14,414.85 (33.15% of impact assessment area)	962.76 (30.05% of Project footprint)
Mature eucalypt open forest and woodland	3,153.98 (7.25% of impact assessment area)	160.42 (5.01% of Project footprint)
Mature eucalypt riparian woodland	332.29 (0.76% of impact assessment area)	13.2 (0.41% of Project footprint)
Mature mixed eucalypt/non-eucalypt woodland	4,214.6 (9.69% of impact assessment area)	287.96 (8.99% of Project footprint)
Mature <i>Acacia harpophylla</i> - <i>Casuarina cristata</i> open forest	276.48 (0.64% of impact assessment area)	58.18 (1.82% of Project footprint)
Shrubland on natural scalds	390.53 (0.90% of impact assessment area)	51.31 (1.60% of Project footprint)
Semi-evergreen vine thicket	38.36 (0.09% of impact assessment area)	0.00 (0.00% of Project footprint)
Regrowth eucalypt communities	579.87 (1.33% of impact assessment area)	27.53 (0.86% of Project footprint)
Wetlands	66.49 (0.15% of impact assessment area)	0.88 (0.03% of Project footprint)



Legend

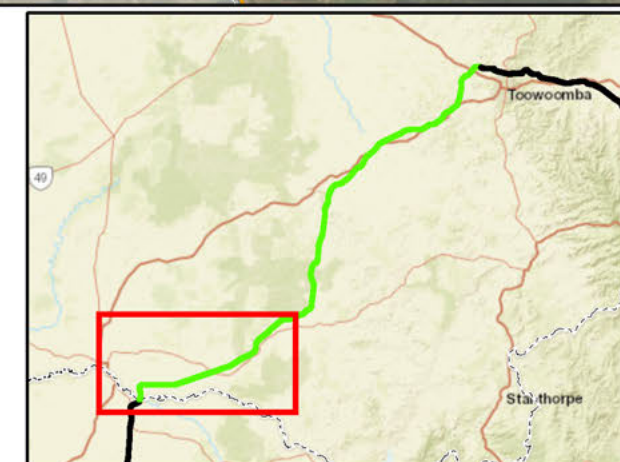
- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border

- Project footprint
- Impact assessment area

Fauna habitat

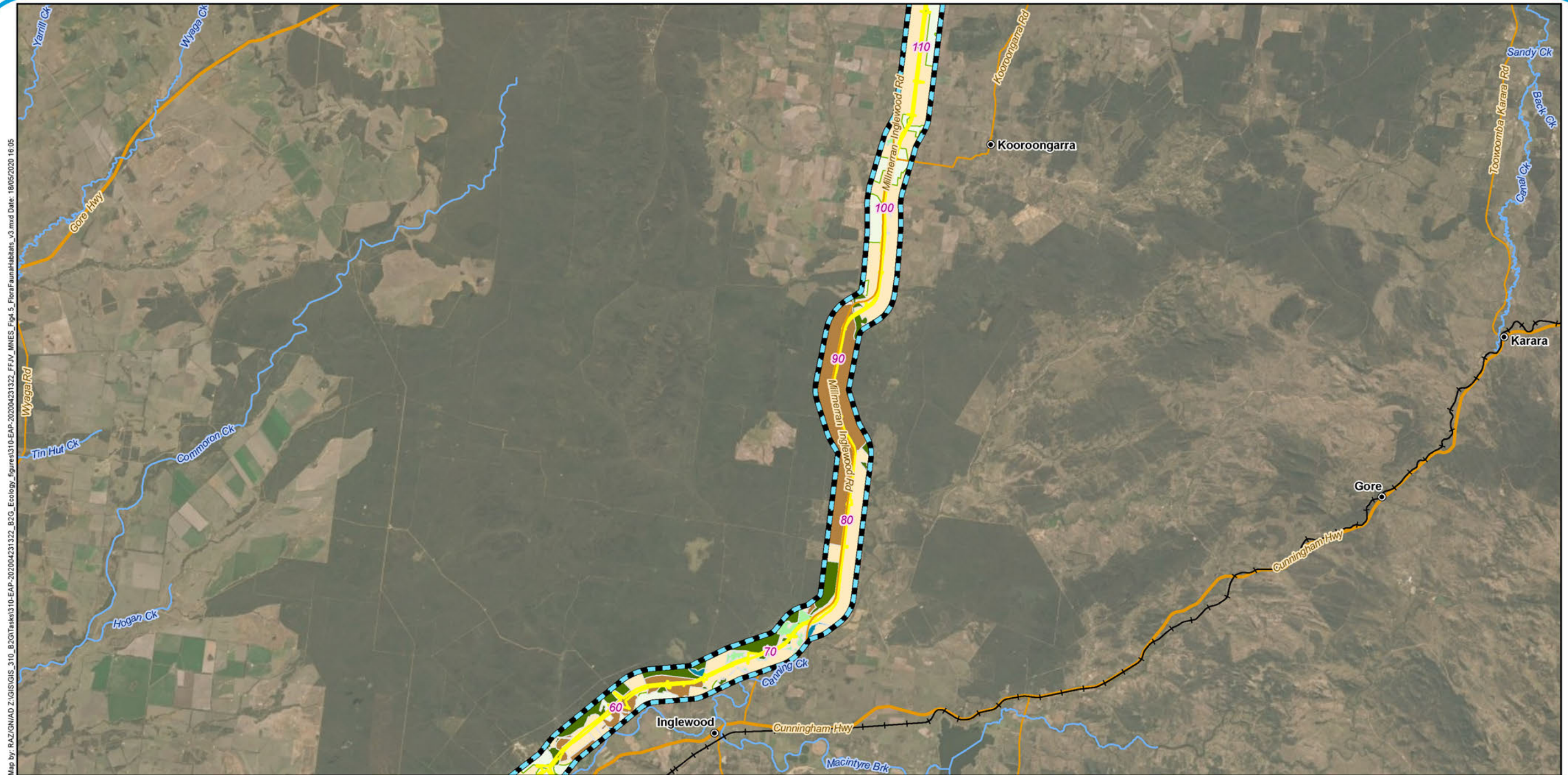
- Mature *Acacia harpophylla*-*Casuarina cristata* open forest
- Cultivated land
- Grassland

- Mature eucalypt open forest and woodland
- Mature eucalypt riparian woodland
- Mature mixed eucalypt/non-eucalypt woodland
- Shrubland on natural scalds
- Regrowth eucalypt communities
- Wetlands



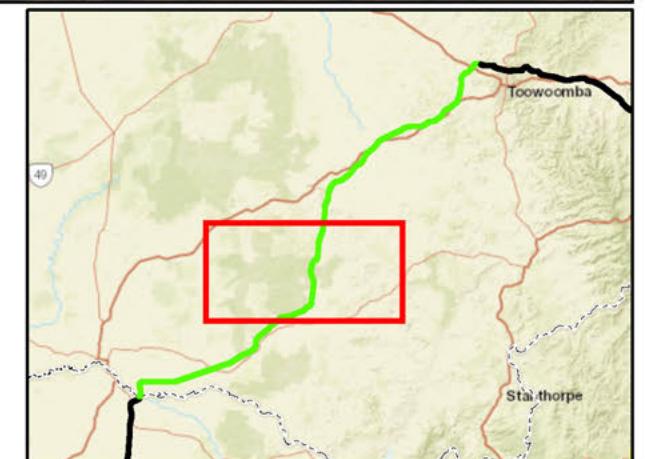
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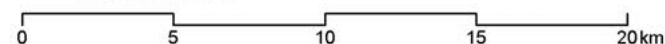


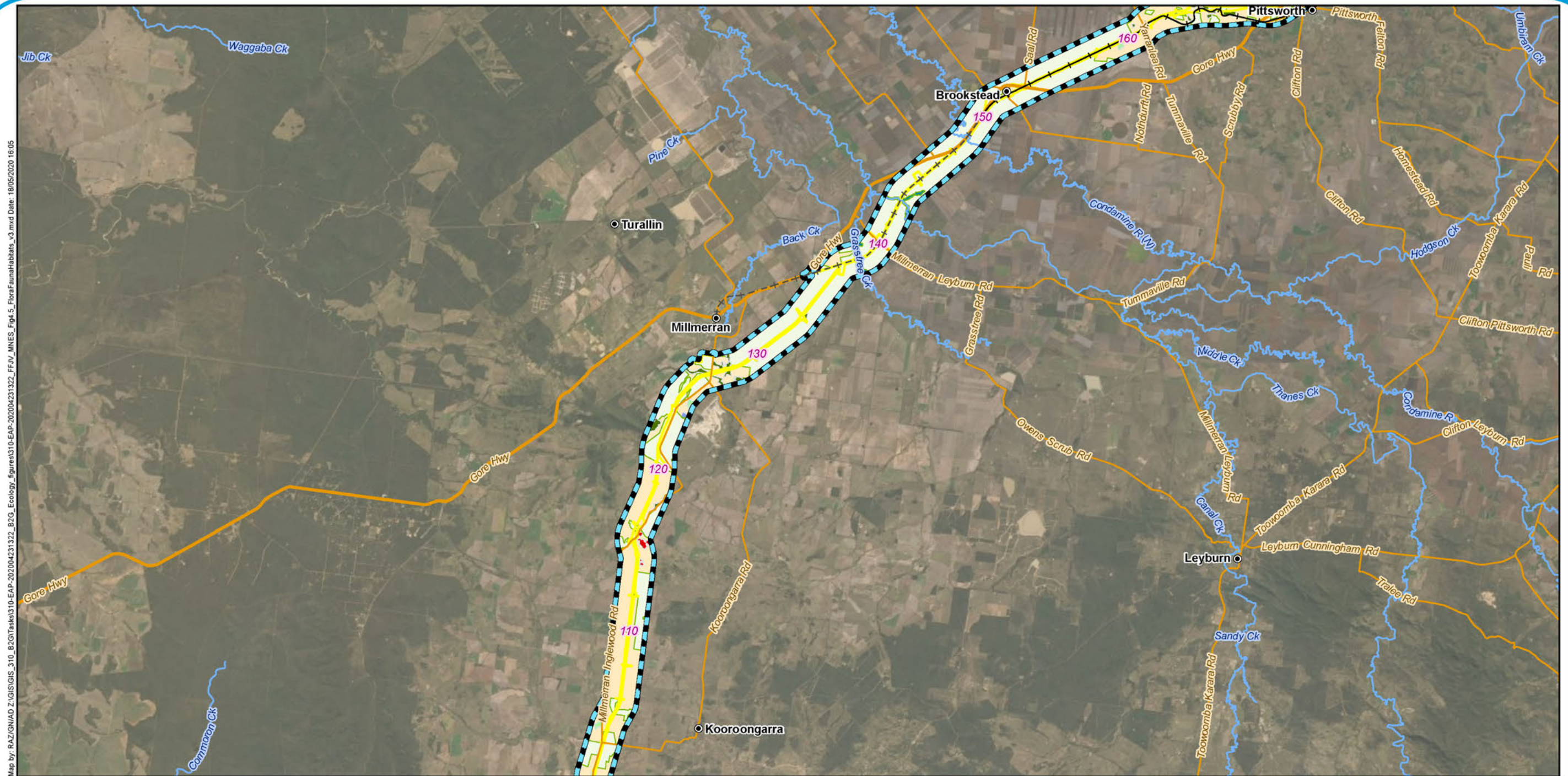
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- | | | |
|-----------------------------|------------------------|---|
| 5 Chainage (km) | Project footprint | Mature eucalypt open forest and woodland |
| Localities | Impact assessment area | Mature eucalypt riparian woodland |
| Existing rail (operational) | Fauna habitat | Mature mixed eucalypt/non-eucalypt woodland |
| Major roads | Cultivated land | Regrowth eucalypt communities |
| Minor roads | Grassland | |
| Watercourses | | |



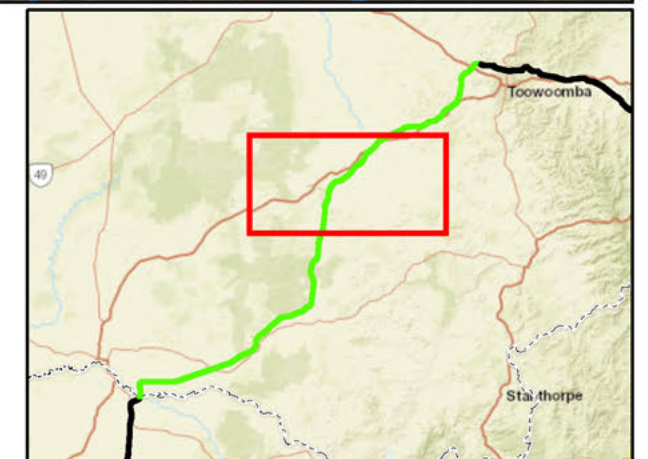
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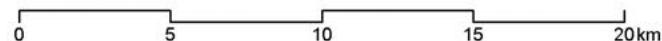


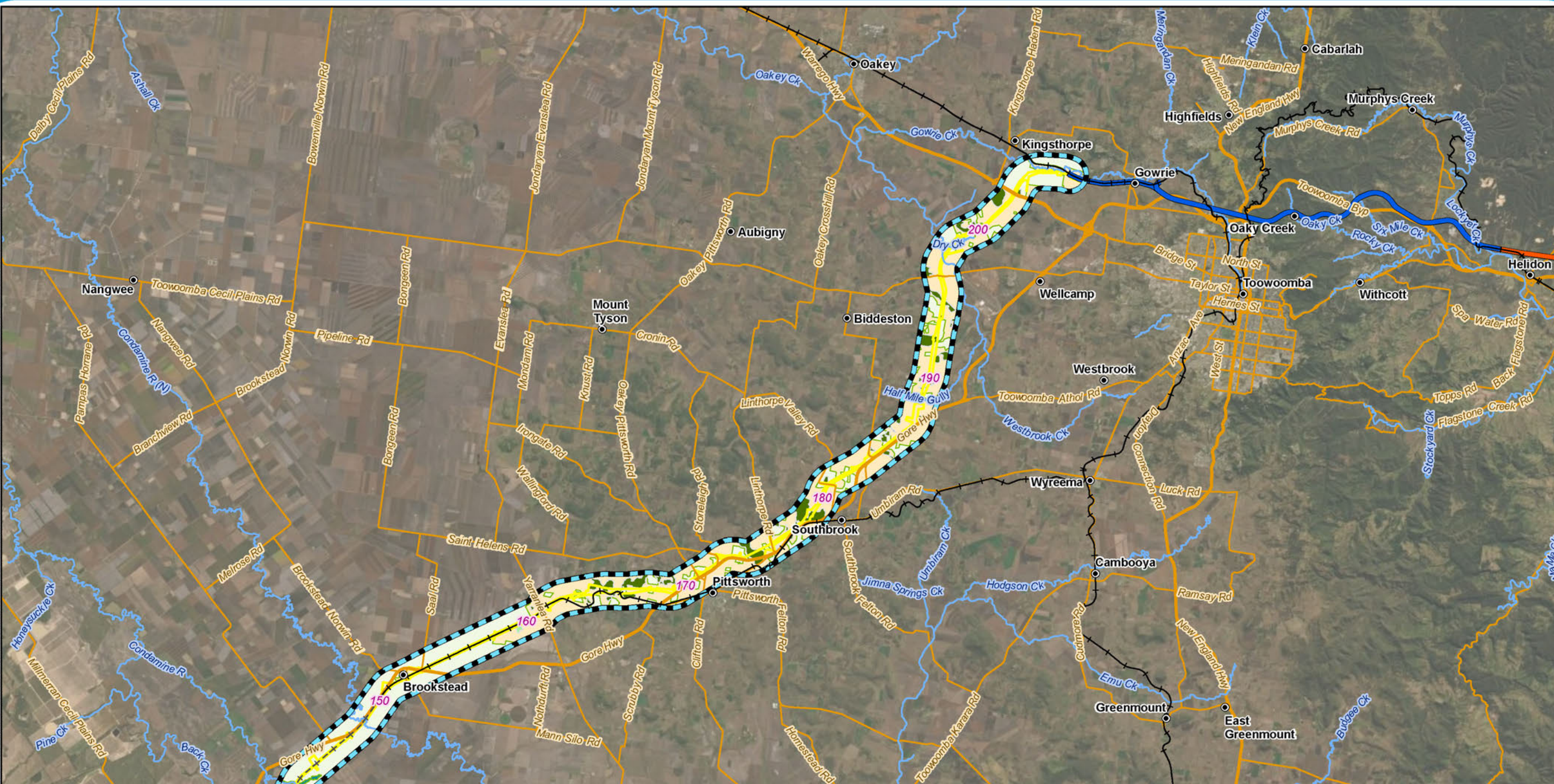
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Fauna habitat**
 - Mature *Acacia harpophylla*-*Casuarina cristata* open forest
 - Cultivated land
 - Grassland
 - Mature eucalypt open forest and woodland
 - Mature eucalypt riparian woodland
 - Regrowth eucalypt communities
 - Semi-evergreen vine thicket



A3 scale: 1:250,000





Legend

5 Chainage (km)

● Localities

— Gowrie to Helidon alignment

— Helidon to Calvert alignment

— Existing rail (operational)

--- Existing rail (non-operational)

— Major roads

— Minor roads

— Watercourses

Project footprint

Impact assessment area

Fauna habitat

Mature *Acacia harpophylla*-*Casuarina cristata* open forest

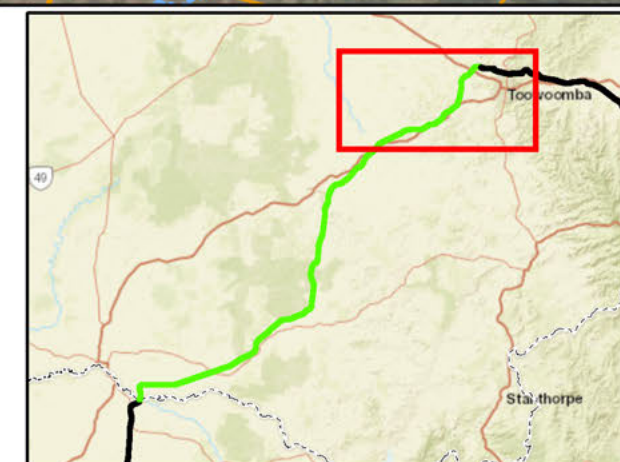
Cultivated land

Grassland

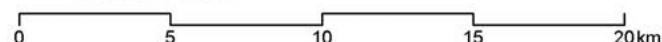
Mature eucalypt open forest and woodland

Mature eucalypt riparian woodland

Regrowth eucalypt communities



A3 scale: 1:250,000



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 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.5d: Location of habitat types contained within the impact assessment area

4.3.4.1 Grassland

Grassland habitats within the impact assessment area include remnant native grasslands, non-native grasslands and derived native grasslands. Small remnants of native grassland include *Dichanthium sericeum* grassland on Cainozoic igneous rocks, *Themeda avenacea* grassland on alluvial plains, and *Triodia scariosa* grassland.

Non-native grasslands are dominated by exotic pasture grasses and are represented by areas of non-remnant vegetation (excluding cultivated land), previously cleared of native-vegetation for agriculture. Dominant pasture grasses include *Chloris gayana* (Rhodes grass), *Megathyrsus maximus* (Green panic), and *Sorghum halepense* (Johnson grass). However, native grass species also occur including *Dichanthium sericeum* (Blue grass), *Digitaria* spp, *Panicum* spp. and *Bothriochloa* spp.

Derived native grasslands are dominated by native grass species and are represented by areas of non-remnant vegetation (excluding cultivated land), previously cleared of woody species (i.e. trees and shrubs) for agriculture. Dominant grass species include *Panicum queenslandicum* (Queensland panic), *Dichanthium sericeum* (Blue grass), *Digitaria* spp., *Themeda* spp., and *Bothriochloa* spp. However, exotic pasture grasses sometimes occur, such as *Chloris gayana* (Rhodes grass).

Non-native and native derived grasslands are considered as one fauna habitat type due to similarities in structure and floristics. Grassland is the most extensive fauna habitat within the impact assessment area by far and is typically located on alluvial floodplains and creek flats. These grassland habitats are commonly utilised for agricultural purposes including livestock grazing and fodder harvesting. Grasslands in road reserves provide the least impacted representation of this habitat (refer Photograph 4.14 and Photograph 4.15).

Grassland within the impact assessment area provides foraging habitat for granivorous bird species such as finches, parrots and pigeons. Grassland habitats also provide important microhabitat refugia (i.e. soil cracks) for small ground fauna such as native rodents, skinks, and snakes. Scattered paddock trees occur across many grassland habitats, providing fauna habitat and connectivity in otherwise cleared and fragmented landscapes.

In general, the grasslands that dominate the Project footprint provide poor habitat value for MNES fauna species potentially occurring in the area, although grasslands may provide temporary habitat for wetland bird species when flooded. Nevertheless, MNES conservation significant fauna species that may utilise grassland habitat within the impact assessment area include Condamine earless dragon (*Tympanocryptis condaminensis*), and Five-clawed worm-skink (*Anomalopus mackayi*) where cracking clay soils occur. Grasslands may also provide suitable habitat for MNES flora species such as Belson's panic (*Homopholis belsonii*), King bluegrass (*Dichanthium queenslandicum*) and Austral toadflax (*Thesium australe*) (a root parasite with a preference for *Themeda* spp).



Photograph 4.14 Example of native grassland in road reserve located south of Millmerran (2018)



Photograph 4.15 Grassland composed of native and non-native species within road reserve south of Toowoomba (2018)

4.3.4.2 Cultivated land

Cultivated land within the impact assessment area is extensive and includes irrigated and dryland crops, stubble fields and fallow fields. Common crops include winter cereals and irrigated cotton. The availability of soil cracks and other microhabitat refugia is greatly reduced by soil cultivation. However, cultivated field and adjacent areas are known to provide habitat for MNES species such as the Condamine earless dragon (*Tympanocryptis condaminensis*) and Belson's panic (*Homopholis belsonii*).

4.3.4.3 Mature eucalypt open forest and woodland

On sedimentary and igneous rocks

Areas of mature eucalypt open forest and woodland on sedimentary/igneous rocks and within the impact assessment area include areas dominated by Mountain grey gum (*Eucalyptus orgadophila*), Narrow-leaved ironbark, (*Eucalyptus crebra*), Queensland bluegum (*Eucalyptus tereticornis*), Poplar box (*Eucalyptus populnea*), and Yellow box (*Eucalyptus melliodora*). Areas of remnant, mature eucalypt open forest and woodland within the impact assessment area are represented by REs 11.9.7, 11.8.4 and 11.8.2. This habitat type was dominant in the elevated areas north-east of Yelarbon associated with the Whetstone State Forest, and north of Inglewood associated with the Bringalily State Forest (refer Photograph 4.16).

The condition and structure of these habitats varies greatly across the impact assessment area, ranging from a simplified structure with sparse shrub and/or ground strata reflective of past land use and current management practices (logging, cattle grazing and vegetation thinning), to a complex vegetation structure with all strata (canopy, mid-storey and understorey) essentially intact. Important microhabitat refugia provided by this habitat type includes tree hollows, hollow logs and termitaria (arboreal and terrestrial).

Canopy species present in this habitat type provide a range of trunk and limb hollows (of a variety of size classes) which potentially provide suitable habitat for *Microchiropteran* bats, gliders, possums, birds (including parrots, cockatoos and owls), arboreal snakes and monitors. Canopy trees and also shrubs provide nectar and pollen resources for a range of fauna species including birds, bats, arboreal mammals and insects. Standing dead trees (stags) also provide roosting sites, nesting dens and breeding locations for a similar range of species. Where mature eucalypt open forest and woodlands occur as fragmented/isolated patches in largely cleared agricultural landscapes, they are somewhat restricted in their capacity to support woodland and forest species and are more likely to offer habitat value to transitional species and support mammal and bird species typical of disturbed areas. However, these isolated trees may provide important feed resources to vagile species during their flowering periods.

Areas of mature eucalypt open forest and woodland (on sedimentary and igneous rock) within the impact assessment area may provide suitable habitat for MNES fauna species including the South-eastern long-eared bat (*Nyctophilus corbeni*), Spotted-tail quoll (*Dasyurus maculatus maculatus*), Koala (*Phascolarctos cinereus*) and Grey-headed flying fox (*Pteropus poliocephalus*).

On alluvial plains

Areas of mature eucalypt open forest and woodland on alluvial plains within the impact assessment area include areas dominated by Queensland bluegum (*Eucalyptus tereticornis*) Poplar box (*Eucalyptus populnea*) and River red gum (*Eucalyptus camaldulensis*). Areas of remnant eucalypt open forest and woodland (on alluvial plains) within the impact assessment area represented the communities REs 11.3.4, 11.3.2, 11.3.14, and 11.3.18. and are associated with the floodplains and creek flats within the impact assessment area. This habitat generally exhibits low structural complexity, particularly at lower strata levels (refer Photograph 4.17). Ground cover is typically low due to of livestock use, and the understorey very sparse with an open canopy of large Queensland blue gums or River red gums. However, mature eucalypt trees on alluvial plains are known to provide important habitat, such as food (nectar) and shelter (hollows), for a range of fauna species including birds, mammals, and reptiles. Conservation significant fauna species that may occur in eucalypt open forest and woodland on alluvial plains within the impact assessment area include Koala (*Phascolarctos cinereus*) and South-eastern long-eared bat (*Nyctophilus corbeni*) (where it occurs in the vicinity of large tracts of remnant woodlands).

Furthermore, during the wet season this habitat type commonly floods temporarily, effectively becoming a wetland habitat (riverine wetland). When flooded this habitat type is suitable for a range of wetland bird species, including ducks, geese, grebes, snipe, cranes, rails, egrets, and herons. MNES fauna species that may utilise flooded eucalypt open forest and woodland on alluvial plains include Australian painted snipe (*Rostratula australis*).

The definition of open forest and woodland habitats applied here excludes riparian vegetation along watercourses which has been classified as the habitat type; mature eucalypt riparian open forest and woodlands.



Photograph 4.16 Mature Eucalypt woodland on sedimentary rock, located within the Inglewood region (2018)



Photograph 4.17 Alluvial Poplar box woodland near Millmerran (2018)

On sand plains

Mature eucalypt woodland and forest on sand plains within the impact assessment area represented by RE 11.5.20. This habitat type is described as Gum-topped box (*Eucalyptus moluccana*) or Grey box (*E. macrocarpa*) or Narrow-leaved box (*E. woollsiana*) woodland to open forest.

Species including Bulloak (*Allocasuarina luehmannii*) and White cypress-pine (*Callitris glaucophylla*) often form a low woodland layer. This habitat occurs on flat to gently undulating plains formed from Cainozoic/Quaternary sediments. MNES fauna that may occur in eucalypt forest and woodland on sand plains include South-eastern long-eared bat (*Nyctophilus corbeni*).

On duricrusts

Mature eucalypt forest and woodland on duricrusts within the impact assessment area represented community RE 11.7.7. This habitat type is described as open forest to woodland dominated by Broad-leaved red ironbark (*Eucalyptus fibrosa* subsp. *nubilis*) forming a distinct but discontinuous open forest to woodland canopy (22-25m high) (refer Photograph 4.18). Broad-leaved red ironbark provides nectar and hollow resources for fauna including birds, arboreal mammals, insects, reptiles and bats.

Narrow-leaved ironbark (*E. crebra*) often co dominates or is locally dominant, particularly on lower slopes. This habitat also includes areas with (Lemon-scented gum (*Corymbia citriodora*) as a codominant. There is usually a low woodland mid layer dominated by *Acacia* spp. or sometimes Bulloak (*Allocasuarina luehmannii*) and Black cypress-pine (*Callitris endlicheri*). Scattered tall shrubs may occur, but rarely form a prominent layer. There is usually a moderately dense, low shrub layer developed with a variable floristic composition. The ground layer is open to moderately dense and dominated by grasses. This habitat occurs on low hills and ranges formed from deeply weathered sediments.

MNES fauna that may occur in eucalypt forest and woodland on duricrusts include South-eastern long-eared bat (*Nyctophilus corbeni*) and Large-eared pied bat (*Chalinolobus dwyeri*).



Photograph 4.18 Eucalypt woodland on duricrust (2018)



Photograph 4.19 Mature Eucalypt riparian woodland located south of Inglewood (2018)

4.3.4.4 Mature eucalypt riparian woodland

Eucalypt riparian open forest and woodlands within the impact assessment area include open forests and woodlands dominated by Forest red gum (*Eucalyptus tereticornis*) or River red gum (*Eucalyptus camaldulensis*) fringing drainage lines with associated species including paperbark (*Melaleuca* spp.) and Rough-barked apple (*Angophora floribunda*), and Riveroak (*Casuarina cunninghamiana*). An open to sparse, tall shrub layer is frequently present dominated by species including Cooba (*Acacia salicina*), and River Cooba (*A. stenophylla*).

Areas of remnant eucalypt riparian open forest and woodland within the impact assessment area were represented by RE 12.3.25 and occur exclusively along the edge of rivers, creeks and vegetated drainage lines within the impact assessment area (refer Photograph 4.13 and Photograph 4.19). Mature eucalypt riparian open forest and woodlands within the impact assessment area is often structurally complex at all strata levels and potentially supports the highest fauna diversity per hectare.

A range of fauna, including birds, mammals, and reptiles, utilise this habitat type for foraging, breeding, and dispersal. Available foraging resources include nectar, water, and prey fauna species. Available breeding habitats may include tree hollows and decorticating bark, hollow logs, soil banks and overhangs and dense vegetation. Riparian woodland is often utilised for dispersal due to a greater vegetation density and landscape connectivity. The movement corridors provided by this habitat type are important for structural connectivity, in otherwise fragmented landscapes.

MNES fauna species that may occur in mature eucalypt riparian open forests and woodland include Regent honeyeater (*Anthochaera phrygia*), Swift parrot (*Lathamus discolor*), Greater glider (*Petauroides Volans*) and Koala (*Phascolarctos cinereus*).

4.3.4.5 Mature mixed eucalypt/non-eucalypt woodland

On clay plains

The community Mature mixed eucalypt/non-eucalypt woodlands on clay plains within the impact assessment area is represented by RE 11.4.10. This habitat type is dominated by Poplar box (*Eucalyptus populnea*) and/or Narrow-leaved box (*E. woollsiana*), or Gum-topped box (*E. moluccana*) or Grey box (*E. macrocarpa*) with an understorey of Brigalow (*Acacia harpophylla*) or Belah (*Casuarina cristata*). Mixed woodland typically occurs on the edges of Cainozoic clay plains, on the lower parts of the plain around its dissecting edges and on natural discharge areas where the clay plains meet higher landforms.

MNES species that may occur within mature mixed eucalypt/non-eucalypt woodland on clay plains include Yakka skink (*Egernia rugosa*) and Dunmall's snake (*Furina dunmalli*) due to habitat associations with Brigalow.

On sand plains

The community Mature mixed eucalypt/non-eucalypt woodlands on sand plains within the impact assessment area is represented by REs 11.5.1 and 11.5.4 (refer Photograph 4.20). These habitat types are dominated by eucalypts and bloodwoods in the canopy, with a low tree layer dominated by she oak and native cypress pine (*Allocasuarina* and *Callitris* spp.) on sandy soils. A sparse ground layer of perennial grasses is usually present.

MNES species that may occur within mature mixed eucalypt/non-eucalypt woodland include South-eastern long-eared bat (*Nyctophilus corbeni*), Dunmall's snake (*Furina dunmalli*) and Yakka skink (*Egernia rugosa*).



Photograph 4.20 Mixed mature eucalypt/Bulloak woodland on sand, located north of Inglewood (2018)



Photograph 4.21 Mixed mature eucalypt/*Callitris* woodland duricrust, located south of Inglewood (2018)

On duricrusts

The community Mature mixed eucalypt/non-eucalypt woodlands on duricrusts within the impact assessment area is represented by RE 11.7.4. This habitat type occurs on Cainozoic lateritic duricrusts and is dominated by Narrow-leaved ironbark (*Eucalyptus crebra*), Gum-topped ironbark (*E. decorticans*), Brown bloodwood (*Corymbia trachyphloia*), Narrow-leaved white mahogany (*E. tenuipes*), Large-fruited yellowjacket (*C. watsoniana*) and White cypress-pine (*Callitris glaucophylla*) (refer Photograph 4.21). There is usually a distinct low tree to tall shrub layer comprising species, including Brown hazelwood (*Lysicarpus angustifolius*) or *Acacia* spp.

MNES species that may occur within mature mixed eucalypt/non-eucalypt woodland include South-eastern long-eared bat (*Nyctophilus corbeni*).

4.3.4.6 Mature *Acacia harpophylla*-*Casuarina cristata* open forest

On sedimentary rocks

Within the impact assessment area this community was represented by RE 11.9.5. This habitat type is dominated by Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*), or Brigalow with a semi-evergreen vine thicket understorey (refer Photograph 4.22). A prominent low tree or tall shrub layer dominated by species including Wilga (*Geijera parviflora*) and False Sandalwood (*Eremophila mitchellii*), and often with semi-evergreen vine thicket species is present. The latter include Currant bush (*Carissa ovata*), Emu apple (*Owenia acidula*), Silver croton (*Croton insularis*), Stiff denhamia (*Denhamia oleaster*) and Velvet mock olive (*Notelaea macrocarpa*). Black tea-tree (*Melaleuca bracteata*) may be present within the community along watercourses.

This habitat type typically occurs on cracking clays that are usually black or grey to brown or reddish-brown in colour, often self-mulching and sometimes with gilgai microrelief in flatter areas. Gilgais provide important habitat refugia and water sources for amphibian species.

This habitat type is suitable for MNES species, including Dunmall's snake (*Furina dunmali*), South-eastern long-eared bat (*Nyctophilus corbeni*), and Brigalow woodland snail (*Adclarkia cameroni*) where shelter-sites such as logs, rocks, tree hollows, decorticated bark, and root cavities are available. The Painted honeyeater (*Grantiella picta*) is associated with this habitat type when *Amyema* spp. mistletoe is abundant.



Photograph 4.22 Brigalow/Belah open forest on sedimentary rock located to south of Millmerran (2018)



Photograph 4.23 Brigalow/Belah open forest on clay plains located within road reserves south of Yelarbon (2018)

On clay plains

This community within the impact assessment area was represented by RE 11.4.3. This habitat type is dominated by Brigalow (*A. harpophylla*) and/or Belah (*C. cristata*). Brigalow (10-16 m high) predominates forming a fairly continuous canopy with varying densities of Belah (14-18 m high), forming part of the canopy or emerging above it (refer Photograph 4.23). *Eucalyptus* spp. including Mountain coolabah (*E. orgadophila*), Poplar box (*E. populnea*), Grey box (*E. macrocarpa*), Narrow-leaved box (*E. woollsiana*), Dawson gum (*E. cambageana*) and *E. thozetiana* (on shallower soils and upper slopes) may be scattered through the canopy or occur as emergents up to 22 m high. Queensland bottle tree (*Brachychiton rupestris*) may also be present in places. An open to dense, tall shrub layer is present, and is dominated by False Sandalwood (*Eremophila mitchellii*) and/or Wilga (*Geijera parviflora*). Low shrubs are often present, occasionally forming a distinct layer dominated by species including Currant bush (*Carissa ovata*) and Scrub boonaree (*Alectryon diversifolius*). Tree/shrub height may range from 3-8 m. Black tea-tree *Melaleuca bracteata* may be present in low-lying areas. The ground layer is sparse to open and composed of grasses and forbs. Occurs on Cainozoic clay plains with cracking clay soils which are often with a weak gilgai microrelief (refer Photograph 4.9 and Photograph 4.10).

Mature *Acacia harpophylla*-*Casuarina cristata* open forest has a relatively high degree of structural connectivity with an intact sub-canopy and shrub layer. However, many patches of Brigalow are degraded by livestock grazing and have a simplified structure. This habitat type provides suitable habitat for taxa that prefer greater structural complexity including insectivorous bats, forest-dependent bird species, and reptiles. The availability of hollows in this habitat type is low, however the loose bark of Brigalow provides important refugia for arboreal geckoes and microbats.

MNES species that may occur include Dunmall's snake (*Furina dunmalli*), South-eastern long-eared bat (*Nyctophilus corbeni*), Painted honeyeater (*Grantiella picta*) and Brigalow woodland snail (*Adclarkia cameroni*).

4.3.4.7 Shrubland on natural scalds

Shrubland on natural scalds within the impact assessment area is represented by RE 11.7.5 (refer Photograph 4.24). This habitat type is described as a shrubland with or without emergent eucalypts. Characteristic genera include Star flowers (*Calytrix* spp.), Hakea (*Hakea* spp.), Kunzea (*Kunzea* spp.), Heath myrtle (*Micromyrtus* spp.), Wattles (*Acacia* spp.), Bottlebrush (*Melaleuca* spp.) and (in the ground layer) Hummock grass (*Triodia* spp.). Often scattered or fringing emergent tree species are present, including Queensland peppermint (*Eucalyptus exserta*), Yetman ironbark (*E. panda*), Plunkett mallee (*E. curtisii*), Brown bloodwood (*Corymbia trachyphloia*) and Blake's wattle (*Acacia blakei*). Occurs on shallow soils often associated with natural scalds on Cainozoic lateritic duricrusts and sometimes lithosols derived from quartzose sandstone.

This habitat type is of limited value as fauna habitat; however, the edge of hard pans may be associated with soak with soft spongy soil and liverworts, mosses and sedges during wet periods, providing important habitat for amphibian species.

MNES species that may occur within shrubland on natural scalds include Dunmall's snake (*Furina dunmalli*).

4.3.4.8 Semi-evergreen vine thicket

Semi-evergreen vine thickets within the impact assessment area are represented by RE 11.8.3 which occurs within the impact assessment area but not within the Project footprint. This habitat type is generally restricted to steeper, rocky hillsides on igneous rocks, with emergent *Acacia harpophylla*, *Casuarina cristata* and *Eucalyptus* spp. Semi-evergreen vine thickets have the greatest structural complexity at all strata levels, providing quality habitat for many species of birds, reptiles and arboreal marsupials. The steep and rocky terrain typical of semi-evergreen vine thickets also provides important habitat refugia for terrestrial marsupials and reptiles.

MNES species that may occur within semi-evergreen vine thickets include Spotted-tail quoll (*Dasyurus maculatus*), Brush-tailed rock wallaby (*Petrogale penicillata*), and Black-breasted button quail (*Turnix melanogaster*).



Photograph 4.24 Shrubland on natural scalds located south of Inglewood (2018)



Photograph 4.25 Regrowth community dominated by Eucalyptus and acacia species, located within the Inglewood region (2018)

4.3.4.9 Regrowth eucalypt communities

Areas of regrowth vegetation, largely represented by the DNRME High Value Regrowth (HVR) vegetation mapping, are present throughout the impact assessment area. A total of 9.3 ha of HVR is mapped within the impact assessment area (refer Photograph 4.25). The patches of regrowth vegetation within the impact assessment area are generally in poor condition, suffering from extensive weed invasion and disturbance from cattle grazing practices. Areas of regrowth habitat may provide foraging and roosting habitat value for transitional bird species and suitable microhabitats, including cracking clay soils for reptile species.

4.3.4.10 Wetlands

Wetland habitats within the impact assessment area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine), and vegetated swamps (palustrine). Artificially created wetlands (i.e. farm dams), which are abundant across agricultural landscapes, are included as they potentially provide suitable wetland alternatives for vertebrate fauna. Artificial wetlands include typically small farm dams and much larger turkey-nest dams associated with irrigated cropping, as well as drinking water supply reservoirs. Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants.

Remnant palustrine wetland vegetation is represented by RE 11.3.27b and represent a very minor area within the Project footprint (0.97 ha). Typical aquatic and emergent plants include *Chara* spp., *Nitella* spp., *Myriophyllum verrucosum*, Blue lily (*Nymphaea violacea*), *Pyrgillus javanicus*, Curled pondweed (*Potamogeton crispus*), *P. tricarinatus*, Swamp lily (*Ottelia ovalifolia*), *Vallisneria caulescens* and Marshwort (*Nymphoides indica*). A narrow fringing woodland commonly dominated by River red gum (*Eucalyptus camaldulensis*) or *E. coolabah* may occur. Wetland habitats within the region are highly ephemeral, particularly in the southern and drier sections of the alignment (refer Photograph 4.26).

Wetland habitats within the impact assessment area are considered to provide suitable habitat for a variety of amphibian, reptile and bird species. Larger palustrine-wetlands potentially provide important refuge habitat for many bird species and may act as stepping stones during periods of travel.



Photograph 4.26 Ephemeral wetland areas located at Yelarbon, associated with the Yelarbon scald (2018)

Wetland habitats within the impact assessment area may provide suitable habitat for a variety of fish, amphibian, reptile (incl. turtles) and bird species. Larger palustrine-wetlands potentially provide important refuge habitat for many bird species, including dispersive species. MNES fauna species that may utilise wetland habitats within the impact assessment area include the Australasian bittern (*Botaurus poiciloptilus*) and Australian painted snipe (*Rostratula australis*) although both of these species are reliant on the presence of dense vegetation either aquatic (in the case of the bittern) or as nearby cover (for snipe). It is noted farm dams are less likely to provide these habitat elements and floodplain wetlands are highly ephemeral. Curlew sandpiper (*Calidris ferruginea*) may rarely occur on larger dams with shallow muddy areas during migrations to coastal areas further south. In addition to birds, MNES fish have the potential to utilise wetland areas when connected to larger areas of habitat or during periods of flood.

There are 9.85 ha of State mapped wetlands (as mapped by DES) considered as 'high ecological significance' (HES) wetlands that occur within the impact assessment area, of which none lies within the Project footprint and will not be directly impacted from activities associated with the Project. Two discrete HES wetlands are located within the impact assessment area within the vicinity of Kurumbul at the western end of the impact assessment area.

Other wetland values within the impact assessment area are represented through aquatic conservation assessment modelling based on water quality monitoring values. The catchment aquatic conservation assessment indicates a skew towards higher value riverine wetlands throughout the alignment with most sites recorded as either 'medium' or 'very high' value. No spring fed wetlands mapped on the Queensland wetland mapping layer (DES 2018) were identified within the impact assessment area.

Targeted aquatic ecology assessments were carried out by Eco Logical (2020) across a number of waterways intersected by the alignment. Aquatic ecology and surface water values were variable across the rail alignment. Ephemeral watercourses, which have been subject to previous disturbance from agricultural development and public infrastructure such as road crossings, are dominant. Many of the waterways surveyed were dry at the time of the assessments and were not deemed to provide suitable habitat for aquatic MNES species. Murray cod (*Maccullochella peelii*) was recorded in the Macintyre River and a site on Macintyre Brook. Bringalily Creek may also provide habitat for this species. Sites on the Condamine River floodplain were generally dry with very little water in the channel (water generally present in small pools with infrequent deeper pools) (refer Photograph 4.27 and Photograph 4.28). Murray cod is known from the Condamine river system and may utilise channels within the impact assessment area the river system during prolonged wetter periods. Waterways in the impact assessment area were not considered suitable for the presence of Silver perch (*Bidyanus bidyanus*).

Further information regarding wetland values are provided in EIS Appendix K: Aquatic Ecology Technical Report.



Photograph 4.27 Grasstree Creek - southern Condamine River floodplain area (Eco Logical Australia 2020)



Photograph 4.28 Condamine River (north branch) (Eco Logical Australia 2020)

4.3.4.11 Groundwater dependent ecosystems

Groundwater plays an important role in sustaining MNES species utilising aquatic and terrestrial ecosystems, such as springs, wetlands and rivers. Shallow (alluvial) groundwater may also sustain associated riparian canopy vegetation during dry conditions including River red gum (*E. camaldulensis*) which is utilised by species such as Koala (*Phascolarctos cinereus*) and Greater glider (*Petauroides volans*). Understanding these groundwater-dependent ecosystems (GDEs) is essential for groundwater management and planning. The presence of GDEs has been identified through interrogation of the DES mapping of GDEs (GDE Atlas). Both aquatic and terrestrial GDEs have been mapped by DES along the Project footprint between the NSW/QLD border and Millmerran. Terrestrial GDEs are most dominant and concentrated in the Inglewood to Millmerran section of the Project alignment, while aquatic GDEs are scattered towards the NSW/QLD border end of Project alignment. The GDE Atlas indicates there are no high potential aquatic GDEs (i.e. surface water expression) located within 5 km of the Project footprint.

Areas where potential aquatic GDEs are identified within 5 km of the Project include:

- Between Ch 40.0 km and Ch 95.0 km the Project alignment crosses numerous unnamed tributaries associated with Macintyre Brook and Canning Creek with a moderate potential to be aquatic GDEs
- Unnamed creeks with moderate potential for aquatic GDEs occur to the southwest of Millmerran within and surrounding the Project footprint between Ch 115.0 km to Ch 125.0 km
- The Condamine River, which the Project alignment crosses near Ch 142.9 km, is considered to have a low potential to be aquatic GDEs
- Low to moderate potential aquatic GDEs are associated with narrow, unnamed creeks underlain by the between Ch 160.0 km to Ch 206.9 km.

Areas where terrestrial GDEs (terrestrial vegetation dependent on groundwater resources) are identified by the GDE Atlas as occurring within 5 km of the Project footprint includes:

- One high potential terrestrial GDE is crossed by the Project alignment between Ch 25.0 km and Ch 28.0 km, near Yelarbon. This GDE is associated with the alkaline landscape of the Yelarbon Desert sandy plains. Here, permeable sediments of the Border Rivers Alluvium store and readily transmit groundwater from the underlying Great Artesian Basin to provide a permanent connection to this GDE.
- Broad areas of moderate potential for terrestrial GDEs occur between Ch 55.0 km and Ch 95.0 km. These areas are characterised to have intermittent connection to brackish aquifers associated with shallow alluvium
- Irregular areas of moderate potential for terrestrial GDEs are crossed by and surround the Project footprint between Ch 165.0 km to Ch 200.0 km. These GDEs are associated with fractured-rock aquifers which may provide an intermittent connection to these ecosystems.

Several ephemeral springs (sourced from bedrock aquifer systems) have been mapped by DES at the Gowrie end of the Project alignment. Springs that occur in proximity to the Project footprint, and that may provide a source of water for GDEs, are listed in Table 4.6.

Table 4.6 Summary of groundwater dependent ecosystem springs

Spring name/site #	Distance from alignment (km)	Direction from alignment	Spring type	Source aquifer
Stone Spring/1145	2	NW of Ch 173.0 km	Active and non-permanent	Main Rand Volcanics
Jimna Springs/1147	5.3	SE of Ch 178.0 km		Main Rand Volcanics
Springside/1146	5.7	N of Ch 168.0 km		Main Rand Volcanics
Wellcamp Spring/1150	7.4	E of Ch 195.0 km		Main Rand Volcanics
Leigh Spring/1144	8.8	NW of Ch 173.0 km		Main Rand Volcanics
Merigandan Creek/1155	9.4	NE of Ch 206.0 km		Main Rand Volcanics
Eustondale Spring/1154	11.6	E of Ch 195.0 km		Main Rand Volcanics
Lilligren Spring/1156	12.1	NE of Ch 206.0 km		Main Rand Volcanics
Westbrook Creek/1153	14.4	E of Ch 195.0 km		Main Rand Volcanics
Kearneys Spring/1139	17.5	E of Ch 195.0 km	Active - Permanent	Main Rand Volcanics

4.4 Summary of matters of national environmental significance values

The overarching ecological values within the impact assessment area, include:

- Australia's natural environmental and native flora and fauna
- Finite natural resources, including conservations parks and wetlands
- Land conducive to the maintenance of existing landforms, ecological health, biodiversity, riverine and wetland areas
- Biodiversity.

The Project footprint provides habitat for a number of threatened species listed under the EPBC Act and their associated habitat. There is one TEC listed under the EPBC Act, Brigalow (*Acacia harpophylla* dominant and co-dominant, confirmed as present within the Project footprint and a further four TECs may potentially occur (refer Table 4.7).

Based on literature review, database searches, and field surveys supporting habitat modelling, habitat for 41 threatened flora (18 species) and fauna (23 species) were confirmed within the Project footprint (43 species within the impact assessment area) (refer Table 4.4). This includes significant habitat associated with the State forest areas north of Inglewood and Habitat critical to the survival of the species for a several species including King blue-grass (*Dichanthium queenslandicum*), Winged peppergrass (*Lepidium monoplacoides*), Hawkweed (*Picris evae*), Australian painted snipe (*Rostratula australis*), Condamine earless dragon (*Tympanocryptis condaminensis*) and Koala (*Phascolarctos cinereus*).

Predictive habitat mapping has been used to assess the species potential to occur within the impact assessment area (refer Appendix A). Mapping associated with this process is presented in Appendix G and the area of predicted habitat contained within the impact assessment area and within the Project footprint is provided in Table 4.4. In instances where species/communities did not have potential habitat contained within the impact assessment area (i.e. Stream clematis (*Clematis fawcettii*), Small-flowered westringia (*Westringia parvifolia*), Brush-tailed rock wallaby (*Petrogale penicillata*)), these species have not been subject to impact assessment and are no longer considered to constitute MNES as the risk to these matters are considered low.

The MNES identified within the impact assessment area are listed in Table 4.7 along with their assigned sensitivity value as determined using the descriptions provided in Table 3.8.

Table 4.7 Identified matters of national environmental significance within the impact assessment area

Associated ecological value	Identified MNES	Assigned sensitivity (refer Table 3.8)	Justification
- Australia's natural environment and native flora and fauna - Biodiversity	EPBC Act listed TECs: - Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) - Natural grassland on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland - Weeping Myall Woodlands - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland - Poplar Box Grassy Woodland on Alluvial Plains	High	- Protected by Commonwealth legislation - Important for biodiversity - Rare - High sensitivity, high exposure to impacts
	Conservation significant terrestrial flora and fauna species listed under the provisions of the EPBC Act (including habitat): Flora - Tara wattle (<i>Acacia lauta</i>) - Hairy-joint grass (<i>Arthraxon hispidus</i>) <i>Bertya opposens</i> - Ooline (<i>Cadellia pentastylis</i>) - King blue- grass (<i>Dichanthium queenslandicum</i>) - Bluegrass (<i>Dichanthium setosum</i>) - Shiny-leaved ironbark (<i>Eucalyptus virens</i>) - Belson's panic (<i>Homopholis belsonii</i>) - Winged peppergrass (<i>Lepidium monoplacoides</i>) - Wandering pepper-cress (<i>Lepidium peregrinum</i>) - Coolmunda Leucopogon (<i>Leucopogon</i> sp. Coolmunda) (D. Halford Q 1635) <i>Macrozamia machinii</i> - Hawkweed (<i>Picris evae</i>) - Dunmore Prostanthera (<i>Prostanthera</i> sp. Dunmore) - Austral cornflower (<i>Rhaponticum australe</i>) - Brush Sophora (<i>Sophora fraseri</i>) - Austral toadflax (<i>Thesium australe</i>) - Slender Tylophora (<i>Tylophora linearis</i>) <i>Xerothamnella herbacea</i> Fauna - Regent honeyeater (<i>Anthochaera Phrygia</i>) - Australasian bittern (<i>Botaurus poiciloptilus</i>) - Curlew sandpiper (<i>Calidris ferruginea</i>) - Red goshawk (<i>Erythrorhynchus radiatus</i>) - Grey falcon (<i>Falco hypoleucos</i>) - Squatter pigeon (southern subspecies) (<i>Geophaps scripta scripta</i>) - Painted honeyeater (<i>Grantiella picta</i>) - White-throated needletail (<i>Hirundapus caudacutus</i>) - Swift parrot (<i>Lathamus discolor</i>)	High	- Protected by Commonwealth legislation - Rare - High sensitivity, high vulnerability

Associated ecological value	Identified MNES	Assigned sensitivity (refer Table 3.8)	Justification
	- Australian painted snipe (<i>Rostratula australis</i>) - Black-breasted button-quail (<i>Turnix melanogaster</i>) - Murray cod (<i>Maccullochella peelii</i>) - Large-eared pied bat (<i>Chalinolobus dwyeri</i>) - Spotted-tailed quoll (<i>Dasyurus maculatus maculatus</i>) - South-eastern long-eared bat (<i>Nyctophilus corbeni</i>) - Greater glider (<i>Petauroides volans volans</i>) - Koala (<i>Phascolarctos cinereus</i>) - Grey-headed flying-fox (<i>Pteropus poliocephalus</i>) - Five-clawed worm-skink (<i>Anomalopus mackayi</i>) - Collared delma (<i>Delma torquata</i>) - Yakka skink (<i>Egernia rugosa</i>) - Dunmall's snake (<i>Furina dunmalli</i>) - Condamine earless dragon (<i>Tympanocryptis condaminensis</i>) - Brigalow woodland snail (<i>Adclarkia cameroni</i>)		

5 Potential impacts

This section provides discussion on the Project activities, by phase, that have potential to result in impacts to MNES. Descriptions are then provided of the particular direct and indirect impacts that may occur.

5.1 Project activities

Activities proposed as part of the Project that may impact on MNES have been categorised into three phases, being construction, commissioning and reinstatement and operation. A summary of Project related activities and the duration of their disturbance is provided in Table 5.1.

Table 5.1 Summary of Project related activities associated with construction, commissioning and reinstatement and operation

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.7)
Construction	Site preparation	Vegetation clearing	Permanent
		Topsoil stripping	Medium term/permanent
		Construction of temporary site compounds	Medium term
		Construction of rail access roads	Permanent
		Installation of offices, hardstands etc	Medium term
		Stockpiling	Medium term
	Utility diversions	Excavation	Temporary
		Trenching	Short term
		Modification, diversion and realignment of utilities and associated infrastructure	Short term/medium term
	Drainage	Culvert installation	Medium term
	Structures	Construction of bridges over main waterways	Medium term
		Road/rail bridge construction	Medium term
	Civil works	Cutting construction	Medium term
		Embankment construction using cut to fill from rail alignment and borrow to fill from external borrow sources, where required	Medium term
		Construction of temporary haul roads	Medium term
		Drainage controls	Medium term
	Road works	Road realignment	Permanent
		Construction of permanent rail maintenance access roads	Permanent
	Rail logistics	Sleeper stockpiling	Medium term
		Rail stockpiling	Medium term
	Rail construction	Drilling	Temporary
		Ballast installation	Short term
		Sleeper placement	Short term
		Rail placement	Short term
		Installation of train signals and communications infrastructure	Short term
		Demobilising site compounds	Short term

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.7)
	Signals and communications installation	Removal of temporary fencing	Temporary
Commissioning and reinstatement	Demobilisation/Decommissioning	Establish permanent fencing	Temporary
		Restoration of disturbed areas, including revegetation where required	Short term
	Spoil mounds	Conversion of haul roads and construction access roads into permanent roads	Medium term
	Fencing	Installation of fencing	Permanent
	Restoration	Minor maintenance works	Temporary
	Road works	Bridge and culvert inspections	Temporary
		Sleeper replacement	Temporary
		Rail welding	Temporary
		Rail grinding	Temporary
		Ballast dropping	Temporary
		Track tamping	Temporary
Operation	Train operations	Train movement along rail	Permanent
	Operational maintenance	Ongoing vehicle movement within rail corridor	Temporary
		Periodic maintenance	Temporary

5.2 Description of potential impacts

Potential impacts to MNES may occur during the construction and operation phases of the Project. The potential impacts and susceptible MNES receptors is summarised in Table 5.2. This section outlines unmitigated potential impacts associated with the Project upon MNES. Mitigations measures for the Project are presented in Sections 6.1 and 6.2. Application of these mitigation measure is likely to reduce the magnitude and duration of impacts upon the Sensitive environmental receptors.

Table 5.2 Summary of impact processes and matters of national environmental significance receptors likely to be impacted

Habitat values	Susceptible MNES receptors		
	TECs	Flora	Fauna
Habitat loss and degradation from vegetation clearing/removal	Yes	Yes	Yes
Fauna species injury or mortality	No	No	Yes
Reduction in biological viability of soil to support plant growth due to soil compaction	Yes	Yes	No
Displacement of threatened flora and fauna by invasion of weeds and pest species	Yes	Yes	Yes
Reduction in the connectivity of biodiversity corridors	No	Yes	Yes
Edge effects	Yes	Yes	Yes
Habitat fragmentation	No	Yes	Yes
Noise, dust and light impacts	No	Yes	Yes
Increase in litter (waste)	No	No	Yes
Aquatic habitat degradation	No	No	Yes

Habitat values	Susceptible MNES receptors		
	TECs	Flora	Fauna
Erosion and sedimentation	Yes	Yes	Yes
Flooding	Yes	Yes	Yes

5.2.1 Potential impacts to matters of national environmental significance

5.2.1.1 Habitat loss and degradation from vegetation clearing/removal

The Project footprint encompasses a total of 3,203.78 ha. Under current Queensland Government (DNRME) vegetation mapping this includes 563.24 ha of remnant vegetation and 34.64 ha of regrowth vegetation. The remaining 2,605.9 ha (81.3 per cent of the Project footprint) (clearing for agriculture/cattle grazing).

The removal of vegetation and construction of linear infrastructure resulting in habitat loss is likely to pose the largest risk of adverse impacts for biodiversity arising from the Project. The impact may be direct in the form of vegetation and habitat removal, or indirect, as fauna and flora diversity may become reduced due to shortages in available habitat resources. Small-scale clearing within largely intact patches of vegetation can cause localised depletion of some species (Kutt et al. 2012) and is particularly relevant to species with small home ranges, or reduced ability to disperse (e.g. Collared delma). Vegetation clearing, and habitat loss are likely to occur during the construction phase activities. Habitat loss and degradation has the potential to impact upon threatened species and communities identified in this assessment (refer Table 7.1). However the significance of habitat loss will vary depending upon the species/ community, with some species being more resilient than others (refer Section 8).

For aerial foraging bird species (White-throated needletail) that do not require forested areas to occur these areas represent the entire Project footprint. Given the species occurs transiently across a broad swathe of eastern Australia the impact from the Project is considered negligible at worst and impacts on this species are not considered further.

Whilst it is acknowledged that the Brigalow Belt southern bioregion exists in a highly modified state and potential vegetation removal associated with the Project is considered to be relatively small when compared to historical broad scale vegetation clearing that has occurred in the region for agricultural purposes, this does not diminish the significance of such loss. Vegetation clearing and habitat loss that cannot be avoided, particularly in high constraint areas, is likely to result in permanent impacts to threatened biodiversity values.

5.2.1.2 Matters of national environmental significance fauna species injury or mortality

Physical trauma to fauna is a direct impact that has the potential to reduce local population size and has the potential to create "source/sink" dynamic, but this may not necessarily alter population size (Furrer and Pasinelli, 2016). However, changes in the mortality rate can affect population viability and may be a critical factor in a fragmented landscape where population sizes are fairly small and/or poorly connected. The impact of mortality on population viability is particularly pronounced for longer-lived, slow breeding species, such as the Koala (*Phascolarctos cinereus*) (i.e. K-selected species) and is less pronounced in those that are R-selected (e.g. those species with high fecundity and shorter lifespans) (Oli, 2004).

Physical trauma to fauna is a direct impact that reduces local population numbers. Physical trauma to MNES fauna has the potential to occur during all phases of the Project with the highest potential likelihood during construction activities that involve vegetation clearing, earthworks, trenching and increased labour force in the fields (through the movement of vehicles). Species most at risk of injuries and mortality are those that are cryptic, difficult to detect and with poorly developed dispersal mechanisms (e.g. Condamine earless dragon (*Tympanocryptis condaminensis*)). However, larger species with defined territories and movement patterns (e.g. Greater glider (*Petauroides volans*), and Koala (*Phascolarctos cinereus*)) are less likely to be at risk to direct mortality where appropriate mitigation measures are applied (i.e. pre-clearance surveys and the use of fauna spotters during clearing).

This potential impact will be proportionate to the extent of vegetation and habitat potential for species that is removed and has the potential to impact MNES, including threatened fauna species listed under the provisions of the EPBC Act.

Some listed diurnal (active during the day) and mobile species, such as listed birds, may move away from areas being disturbed (i.e. vegetation removal) and may not be adversely impacted in terms of direct physical trauma unless fauna are nesting. However, other listed species that are less mobile (i.e. ground-dwelling reptile, mammal species and aquatic species), or those that are nocturnal and nest or roost in tree or tree hollows during the day (i.e. arboreal mammals such as listed gliders and Koala), may find it difficult to move away from roosts or active breeding places.

There is the potential for fauna injury or mortality during all phases of the Project through vehicle collision, but particularly when high volumes of vehicle activity occur or during the operational stages of the rail. Vehicle collision is a direct impact that reduces local population numbers and is a common occurrence in Australia (Coffin 2007; Rowden et al. 2008). The development of temporary construction tracks, as well as the general use of permanent access tracks and roads across the Project footprint will result in increased vehicle movements that may cause injury or death to fauna by vehicle strike. In addition, once operational, train strike may also occur. Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly common species (e.g. macropods) that are tolerant of disturbance and/or those species that can utilise roads for movement pathways or as foraging habitat.

In addition, entrapment of wildlife in utility diversions (e.g. trenches) or other excavations associated with the Project may also cause physical trauma to fauna. For example, open trenches for underground utilities, or other pits are known to be effective at trapping a wide variety of wildlife and often result in mortality (Ayres and Wallace 1997; Doody et al. 2003; Woinarski et al. 2006). Species most likely to become trapped in pits or other excavations during construction of the Project are ground dwelling species that are capable of moving across modified areas [e.g. Condamine earless dragon (*Tympanocryptis condaminensis*) and arboreal species which descend to the ground to disperse such as Koala (*Phascolarctos cinereus*)].

Given the nature of the Project, there is potential for some species such as the Greater glider (*Petauroides volans volans*) to be struck by trains during periods of dispersal and movement (e.g. whilst gliding over the alignment). This would only be the case where the alignment is at ground level in predicted habitat (i.e. not in locations of high embankments, bridges or cuttings).

In addition, entrapment of wildlife in utility diversions (e.g. trenches) or other excavations associated with the Project may also cause physical trauma to fauna. For example, open trenches for underground utilities, or other pits are known to be effective at trapping a wide variety of wildlife and often result in mortality (Ayres and Wallace 1997; Doody et al 2003; Woinarski et al 2006). Species most likely to become trapped in pits or other excavations during construction of the Project are ground dwelling species that are capable of moving across modified areas in the absence of woodland or forest habitat such as mammals, amphibians, and reptiles.

Aquatic fauna may be injured or killed during construction within waterways, such as the construction of culverts and bridges and associated temporary impoundments required during construction. Species most susceptible to death or injury include smaller and/or sessile species such as freshwater invertebrates. Species such as Murray cod (*Maccullochella peelii*) are less likely to be at risk to direct mortality where appropriate mitigation measures are applied (i.e. pre-clearance relocation activities prior to creating temporary impoundments).

The unmitigated potential occurrence of fauna species injuries or mortalities resulting from the Project can be permanent, where mortality to the species occurs, or temporary where the species is rehabilitated and re-released (refer Table 3.7 for definitions associated with timeframes).

5.2.1.3 Reduction in biological viability of soil to support plant growth due to soil compaction

Compaction of soil and loss of top soil as a result of the Project activities may result in direct impacts to soil consistency (i.e. the strength and coherence of a soil) and soil structure (i.e. the arrangement of soil particles). Changes to soil consistence and structure can affect the productive capacity of the soil for agricultural practices, the suitability of the soils for various land uses, how the soil and landscape will respond to management practices, and the flow paths by which water moves within the soil and landscape (Fitzpatrick et al 1999).

The most direct effect of soil compaction is an increase in the bulk density of soil which can restrict plant root growth and function. Due to the increase in bulk density, large pores essential for water and air movement in soil are primarily affected. This influence over water and air movement can impact root penetration, seedling emergence and plant growth (Fitzpatrick et al 1999; Duiker 2004). Reduction in soil viability may negatively impact the Brigalow TEC, the Weeping Myall Woodlands TEC and the Poplar Box Grassy Woodland TEC, as well as threatened flora such as Tara wattle (*Acacia lauta*), Hairy-joint grass (*Arthraxon hispidus*), *Bertya opposens*, King bluegrass (*Dichanthium queenslandicum*), Bluegrass (*Dichanthium setosum*), Belson's panic (*Homopholis belsonii*), Winged peppergrass (*Lepidium monoplacoides*), Wandering pepper-grass (*Lepidium peregrinum*), Coolmunda leucopogon (*Leucopogon* sp. Coolmunda (D. Halford Q 1635)), Hawkweed (*Picris evae*), Dunmore Prostanthera (*Prostanthera* (sp. Dunmore)), Austral cornflower (*Rhaponticum australe*), Austral toadflax, Slender Tylophora (*Tylophora lineari*) and *Xerothamnella herbacea*. Impacts to soil may also have flow on effects to MNES fauna through degradation of their associated habitat.

Soil biota may also be affected by compaction, for example earthworm numbers and activity can be reduced in compacted soils and compaction may impact upon the growth of fungi that are a potential food source for some species. In addition, water infiltration and percolation are slower in compacted soils, thereby inhibiting root growth, leading to the potential reduced uptake of immobile nutrients such as phosphorus and potassium; and increased nitrogen losses can be expected because of prolonged periods of saturated conditions in compacted soils.

The unmitigated potential impacts of soil compaction resulting from the Project are generally short term and temporary (refer Table 3.7 for definitions associated with timeframes).

5.2.1.4 Displacement of threatened flora and fauna by invasion of weeds and pest species

Weed and pest species have the potential to impact on terrestrial and aquatic biodiversity as native species can become displaced through predation and competition. In addition, weeds may result in impact to the Brigalow TEC, the Weeping Myall Woodlands TEC and the Poplar Box Grassy Woodland TEC through competitive process and displacement by altering nutrient cycling and outcompeting for limited resources.

Pest species can also damage native vegetation that is either an MNES or supports MNES, by grazing and trampling (Adair and Groves 1998; Clarke et al. 2000; Thorp and Lynch 2011) or through direct competition/predation (e.g. Mosquitofish (*Gambusia holbrooki*) within aquatic ecosystems). Therefore, weed and pest species may reduce the extent or quality of available habitat and hence population size for specific MNES. This may have the effect of increasing mortality and reducing the size and viability of population sizes through resource limitation and associated stress.

Proliferation of weed and pest species is an indirect impact (i.e. not a direct result of the Project activities) that may have cumulative effects as each project activity, as well as agricultural practices and other resource project activities, may act in conjunction to increase the chances of weed and pest proliferation throughout the Project footprint and adjoining areas. Proliferation of weed and pest species has the potential to occur during all phases of the Project, especially during the construction phase, however the highest likelihood of weed and pest species occurring is from vegetation clearing and soil disturbance from local agricultural land practices.

The effects of proliferation of weed and pest species may not be noticeable immediately or even in the short term, as visible signs may take several months or seasons to impact on ecological MNES. These potential impacts are likely to be long term and affect all ecological MNES in the impact assessment area, including affecting the quality and integrity of TECs, remnant vegetation, habitat for conservation significant species, wetlands and waterways.

Non-native species comprised 30 per cent of the flora species recorded in the impact assessment area (refer Appendix E). Of these, 24 flora species (as well as nine pest fauna species) are considered as 'restricted matters', listed under the provisions of the Biosecurity Act (including six species listed as weeds of national significance). Weeds were prevalent across the entire ecology significant impact area but were most abundant in areas subject to anthropogenic disturbance such as roadsides and areas subject to cattle grazing. Without appropriate management strategies, the Project activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently in low densities. In areas that provided highly specific habitat for MNES [(e.g. Collared delma (*Delma torquata*)], weed/pest infestations are likely to have the most significant impact and will contribute towards threatening processes. However, pest and weed invasion may benefit some species and some MNES by supplying an abundant food source which would otherwise be unavailable [e.g. Mosquitofish as a food source for the Murray cod and non-native plants as a food source for the Brush-tailed rock-wallaby (*Petrogale penicillata*)].

Project activities also have the potential to introduce new weed species into the impact assessment area. The most likely causes of weed dispersal and introduction associated with the Project include earthworks, movement and disturbance of soil, and attachment of seed (and other propagules) to vehicles and machinery during all phases. Weed dispersal by vehicles along access tracks and roads is a key source of weed invasion (Birdsall et al 2012). Weed invasion is an indirect impact that may degrade the quality of habitats, potentially resulting in habitat loss.

Soil disturbance during construction may increase the risk of invasion from weed and/or pest species, which can further reduce habitat quality and compromise the integrity of adjacent areas such as the Brigalow TEC, the Weeping Myall Woodlands TEC and the Poplar Box Grassy Woodland TEC.

Large areas of the impact assessment area have significant weed growth, particularly non-native grasses, which have been introduced as part of historic agricultural land use of the area. Therefore, the potential for habitat modification from weed invasion resulting from the Project is highest where Project activities take place in relatively intact areas, such as those identified as containing in Large areas of the impact assessment area have significant weed growth, particularly non-native grasses, which have been introduced as part of historic agricultural land use of the area. Therefore, the potential for habitat modification from weed invasion resulting from the Project is highest where Project activities take place in relatively intact areas, such as those identified as containing intact remnant vegetation that currently has low weed diversity and abundance.

Large areas of the impact assessment area have significant weed growth, particularly non-native grasses, which have been introduced as part of historic agricultural land use of the area. Therefore, the potential for habitat modification from weed invasion resulting from the Project is highest where Project activities take place in relatively intact areas, such as those identified as containing in-tact remnant vegetation that currently has low weed diversity and abundance.

Unmitigated Project activities have the potential to disperse pest (animal) species from the impact assessment area into the surrounding landscape, due to habitat removal, noise disturbance, and human presence during the construction and operation phases of the Project.

Construction of access tracks and the rail infrastructure through large patches of intact vegetation may result in the establishment of pest species (particularly predators such as foxes and cats) into areas where they are currently absent or in low numbers. Therefore, unmitigated potential impacts of the displacement of native species through the invasion of non-native may be temporary or irreversible (refer Table 3.7 for definitions associated with timeframes).

5.2.1.5 Reduction in the connectivity of biodiversity corridors

Biodiversity corridors (including those associated with waterways) can be defined as systems of linear habitat which enhance the connectivity of wildlife populations and may help to overcome the main consequences of habitat fragmentation (Wilson and Lindenmayer 1995). Corridors can assist ecological functioning at a variety of spatial and temporal scales from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions. Fragmentation of such corridors have been identified as important threatening process to MNES such as Spotted-tail quoll (*Dasyurus maculatus maculatus*) and Koala (*Phascolarctos cinereus*) (refer Appendix B).

State based mapping for the Brigalow belt (Queensland Government 2016) depicts State corridors within the impact assessment area where the alignment intersects vegetation associated with Whetstone and Bringalily State Forests. The alignment intersects a regional corridor comprising patchy fragmented vegetation to the north of Pittsworth. The corridor mapping portrays vegetation that is significant for the spread and movement of flora and fauna, including MNES. Connectivity is generally present only in the south of the impact assessment area, where the majority of native vegetation is situated within State Forest and along the higher stream order watercourses.

Most of the impact assessment area exists in a very fragmented environment. However, functional connectivity is retained through local linkages of remnant and regrowth vegetation, associated with roadside and riparian corridors linking larger patches of vegetation on private land. These linkages are likely to provide landscape permeability for vagile MNES such as birds and bats.

The potential impacts of linear infrastructure traversing these biodiversity corridors include habitat fragmentation, edge effects and barrier effects. These potential impacts are discussed further in the sections below. An additional potential impact upon biodiversity corridors resulting from the Project is the proliferation of weeds and pest species, as mentioned previously. Conservation significant species listed under the provisions of the EPBC Act, bioregional corridors and wildlife refugia are likely to be impacted the most from these potential impacts due to the importance of habitat quality and connectedness for species at a local scale and the cumulative impacts which may be realised at a regional landscape scale.

The unmitigated potential impacts to biodiversity corridors resulting from the Project are likely to be long term and irreversible.

5.2.1.6 Edge effects

Edge effects refer to the changes in environmental conditions (e.g. altered light levels, wind speed, temperature) that occur along the edges of habitats. These new environmental conditions along the habitat edges can promote the growth of different vegetation types (including weed species), promote invasion by pest animals specialising in edge habitats, or change the behaviour of resident native animals (Moenting and Morris 2006). Edge zones can be subject to higher levels of predation by introduced mammalian and native avian predators. The distance of edge effect influences can vary and has been previously recorded from 50 m to greater than one kilometre from an edge (Forman et al 2000; Bali 2005).

Within the impact assessment area, many patches of vegetation are small, irregularly shaped, and fragmented, and as such are already subject to considerable edge effects. Therefore, it is unlikely that the Project would increase the overall extent of edge effects in these areas. However, in large habitat patches with low edge to area ratios (e.g. State forests or remnant vegetation), Project activities (vegetation clearing, temporary and permanent) may create edge effects resulting in habitat degradation and a reduction of the habitat available for a range of species.

Edge effects have the potential to impact on the range of flora and fauna species identified as potentially occurring in the impact assessment area, especially upon the species with specific micro-habitat requirements that are less tolerant to disturbance [e.g. *Xerothamnella herbacea*, Brigalow woodland snail (*Adclarkia cameroni*) and Collared delma (*Delma torquata*)] Conversely, some threatened plant species appear to respond positively to edge effects, particularly ground disturbance, and colonise these edge areas reasonably quickly [Hairy-joint grass (*Arthraxon hispidus*), King bluegrass (*Dichanthium queenslandicum*), Bluegrass (*Dichanthium setosum*), Belson's panic (*Homopholis belsonii*), Hawkweed (*Picris evae*), Austral cornflower (*Rhaponticum australe*), and Austral toadflax (*Thesium australe*)].

It is anticipated that MNES involving threatened species and wetland and waterway habitat [including habitat for Silver perch (*Bidyanus bidyanus*) and Murray cod (*Maccullochella peelii*)] may be impacted greatest from edge effects, where avoidance of vegetated areas is not practicable.

However, given the fragmented nature of the receiving environment, the unmitigated potential impacts of edge effects resulting from the Project are considered to be short term (refer Table 3.7 for definitions associated with timeframes).

5.2.1.7 Habitat fragmentation

Habitat fragmentation relates to the physical dividing up of a continuous habitat into separate smaller fragments (Fahrig 2002). The habitat fragments tend to be smaller and separated from each other by a matrix of less suitable habitat. The new habitat type situated between fragments is often artificial and less suitable to the species remaining within these newly created fragments (Bennett 1990) or is generally only used by adaptive and aggressive generalist species (i.e. Noisy miners) (Loyn et al. 1983) which further decreases population levels of other species remaining in the fragments. Fragmentation reduces patch size, thereby increases edge effects within a patch and reducing the area of undisturbed 'core' habitat for the fauna species present in an area.

The landscape in which the Project is situated is generally highly fragmented with most vegetation occurring as small fragments due to agricultural practices such as pasture, cropping and horticulture. The Project activities will contribute to further fragmentation along with the associated edge effects and reduction in habitat. This effect will largely impact habitat associated with the large tracts of extant vegetation within the State Forests north of Inglewood. Habitat fragmentation has been identified as important threatening process to MNES such as Spotted-tail quoll (*Dasyurus maculatus maculatus*) and Koala (*Phascolarctos cinereus*) (refer Appendix B). This is due to the importance of connectivity, dispersal opportunities and habitat quality for species at a local scale and the cumulative impacts at a regional scale. In some instances the Project may not result in significant fragmentation of populations identified as relevant to the area (refer to species-specific population information in Section 8.2 and Section 8.3) given the capacity of some species to disperse widely across the landscape (e.g. Koala (*Phascolarctos cinereus*)).

Linear project activities may however result in some small scale localised fragmentation which has the potential to be detrimental to the dispersal of relatively sedentary species, such as small mammals, frogs, and reptiles which can lead to crowding effects and increased competition within habitat patches. Mobile species such as larger mammals, birds, and bats may not be affected by this small-scale fragmentation, as the landscape in which they currently exist is fragmented and the predicted level of fragmentation would not be enough to restrict their dispersal between habitat patches providing that mitigation measures are in place to facilitate dispersal in these species.

The unmitigated potential impacts of habitat fragmentation resulting from the Project are considered to be long term and irreversible (refer Table 3.7 for definitions associated with timeframes).

5.2.1.8 Barrier effects

Barrier effects (permanent and/or temporary) occur where particular species are either unable or are unwilling to move between suitable areas of habitat due to the imposition of a barrier. This can include a habitat type that has become unsuitable (e.g. cleared areas devoid of vegetation or structure) or a physical barrier such as a fence, alteration to a waterway or a culvert that does not provide movement opportunities [(particularly important to aquatic MNES such as the Murray cod (*Maccullochella peelii*)]. As noted in the previous section (fragmentation) this is considered a potential impact in the area north of Inglewood (associated with State Forests) due to the highly modified nature of much of the landscape elsewhere in the alignment.

Species most vulnerable to barrier effects include uncommon species, smaller ground-dwelling species, and relatively sessile species with smaller home ranges. Terrestrial MNES most vulnerable to barrier effects include the Condamine earless dragon (*Tympanocryptis condaminensis*), Greater glider (*Petauroides volans*), Brush-tailed rock-wallaby (*Petrogale penicillata*), Koala (*Phascolarctos cinereus*).

Various Project activities may create temporary and/or permanent barrier effects, particularly those that may create a hard barrier that restricts fauna movement (e.g. operational and construction access tracks, temporary waterway barrier works such as the construction of culverts within watercourses, operational rail corridor, construction laydown areas etc). Mobile species such as larger mammals, birds, and bats may not be affected to the same extent. However, in some instances the Project infrastructure/works may not present a barrier to populations identified as relevant to the area (refer to species-specific population information in Section 8.2 and Section 8.3) given the capacity of the species to disperse widely across the landscape (including heavily disturbed areas) and utilise Project infrastructure (such as culverts) (e.g. Koala (*Phascolarctos cinereus*)).

Human activity and infrastructure are likely to create a barrier as many species are known to avoid areas of human activity resulting in indirect habitat loss. Human presence may affect species in different ways. Some species display avoidance behaviour while others may habituate and become attracted to areas of human activity. Predators and prey may respond differentially to human activity, causing a disruption of community interaction and potentially disrupting ecological processes (Caro 2005). Human presence and activity is likely to produce avoidance responses in larger mammalian predators that are sensitive to disturbance (i.e. Quolls), while species such as macropods (i.e. kangaroos and wallabies) and smaller amphibian and reptile species are more likely to habituate to human presence.

Similarly, barrier effects may be experienced by native animals in the form of increased patrolling and predation by pest animals (e.g. foxes and wild dogs) along barriers, such as a cleared corridor, as prey becomes more exposed and easier to detect and catch.

The unmitigated potential impacts of barrier effects resulting from the Project are considered to be in most cases short term and temporary but may in some cases be long term and irreversible (refer Table 3.7 for definitions associated with timeframes).

5.2.1.9 Noise

Understanding of the impacts of anthropogenic noise on fauna is limited. There are no current State or Commonwealth government policies or guidelines that recommend noise thresholds or limits associated impacts to fauna. Noise may adversely affect wildlife by interfering with communication, masking the sound of predators and prey, causing stress or avoidance reactions, and in some cases, may lead to changes in reproductive or nesting behaviour. Excessive noise may lead some species to avoid noisy areas, potentially resulting in the fragmentation of species habitat. On the other hand, many animals react to new noise initially as a potential threat, but quickly 'learn' that the noise is not associated with a threat (Radle 2007).

The following provides a summary of the potential construction and operation noise impacts of the project and the potential effects that this may have on MNES.

Construction noise

Construction activities that may result in the generation of noise, and their anticipated sound power level, are summarised in Table 5.3.

Table 5.3 Construction activities and proposed equipment

Construction stage	Activities	Plant and equipment	Overall sound power level (dB(A) ¹)
Site setup/ laydown areas	- Establishment of site compounds/laydown areas, site facilities and non-resident workforce accommodation facilities - Potential construction of water storage dams to harvest/store construction water - Haul road and access roads construction - Haul road maintenance	Grader, truck, dump truck, 40 t excavator, scraper, water cart	121
Earthworks ³	- Clearing and grubbing/topsoil stripping - Cut to fill - Import general fill - Place and compact general fill - Import structural fill - Place structural fill	Dozer, 40 t excavator, trucks, scraper, water cart, scraper, front end loader, padfoot roller, compactor, grader, 15 t roller, mulcher ²	127 – during CoP Vol 2 standard assessment hours 122 – during CoP Vol 2 non-standard assessment hours
Structures	- Substructure/foundations construction - Pier construction - Superstructure construction	40 t excavator, piling rig, concrete truck, crane	123
Drainage	Install cross drainage	Backhoe, 30 t excavator, work truck (hiab), compactor, concrete truck, concrete pump, franna crane	120
Rail civil works	- Capping material import - Capping material placement - Bottom ballast - Sleeper installation - Rail installation - Top ballast - Track tamping and regulating - Rail stressing - Rail grinding	Tamper, regulator, 20 t excavator, water cart, trucks, dozer, 40 t excavator, 15 t roller, compactor, grader, 20 t excavator, smooth drum roller, ballast train, rail grinder	123
Road civil works	Road works	Grader, 30 t excavator, compactor, water cart, trucks	121
Non-residence workforce accommodation facilities	- Mechanical plant operation - Bus movements - Light vehicle movements	Condenser units, bus, light vehicle	102
Borrow pit establishment and operation	- Drilling - Jack hammering - Rock crushing	Front end loader, trucks, excavator, drill, rock crusher, rock breaker	128
Concrete batching	Preparation, mixing and discharging of concrete	Concrete batching plant	108

Construction stage	Activities	Plant and equipment	Overall sound power level (dB(A) ¹)
Flash-butt welding	■ Track welding	Generator for welding, welder	104

Table notes:

- 1 dB(A) = A-weighted decibel. A term used in noise assessments, which describes the frequency filter that approximates the subjective response of human hearing.
- 2 The mulcher is expected to only typically operate during standard working hours and as such two scenarios have been assessed to represent typical conditions during standard and non-standard hours.
- 3 Excludes blasting. The sound power level for blasting activities will be dependent on the charge mass.

A construction noise impact assessment has been carried out for the Project in accordance with the *Transport Noise Management Code of Practice: Volume 2 – Construction Noise and Vibration* (CoP Vol 2) and the ToR. Reasonable worst-case construction scenarios have been assessed for each of the main construction activities listed in Table 5.3.

The assessment of noise associated with the construction of the Project indicates a high number of exceedances against both the lower and upper external noise limits, specified by CoP Vol 2, within the impact assessment area. The 'earthworks' and 'rail civil works' construction stages are predicted to have the greatest impact from construction noise; however, other construction stages may have greater overall impact depending on actual timing and duration of each construction stage.

Construction traffic noise is predicted to exceed the adopted performance criteria, specified by CoP Vol 2, for 44 different roads within the impact assessment area across the full construction period, with a maximum predicted increase of 22 dB(A). The 44 roads on which the predicted increase in noise level is greater than the 3.0 dB(A) criterion are primarily in rural locations and the existing base traffic volumes quantities are small. As such the initial airborne road traffic noise levels are low before the addition of construction traffic and the criteria for these roads is stringent.

For MNES fauna species the greatest potential for construction noise impacts may be in woodland habitat associated within the State forests in the Inglewood area which provides substantial potential habitat for a range of species. Outside of this area the landscape is heavily disturbed (through agriculture and grazing impacts) and the presence of MNES is limited to species tolerant of disturbance such as Koala (*Phascolarctos cinereus*) and Condamine earless dragon (*Tympanocryptis condaminensis*). Construction noise may lead to some fauna species vacating/avoiding nearby habitat. However, construction noise will be temporary only and fauna species would be expected to return to the area on completion. Measures have been proposed to mitigate construction noise impacts with the final number, degree and nature of the measures to be largely dependent on the construction strategy and work carried out.

Operational noise

The assessment of noise and vibration considered the proposed day time and night time railway operations for the Project. The assessment found that the predicted noise levels from operational rail would achieve the adopted airborne noise assessment criteria at the majority of sensitive receptors included in the noise prediction modelling. At a total of 136 sensitive receptors (131 residential and 5 non-residential) the predicted noise levels are predicted to be above the noise assessment criteria adopted for the Project without the implementation of mitigation. These are largely residential sites associated with Yelarbon, Brookstead and Pittsworth. To mitigate noise levels, where feasible and reasonable, to achieve the assessment criteria and ameliorate impacts, consideration has been given to noise mitigation options for these receptors.

The assessment determined that the vibration criteria adopted for the Project would be achieved where receptors are greater than 10 m from the closest rail.

A desktop assessment of 35 new road sections and 46 upgraded road sections was undertaken to predict the potential noise impacts associated with each road alteration. These roads were assessed against relevant criteria from DTMR's document *Transport Noise Management Code of Practice Volume 1 – Road Traffic Noise* (CoP Vol 1). The desktop assessment considered the increase in traffic flows and relative distance to the nearest sensitive receptors for each road. Influence from other dominant noise sources has not been considered.

Operational noise from four new road sections and three upgraded road sections are predicted to exceed the relevant criteria at one or more sensitive receptors. Operational road traffic noise impacts will be iteratively re-assessed during the detail design process, in accordance with CoP Vol 1, to confirm the receptors at which noise criteria may be exceeded. Where criteria are expected to be exceeded, location specific mitigation measures will be incorporated into the detail design, where possible.

Operational noise is not expected to impact MNES fauna species to more than a very minor extent. Linear transport infrastructure already occurs throughout the impact assessment area, in the form of highways, local roads and rail. Approximately 71.2 km of the Project alignment will utilise existing rail corridor and, whilst the Project will result in an increased intensity of rail operation, operational rail noise is an existing component of the local conditions. Based on this, it is expected that most, if not all resident species are accustomed to some form of transport noise and are likely to become accustomed to additional train movements.

The Project impacts from noise and vibration are assessed in detail in EIS Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report and EIS Appendix T: Operational Railway Noise and Vibration Technical Report.

5.2.1.10 Dust

The Project may lead to localised increases of airborne dust levels during construction. Increased dust can result in respiratory issues in fauna, adverse impacts on plant photosynthesis and productivity (Chaston and Doley 2006), changes in soil properties ultimately impacting plant species assemblages' (Farmer 1993), and mortality and/or decrease in aquatic health on aquatic communities from the toxicity of poor water quality. Evidence of potential impacts on entire vegetation communities is scarce. Many studies focus on specific impacts to single species. Recent research on threatened flora in a semi-arid environment in Western Australia found no significant impact on plant health as a result of a range of dust accumulation loads caused by vehicle movements (Matsuki et al. 2016). The deposition of (unpaved) road dust on nearby freshwater wetlands caused by heavy traffic increases due to energy development projects found minimal impact on water quality or soils (Creuzer et al. 2016).

For the assessment of construction phase impacts, a qualitative construction dust risk assessment was undertaken in reference to the *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014). The risk of dust soiling and human health impacts due to particulate matter on surrounding areas were determined based on the scale of activities and proximity to sensitive receptors. The outcome of the assessment showed that the residual risk with the proposed mitigation measures is low or negligible. Consistent with the IAQM guidance, it is expected that with effective implementation of the proposed mitigation measures the impacts to air quality with respect to dust deposition and human health will not be significant. Therefore, with effective implementation of the proposed mitigation measures the construction of the Project is not anticipated to significantly adversely impact environmental values.

A Dust Management Sub-plan, as a component of the CEMP, will be required for the construction of the Project to manage potential impacts from dust emissions. It is expected that implementation of mitigation measures and monitoring of the effectiveness of these mitigation measures will prevent exceedance of air quality goals and the residual impact with respect to dust soiling and human health will not be significant. Therefore, with effective implementation of the proposed mitigation measures the construction of the Project is not anticipated to significantly adversely impact MNES flora and fauna species or their habitat.

For the assessment of operation phase impacts, a quantitative dispersion modelling assessment was undertaken using the dispersion model CALPUFF. Diesel exhaust emissions from locomotives were estimated for projected peak train movements for the Project in 2040. Twelve months of representative meteorological input was developed for use in CALPUFF. Ground level concentrations of particulate matter, NO₂, volatile organic compounds, and heavy metals were predicted using CALPUFF at nearby sensitive receptors. The assessment predicted that cumulative pollutant concentrations and deposition levels would be below the relevant air quality goals at all identified sensitive receptors for all pollutants of concern with the exception of 24-hour average PM₁₀. The air quality goal for 24-hour PM₁₀ is predicted to be exceeded by 0.1 µg/m³ at a single sensitive receptor located approximately 1.1 km to the north of the existing Commodore Mine. The dominant source of PM₁₀ at the exceeding receptor is Commodore Mine.

Based on the intention of the Environmental Protection (Air) Policy 2019, the operation of the Project is not expected to significantly adversely impact environmental values, including human health. Therefore, with effective implementation of the proposed mitigation measures the construction of the Project is not anticipated to significantly adversely impact MNES flora and fauna species or their habitat.

The Project impacts on air quality are assessed in detail in EIS Appendix O: Air Quality Technical Report.

5.2.1.11 Lighting

Artificial lighting may have a range of impacts across different groups of taxa and between species within these groups. Rodents may avoid brightly lit areas at night. Frogs and nocturnal reptiles may congregate at artificial lights to feed on insects attracted to light (Perry et al. 2008). Similarly, many microbat species may congregate at artificial lighting (Rich and Longcore, 2006), although other species may avoid well-lit areas (Threlfall et al. 2013).

There is limited lighting associated with the construction (flashing beacons and temporary spot lights in support of short-duration night works, if required) and operation (head lamp on rollingstock and safety lighting at road-rail interfaces) of the Project. Qualitative desktop assessment of lighting impacts concluded that the proposed alignment and associated infrastructure are unlikely to create any measurable impacts associated with obtrusive lighting into the external environment as a result of the likely construction activities or permanent Project lighting.

Whilst light spill may impact negatively on many species, it may positively impact upon species such as the Large-eared pied bat (*Chalinolobus dwyeri*) and the South-eastern long-eared bat (*Nyctophilus corbeni*) by attracting nocturnally flying insects upon which these species feed.

The Project impacts due to lighting are assessed in detail in EIS Appendix I: Landscape and Visual Impact Assessment Technical Report.

5.2.1.12 Increase in litter (waste)

The act of littering has the potential to impact the surrounding environment (by causing injury to wildlife), poses threats to human health and is aesthetically displeasing. When discarded as litter, human-made materials such as plastic, glass and aluminium have the potential to cause external injury to wildlife, entanglement, and if accidentally ingested, may cause starvation or suffocation and as such negatively impact species such as the Murray cod (*Maccullochella peelii*). Littered objects may also provide suitable habitat for disease-spreading insects, such as flies and mosquitoes (Healthy Land and Water 2019).

According to the National Litter Index, across Australia the most littered items are cigarette butts; and plastic objects are the most littered by volume of material. Cigarette butts and small plastic items are often mistaken for food resources and have been found in the stomachs of juvenile birds. In addition, littering of cigarette butts also poses a bushfire risk (Healthy Land and Water 2019).

Ecological MNES affected from this potential impact include all threatened flora (through alterations in recruitment and nutrient cycles) and fauna species (direct consumption, declines in habitat suitability and entanglement). This type of impact has the potential to be long-term in duration due to the varying times of decomposition; however, it is likely to be localised and manageable.

5.2.1.13 Aquatic habitat degradation

Activities related to the construction and operation of the Project are likely to impact water quality, thereby degrading habitats for aquatic fauna and flora and terrestrial species reliant on aquatic habitats (surface and groundwater fed). Erosion and sedimentation (refer Section 5.2.1.14), contamination and an increase in litter (refer Section 5.2.1.12) are all potential mechanisms that will adversely impact aquatic habitat. Direct loss of waterway habitat may occur through activities associated with waterway crossings during construction and operation and may include changes in surface water flows and groundwater levels.

With respect to MNES species, aquatic habitat degradation is considered a threatening process to the Murray cod (*Maccullochella peelii*) (National Murray Cod Recovery Team, 2010), although this largely occurs at the catchment scale as a result of land clearing and flow regulation which influence water quality. Murray cod is restricted to areas of permanent water and is known to complete their lifecycle entirely within freshwater habitats (i.e. potamodromous). The species is regularly stocked in impounded waters on rivers as well as in dams. The temporary impoundment of watercourses intersected by the Project in which Murray cod may occur (Macintyre River, Macintyre Brook and Condamine River) is not expected to pose a risk to the species.

Lowering groundwater levels has potential to impact waterhole levels where surface waters and groundwaters are connected (aquatic GDEs). This may also impact riparian tree species known to periodically access groundwater (terrestrial GDEs) such as Queensland blue gum (*Eucalyptus tereticornis*), a tree species known to support MNES fauna such as Koala (*Phascolarctos cinereus*) and Greater glider (*Petauroides volans*). The location of potential GDEs associated with the Project are identified in Section 4.3.4.10.

Changes to surface water quality

All waterways within the impact assessment area have been identified as sensitive receptors within the receiving environment. Of these, a number of high sensitivity water quality receptors with associated Environmental Values (EVs) were identified within the impact assessment area. Associated EVs included MNES species and MSES wetlands. High sensitivity water quality receptors include the Macintyre River, Macintyre Brook, Canning Creek and the Condamine River.

Physical habitat modification due to temporary/permanent water diversions and hydrological regime change may degrade current habitat morphological features including substrate composition, channel form and bank stability which may reduce aquatic ecological values. Further loss of ecological services may occur from a removal of riparian vegetation required for both watercourse and drainage feature infrastructure (within construction and operation phases), which may compound physical habitat modification from any changes to hydrological regimes. It is noted most waterways intersected by the Project are already subject to significant habitat modification due to adjacent land use.

Potential direct and indirect impacts to surface water quality that may arise due to construction and operation activities for the Project are discussed in Table 5.4. Impacts include those to the water feature itself, in addition to receptors that may be indirectly impacted due to alterations in water quality, such as fish species, riparian vegetation etc.

Table 5.4 Potential construction and operation impacts to water quality and impacting processes

Potential impact	Impacting process
Increased debris load in waterways, thereby reducing the aesthetic quality of downstream waterway systems. Debris may also impact on the health of aquatic and terrestrial fauna, particularly if ingested.	Potential for rubbish and debris from construction sites to be blown off or washed away from a construction area into nearby waterways, due to poor housekeeping or loss of containment.

Potential impact	Impacting process
Altered water quality, principally from increased water turbidity and sedimentation. Suspended sediments can clog fish and invertebrate gills, decrease light availability for aquatic plants and reduce visibility for fish. Furthermore, localised high sediment contamination can become a barrier to migration of some species that then decline in abundance due to restriction in range or loss of seasonal habitat above the contaminated reach (ANZECC, 2000).	Increased sediment loading of waterways may arise due to: ■ Construction activities that involved the clearance of vegetation and disturbance of topsoil, thereby leaving subsoils exposed to erosional processes. In turn, this may result in elevated sediment concentrations in surface runoff ■ Construction works involving disturbance to the riparian corridor (e.g. removal of riparian vegetation, alterations to the profile of banks) may indirectly result in erosion and scouring of streambanks ■ Physical disturbance of stream beds and banks during the establishment of culverts and bridges, leading to a reduction in stability during construction of creek crossings ■ Dewatering associated with the decommissioning of artificial waterbodies that intersect the Project alignment may cause an increase in erosion and sedimentation of waterways if the discharge of that water is not adequately managed.
Altered water chemistry, including an increase in salinity. Alterations to water chemistry may impact on the aquatic ecosystem condition of the downstream waterway system, as well as affect the useability of downstream waters for purposes such as irrigation, farm supply, stock use, recreation etc.	Water chemistry may be altered due to the following processes: ■ Salinity: – Disturbance and exposure of saline soils during construction, which could increase salinity in overland flows. The Project alignment directly intersects moderate to high salinity hazard rating areas, which may result in discharge of saline runoff into proximal waterways. The risk is considered to be low where there is existing disturbance at points where the Project alignment crosses the waterways, e.g. existing rail corridor. – Changes to riparian vegetation communities, stockpiling of sediment and Project-associated earthworks may result in saline discharge at drainage points into watercourses proximal to high salinity hazard areas. ■ Nutrient loading: – Nutrients may migrate into waterways with sediment lost from cleared areas and from stockpiles. This has the potential to: ■ Change light conditions and water temperature ■ Smother aquatic life and prevent photosynthesis for aquatic flora ■ Affect downstream environments ■ Impact upon breeding and lifecycle of aquatic fauna. ■ Contaminants and toxicants: – Accidental spills and leaks of chemicals or fuels from construction equipment or fuel storages, which could introduce chemicals into overland flows – Chemical spills, due to inappropriate storage controls resulting in an introduction into waterways of fuels and oils used for construction machinery – Contaminants may also leach from the following sources during construction: ■ Residual heavy metals from rail grinding and welding, ■ Compounds adhered to ballast materials – Dewatering activities leading to liberation of toxicants from potentially contaminated land – Contaminated land disturbance – if any nearby contaminated lands are disturbed near waterways, there is the potential for contamination from runoff on these waterways.

In-stream works will need to be undertaken in accordance with *Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works* (DAF 2018) for lower risk watercourses. In-stream works for higher risk watercourses will be planned and undertaken in accordance with applicable assessment benchmarks for assessable development. Where in-stream works are developed in accordance with applicable accepted development requirements or acceptable outcomes within relevant codes, works are expected, at a minimum, to reduce increases in barriers for water movement during construction.

In-stream works will also need to be undertaken in accordance with the requirements of the Riverine Protection Permit Exemption Requirements (DNRME, 2018a). ARTC is an 'approved entity' for exemption from the requirement for Riverine Protection Permit applications. As such activities associated with in-stream disturbance works will be exempt from requiring approval as long as the exemption requirements are adhered to.

A significance assessment was undertaken and assessed the residual impact of identified potential impacts after assessment of design considerations and additional mitigation measures. The assessment identified:

- During the construction phase, the combination of design considerations and mitigation measures relevant to surface water quality would be sufficient to mitigate most potential impacts, such that the residual significance would be low
- For the operation phase, the combination of design considerations and mitigation measures relevant to surface water quality would be sufficient to mitigate most potential impacts, such that the residual significance would be low.

The significance impact assessment has identified that with design considerations and mitigation measures in place, the risk of significance of impact from construction phase (including pre-construction) and operation phase activities is low. It is not expected that significant residual impact on surface water quality will be a result of Project activities. Therefore, the likelihood of indirect impacts to MNES as a consequence of surface water quality impacts is considered to be low.

The Project impacts on surface water quality are discussed in detail in EIS Appendix P: Surface Water Quality Technical Report.

Changes to hydrology

Modelling of the current state of development (Existing Case) was undertaken and details of the existing flood regime were determined for the modelled design events. The proposed works associated with the Project were incorporated into the hydraulic models (Developed Case) and assessment of the potential impacts upon the existing flood regime was undertaken. The hydraulic models were run for a suite of design events from the 20% AEP event to the 1 in 10,000 Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) events. Changes in peak water levels, velocities, flow patterns and flood inundation extents and durations have been identified, mapped or tabulated.

Flood impact objectives have been established and used to guide the Project design, including mitigation of impacts through refinement of the hydraulic design, including adjustment of the numbers, dimensions and location of major drainage structures. Table 5.5 summarises how the Project design performs against each of the flood impact objectives.

Table 5.5 Flood impact objectives and outcomes

Parameter	Objectives and outcomes				
Change in peak water levels	Existing habitable and/or commercial and industrial buildings/premises (e.g. dwellings, schools, hospitals, shops)	Residential or commercial/industrial properties/lots where flooding does not impact dwellings/buildings (e.g. yards, gardens)	Existing non-habitable structures (e.g. agricultural sheds, pump-houses)	Roadways Agricultural (cropping) land	Agricultural (grazing) land/forest areas and other non-agricultural land
	≤ 10 mm	≤ 50 mm	≤ 100 mm	≤ 100 mm with localised areas up to 400 mm	≤ 200 mm with localised areas up to 400 mm

Parameter	Objectives and outcomes
	Objective: Changes in peak water levels are to be assessed against the above proposed limits. Outcome: Generally, the Project design meets the above limits with the exception of a few localised areas along the Project alignment where these limits are exceeded. These areas are generally on agricultural land. Flood sensitive receptors that are impacted by changes in peak water levels under the 1% AEP event that exceed the flood impact objectives include: ■ Nine dwellings (five between Pampas and Yandilla, and four at Yelarbon) ■ One shed at Pampas ■ Three commercial buildings (grain silos) at Yandilla ■ One state-controlled road (Cunningham Highway at Yelarbon) ■ One local public road (Leesons Road between Kingsthorpe and Gowrie Junction).
Change in duration of inundation	Objective: Identify changes to duration of inundation through determination of ToS. For roads, determine AAToS (if applicable) and consider impacts on accessibility during flood events. Outcome: There are localised increases in ToS at the same locations where peak water levels are increased. These changes in inundation duration do not affect flood sensitive receptors except for one local public road local being Draper Road and one state-controlled road being the Cunningham Highway. The Cunningham Highway has a +0.8 hours per year increase in AAToS which is a negligible change with Draper Road experiencing an even lower impact.
Flood flow distribution	Objective: Aim to minimise changes in natural flow patterns and minimise changes to flood flow distribution across floodplain areas. Identify any changes and justify acceptability of changes through assessment of risk with a focus on land use and flood sensitive receptors. Outcome: The Project has minimal impacts on flood flows and floodplain conveyance/storage with significant floodplain structures included to maintain the existing flood regime.
Velocities	Objective: Maintain existing velocities where practical. Identify changes to velocities and impacts on external properties. Determine appropriate scour mitigation measures taking into account existing soil conditions. Outcome: In general, changes in velocities are minor, with most changes in velocities experienced immediately adjacent to the Project alignment and no flood sensitive receptors impacted. Scour protection has been specified where the outlet velocities for the 1% AEP event exceed the allowable soil velocities for the particular soil type for each location, which was identified from published soil mapping.
Extreme event risk management	Objective: Consider the risks posed to neighbouring properties for events larger than the 1% AEP event to ensure no unexpected or unacceptable impacts. Outcome: A review of impacts under the 1 in 2,000 AEP, 1 in 10,000 AEP and PMF events has been undertaken with the existing flood depths and increase in peak water levels at flood sensitive receptors identified on each floodplain. Considering the flood depths that occur, particularly under the PMF event, indicates that the changes in peak water levels would be unlikely to exacerbate flood conditions during extreme events.
Sensitivity testing	Objective: Consider risks posed by climate change and blockage in accordance with ARR 2016. Undertake assessment of impacts associated with Project alignment for both scenarios. Outcomes: Climate change – climate change has been assessed in accordance with ARR 2016 requirements with the representative concentration pathway 8.5 (2090 horizon) scenario adopted. The impacts resulting from changes in peak water levels under the 1% AEP event with climate change are generally similar to those seen under the 1% AEP event, with some additional impacts on flood sensitive receptors. Blockage – Blockage of drainage structures has been assessed in accordance with ARR 2016 requirements. The blockage assessment resulted in no blockage factor being applied to bridges and a blockage factor of 25 per cent being applied to culverts. Two blockage sensitivity scenarios were tested with both 0 per cent and 50 per cent blockage of all culverts assessed. The resulting changes in peak water levels associated with the Project alignment are localised but impact on some flood sensitive receptors.

The hydrologic and flooding assessment undertaken has demonstrated that the Project is predicted to result in impacts on the existing flooding regime that generally comply with the flood impact objectives. These predicted changes are not expected to impact habitat for MNES species or TECs in more than a minor and transient manner.

The Project impacts on hydrology and flooding are discussed in detail in EIS Appendix Q: Hydrology and Flooding technical Report.

Groundwater drawdown

Numerical predictive models have been developed to support the hydrogeological design and assessment of impacts for the Project. These local-scale groundwater models were developed as 2-D cross-sectional models oriented perpendicular to the Project alignment. The primary objectives of the predictive modelling were to:

- Assess potential groundwater drawdown due to drainage of cuts
- Estimate groundwater seepage rates for cuts
- Assess groundwater quality parameters to inform reference design for earthworks and cuts.

Predictive simulations indicate:

- Seepage is concentrated at the bottom of the cuts, on both sides of infill material
- Initial inflow of seepage will be higher than the average rate predicted for steady-state scenarios then will plateau
- Seepage values simulated are considered to be low and attributed to the low hydraulic conductivity values applied, based on an average of site-specific data
- Temporary increases in seepage may be observed in cuts with sandy soil or weathered sandstone following rainfall events
- Seepage of groundwater from bedrock is anticipated to be low except where enhanced by weathering of fractures.

Modelling results indicate that drawdown is only expected to occur at three of the five modelled locations. At the locations where drawdown is anticipated to occur, the maximum extent of drawdown is predicted to range from 15 m to 80 m from the centre of the Project alignment.

Table 5.6 presents the potential impacts on groundwater as a result of Project activities that may affect MNES, as indicated by aquatic and terrestrial ecosystem EVs.

Table 5.6 Potential impacts on groundwater

Impacting process	Potential impacts	Likelihood of impact
Groundwater resources		
Site clearing and grading	Removal of vegetation reducing evapotranspiration, which can influence the groundwater discharge of shallow aquifers (i.e. result in higher groundwater levels). EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	The Project footprint has been delineated to include the minimum extent of land required to safely and efficiently construct and operate the Project. The Project alignment has also been aligned to maximise the use of existing rail corridor, where possible. As a consequence, approximately one third of the total Project alignment is located in existing rail corridor. The total area proposed to be cleared and graded for construction purposes is considered to be negligible in comparison to the total recharge surface area of the alluvial aquifers which underlay the Project. Consequently, there is likely to be little impact on the groundwater resources due to site clearing and grading activities
	Compaction of ground resulting in reduced groundwater recharge. EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	
	Alteration of possible existing areas where ponding surface water occurs naturally, which could reduce groundwater recharge in these areas. EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	

Impacting process	Potential impacts	Likelihood of impact
Drawdown due to seepage	Drawdown of localised groundwater levels may occur as a consequence of seepage from the exposed face of cuts that intersect the underlying groundwater table. This drawdown has the potential to temporarily affect the availability of groundwater from registered bores in proximity to the works, which are not otherwise decommissioned by the Project. Drawdown also has potential to affect GDEs within the radius of impact. EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	Predictive modelling results indicate that drawdown of the water table may be experienced at three deep cuts as a consequence of seepage. Seepage from the faces of cuts will be minimised via the application of engineering controls. For example, the reference design has allowed for the application of a 300 mm drainage blanket to be applied to the face of all cuts where groundwater is encountered within 2 m of the base of the cutting. Alternative seepage control measures will be considered and assessed through the detail design, on a cut-by-cut basis.
	Subsidence/settlement of compressible substrates and possible damage to adjacent structures, such as embankments, culverts and utilities. EVs with potential to be impacted: aquatic and terrestrial ecosystems.	Deep cuts, in which the water table is expected to be encountered, are located within competent substrate, such as basalt and sandstone where the likelihood of settlement is less probable than in unconsolidated substrates.
Construction of new fill embankments	Establishment of new embankments may cause the obstruction of natural drainage pathways, resulting in more frequent inundation of areas upstream of the embankments. This more frequent inundation could result in groundwater mounds forming underneath these areas. Groundwater mounding may also result from the compacting of soils following the addition of embankment soils. In addition, groundwater depressions may form in areas which formerly received recharge (i.e. down gradient of the emplaced embankments). EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	There are 77 embankment sections (fill) in the reference design. The subgrade beneath these embankments is primarily Cainozoic Alluvium and MRV, with some overlaying the WCM. The depth to groundwater is typically over 5 m for the Border Rivers and Condamine Alluvium and Walloon Coal Measures with the risk of mounding considered to be generally low in this substrate. Where embankments are located on the Main Range Volcanics, groundwater mounding is generally only possible in areas where the fractured rocks are hydraulically connected to flooded alluvial units or outcrops in flooded areas. EIS Appendix R: Groundwater Technical Report provides further discussion in regard to groundwater level variation with respect to embankments.
Establishment of borrow pits	Temporary borrow pits may be established as a source of material for construction of the Project. Subject to their location, shallow groundwater may be intersected during the development of borrow pits, particularly if depths of greater than 5 mbgl are required. These localised interactions with the water table could impact on the hydraulic regime (i.e. disrupt groundwater flow or induce drawdown). EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	Twelve potential/existing borrow pit locations have been identified. More detailed feasibility assessments of each borrow pit location will be undertaken during the detail design phase of the Project (post-EIS) to determine material usability, volumes, environmental and social impacts (including groundwater). Following assessment, locations where groundwater is identified as likely to be intersected will be considered less viable than borrow pit locations where groundwater is unlikely to be intersected.

Impacting process	Potential impacts	Likelihood of impact
Dewatering	Temporary excavations during construction (i.e. trenching, boring for piles etc.) may encounter groundwater. In these instances, it may be necessary to extract the water from the excavation in order to maintain structural integrity of the excavation and to enable safe establishment of the planned infrastructure. Piling for the establishment of bridge piers can cause alteration of aquifer parameters (lower permeability), altered groundwater flow patterns (mounding or drawdown up and down gradient of the piles; upward leakage along the pile/soil interface) and reduction in groundwater resources through extraction of wet soil/rock during piling. EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	If dewatering is required in support of construction activities, the duration of the impacts is likely to be temporary as the construction works are limited in duration. Impact is not anticipated to extend long after construction works are completed, if at all, dependant on the localised recharge of the of the affected aquifer unit.
Alterations of existing groundwater flow pathways due to new infrastructure or modified landform	Deep cuttings could create voids which intersect shallow groundwater and perturb the antecedent groundwater flow regime. Piles or other structures spaced closely together have potential to influence the natural groundwater flow regime. Reduced permeability of the substrate beneath embankments may modify the flow direction of shallow groundwater in portions of the alluvium and possibly the saturated portion of weathered bedrock. EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	It is possible for the antecedent groundwater flow regime to be interrupted to deep cut locations; however, the length of the cuts in comparison to the overall aquifer is negligible. Further, two cuts at which groundwater may be encountered are predicted to intersect the Main Range Volcanics aquifer which, due to the fractured nature of this aquifer, is unlikely to be impacted outside of the localised area to the cuts. The foundation pilings associated with bridges for this Project will be spaced a distance apart to be of sufficient spacing and diameter to avoid impacts on existing groundwater flow. The distance/spacing is cut/bridge-specific and will be finalised during the detail design phase.
Groundwater quality		
Contamination /accidental discharge	Contamination of groundwater may arise as a consequence of: ■ Unintended spills and leaks of hydrocarbons (i.e. oils, fuels and lubricants) and other chemicals related to the use of heavy plant and equipment (accidental discharge). ■ Water mixtures and emulsions related to washdown areas (accidental discharge). ■ Upward seepage along piles/soil interfaces of saltier groundwater from the deeper confined aquifers into the fresher alluvium aquifers. ■ Groundwater bores installed for environmental monitoring or water supplies have the potential to create a vertical pathway between aquifers if not installed correctly or if the bores deteriorate due to abandonment. EVs with potential to be impacted: aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	Direct infiltration of contaminants in areas of low relief with shallow water levels is likely to be reduced due to the dominant fine-grained sediments of the soil profile (clays and silts). The ephemeral nature of the majority of surface water bodies along the Project is also likely to reduce the chance of contaminants in surface water infiltrating into shallow aquifers during dry months. If used in sufficient volume, water applied during the construction phase of the Project has the potential to infiltrate past the root zone and contribute to rising water tables/levels in shallow aquifers. Leakage (accidental discharge) from water storage areas may also contribute to rising water levels.

Impacting process	Potential impacts	Likelihood of impact
Acid rock drainage (ARD) or potential acid sulphate soils (PASS)	Intersection of sulphide-bearing rocks in cuts or use of sulphide-bearing materials in embankment fill could present an ARD risk following exposure of the rocks to oxygen and subsequent runoff (leachate) which could impact on EVs (i.e. aquatic GDEs and groundwater users). Rainfall infiltration into cuttings with sulphide-bearing minerals above the saturated zone may also pose an ARD (leachate) risk even if the entire cut is in the unsaturated zone (above groundwater). PASS also present a risk though excavation of cuts in soils susceptible to acid forming conditions which can then result in leached condition entering the environment. EVs with potential to be impacted: Aquatic and terrestrial ecosystems, irrigation, stock water, farm supply/use, drinking water, and cultural and spiritual values.	Geology within the Project footprint indicates a potential for the Kumbarilla Beds and WCM to host disseminated sulphide minerals (i.e. pyrite), particularly within shale and mudstone units. Given that cuts will primarily be into the weathered to extremely weathered units portions of the Kumbarilla Beds and WCM, the risk could be naturally mitigated as sulphides minerals may have already been oxidised. Unweathered areas of the Kumbarilla Beds and WCM will be avoided, where possible, through the detail design phase.

The majority of potential impacts related to groundwater for the Project are considered temporary in nature and related to the construction phase of the Project. All potential impacts to groundwater resources through Project activities are considered to be manageable with the implementation of mitigation measures.

The Project impacts on groundwater are discussed in detail in EIS Appendix R: Groundwater Technical Report.

Other aquatic impacts

The transport of sediment and eroded material can be washed off areas of exposed soil, stockpile locations, or localised areas in proximity to Project infrastructure (e.g. culverts and bridges) during rainfall events and thus may also affect terrestrial habitats. This in turn may lead to increased sediment loads and turbidity within waterways and potentially increase nutrient loads in habitat for MNES species such as Murray cod although these effects are expected to be localised to construction works and temporary in nature. In addition to direct impacts to aquatic habitat degradation associated with erosion and sedimentation, flow on effects from increased sedimentation may impair the functioning of culverts should deposition be too high, exacerbating barrier effects (refer Section 5.2.1.8).

There is potential for contaminants and pollutants associated with construction and operation of the Project to enter aquatic environments, resulting in the alteration or loss of potential habitat for terrestrial and aquatic species. Concrete, oil and grease and other chemicals associated with construction and operation may result in localised run-off into adjacent watercourses and waterbodies following rainfall events.

The disturbance and modification of some riparian zones and works within watercourses/wetlands during the construction phase of the Project has the potential to reduce the ecological integrity of the watercourse thereby impacting on structural aspects that support breeding and foraging requirements of aquatic species.

Assessment was undertaken to assess the potential for residual impacts to water quality values from Project activities after assessment of design considerations and additional mitigation measures (refer to surface water quality discussion, above). The assessment identified that with design considerations and mitigation measures in place, the risk of impacts from the construction phase (including pre-construction) and operation phase activities is low. It is not expected that impacts to surface water quality deleterious to MNES species will result from Project activities.

5.2.1.14 Erosion and sedimentation

During construction and operation of the Project, there is potential for significant impact to soils resulting from disturbance and exposure of subsurface soils vulnerable to accelerated erosion, dispersivity and/or salinity due to their physical and chemical characteristics.

Highly erodible soils are those where the individual particles are most easily detached and transported by erosive forces (DSITI, 2015). The most erodible soils are those that are sodic and dispersive. Dispersive soils are usually predominantly composed of clays that readily break down into individual particles. Soils with a high proportion of silt may also be dispersive.

Sodosols, as encountered throughout the impact assessment area, have a particularly dispersive sodic clay subsoil. This is as a consequence of sodium ions that are attached to the clay particles. When exposed to water, the size of the sodium ions increases, forcing the individual clay platelets to separate and causing the soil to disperse (DSITI, 2015).

Soils that are not dispersive, such as vertosols, can still be susceptible to erosion. Unlike soils that disperse, the aggregates of vertosols retain some of their natural structure after they have been removed by runoff (DSITI, 2015). These relatively large particles are readily deposited when runoff velocity is reduced such as in a contour bank or waterway, and they generally travel only a limited distance.

Some soils within the impact assessment area have hard-setting surfaces that reduce the rate of infiltration during rainfall, but which also resist erosion. These soils can have low rates of erosion themselves. However, they can contribute to high rates of runoff with erosive power further down the slope where the soils may be less protected (DSITI, 2015).

Soils that are regularly cultivated can also be very susceptible to erosion. Cultivation reduces cover and creates a layer of loose soil, overlying the soil compacted by the wheels of tractors, implements and harvesting equipment.

Levels of exchangeable sodium percentage above six per cent are generally regarded as high (Queensland Government 2016). Analysis of surface soil samples collected during Project investigations reported that the ESP exceeded six per cent for approximately 50 per cent of all samples. The only locations where exceedances of six per cent were not recorded, were from soil samples collected between Ch 170.0 km to Ch 201.0 km, in areas mapped as vertosols.

Soils of particular concern for management and stability will be those that are dispersive, erosion prone soils i.e. sodosols and, to a lesser extent, chromosols. However, regardless of soil type, erosion risk will be increased where the following activities occur:

- Clearing of vegetative cover
- Changes in topography, drainage patterns and localised concentration of storm water flows due to construction of both access tracks and the rail corridor
- Excavation or cuttings and stockpiling of material
- Construction during high rainfall events, particularly erosive rainfall events
- Constructing through areas with high soil erodibility risks (e.g. sodosols).

Terrestrial impacts associated with erosion and sedimentation include compaction of soil, loss of soil structure, nutrient degradation, and increased soil salinity all of which can lead to reductions in the carrying capacity of the terrestrial environment as a result of decreasing habitat value.

Erosion and subsequent sedimentation can be damaging to the ecological health of waterways and the surrounding terrestrial environment and may be a proximate cause of environmental degradation. Mobilised coarse sandy sediment tends to accumulate in areas of slow-flow and may smother bottom-dwelling organisms and their habitats. Deep permanent river pools, that are valuable habitats for aquatic fauna and refuges for wildlife during summer and drought, may become filled by coarse sediments, which may render them ineffective in relation to their ability to support aquatic and terrestrial species.

Large sediment accumulations can cause upstream flooding or deflect the flow into the adjacent stream bank or even onto adjacent land, causing further erosion and transported sediments can fill the deep permanent pools of rivers to ruin this critical refuge habitat.

In addition to the secondary impact of erosion and sedimentation on aquatic habitats, the primary impact of erosion on terrestrial habitat has potential to occur in relation to Project activities. As indicated above, these would be expected to occur within areas of exposed soil, stockpile locations, or localised areas in proximity to Project infrastructure (e.g. culverts and bridges) during rainfall events. The changes to overland flow paths from erosion have the potential to have a localised direct impact on terrestrial habitats. These impacts are principally associated with a loss of substrate stability around vegetation and may result in a loss of vegetation quality and cover.

Additional soil investigations will be undertaken during detail design by a suitably qualified soil practitioner to ensure that the design of structures, embankments, erosion control measures (temporary and permanent) and site rehabilitation planning are reflective of site-specific soil conditions. Soil investigations will be in accordance with the *Guidelines for surveying soil and land resources* (McKenzie et al. 2008), the *Australian soil and land survey field handbook* (National Committee on Soil and Terrain, 2009) and the *Guidelines for Soil Survey along Linear Features* (Soil Science Australia, 2015). Additional soil investigations will specifically identify materials that are:

- Sodic (dispersive)
- Saline
- Acidic

Examples of soils that will require specific design consideration include:

- The high naturally occurring sodicity of soils in the Yelarbon area (sodosols)
- Cracking clays of the Condamine River floodplain (vertosols).

A Soil Management Sub-plan will be developed for the Project which will include erosion and sediment controls as a component of the CEMP. The erosion and sediment control measures will be developed by a Certified Practitioner in Erosion and Sediment Control in accordance with the International Erosion Control Association Best Practice Erosion and Sediment Control (IECA, 2008) and with reference to Soil Conservation Guidelines for Queensland (DSITI, 2015) and will be implemented during construction of the Project.

5.2.1.15 Flooding

The potential hydrology and flooding changes are not expected to impact habitat for MNES species or TECs in more than a minor and transient manner. Five TEC's have the potential to occur within the impact assessment area. These TECs consist of the following:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland
- Weeping Myall Woodlands
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland)
- Poplar Box Grassy Woodland on Alluvial Plains.

Of these TEC's Brigalow (*Acacia harpophylla* dominant and co-dominant, Weeping Myall Woodlands and Poplar Box Grassy Woodland on Alluvial Plains are considered to be the main receptors for changes to hydrological regime. As these TEC's occur on floodplains (which are naturally highly variable in flood regime), these were not further considered in potential impacts from flooding changes associated with the Project.

Potential impacts associated with alterations to hydrology are likely to impact species that are less mobile. For example, the Condamine Earless Dragon and other receptors that are unable to mobilise in the face of changing environmental conditions (i.e. flora). Larger species and avian fauna are likely to mobilise away from indirect impacts. While indirect impacts may result in a loss of habitat, this loss is expected to be transient. Hydrology and flooding issues are not expected to result in a significant residual impact due to the temporary nature of flooding impacts related to the Project.

The hydrology variables used for potential impacts involved watercourse catchment change in peak water levels, changes to wetting/drying and change in time of inundation. The modelled catchments included Gowrie Creek; Westbrook Creek, Condamine River (including Grasstree Creek), Back Creek, Nicol Creek, Bringalily Creek, Native Dog Creek, Cattle Creek, Pariagara Creek, Macintyre Brook, Macintyre River.

The following sensitive environmental receptors were selected to identify potential indirect impact from the changes to hydrology and flooding (refer Table 5.7) due to potential susceptibility to flood events (i.e. poor dispersal ability of sessile nature):

- King blue-grass (*Dichanthium queenslandicum*)
- Winged peppercress (*Lepidium monoplacoides*)
- *Xerothamnella herbacea*
- Shiny-leaved ironbark (*Eucalyptus virens*)
- Belson's panic (*Homopholis belsonii*)
- *Macrozamia machinii*
- Hawkweed (*Picris evae*)
- Austral cornflower (*Rhaponticum australe*)
- Spotted-tail quoll (mainland) (*Dasyurus maculatus maculatus*)
- Condamine earless dragon (*Tympanocryptis condaminensis*)
- Five-clawed worm-skink (*Anomalopus mackayi*)
- Collared delma (*Delma torquata*)
- Yakka skink (*Egernia rugosa*)
- Dunmall's snake (*Furina dunmalli*)

Table 5.7 details those susceptible sensitive receptors (identified as having a potential impact from changes to hydrology (namely flooding). The table details a potential presence of impact under the varying scenarios according to a temporary loss of habitat availability. The scenarios include a mix of common events (1% AEP and 5% AEP) and extreme events (1 in 10,000 AEP and PMF). Potential indirect impact was identified as a temporary displacement from habitat (proximal waterways and defined watercourses), corresponding to a variation in peak water levels, changes to wetting/drying and 1% AEP change in time of inundation in areas of predicted habitat. Where the same catchment is identified under varying scenarios, this indicates the presence of potential impact under each category and should be considered as discrete identifiers (due to the scenarios describing separate flooding events).

The Project impacts on hydrology and flooding are discussed in detail in EIS Appendix Q: Hydrology and Flooding technical Report.

Table 5.7 Potential indirect impact to susceptible sensitive environmental receptors under non-mitigated flooding scenarios

MNES receptor	5% AEP	1% AEP	1 in 10,000 AEP	PMF
King blue-grass (<i>Dichanthium queenslandicum</i>)	Nil	Nil	WES – WD, CpW	WES – WD, CpW
Shiny-leaved ironbark (<i>Eucalyptus virens</i>)	Nil	Nil	CAT – WD, CpW PAR – CpW	BAC – WD, CpW, CAT – WD, CpW PAR – CpW

MNES receptor	5% AEP	1% AEP	1 in 10,000 AEP	PMF
Belson's panic (<i>Homopholis belsonii</i>)	BAC – WD, CpW,	BAC – WD, CpW NIC – CpW, WD, CTI	WES – WD, CpW BAC – WD, CpW NIC – CpW, WD PAR – WD, CpW MACR - CpW	WES – WD, CpW BAC – WD, CpW NIC – CpW NAT – CpW PAR – WD, CpW MACR - CpW
Winged peppergrass (<i>Lepidium monolocoides</i>)	Nil	Nil	BAC – WD, CpW CAT – WD, CpW PAR – WD, CpW	BAC – WD, CpW CAT – WD, CpW PAR – WD, CpW
<i>Macrozamia machinii</i>	Nil	Nil	CAT – WD, CpW	CAT – WD, CpW
Hawkweed (<i>Picris evae</i>)	Nil	Nil	GOW – WD, CpW WES – WD, CpW CON - CpW	GOW – WD, CpW WES – WD, CpW CON - CpW
Austral cornflower (<i>Rhaponticum australe</i>)	Nil	BRI – WD, CpW	GOW - WD, CpW WES – WD, CpW BRI – WD, CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW	GOW - WD, CpW WES – WD, CpW BRI - CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW
<i>Xerothamnella herbacea</i>	Nil	Nil	MACB – WD, CpW	MACB - CpW
Five-clawed worm-skink (<i>Anomalopus mackayi</i>)	WES – WD BAC – WD	WES – WD BAC – WD, CpW	WES – WD, CpW CON – CpW BAC – CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW	WES – WD, CpW CON – CpW BAC – CpW BRI – CpW NAT - CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW
Spotted-tail quoll (mainland) (<i>Dasyurus maculatus maculatus</i>)	BAC – WD, CpW	BAC – WD, CpW	CON – CpW BAC – CpW BRI – CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW	CON – CpW BAC – CpW BRI – CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW
Condamine earless dragon (<i>Tympanocryptis condaminensis</i>)	BAC – CpW	BAC – CpW	CON – CpW BAC – CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW	GOW – CwP CON – CpW BAC – CpW BRI – CpW NAT - CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW
Collared delma (<i>Delma torquata</i>)	Nil	Nil	CAT – WD, CpW	CAT – WD, CpW
Yakka skink (<i>Egernia rugosa</i>)	Nil	Nil	BAC – CpW BRI – CpW CAT – WD, CpW PAR – WD, CpW MACR - CpW	BAC – WD, CpW BRI – CpW CAT – WD, CpW PAR – CpW MACR - CpW

MNES receptor	5% AEP	1% AEP	1 in 10,000 AEP	PMF
Dunmall's snake (<i>Furina dunmalli</i>)	Nil	Nil	CAT – WD, CpW PAR – CpW	CAT – WD, CpW PAR – CpW

Table note:

GOW – Gowrie Creek; WES – Westbrook Creek, CON – Condamine River (including Grasstree Creek), BAC – Back Creek, NIC – Nicol Creek, BRI – Bringallily Creek, NAT – Native Dog Creek, CAT – Cattle Creek, PAR – Pariagara Creek, MACB – Macintyre Brook, MACR – Macintyre River.

Temporary Displacement from Habitat from: WD- Wetting/Drying; CpW - Change in peak water levels (< or > 0.20 m); CTI - Change in time of Inundation at 1% AEP (< or > 50%).

Nil – No temporary displacement from change in peak water levels, changes to wetting/drying and change in time of inundation in any corresponding catchments.

Hydrology and flooding for the susceptible sensitive environmental receptors are typically related to a variation in peak water levels of 0.20 m and a change to dry or wet periods during the extreme flooding events (i.e. 1 in 10,000 AEP or PMF). Variation across impacts for separate sub-catchments (associated with single waterway and defined watercourses) suggests that potential impact is linked to habitat use. Time of inundation was only considered as a potential impact for Belson's panic (*Homopholis belsonii*), however this is associated with smaller flood events and would not likely be a significant impact. Within the smaller flooding scenarios, identified as occurring more commonly, only Belson's panic (*Homopholis belsonii*), Five-clawed worm-skink (*Anomalopus mackayi*), Spotted-tail quoll (mainland) (*Dasyurus maculatus maculatus*) and Condamine earless dragon (*Tympanocryptis condaminensis*) were identified as potentially impacted from changes to wet and dry landscape variation or changes to peak water levels.

5.2.2 Potential impacts to matters of national environmental significance associated with air quality, surface water and hydrology, groundwater, noise and vibration

An assessment of potential Project related impacts associated with air quality, surface water and hydrology, groundwater, and noise and vibration has been undertaken for the identified MNES. This assessment is summarised in Table 5.8. Potential impacts identified within Table 5.8 were incorporated into the assessment of initial impact magnitude as shown in Table 7.2.

Specific impacts associated with the relevant MNES are discussed in Section 7.2, 8, 8.2 and 8.3.

Table 5.8 Assessment of potential impacts related to air quality, surface water and hydrology, groundwater, and noise and vibration upon matters of national environmental significance

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
TECs	Air quality	Construction	Air quality has not been identified as a threatening process to TECs (i.e. Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant), Weeping Myall Woodlands, or Poplar Box Grassy Woodland on Alluvial Plains and is not likely to impact upon TECs identified within the impact assessment area.	- Section 5.2.1.10 - Section 6– Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix O: Air Quality Technical Report
		Commissioning and reinstatement		
		Operation		
	Surface water and hydrology	Construction	Surface and hydrological impacts are not identified as a threatening process to TECs (i.e. Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant), Weeping Myall Woodlands, or Poplar Box Grassy Woodland on Alluvial Plains and is not likely to impact upon TECs identified within the impact assessment area.	- Section 5.2.1.13 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix P: Surface Water Quality Technical Report - EIS Appendix Q: Hydrology and Flooding Technical Report
		Commissioning and reinstatement		
		Operation		
	Groundwater	Construction	No significant impact expected during this phase	- Section 4.3.4.11 - Section 5.2.1.13 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix R: Groundwater Technical Report
		Commissioning and reinstatement		
		Operation		
	Noise and vibration	Construction	No significant impact expected during this phase	- Section 5.2.1.9 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report - EIS Appendix T: Operational Railway Noise and Vibration Technical Report
		Commissioning and reinstatement		
		Operation		
Conservation significant flora species	Air quality	Construction	Air quality has not been identified as a threatening process to any of the Flora MNES identified (refer Appendix B). Whilst it is acknowledged that particulate matter (e.g. dust during the construction period) has the potential to settle on foliage, this is not expected that this will significantly impede photosynthetic processes. Impact associated with air quality are not likely to result in an impact to MNES flora species within the impact assessment area.	- Section 5.2.1.10 - Section 6– Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix O: Air Quality Technical Report
		Commissioning and reinstatement		
		Operation		

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
	Surface water and hydrology	Construction	Some of the identified flora MNES may be susceptible to alterations to hydrology (refer Appendix B). Whilst listed as a threatening process, significant alterations to hydrology are not likely to occur as part of the Project.	- Section 5.2.1.13 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix P: Surface Water Quality Technical Report - EIS Appendix Q: Hydrology and Flooding Technical Report
		Commissioning and reinstatement	No significant impact expected during this phase	
		Operation	No significant impact expected during this phase	
	Groundwater	Construction	Some of the identified flora MNES may be susceptible to alterations to hydrology (refer Appendix B). However, there are no significant impacts expected to occur to ground water that are likely to impact upon the any of the identified flora MNES as a result of project activities.	- Section 4.3.4.11 - Section 5.2.1.13 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - Appendix R: Groundwater Technical Report
		Commissioning and reinstatement	No significant impact expected during this phase	
		Operation	No significant impact expected during this phase	
	Noise and vibration	Construction	Noise and vibration have not been identified as a threatening process to any of the identified MNES flora species (refer Appendix B) and are not likely to impact upon flora MNES identified within the impact assessment area.	- Section 5.2.1.9 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report - EIS Appendix T: Operational Railway Noise and Vibration Technical Report
		Commissioning and reinstatement		
		Operation		
Conservation significant fauna species	Air quality	Construction	The greatest Impacts associated with air quality (i.e. dust) will be during the construction period. Whilst not identified as a threatening process to MNES fauna species <i>per se</i> , particulate matter (e.g. dust) may settle on plants and in waterways. Once in waterways it may result in declining water quality. However, despite these potential impacts, significant impacts to MNES fauna species are not expected to occur as a result of air quality.	- Section 5.2.1.10 - Section 6– Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix O: Air Quality Technical Report - Appendix B – Species information, threatening processes, applicable threat abatement/recovery plans
		Commissioning and reinstatement	No significant impact expected during this phase	
		Operation	No significant impact expected during this phase	

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
	Surface water and hydrology	Construction	Two identified MNES fauna species (e.g. Silver perch and Murray cod) are aquatic (refer Appendix B). Whilst these species are susceptible to declines in water quality, any impact associated with construction is considered to be short-term and temporary. It is not expected that water quality will decline to the point at which these aquatic species will be adversely impacted. It is not expected that water quality will decline to the point at which these aquatic species will be adversely impacted	- Section 5.2.1.13 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix P: Surface Water Quality Technical Report - EIS Appendix Q: Hydrology and Flooding Technical Report - Appendix B – Species information, threatening processes, applicable threat abatement/recovery plans
		Commissioning and reinstatement	No significant impact expected from the Project on hydrological flows that may impact aquatic species habitat.	
		Operation	No significant impact expected from the Project on hydrological flows that may impact aquatic species habitat.	
	Groundwater	Construction	No MNES fauna species are dependent exclusively upon groundwater. However, it is noted that two species (i.e. Silver Perch and Murray Cod) are aquatic and utilise surface waters. Whilst these species are susceptible to declines in water quality, the Project is not likely to significantly alter the existing quality or levels of groundwater, to the point where it will impact upon these MNES.	- Section 4.3.4.11 - Section 5.2.1.13 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix R: Groundwater Technical Report - Appendix B – Species information, threatening processes, applicable threat abatement/recovery plans
		Commissioning and reinstatement		
		Operation		
	Noise and vibration	Construction	Whilst noise and vibration have not been identified as a specific threatening process for MNES fauna species that have potential to occur within the impact assessment area, animals typically show avoidance behaviours to foreign stimuli, including noise and vibration. Whilst such stimuli may result in little impact to vagile species such as the Grey-headed flying-fox and the Swift parrot, other less vagile species such as the Koala and Spotted-tailed quoll may avoid areas that are subject to acute noise and vibration events. Avoidance of areas subject to such stimuli is likely to occur during the construction phase and may result in a temporary reduction in foraging efficiency	- Section 5.2.1.9 - Section 6 – Impact mitigation - Appendix B – TEC information and threatening processes - EIS Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report - EIS Appendix T: Operational Railway Noise and Vibration Technical Report - Appendix B – Species information, threatening processes, applicable threat abatement/recovery plans
		Commissioning and reinstatement		
		Operation	Whilst acute noise and vibration are known to result avoidance behaviours in animals, chronic noise and vibration, particularly when applied at regular intervals, are less likely to illicit a response. It is therefore likely that once operational, impacts associated with noise and vibration will not adversely impact upon MNES fauna species	

6 Mitigation measures

This section provides discussion of mitigation measures and controls that have been incorporated into the reference design development process, as appropriate and where possible (refer Section 6.1), as well as those measures that are proposed to be adopted for future phases of Project delivery (refer Section 6.2).

6.1 Mitigation through the reference design phase

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

Mitigation measures and controls that have been factored into the reference design for the Project are as follows:

- The Project has been positioned to maximise the use of existing rail corridors and to be co-located with existing road infrastructure, where possible. Co-location with existing linear infrastructure minimises the need to develop natural and rural landscapes that have not previously been subject to disturbance for a similar purpose.
- The Project footprint has been restricted to what is anticipated to be required to construct and operate the works in a safe and efficient manner. Restricting the temporary construction disturbance footprint and the permanent operational disturbance footprint, minimises the extent of disturbance required to vegetation and habitats during construction and operation.
- Greenfield components of the Project have been aligned to minimise the extent of impact to remnant vegetation, and the number of watercourses traversed by the Project. Clearing of remnant vegetation will be restricted to the minimum required to enable the safe construction, operation and maintenance of the rail corridor, including minimising the disturbance of sensitive areas such as:
 - Habitat for 'critically endangered', 'endangered' and 'vulnerable' flora and fauna species
 - TECs
 - Riparian vegetation
 - Steep slopes
 - Along riverbanks
- Watercourse crossing structures (including culverts and bridges) have been designed to maintain aquatic fauna passage and minimise the risk of blockages in reference to the accepted development requirements for operational work that is constructing or raising waterway barrier works (DAF, 2018)
- The Project has been developed to minimise impacts to watercourses, riparian vegetation and instream habitats by adopting a crossing structure hierarchy where bridges are preferred to culverts to maintain connectivity for MNES species such as Murray Cod and riparian fauna conduits that are important to MNES species
- Bridges have been designed to minimise impacts to the bed, banks and environmental flows of watercourses in accordance with requirements of the *Fisheries Act 1994* (Qld)
- Bridge and culvert structures have been located and sized to avoid increases in peak water levels, velocities and duration of inundation
- The Project incorporates bridge and culvert structures to maintain existing flow paths and flood flow distributions, such as across the Condamine River floodplain where six bridges have been incorporated into the design with a combined length of 6 km

- Twenty bridge structures over watercourses are to be constructed to minimise disturbance of aquatic habitats. These bridge structures consist of:
 - Macintyre River Viaduct 1 (Ch (NS2B) 30.5 – 30.7 km)
 - Macintyre River Viaduct 2 (Ch (NS2B) 30.7 – 31.1 km)
 - Macintyre Floodplain #1 Rail Bridge (Ch (NS2B) 31.4 – 31.6 km)
 - Macintyre Floodplain #2 Rail Bridge (Ch (NS2B) 32.2 – 32.8 km)
 - Macintyre Brook Rail Bridge 1 (Ch 52.4 – 52.7 km)
 - Macintyre Brook Rail Bridge 2 (Ch 55.4 – 55.6 km)
 - Pariagara Creek Rail Bridge (Ch 67.2 – 67.5 km)
 - Cattle Creek Rail Bridge (Ch 88.2 – 88.3 km)
 - Native Dog Creek Rail Bridge (Ch 93.8 – 94.0 km)
 - Bringalily Creek 1 Rail Bridge (Ch 97.4 – 97.7 km)
 - Bringalily Creek 3 Rail Bridge (Ch 100.1 – 100.7 km)
 - Nicol Creek Rail Bridge (Ch 104.3 – 104.4 km)
 - Back Creek Rail Bridge (Ch 127.9 – 128.1 km)
 - Grasstree Creek #1 Rail Bridge (Ch 138.6 – 138.9 km)
 - Grasstree Creek #2 Rail Bridge (Ch 138.9 – 139.9 km)
 - Condamine River #1 Rail Bridge (Ch 141.9 – 142.5 km)
 - Condamine River #2 Rail Bridge (Ch 143.1 – 145.1 km)
 - Condamine River #3 Rail Bridge (Ch 145.1 – 145.7 km)
 - Condamine River North Branch Rail Bridge (Ch 147.8 – 149.3 km)
 - Westbrook Creek Rail Bridge (Ch 197.1 – 197.4 km)
 - Dry Creek Rail Bridge (197.9 – 198.0 km)
- Scour and erosion protection measures have been incorporated into the design in areas determined to be at risk, such as around culvert headwalls, drainage discharge pathways and bridge abutments
- Fauna crossing opportunities for species such as Koala and Greater glider have been co-located with waterway crossing structures to maintain habitat connectivity across the rail corridor (refer Figure 6.1). The structures attempt to align with the State significant fauna movement corridor to the north of Inglewood and locations assessed as providing movement opportunities for the greatest number of species. Opportunities to incorporate fauna infrastructure at other potential crossing points (such as large culverts) will be considered during the detail design process (refer EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy for more detail).
- Opportunities for the provision of fauna fencing and fauna movement solutions have been identified (refer Figure 6.1 and Figure 6.2). These include fencing strategies to guide species such as Koala to safe movement opportunities. These opportunities will be refined through the detail design process and incorporated where appropriate (refer EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy for more detail).

6.2 Proposed mitigation measures

In order to manage and mitigate Project risks, several mitigation measures have been proposed for implementation in future phases of Project delivery, as presented in Table 6.1.

These proposed mitigation measures have been identified to address Project specific issues and opportunities. Information related to government threat abatement plans and recovery plans has been incorporated into the identified mitigation measures wherever applicable. Mitigation measures have been selected based on the best available information including government guidelines (e.g. DTMR's Fauna Sensitive Road Design Manual (DTMR 2000)) and the appropriateness and effectiveness in managing the identified impacts including mitigation measures used on similar projects that have been subject to legislative approval (refer footnotes to Table 6.1). It is acknowledged the effectiveness of these measures may not be subject to rigorous peer-reviewed analysis.

ARTC has reviewed a cross-section of available published literature on effectiveness of mitigation measures used on linear infrastructure. There is significant literature which corroborates ARTC's proposed mitigation measures as being effective:

- Installation and regular maintenance of fauna exclusion fences can help reduce wildlife mortality during construction. Wildlife crossing structures (underpasses and overpasses) have been constructed around the world and are used by many species to safely cross linear infrastructure (Bond and Jones 2008; VicRoads 2012; van der Grift et al. 2015; van der Ree et al. 2015; Weller 2015)
- Wildlife crossing structures also improve traffic safety and contribute to the conservation of biodiversity by allowing animals to move safely across roads, thereby reducing the risk of collision (Smith et al. 2015)
- Wildlife crossing structures are the most effective approach to mitigate the barrier effect of linear infrastructure on wildlife movement (Taylor and Goldingay 2010; Smith et al. 2015)
- The combination of exclusion fencing with wildlife passes are complementary, with the ability to avoid animal collisions and maintain infrastructure permeability (VicRoads 2012; Carvalho et al. 2017; Ghent 2018; Barrientos et al. 2019).
- VicRoads (2012) corroborates the use of bridge underpasses for the effective use of koala crossings
- The most effective stream crossings for fish, when long-span bridges are not an option, are culverts or shorter span bridges that simulate the natural channel (Offburg and Blank 2015).
- Use of planting native species to the region was validated by Milton, et al. (2015).

ARTC is committed to implementing ongoing monitoring of the effectiveness of the measures with contingency (under an adaptive management framework) to change/improve management strategies where deleterious impacts to the identified environmental values are observed, or are not minimised, as per the objectives of the proposed mitigation measures.

Literature is in agreement that monitoring is a critical component of quantifying effectiveness of a specific mitigation measure (van der Ree et al. 2008; van der Grift et al. 2015). This is because the success of mitigation measures are heavily reliant on factors such as existing environment, potential habitat, species, climate, design components of the linear infrastructure, and operational frequency of the transport; due to these factors it is not feasible to be able to provide a quantification of effectiveness of the Project's mitigation measures (Ghent 2018).

For example a comprehensive evaluation of the effectiveness of wildlife crossing structures requires a clear definition of success. Effectiveness is defined as the extent to which the goals of mitigation are reached. However, it is difficult to assess effectiveness without a specific and measurable goal. Therefore, ARTC recommends the SMART approach, that is, goals that are Specific, Measurable, Achievable, Realistic and Time framed (van der Ree et al. 2008; van der Ree et al. 2015; van der Grift, van der Ree and Jarger 2015). Van der Ree et al. (2007) proposed that the overall objective of wildlife crossing structures is to 'increase the permeability of a road corridor'. Criteria that can be used to measure effectiveness include:

- Rates of road-kill
- Habitat connectivity

- Biological requirements are met
- Allowance for dispersal and re-colonisation
- Maintenance of meta-population processes and ecosystem services.

It is also recommended that goals should be set for individual projects that are specific to species, location and the nature of the conflict. For example, a specific goal might be to ensure more than 90 per cent of individuals that approach a crossing structure successfully cross it, or to maintain the risk of extinction of a population to less than 5 per cent over the next 100 years.

Additional strategies as identified by the relevant threat abatement plan/recovery plans will be incorporated into the Project's mitigation strategies as part of detail design. A summary of threat abatement plans and recovery plans applicable to the identified MNES is provided in Appendix B and Sections 8.2 and 8.3.

Table 6.1 identifies overarching mitigation and management measures for all ecological values and Table 6.2 provides mitigation measures specific to MNES. In each instance, the relevant Project phase, the Sensitive environmental receptor that is impacted and the proposed mitigation measures are provided. The measures presented have then been factored into the assessment of residual significance, as documented in Section Table 7.4.

It is considered that none of the mitigation measures proposed are new or unique to this Project, i.e. all nominated mitigation measures are consistent with the intent of relevant threat abatement plans/recovery plans, have been previously adopted on other projects approved under the EPBC Act and/or are an extension of a traditionally accepted approach to avoiding or minimising ecological impacts. All mitigation measures will be subject to monitoring and corrective actions throughout the implementation period as a means of tracking and ensuring effectiveness.

EIS Chapter 22: Outline Environmental Management Plan provides further context and the framework for implementation of these proposed mitigation and management measures.

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Table 6.1 Project impact mitigation measures

Delivery phase	Aspect	Mitigation and management measures
Detail design	Flora and fauna/ biodiversity	■ The assessment assumes the entire Project disturbance footprint will be cleared. Work with the design team, construction contractor and where applicable the constructing authority to refine the disturbance footprint through detailed design as far as practical, to that required to safely and efficiently construct and operate the Project. ■ A Biodiversity Management Sub-plan will be developed as part of the CEMP^{1,2,3}. This plan will include appropriate criteria, directives and procedures in relation to: – Methods and sequencing of protected plant surveys, including seasonal timing, in accordance with the requirements of the <i>Protected Plants Assessment Guidelines</i> (DEHP, 2016). Flora species to be targeted through these surveys include, but are not limited to the following species: ■ MNES: – Tara wattle (<i>Acacia lauta</i>) – Hairy-joint grass (<i>Arthraxon hispidus</i>) – <i>Bertya opposens</i> – King blue-grass (<i>Dichanthium queenslandicum</i>) – Bluegrass (<i>Dichanthium setosum</i>) – Shiny-leaved ironbark (<i>Eucalyptus virens</i>) – Belson's panic (<i>Homopholis belsonii</i>) – Winged peppercress (<i>Lepidium monoplacoides</i>) – Wandering pepper-cress (<i>Lepidium peregrinum</i>) – Coolmunda leucopogon (<i>Leucopogon</i> sp. Coolmunda (D. Halford Q 1635)) – <i>Macrozamia machinii</i> – Hawkweed (<i>Picris evae</i>) – Dunmore prostanthera (<i>Prostanthera</i> sp. Dunmore) – Austral cornflower (<i>Rhaponticum australe</i>) – Austral toadflax (<i>Thesium australe</i>) – Slender tylophora (<i>Tylophora lineari</i>) – <i>Xerothamnella herbacea</i> – Methods and sequencing of pre-clearance fauna surveys, including terrestrial, aquatic habitats and breeding habitats (including burrows and hollow bearing trees/logs, existing culverts and structures). Fauna species to be targeted through these surveys include, but are not limited to the following: ■ MNES: – Brigalow woodland snail (<i>Adclarkia cameroni</i>) – Five-clawed worm-skink (<i>Anomalopus mackayi</i>) – Regent honeyeater (<i>Anthochaera phrygia</i>)

Delivery phase	Aspect	Mitigation and management measures
		– Australasian bittern (<i>Botaurus poiciloptilus</i>) – Curlew sandpiper (<i>Calidris ferruginea</i>) – Large-eared pied bat (<i>Chalinolobus dwyeri</i>) – Spotted-tailed quoll (<i>Dasyurus maculatus maculatus</i>) – Collared delma (<i>Delma torquata</i>) – Yakka skink (<i>Egernia rugosa</i>) – Red goshawk (<i>Erythroriorchis radiatus</i>) – Grey falcon (<i>Falco hypoleucos</i>) – Dunmall's snake (<i>Furina dunmali</i>) – Squatter pigeon - southern subspecies (<i>Geophaps scripta scripta</i>) – Painted honeyeater (<i>Grantiella picta</i>) – Swift parrot (<i>Lathamus discolor</i>) – Murray cod (<i>Maccullochella peelii</i>) – South-eastern long-eared bat (<i>Nyctophilus corbeni</i>) – Greater glider (<i>Petauroides volans</i>) – Koala (<i>Phascolarctos cinereus</i>) – Grey-headed flying-fox (<i>Pteropus poliocephalus</i>) – Australian painted snipe (<i>Rostratula australis</i>) – Black-breasted button-quail (<i>Turnix melanogaster</i>) – Condamine earless dragon (<i>Tympanocryptis condaminensis</i>)

Delivery phase	Aspect	Mitigation and management measures
		– Staging works so that they avoid animal breeding periods as much as possible within areas of habitat (large watercourses) – Staged and sequential clearing protocols – Animal handling protocols, including engagement of an approved fauna handler with a valid damage mitigation permit – Relocation of plants and habitats for threatened species, where possible and documented evidence of previous relocation exists – Requirements for inspections and corrective actions during construction and rehabilitation activities – Biodiversity/fauna and flora management actions to be undertaken by suitably qualified persons – Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction – Corrective actions should the outcomes not achieve the adopted objectives ■ A Soil Management Sub-plan will be developed and will include the following procedures and protocols relevant to potential impacts to the receiving environment: – Soil/land conservation objectives for the Project to minimise impacts on soil conservation plans and viable productive land, and include: ■ Appropriate design measures to ensure velocity of flow remains low enough to avoid erosion of contour banks and waterways ■ Consideration of land slope, land use, soil type, rainfall, trafficability and farm type when designing new contour banks ■ Stabilisation of banks – Management of problem soils, such as: ■ ASS ■ Erosive or dispersive soils, such as sodosols that are expected to be encountered between the Macintyre River and Yelarbon as well as along the fertile lands north of Inglewood to the west of Kooroongarra ■ Cracking/expansive clays (vertosols) that are expected to be encountered between Kooroongarra and Millmerran and from Yandilla to Gowrie ■ Saline soils, particularly in high salinity hazard areas such as between Kurumbul and Yelarbon. – Minimising exposure of dispersive subsoils through methods such as staging construction disturbance, topsoil replacement or rehabilitation immediately following construction. – Appropriate design considerations will be implemented where cracking/expansive clays feature, as well as minimising shrink swell characteristics through methods such as keeping constant soil moisture. – Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material – Vehicle, machinery and imported fill hygiene protocols and documentation, in accordance with the requirements of the <i>Biosecurity Act 2014</i>. – Specification of the type and location of erosion and sediment controls. The erosion and sediment control measures will be developed by a certified professional in erosion and sediment control and be in accordance with the International Erosion Control Association Best Practice Erosion and Sediment Control (2008). Details will include: ■ Locations for specific temporary/permanent erosion and sediment control measures, such as: – Sediment retention basins – Scour protection (included in the reference design)

Delivery phase	Aspect	Mitigation and management measures
		– Sediment fencing – Berms and other surface flow diversions. ■ Nomination of location-specific erosion controls will include consideration of site conditions, proximity to environmental receptors, adjoining land uses, climatic and seasonal factors, and will be based on an erosion risk assessment ■ Minimise the area of disturbance during each stage to that required to enable the safe construction, operation and maintenance of the rail corridor ■ Scheduling of works with consideration to avoiding periods of higher rainfall (summer months) ■ Establish and specify the monitoring and performance objectives for handover on completion of construction ■ Stockpiling and management/segregation of topsoil where it contains native plants, seedbank or weed material ■ Removal and lawful disposal of restricted matters (noxious weeds) ■ Vehicle, machinery and imported fill hygiene protocols and documentation, in accordance with the requirements of the Biosecurity Management Sub-plan ■ Practical scheduling of construction to minimise land disturbance and exposure of soils ■ Where practical, plan to use existing tracks. Design new access tracks (permanent and temporary) with the aim of minimising disturbance of substrate and vegetation ■ Detailed ecological surveys of the Project footprint will be undertaken in parallel to the development of the detail design. These surveys will be in accordance with the relevant survey guidelines for nationally threatened species (refer Section 2). Data obtained from these detailed surveys will be used to refine the quantification of ecological impacts and revise the calculation of offset requirements for the Project.
	Riparian vegetation, aquatic fauna and habitats	■ The design will continue to be developed to minimise the extent of impacts to waterways, riparian vegetation and in-stream flora and habitats, in accordance with the intent of: – Riverine protection permit exemption requirements (WSS/2013/726). Where the Project is unable to comply with the exemption requirements, a riverine protection permit will be sought for works within a watercourse. – Accepted development requirements for operational work that is constructing or raising waterway barrier works (DAF, 2018), e.g. for the dimensions, design and configuration of new culvert crossings. Where the Project is unable to comply with the accepted development requirements for operational work that is constructing or raising waterway barrier works, a development approval for operational work that is constructing or raising waterway barrier works will be sought ■ Design modifications during the detail design phase will be subject to re-runs of the existing flood models to demonstrate continued compliance with the design objectives of the Project, including for extent and time of inundation, afflux and flow velocities.
	Water quality	■ A Surface Water Management Sub-plan will be developed as a component of the CEMP (refer Chapter 12: Surface water and hydrology). The Sub-plan will provide a surface water monitoring framework for the Project that establishes: – Additional monitoring and sampling required to establish baseline water quality conditions, as a continuation of data collected during development of the draft EIS. Baseline water quality conditions will preferentially utilise water quality monitoring sites used within the draft EIS, with consideration of construction activities, seasonality and watercourse sensitivity. These will be monitored, at a minimum monthly, for a period of 12 months prior to commencement of construction to determine baseline conditions as a reference for monitoring of impact (as per Queensland Water Quality Guidelines (QWQG) (DEHP, 2009)). – Watercourse-specific water quality values, based on baseline data, <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality</i> (ANZECC & ARMCANZ, 2018), QWQG and relevant Water Quality Objectives (WQOs) under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019

Delivery phase	Aspect	Mitigation and management measures
		– Frequency and location of surface water sampling during construction of the Project, with consideration for: ■ Construction activities with potential to impact water quality ■ Seasonality ■ Sensitivity of receiving watercourse – In situ water quality parameters (pH, electrical conductivity, dissolved oxygen, temperature, oxidation-reduction potential and total dissolved solids) and laboratory analysis required for samples collected at each sampling location – Quality assurance and quality control requirements for surface water sampling and analysis – A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment – Responses to impact threshold exceedances (to be determined after the establishment of baseline water quality conditions) – Data management and reporting requirements
	Fauna movement ^{1,2}	■ Fauna movement opportunities (refer EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy) will be assessed and, where appropriate, developed during detail design including: – Assessment of the compatibility of each approach with the general design principles at each location – Consideration of safety requirements for the rail corridor and adjoining properties. For example, elevated fauna crossing structures may provide insufficient clearance for double-stacked trains – Consultation with adjoining landowners to confirm the acceptability of a fauna movement solution and ensure compatibility with their land use operation, e.g. grazing, animal husbandry etc. ■ Fauna passage design will be consistent with the intent of the <i>Fauna Sensitive Road Design Manual</i> (DTMR, 2000) and where applicable, will include species specific requirements.
	Fauna fencing ^{1,2}	■ Fauna fencing opportunities (refer EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy) will be further assessed and, where appropriate, developed during detail design including: – Assessment of the compatibility of each approach with the general fencing principles at each location – Consideration of safety requirements for the rail corridor and adjoining properties. For example, rail corridor fencing has not been proposed across the Condamine River floodplain to prevent the possibility of debris accumulation in fencing during flood events – Consultation with adjoining landowners to confirm the acceptability of a localised fencing approach and ensure compatibility with their land use operation – Consideration for maintenance constraints that a fauna connectivity or fencing opportunity may introduce. ■ Fauna fencing will be designed in reference to guidelines documented in the <i>Fauna Sensitive Road Design Manual</i> (DTMR, 2010). Additional expert guidance in relation to specific design features will be sought during the detail design process. ■ Priority will be given to fauna fencing in areas identified as State, regional or local fauna movement corridors to channel fauna toward safe movement options (i.e. culverts) to limit vehicle strikes and associated incidents.

Delivery phase	Aspect	Mitigation and management measures
	Weeds and pests	■ A Biosecurity Management Sub-plan^{1,2,3} will be developed as a component of the CEMP. This Plan will include: – Requirements for pre-clearing and operational surveys to determine the risk of weeds or pest animals being present within the Project footprint – Maps of the existing extent, confirmed through surveys, and severity of weed infestation (e.g. restricted matters including mother-of-millions (<i>Bryophyllum delagoense</i>), <i>opuntoid</i> cacti, African boxthorn (<i>Lycium ferocissimum</i>), lippia (<i>Phyla canescens</i>) and lantana (<i>Lantana camara</i>) and weed management requirements – Pest animal management controls, including protocols for severing, realigning and reinstating the wild dog check fence and the DDMRB rabbit fence – Site hygiene and waste management procedures to deter pest animals – Locations of vehicle washdown (light vehicle and oversize vehicles), wheel washes and rumble grids – Weed surveillance and treatment during construction and rehabilitation activities such as: ■ Vehicle and plant washdown requirements for fleet moving from low-risk areas to and high-risk areas ■ Weed certification requirements for vehicles, plant and materials arriving onto the construction site. – Requirements in relation to pesticide and herbicide use, including any limitations on use. Restrictions may apply in proximity to watercourses, known areas of MNES or MSES habitat or land uses sensitive to spray-drift from the application of pesticides and herbicides (e.g. organic farming practices) – Erosion and sediment control risks associated with broad-scale weed removal or treatment – Corrective actions should the outcomes not achieve the adopted objectives. ■ Property-specific weed hygiene requirements will be developed in consultation with the relevant landowners/operators prior to pre-construction/construction activities occurring on that property, outside of the permanent footprint. Protocols, where agreed, will be documented in individual property management agreements. ■ Further liaison with GRC and DDMRB will be undertaken during detail design to confirm the fencing specifications for the dog check and rabbit exclusion fence, respectively.
	Rehabilitation	■ A Rehabilitation and Landscaping Management Sub-plan will be developed for the Project, as a component of the CEMP^{1,3}. This sub-plan will be based on the Inland Rail Landscape and Rehabilitation Strategy and location-specific reinstatement commitments. As a minimum it will establish the following: – Location-specific objectives for rehabilitation, reinstatement and/or stabilisation. – Within the rail corridor, maintaining operational safety and rail formation stability will be the driving factors. – Objectives and timeframes for rehabilitation and/or reinstatement/stabilisation works (including biodiversity, vegetation establishment and erosion and sediment control outcomes to be achieved) – Where appropriate, how the objectives align with relevant recovery plans, threat abatement plans, conservation advices or policy guidance for target species in areas identified for rehabilitation – Details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, whilst minimising the duration of exposure in disturbed areas – Include rehabilitation requirements such as: ■ Milling and removal of bitumen pavement

Delivery phase	Aspect	Mitigation and management measures
		■ Removal of any decommissioned culverts ■ Tying and ripping of base and sub-base material ■ Application of soil ameliorants ■ Topsoiling and/or compost blanket ■ Stabilisation and rehabilitation (e.g. planting and or seeding). – Native flora species endemic to the Darling Downs and Toowoomba regions or other suitable species appropriate to the landscape context and nursery/seed stock sources – Consideration for maintenance or performance issues of rehabilitation e.g. use of groundcover that does not grow and obscure signals or impact the longevity of rail infrastructure – Procedures, timeframes, measurable performance objectives and responsibilities for monitoring the success of rehabilitation and/or reinstatement/stabilisation areas.
	Offsets ^{1,2}	■ Restriction of the Project footprint through detail design as far as practical to that required to safely and efficiently construct and operate the Project^{1,2,3}. In doing so, areas of MNES, MSES and their associated habitat will be avoided, thereby minimising significant adverse residual impacts to MNES. ■ Significant adverse residual impact to habitat for MNES and MSES will be re-calculated to confirm the Project's offset obligations under Australian Government and State requirements¹. ■ A Project offset plan will be developed to provide for the staged delivery of offsets, where appropriate, ahead of relevant clearing works being undertaken and finalised in consultation with relevant Australian Government and State regulatory agencies (refer EIS Appendix N: Draft Offset Strategy).
Pre-construction	Flora and fauna/biodiversity	■ The Biodiversity Management Sub-plan, as a component of the CEMP, will be implemented (refer above) ■ Scheduling of construction activities to minimise time of works in or adjacent to drainage lines, waterways or watercourses particularly during periods of flow¹ ■ Construction areas, including compounds, stockpiles, fuel storage areas, laydown areas and staff parking, will be located and established outside the tree protection zone as defined in <i>AS4970-2009 Protection of trees on development sites</i>¹.
	Rehabilitation	■ The Rehabilitation and Landscaping Management Sub-plan, as a component of the CEMP, will be implemented (refer above).
	Weeds and pests	■ Where the Project footprint interacts with the wild dog check fence, between chainages Ch 26.8 km and Ch 56.0 km (approximately), the fence will be reinstated on the northwest side of the rail corridor in accordance with the design solution agreed with GRC through the detail design process. ■ Where the Project crosses the DDMRB fence at chainage Ch 120.2 km, the fence will be reinstated, and a rabbit trap will be established in accordance with the design solution developed in consultation with DDMRB through the detail design process. ■ Undertake pre-construction survey and mapping of weeds within the Project footprint, prior to the commencement of pre-construction and construction activities^{1,2}, in accordance with the Biosecurity Management Sub-plan (refer above).

Delivery phase	Aspect	Mitigation and management measures
	Flora	- Protected plant surveys, in accordance with the requirements of the <i>Nature Conservation Act 1992</i>, will be undertaken as required in support of pre-construction enabling works. Such works may include additional geotechnical investigations to confirm the viability of borrow pit locations, re-fencing works or the establishment of non-resident workforce accommodation. - Prior to any pre-construction clearing works being undertaken, the clearing extents/site boundary/limit of works will be clearly defined with flagging or marking tape. No-go areas will also be marked. - A qualified Fauna Spotter Catcher will undertake pre-clearance surveys of remnant and regrowth vegetation^{1,2,3} - The Fauna Spotter Catcher will supervise the subsequent clearing of remnant and regrowth vegetation^{1,2,3}.
Construction	Flora and fauna/biodiversity	- Minimise clearance of remnant vegetation to that necessary for construction^{1,2}. Ensure all necessary permits and approvals are in place prior to the commencement of construction. - Where necessary, clearing activities are to be conducted in accordance with approved performance requirements under the accepted development vegetation management codes¹ - Clearly mark designated revegetation/rehabilitation zones and other no-go areas (including large significant trees) prior to any vegetation clearing. High visibility tape, barricade webbing or similar will be used. All contractors will be briefed on clearing requirements and restrictions (including fines) to prevent over-clearing of these areas. - Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species¹ - A qualified Fauna Spotter Catcher will undertake pre-clearance surveys of vegetation and will supervise the subsequent clearing of vegetation^{1,2,3} - Clearing extents will be limited to the area safely and reasonably required for permanent and temporary works, avoiding impacts to native vegetation and habitats as far as practicable.
	Riparian vegetation and aquatic habitats	- Refuelling will only occur at designated locations within the Project footprint and sited at suitable separation distances from sensitive receptors, including surface water features and drainage lines. These refuelling locations will be equipped with on-site chemical and hydrocarbon absorbent socks/booms and spill kits. - The Surface Water Management Sub-plan, as a component of the CEMP, will be implemented (refer above) - Works within or adjacent to watercourses will be conducted in accordance with the intent of: <i>Riverine protection permit exemption requirements</i> (WSS/2013/726) or conditions of a riverine protection permit issued for the Project <i>Accepted development requirements for operational work that is constructing or raising waterway barrier works</i> (DAF, 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works. - The salvage and relocation of fish within isolated aquatic environments will be managed in accordance with <i>Guidelines for fish salvage</i> (DAF, 2018)¹ - An appropriately qualified person will be consulted to make an assessment on the method of recovery, transport and release of fish and other aquatic fauna, as required¹. As a minimum, the following will be implemented: - Relocation will be undertaken by a suitably qualified person - Dewatering pumps will have an intake screen - Records of all fish recovered, and the location of their release will be maintained. - In the event of a spill incident during construction, any impacted aquatic environments will be assessed for the presence of fauna. If necessary, salvage and recovery efforts will be undertaken¹.

Delivery phase	Aspect	Mitigation and management measures
	Flora	- Minimise clearance of remnant vegetation to that necessary for construction and safe operation^{1,2,3} - Clearly mark designated revegetation/rehabilitation zones and other no-go areas (including large significant trees) prior to any vegetation clearing. High visibility tape, barricade webbing or similar will be used. All contractors are to be briefed on clearing requirements and restrictions (including fines) to prevent over-clearing of these areas. - Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species will be minimised - Topsoil stockpiles will be a maximum of 2.5 m in height to avoid heat sterilisation of the seed bank¹ - Topsoil stockpiles will be managed to maintain the viability of soil seed banks for threatened flora species such as Belson's panic, hawkweed, finger panic (<i>Digitaria porrecta</i>), austral toadflax and austral cornflower¹.
	Fauna movement	Fauna movement opportunities will be constructed to reinstate safe fauna passage as soon as possible, in accordance with the fauna movement strategy (refer EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy), which will be finalised and documented in the detail design.
	Fauna fencing	Fauna fencing will be installed where practically possible generally in accordance with the fencing strategy (refer EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy), which will be finalised and documented in the detail design^{1,2}.
	Weeds and pests	- The Biosecurity Management Sub-plan, as a component of the CEMP, will be implemented (refer above) - The effectiveness of weed hygiene measures will be monitored as a component of the environmental monitoring procedure for the Project - Any vegetated material containing, or with the potential to contain, weed seed material will not be used for on-site mulching or erosion protection^{1,2} - A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.
	Erosion and sediment control	Implement the Soil Management Sub-plan, including erosion and sediment controls, as a component of the CEMP (refer above).
	Rehabilitation and landscaping	- The Rehabilitation and Landscaping Management Sub-plan, as a component of the CEMP, will be implemented (refer above) - Rehabilitation and landscaping will occur sequentially as work fronts are completed - The rail corridor will be maintained free of woody vegetation.
Operation	Riparian vegetation and aquatic habitats	- Maintenance activities within or adjacent to watercourses will be conducted in accordance with the intent of: <i>Riverine protection permit exemption requirements</i> (WSS/2013/726) or conditions of a riverine protection permit issued for the Project <i>Accepted development requirements for operational work that is constructing or raising waterway barrier works</i> (DAF, 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works.
	Weeds and pests	- Weed management protocols for the operational rail corridor and other ARTC facilities will be in accordance with the requirements of the <i>Biosecurity Act 2014</i>, <i>ARTC operation and maintenance procedures and policies</i> and the Operation EMP^{1,2,3}. These protocols will include: - Site hygiene and waste management procedures to deter pest animals - Weed surveillance and treatment during operation and maintenance activities - Requirements in relation to pesticide and herbicide use, including any limitations on use. Restrictions may apply in proximity to watercourses, known areas of MNES or MSES habitat or land uses sensitive to spray-drift from the application of pesticides and herbicides

Delivery phase	Aspect	Mitigation and management measures
		– Vehicle, machinery and imported fill hygiene protocols and documentation – Erosion and sediment control risks associated with broad scale weed removal or treatment – Corrective actions should the outcomes not achieve the adopted objectives.
	Fauna passage	■ Fauna movement/passage infrastructure and surrounding vegetation will be inspected and maintained during operation to retain the integrity/viability of the fauna movement opportunities^{1,2}.
	Fauna fencing	■ Fauna movement/passage infrastructure, fencing and surrounding vegetation will be inspected and maintained during operation^{1,2}.

Table notes:

- 1 Mitigation measure successfully implemented as part of the Toowoomba Second Range Crossing Project.
- 2 Mitigation measure approved by the Commonwealth as part of the rail component for the Carmichael Coal Mine and Rail Project (EPBC 2013/6885) [refer measures within *Species Management Plans. Carmichael Rail Project* (CRN 2019)].
- 3 Mitigation measure commonly applied across other projects as approved by the Commonwealth in central and southern Queensland e.g. *Santos Significant Species Management Plan – GFD Project* (Santos 2016), *Anyu Significant Species Management Plans* (Shell 2017), *Species Management Plans. Carmichael Rail Project* (CRN 2019).

Table 6.2 Project impact mitigation measures specific to matters of national environmental significance

Sensitive environmental receptor	Receptor-specific mitigation and management measures (in addition to those specified in Table 6.1)
Construction	
Brigalow (<i>Acacia harpophylla</i> dominant and codominant), Weeping Myall woodlands and Poplar box grassy woodlands	- Pre-construction surveys will be carried out to confirm to what extent the identified TECs occur within, or adjacent to the Project footprint^{1,2,3}. Surveys will be carried out using diagnostic criteria/condition threshold detailed in relevant Approved conservation advice for the community. Where TECs are found to occur condition assessment will be undertaken (using BioCondition assessment) with regular monitoring against initial assessment values. Corrective actions to minimise impacts are to be implemented where Project-associated impacts are identified. - Quantification of the area of TECs removed to enable the Environmental Offsets Delivery Strategy - Qld to be refined - The Soil Management Sub-plan is to include soil conservation measures and erosion and sediment controls with specific reference/controls to identified TEC areas - The Biosecurity Management Sub-plan will include reference to relevant guidelines to control potential deleterious pathogens including <i>Phytophthora cinnamomi</i> and Myrtle rust (e.g. DotE 2015) associated with Project activities both of which may impact eucalypt species. - Design modifications during the detail design phase will seek to maintain inundation regimes within the TEC as close to natural conditions as possible. - Annual monitoring of TECs retained within the Project footprint against the initial BioCondition assessment. Corrective actions to be implemented where Project-associated impacts are identified³ - Rehabilitation of disturbed areas, within the Project footprint but outside of the rail corridor, using local native species
King bluegrass (<i>Dichanthium queenslandicum</i>), Winged peppergrass (<i>Lepidium monoplacoides</i>), <i>Xerothamnella herbacea</i>, Belson's panic (<i>Homopholis belsonii</i>), Hawkweed (<i>Picris evae</i>), Austral cornflower (<i>Rhaponticum australe</i>), and <i>Westringia parvifolia</i>	- Pre-construction protected flora surveys^{1,2,3}, as per DEHP 2014 guidelines, within the Project footprint that target areas identified as potential habitat for the species as per species habitat mapping (refer Appendix I). In particular, the following will be targeted: - Suitable habitat in the Yelarbon/Inglewood area for <i>Westringia parvifolia</i> and <i>Xerothamnella herbacea</i> - All other identified threatened flora species occur on the dark clay soils in the northern portion of the Project footprint (north of Bringalily State Forest) - Undertake translocation of specimens where appropriate¹ for a species and there is documented record of previous successful translocation trials/schemes [e.g. for <i>Macrozamia</i> species refer Commonwealth approved <i>Translocation and Management plan for Cycas megagarpa</i> (Shell 2016)] - Where a threatened flora species is found to occur within the Project footprint, pre-construction condition assessment of species habitat will be undertaken (using BioCondition assessment) with regular monitoring against initial assessment values. Corrective actions to minimise impacts are to be implemented where Project-associated impacts are identified. - Quantification of the area of threatened flora species removed to enable the Environmental Offsets Delivery Strategy - Qld to be refined - The Soil Management Sub-plan is to include soil conservation measures and erosion and sediment controls with specific reference to identified habitat for threatened flora (where they are found to occur) - Where threatened flora species are found to occur within the Project footprint and will be retained, species-specific biosecurity controls will be implemented in proximity to the area of occurrence¹ - Annual monitoring of threatened flora species retained within the Project footprint against the initial BioCondition assessment. Corrective actions to be implemented where Project-associated impacts are identified - Rehabilitation of disturbed areas^{1,2,3}, within the Project footprint but outside of the rail corridor, using local native species

Sensitive environmental receptor	Receptor-specific mitigation and management measures (in addition to those specified in Table 6.1)
Wandering peppergrass (<i>Lepidium peregrinum</i>), Coolmunda Leucopogon (<i>Leucopogon</i> sp. Coolmunda), Slender Tylophora (<i>Tylophora linearis</i>), Hairy-joint grass (<i>Arthraxon hispidus</i>), <i>Bertya opposens</i>, Ooline (<i>Cadellia pentastylis</i>), Bluegrass (<i>Dichanthium setosum</i>), Shiny-leaved ironbark (<i>Eucalyptus virens</i>), Dunmore Prostanthera (<i>Prostanthera</i> sp. Dunmore), <i>Macrozamia machinii</i> and Austral toadflax (<i>Thesium australe</i>)	- Pre-construction protected flora surveys, as per DEHP 2014 guidelines, within the Project footprint that target areas identified as potential habitat for the species as per species habitat mapping (refer Appendix I). - Undertake translocation¹ of specimens where appropriate for a species and there is documented record of previous translocation trials/schemes [e.g. for <i>Macrozamia</i> species refer Commonwealth approved <i>Translocation and Management plan for Cycas megagarpa</i> (Shell 2016)] - Where a threatened flora species is found to occur within the Project footprint, pre-construction condition assessment of species habitat will be undertaken (using BioCondition assessment) with regular monitoring against initial assessment values. Corrective actions to minimise impacts are to be implemented where Project-associated impacts are identified^{1,2}. - Quantification of the area of threatened flora species removed to enable the Environmental Offsets Delivery Strategy - Qld to be refined - The Soil Management Sub-plan is to include soil conservation measures and erosion and sediment controls with specific reference to identified habitat for threatened flora (where they are found to occur) - Where threatened flora species are found to occur within the Project footprint and will be retained, species-specific biosecurity controls will be implemented^{1,2} in proximity to the area of occurrence - Annual monitoring of threatened flora species retained within the Project footprint against the initial BioCondition assessment³. Corrective actions to be implemented where Project-associated impacts are identified - Rehabilitation of disturbed areas, within the Project footprint but outside of the rail corridor, using local native species³
Murray cod	- Construction activities scheduled to avoid/minimise instream works and associated riparian habitat in identified habitat, where possible. - Construction works will, where possible, take place outside of the wet season when flows in floodplain systems are more likely - Pre-construction surveys of watercourse crossings that are identified as potential habitat if suitable waterholes are present (i.e. Condamine River floodplain channels and Macintyre River) to identify whether the species occurs. Surveys will follow the <i>Survey guidelines for Australia's threatened fish</i> (DSEWPaC 2011b). - Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, an appropriately qualified person will be consulted to make an assessment on the method of recovery, transport and release of fish and will follow relevant State (DAF) fish salvage guidelines during construction activities¹. - Where possible, instream habitat will be reinstated to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and allow fish passage). - Implementation of the Biosecurity Management Sub-plan, Soil Management Sub-plan and the Surface Water Management Sub-plan^{1,2}.
Wetland migratory species: Common sandpiper, Sharp-tailed sandpiper, Pectoral sandpiper, Red-necked stint, Latham's snipe, Yellow wagtail, Osprey, Glossy ibis, Common greenshank Wetland birds: Australian painted snipe, Australasian bittern and Curlew sandpiper	- Pre-construction surveys of wetlands identified as potential habitat of species to identify whether any of these species occurs. - Restricted works measures in place should nesting species be detected - Implement measures to ensure pest predator fauna are not attracted to works areas¹ or to utilising the Project footprint for shelter¹ - Implementation of the Biosecurity Management Sub-plan, Soil Management Sub-plan and the Surface Water Management Sub-plan - Establish and maintain a fauna management and incident register to record sightings and/or incidents involving fauna species during the undertaking of Project activities^{1,3}.

Sensitive environmental receptor	Receptor-specific mitigation and management measures (in addition to those specified in Table 6.1)
Condamine earless dragon, Five-clawed worm-skink, Dunmall's snake, Squatter pigeon, South-eastern long-eared bat and Koala¹	■ Pre-construction surveys of areas identified as potential habitat of species, as per species habitat mapping (refer Appendix I), to establish whether individuals occur within the Project footprint^{1,3}. Particularly focus on the following: – Suitable habitat on dark clay soils in northern portion of the alignment for Condamine earless dragon and Five-clawed worm-skink [refer <i>Survey guidelines for Australia's threatened reptiles</i> (DSWEPaC 2011) for survey methods] – Suitable habitat in the Inglewood area for Dunmall's snake [refer <i>Survey guidelines for Australia's threatened reptiles</i> (DSWEPaC 2011) for survey methods] – Identified potential habitat for South-eastern long-eared bat with focus on areas outside of the State forests north of Inglewood where the species can be assumed as present [refer <i>Survey guidelines for Australia's threatened bats</i> (DEWHA 2010) for survey methods] – Identified potential habitat for Squatter pigeon with focus on areas outside of the State forests north of Inglewood where the species can be assumed as present [refer <i>Survey guidelines for Australia's threatened birds</i> (DEWHA 2010) for survey methods] – Koala may be assumed as potentially present throughout eucalypt woodlands in the Project footprint ■ Undertake pre-clearance ground surveys for Condamine earless dragon and Five-clawed worm-skink where pre-construction surveys have identified the species as occurring or likely to occur. ■ Undertake retrieval of tree hollows, where safe to do so, during vegetation clearing allowing for inspections for roosting South-eastern long-eared bat³. ■ Implement protocols to allow safe daytime storage of roosting bats and evening release of individuals³ Vegetation clearing within the Project footprint in Koala habitat will be carried out in a manner to minimise stress on potential individuals as much as is practicably possible (e.g. sequential clearing and minimising time of disturbance to animals)^{1,2,3}. Where possible, clearing activities will take place outside the breeding season for Koala (October-May). ■ Restricted works measures in place should Koala or Squatter pigeon be observed within Project footprint to allow safe movement away from the works area^{1,2,3} ■ Implement measures to allow safe and responsible handling of fauna (where required) and repatriation in pre-identified appropriate habitat outside of the Project footprint^{1,2,3} ■ Koalas subject to handling will be examined and, if suspected of Chlamydia infection, will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release^{1,3} ■ Establish and maintain a fauna management and incident register to record sightings and/or incidents involving fauna species during the undertaking of Project activities^{1,3} ■ The Biosecurity Management Sub-plan will include reference to relevant guidelines to control potential deleterious pathogens including <i>Phytophthora cinnamomi</i> and Myrtle rust (e.g. DotE 2015f) associated with Project activities both of which may impact eucalypt species and therefore Koala. ■ Fauna crossing structures and fencing are installed in accordance with design specifications^{1,2} ■ Rehabilitation of temporary construction areas where woodland habitat has been cleared. Revegetation plant species will be obtained from a reliable source that is certified free of pathogens^{1,3}

Sensitive environmental receptor	Receptor-specific mitigation and management measures (in addition to those specified in Table 6.1)
Collared delma, Yakka skink, Spotted-tail quoll, Greater glider and Large-eared pied bat and Brigalow woodland snail ¹	■ Pre-construction surveys of areas identified as potential habitat of species^{1,3}, as per species habitat mapping (refer Appendix I), to establish whether individuals occur within the Project footprint. Surveys will be species specific following the <i>Survey guidelines for Australia's threatened mammals</i> (DSEWPac 2011a) and <i>Survey guidelines for Australia's threatened reptiles</i> (DSEWPac 2011c) and include the following: – Identification of species-specific habitat and habitat features considered suitable for species presence (e.g. cliff faces/boulder piles for Large-eared pied bat and spotted-tail quoll and loose surface rocks for Collared delma) – Targeted surveys for Brigalow woodland snail in identified habitat (Condamine River floodplain riparian woodland). Surveys to be carried out as per expert advice. The Biodiversity Management Sub-plan will include: ■ Implement measures to ensure safe retrieval of tree hollows during vegetation clearing and allow safe movement of species (e.g. Greater glider) away from works area ■ Implement measures to ensure retrieval of potential habitat elements (loose surface rock, large fallen timber) during vegetation clearing and placement in adjacent unimpacted habitat ■ Implement restricted works measures should larger species (Spotted-tail quoll) be observed within the Project footprint to allow safe movement safe away from works area ■ Implement measures to allow safe handling of fauna (where required) and repatriation in suitable habitat away from site ■ Establish and maintain a fauna management and incident register to record sightings and/or incidents involving fauna species during the undertaking of Project activities ■ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near the Project footprint), and procedures for working around them.
Grey-headed flying-fox	■ Pre-construction surveys of riparian habitat identified as potential roost sites of species. The purpose of surveys will be to identify whether camps occur within or near to the Project footprint. It is noted the species were recorded at a known flying-fox roost site in Inglewood (3 km south of Project) during Project surveys although this is not known to be a regular roost. No other regular roosts for the species have been previously identified within 10 km of the Project. ■ Should a roost site be found to occur management actions will incorporate the mitigation standards detailed in the Commonwealth's Referral guideline for management actions in grey-headed and spectacled flying-fox camps (DotE 2015b).
Woodland birds: Swift parrot, Painted honeyeater, Regent honeyeater and Red goshawk, Oriental cuckoo, Black-faced monarch, Satin flycatcher, Rufous fantail, Spectacled monarch	■ Pre-construction surveys of woodlands identified as potential habitat (refer Appendix I), particularly: – For Red goshawk to identify whether individuals occur and potentially nest within the Project footprint. – For Painted honeyeater in relevant nesting habitat (Brigalow woodlands) to determine whether the species and potential nesting occurs within the Project footprint. – For other nest sites within the Project footprint, as per MNES guidelines where suitable nesting habitat (i.e. large emergent trees near water) is identified. ■ Should active nest sites for either Red goshawk or Painted honeyeater be identified restricted works measures will be implemented to allow nesting to continue undisturbed^{1,3}.

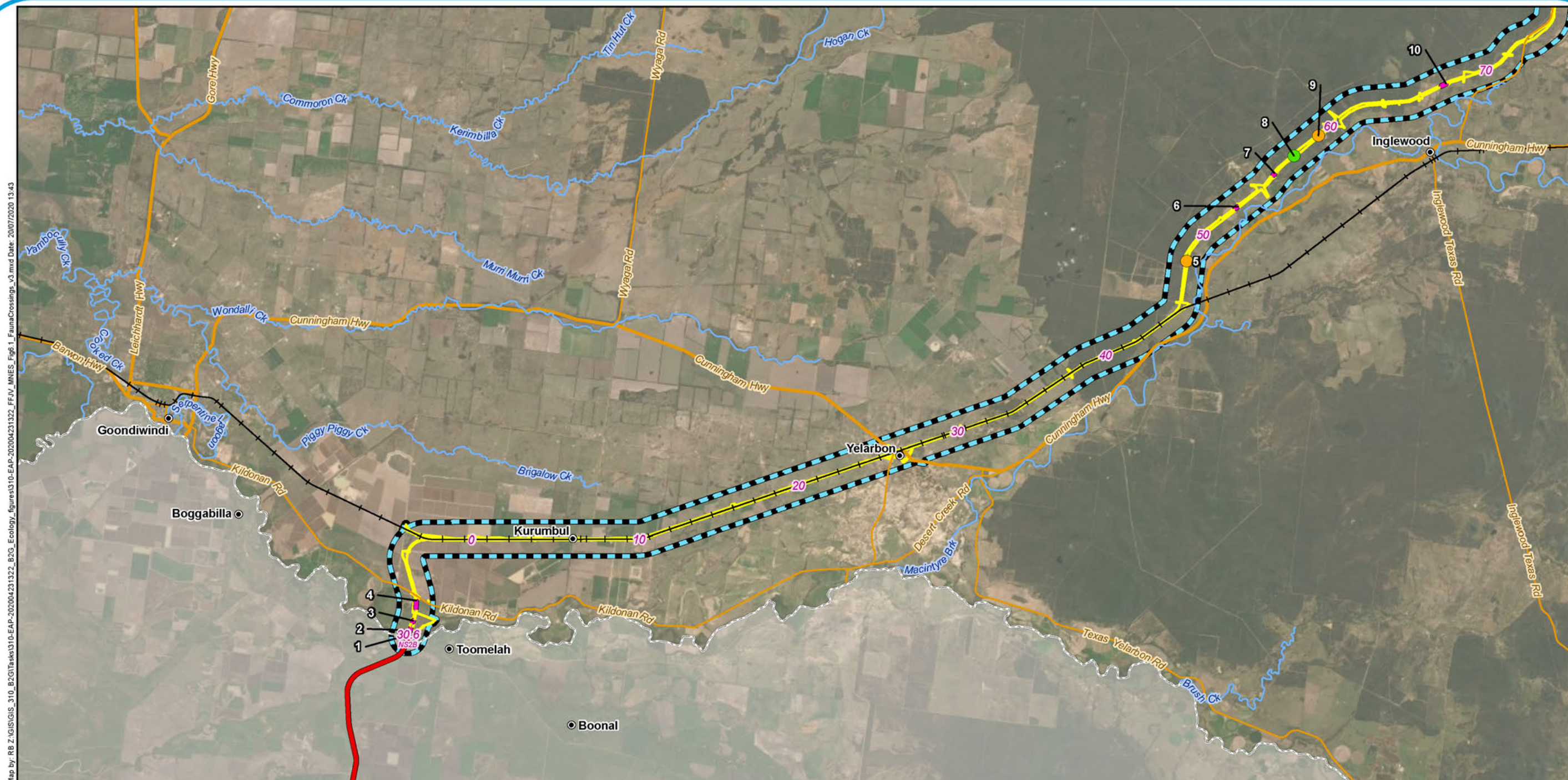
Sensitive environmental receptor	Receptor-specific mitigation and management measures (in addition to those specified in Table 6.1)
Operation	
All sensitive receptors	■ Ongoing weed monitoring within the rail corridor^{1,2} with specific reference to maintaining the pre-construction condition of TEC and habitats that adjoin the rail corridor ■ Maintenance of erosion and sediment controls^{1,2} within the rail corridor with specific reference to maintaining the pre-construction condition of TECs and habitats that adjoin the rail corridor ■ Maintenance of the effectiveness of cross-drainage structure (e.g. culverts) to ensure continued connectivity of watercourses and drainage features that are aligned across the rail corridor. ■ Maintain a fauna management and incident register including observed collisions associated with rail operations^{1,3} ■ Information on fauna strike will be used to monitor the effectiveness of structures for fauna passage and to inform potential for further measures to be applied to minimise/eliminate the risk of future incidents.

Table notes:

The specific management measures for MNES target habitat types in the first instance, as opposed to individual species. Therefore, some MNES species are grouped together despite being of different taxonomic classes.

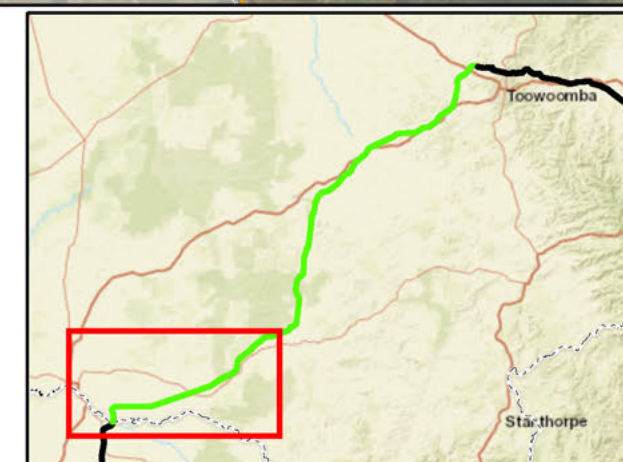
- 1 Mitigation measure successfully implemented as part of the Toowoomba Second Range Crossing Project.
- 2 Mitigation measure approved by the Commonwealth as part of the rail component for the Carmichael Coal Mine and Rail Project (EPBC 2013/6885) [refer measures within *Species Management Plans. Carmichael Rail Project* (CRN 2019)].
- 3 Mitigation measure commonly applied across other projects as approved by the Commonwealth in central and southern Queensland e.g. *Santos Significant Species Management Plan – GFD Project* (Santos 2016), *Anya Significant Species Management Plans* (Shell 2017), *Species Management Plans. Carmichael Rail Project* (CRN 2019).

Map by: RE Z:\GIS\GIS_310_B2G\Task\310-EAP-202004231322_B2G_Ecology_Figures\310-EAP-202004231322_FF_V1_MNES_Fig6.1_FaunaCrossings_v3.mxd Date: 20/07/2020 13:43



Legend

- | | | |
|--|------------------------|--|
| 5 Chainage (km) | Major roads | Proposed fauna crossings |
| Localities | Minor roads | Proposed rail bridge over waterway |
| North Star to NSW/QLD border alignment | Watercourses | Canopy bridge overpass |
| Existing rail (operational) | NSW/QLD border | Over track at natural level (cut / fill interface) |
| | Project footprint | |
| | Impact assessment area | |



A3 scale: 1:250,000

0 5 10 15 km

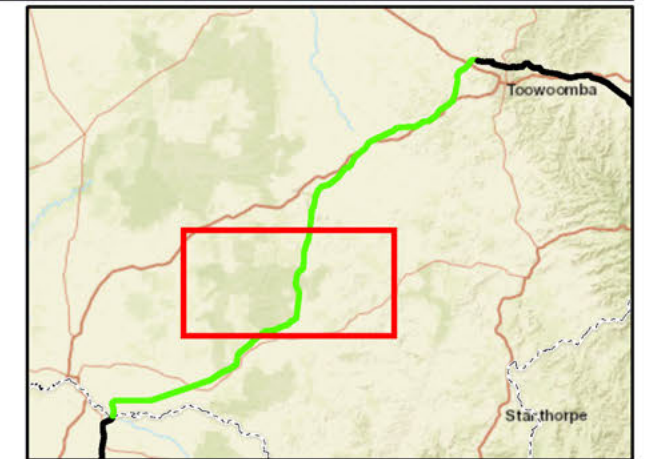


Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area

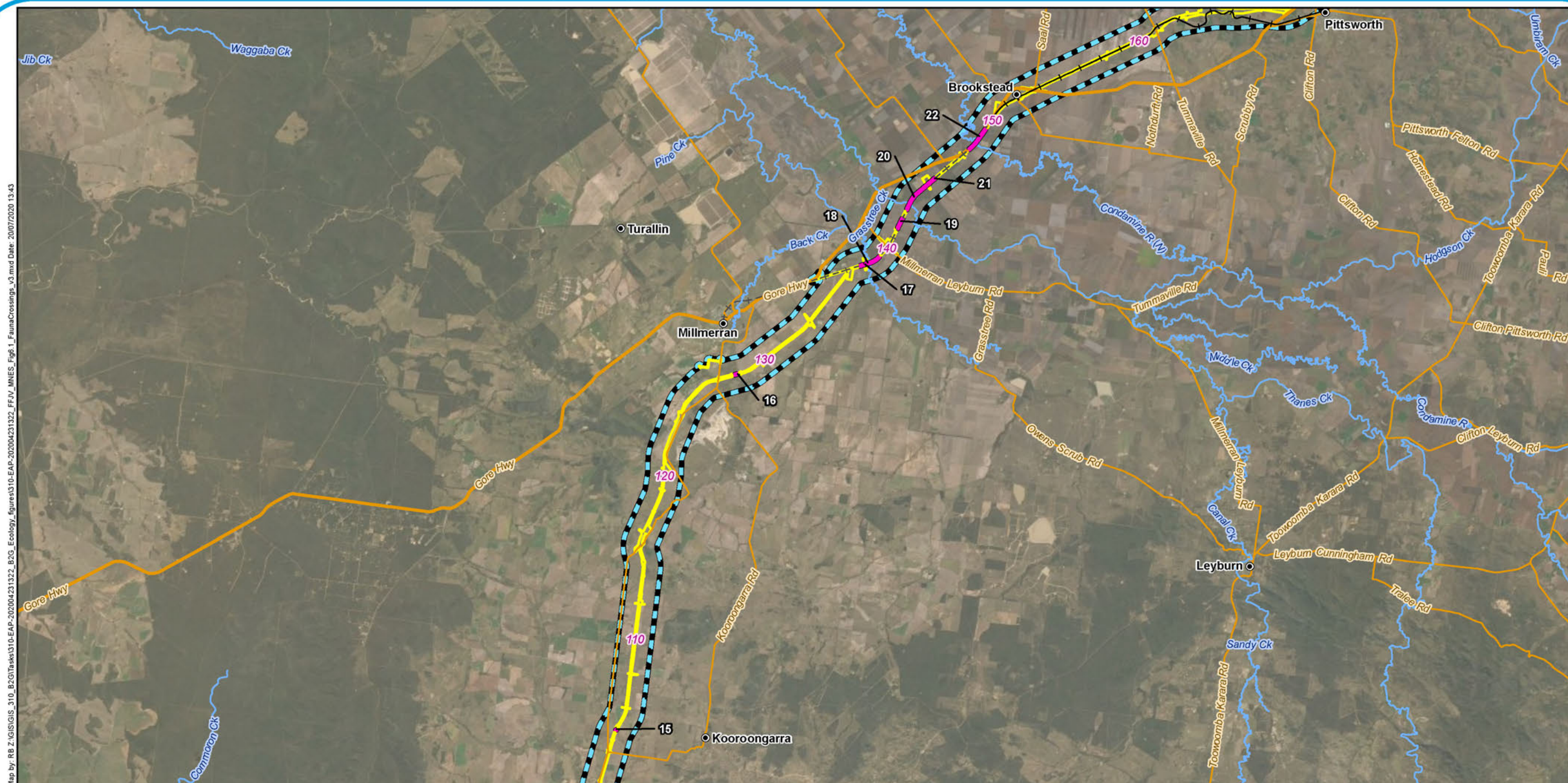
Proposed fauna crossings

- Proposed rail bridge over waterway
- Canopy bridge overpass
- Over track at natural level (cut / fill interface)



A3 scale: 1:250,000





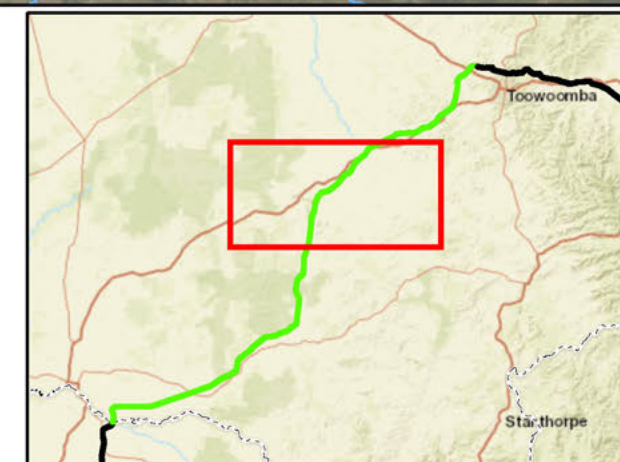
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Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area

Proposed fauna crossings

- Proposed rail bridge over waterway



A3 scale: 1:250,000



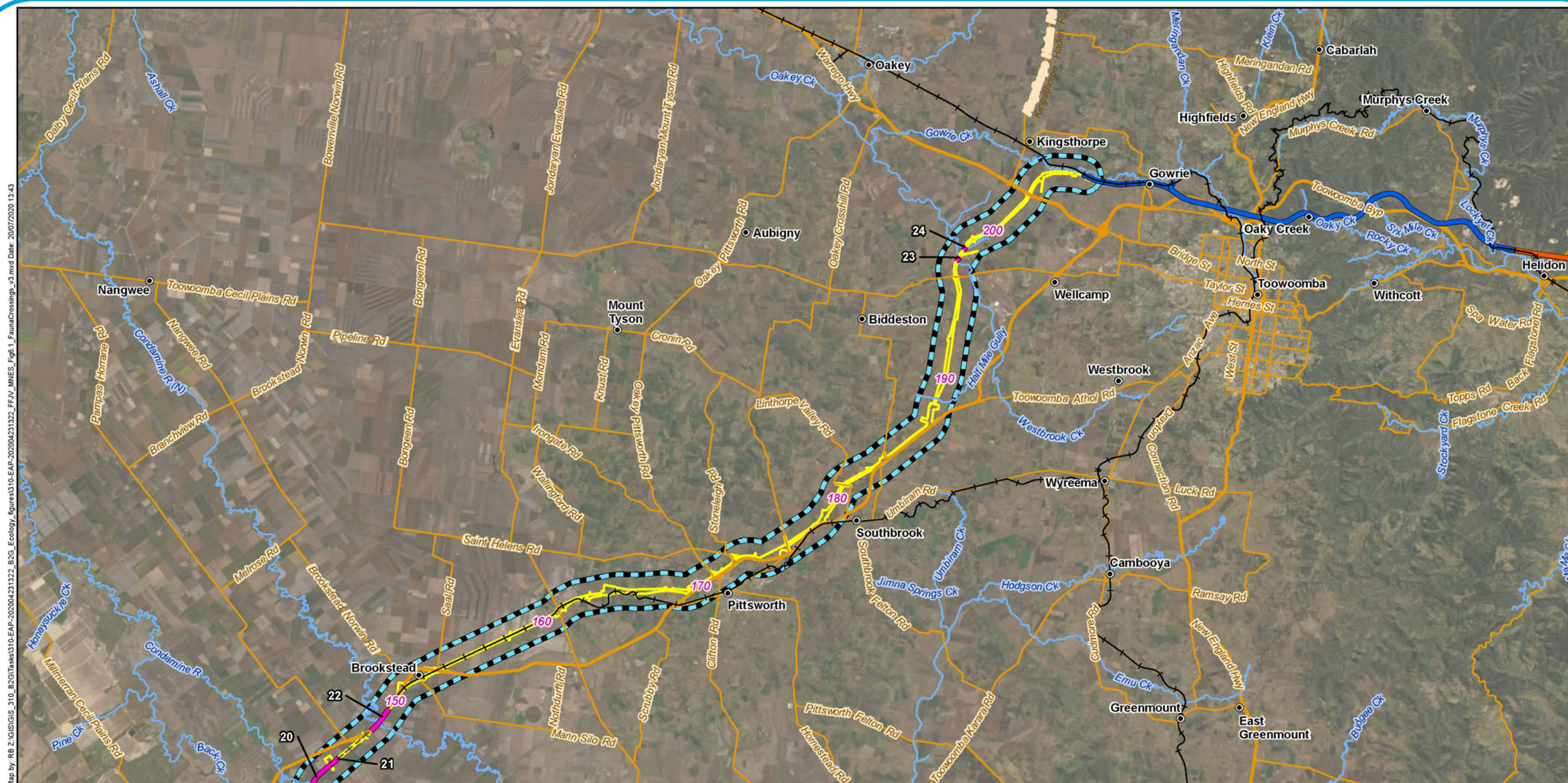
Future Freight
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Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 6.1c:

Location of proposed fauna crossings

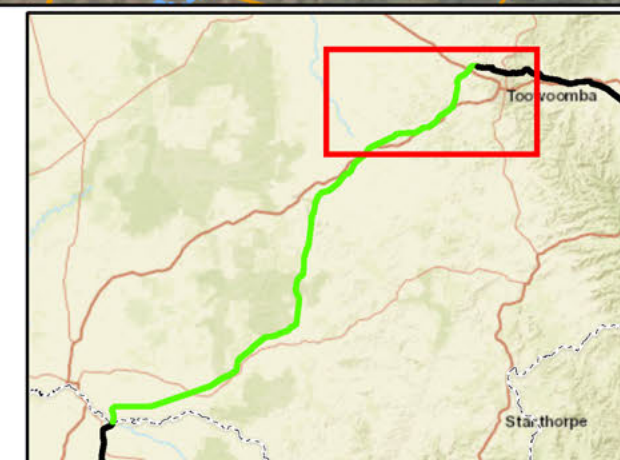


Legend

- 5 Chainage (km)
- Localities
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area

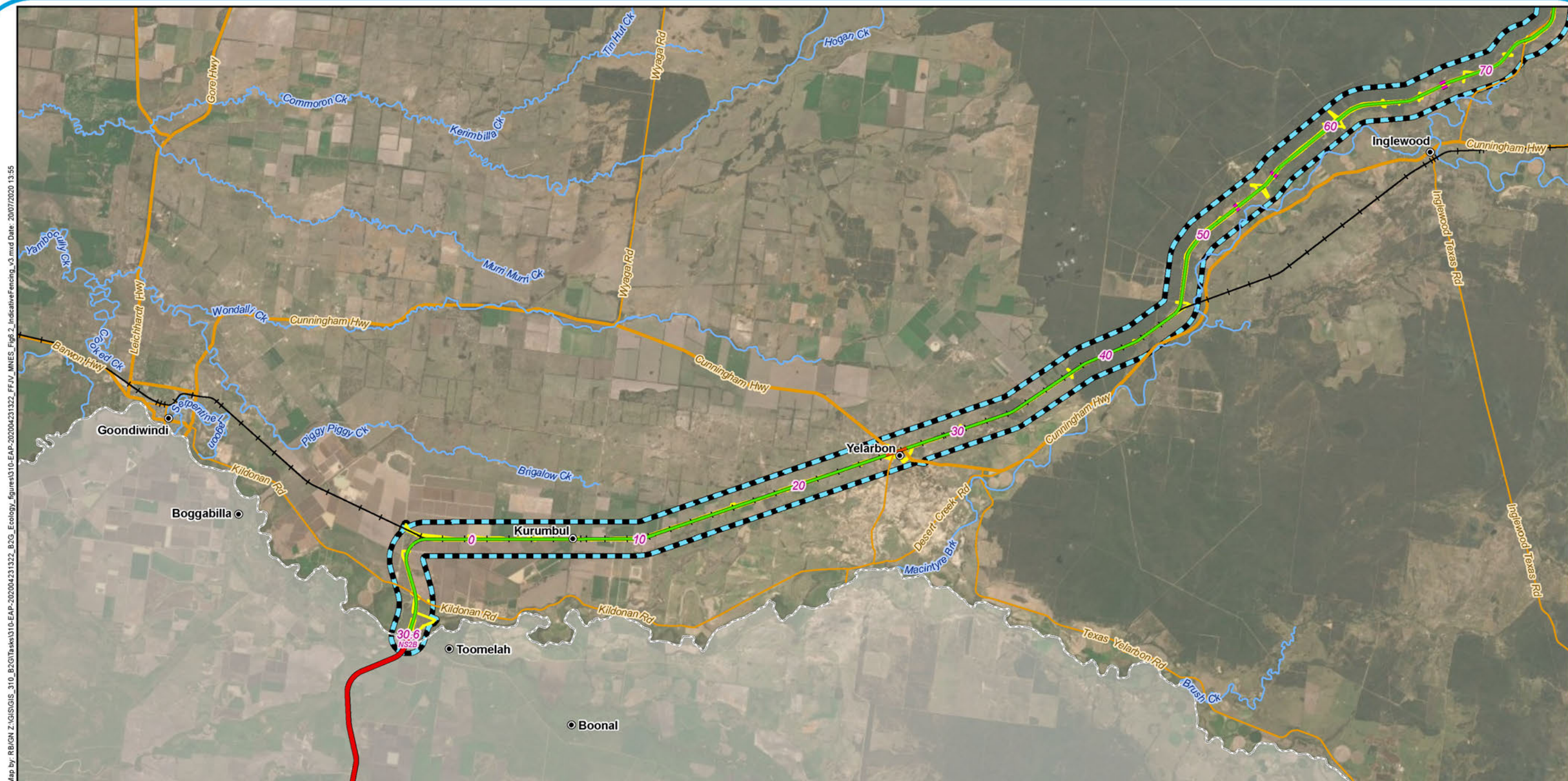
Proposed fauna crossings

- Proposed rail bridge over waterway



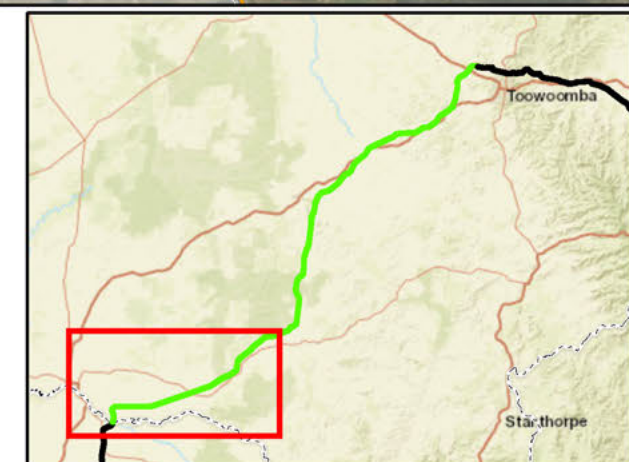
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Legend

- | | | |
|--|------------------------|---|
| 5 Chainage (km) | Major roads | Fence type |
| Localities | Minor roads | — Fauna exclusion fencing 150m either side of chainage (exclude crossing point) |
| North Star to NSW/QLD border alignment | Watercourses | — Standard chain link boundary fence |
| Existing rail (operational) | NSW/QLD border | — Standard rural chain wire |
| | Project footprint | |
| | Impact assessment area | |

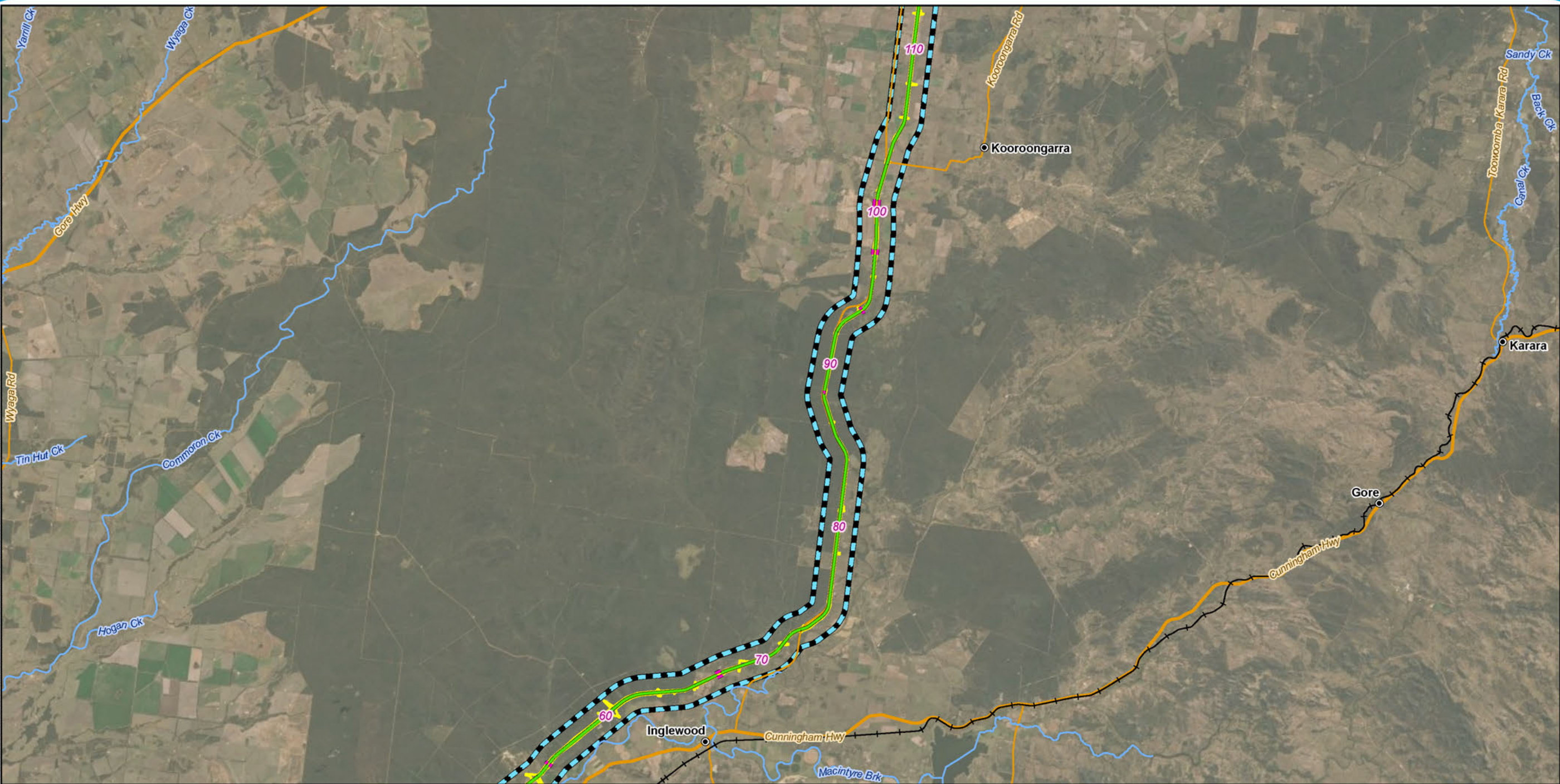


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Border to Gowrie

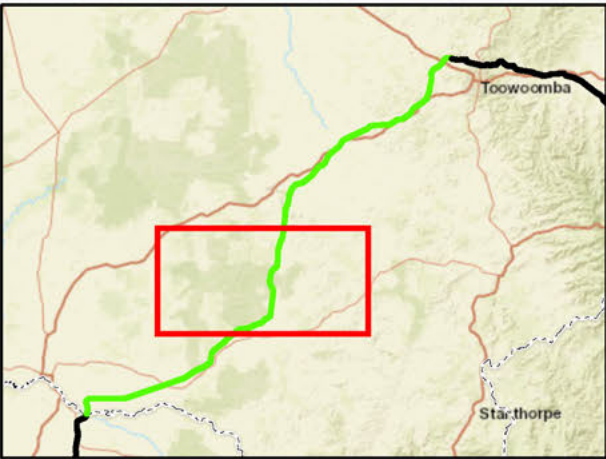
Figure 6.2a: Location of indicative fencing including of fauna crossing solutions



Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area

- Fence type**
- Fauna exclusion fencing 150m either side of chainage (exclude crossing point)
 - Standard rural chain wire



A3 scale: 1:250,000

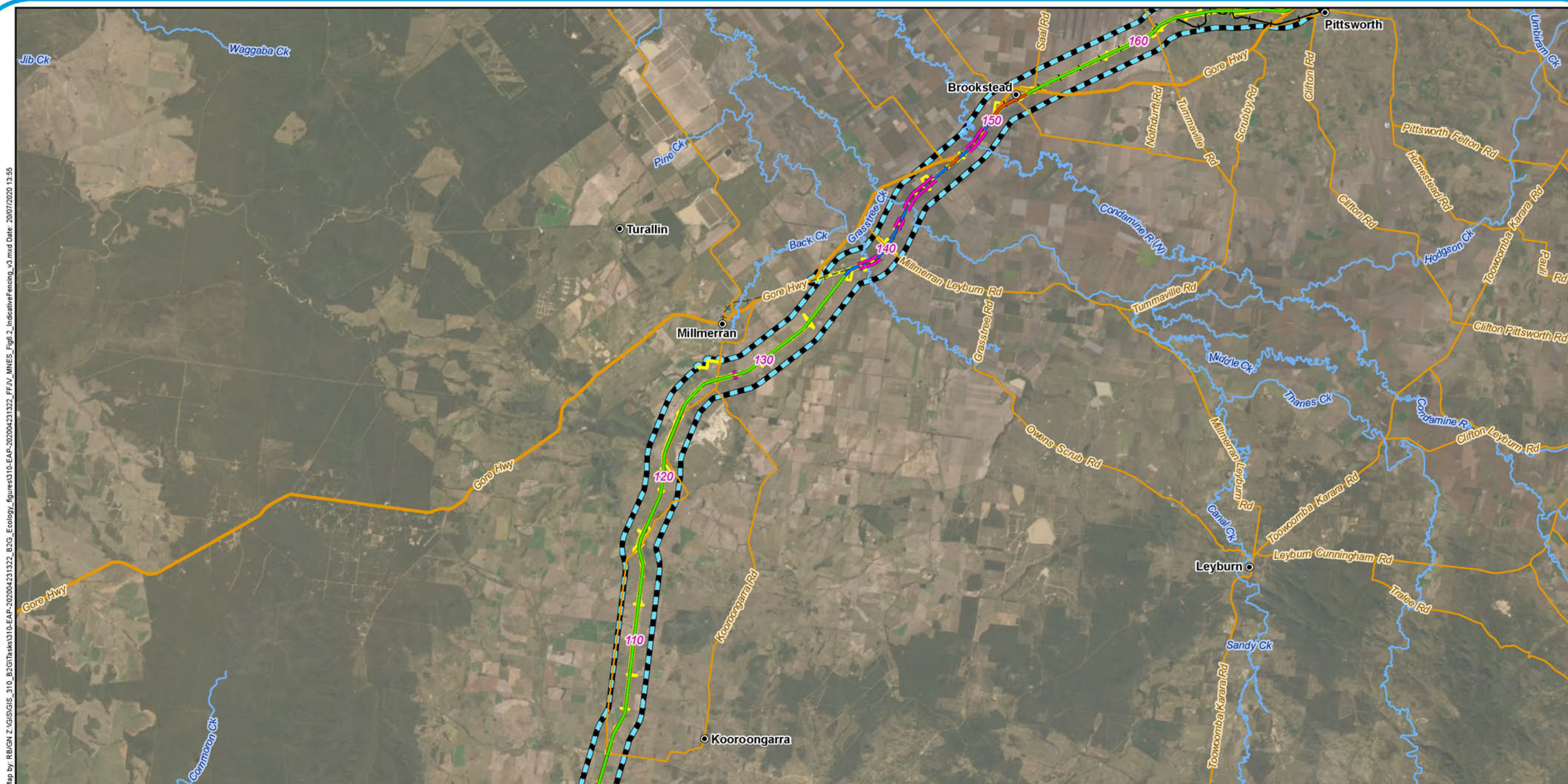


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 Coordinate System: GDA 1994 MGA Zone 56

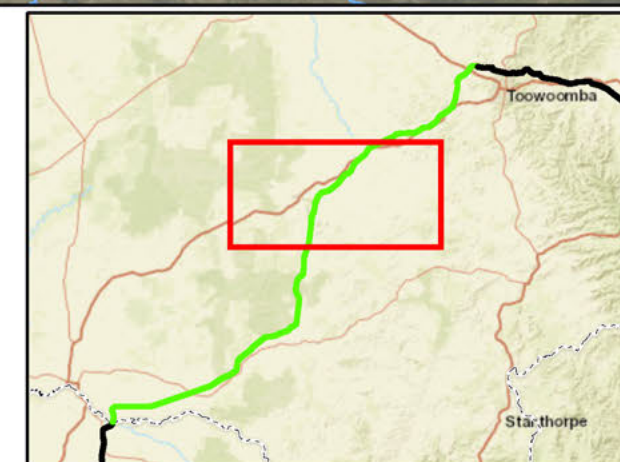
Border to Gowrie

Figure 6.2b: Location of indicative fencing including of fauna crossing solutions



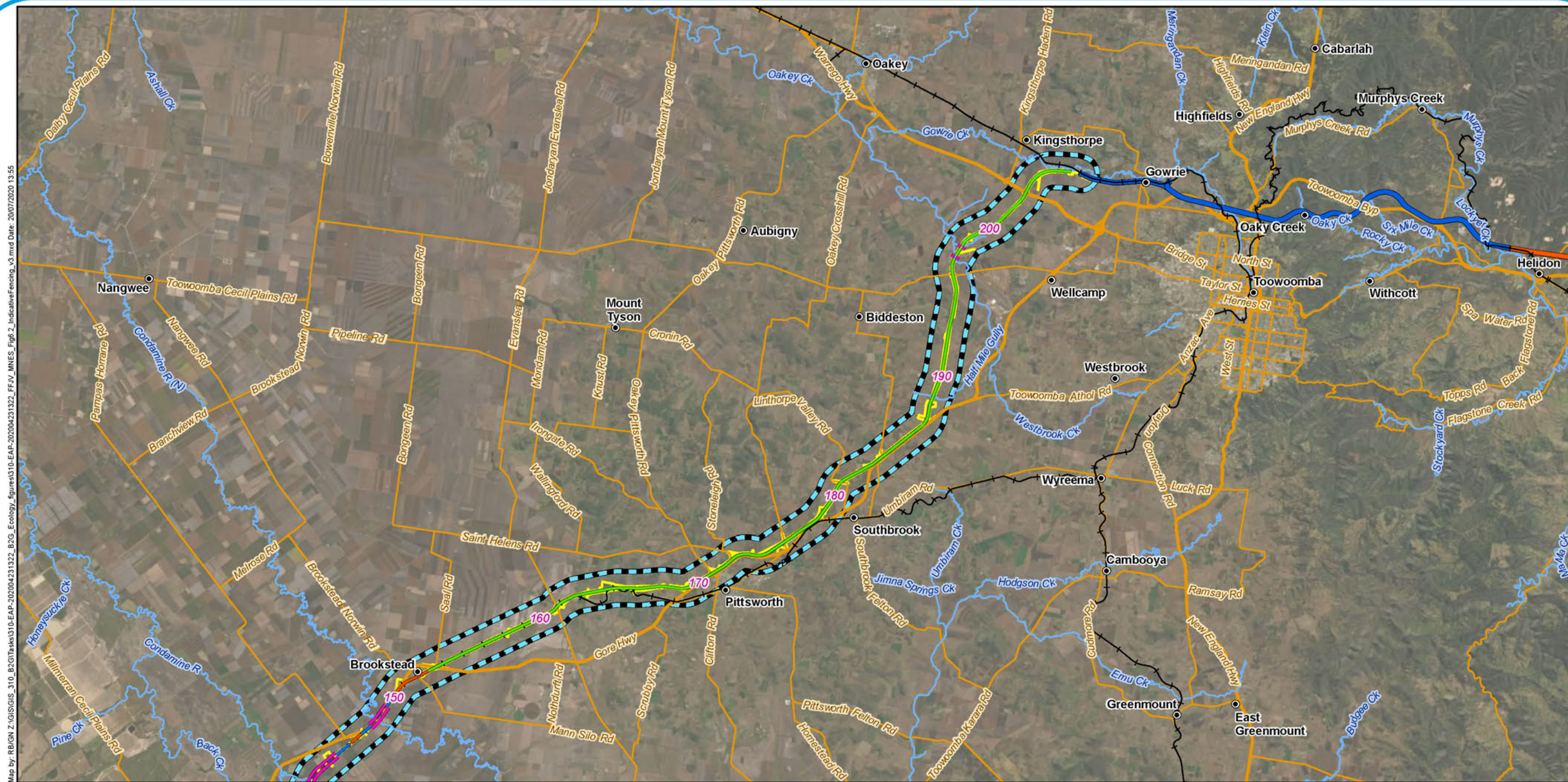
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- | | | |
|---------------------------------------|------------------------|---|
| 5 Chainage (km) | Major roads | Fence type |
| ● Localities | Minor roads | — Fauna exclusion fencing 150m either side of chainage (exclude crossing point) |
| — Existing rail (operational) | Watercourses | — Guide posts only |
| - - - Existing rail (non-operational) | Project footprint | — Standard chain link boundary fence |
| | Impact assessment area | — Standard rural chain wire |



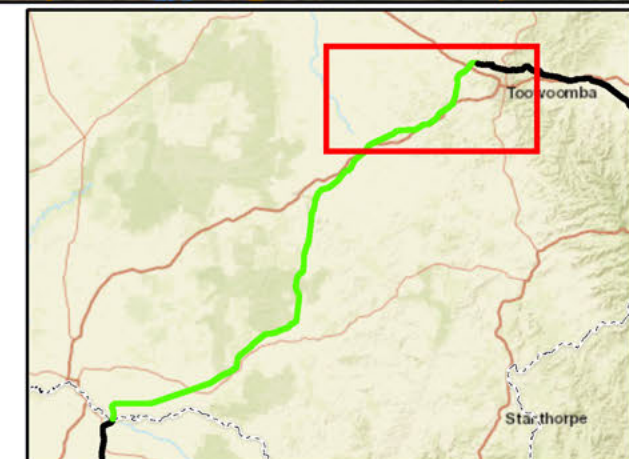
A3 scale: 1:250,000

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Legend

- | | | |
|-----------------------------------|------------------------|---|
| 5 Chainage (km) | Major roads | Fence type |
| ● Localities | Minor roads | — Fauna exclusion fencing 150m either side of chainage (exclude crossing point) |
| — Gowrie to Helidon alignment | Watercourses | — Guide posts only |
| — Helidon to Calvert alignment | Project footprint | — Standard chain link boundary fence |
| — Existing rail (operational) | Impact assessment area | — Standard rural chain wire |
| — Existing rail (non-operational) | | |



A3 scale: 1:250,000



7 Impact assessment

Potential flora and fauna impacts during construction, commissioning/reinstatement and operation have been assessed in accordance with the qualitative impact assessment methodology outlined in Section 3.4.

Potential impacts to environmental values due to construction of the Project are summarised in Section 7.2 and have been assessed in Sections 8, 8.2 and 8.3. For the purposes of impact assessment, the maximum potential direct disturbance to each MNES (i.e. areas identified using the predictive habitat mapping) have been used. This mapping assumes the presence of species if habitat has been identified as being present (i.e. habitat has been used as a proxy for species presence). This represents an application of the precautionary approach and provides a highly conservative, overestimate of Project impacts. Given the highly conservative approach adopted, impacts identified represent the maximum potential impact and assume a “worst-case” scenario in relation to the Project’s disturbance. The impacts identified during this assessment are expected to be significantly reduced through detail design as the Project disturbance footprint is refined and confirmed.

ARTC are committed to undertaking detailed ecological surveys throughout the Project footprint in parallel to the development of the detail design. The quantification of impacts to MNES will be updated, as necessary, following the conclusion of detailed ecological surveys of the Project footprint. Conclusions from the updated impact assessment will be used to refine the quantification of significant residual impacts and confirm the biodiversity offset requirements for the Project.

7.1 Quantification of potential magnitude of direct impacts

Estimations of the potential magnitude of disturbance (i.e. clearing as a result of the Project) was undertaken for each MNES, using the total quantity of habitat as identified in Table 7.1.

The table also provides an estimate of the total extent of habitat within the impact assessment area for each MNES and the per cent of this habitat being disturbed as a result of the Project.

Table 7.1 Estimation of potential magnitude of disturbance for each of the matters of national environmental significance identified for the Project

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the Project footprint (ha) ^{1, 2, 3, 4}				Percentage (%) disturbance to MNES within the impact assessment area				Magnitude of disturbance area ^{5,6}
				Potential habitat	Important habitat	Habitat critical to the survival of the species	Total Habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species	Total Habitat	
Threatened ecological communities												
Brigalow (<i>Acacia harpophylla</i> dominant and codominant)		-	E	-	-	-	62.89	-	-	-	12.48	Moderate
Natural grassland on basalt and fine-textured alluvial plains on northern NSW and southern QLD		-	E	-	-	-	0.00	-	-	-	0.00	Absent- not applicable
Weeping Myall Woodlands		-	E	-	-	-	81.92	-	-	-	5.02	Moderate
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		-	E	-	-	-	0.00	-	-	-	0.00	Absent- not applicable
Poplar Box Grassy Woodland on Alluvial Plains		-	E	-	-	-	81.92	-	-	-	5.02	Moderate
Flora (threatened)												
<i>Acacia lauta</i>	Tara wattle	V	V	295.85	0.00	0.00	295.85	5.37	0.00	0.00	5.37	Moderate
<i>Arthraxon hispidus</i>	Hairy-joint grass	V	V	33.09	0.00	0.00	33.09	3.98	0.00	0.00	3.98	Moderate
<i>Bertya opposens</i>	-	LC	V	10.60	0.00	0.00	10.60	4.74	0.00	0.00	4.74	Moderate
<i>Cadellia pentastylis</i>	Ooline	V	V	4.56	0.00	0.00	4.56	1.44	0.00	0.00	1.44	Low
<i>Clematis fawcettii</i>	Stream clematis	V	V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Negligible
<i>Dichanthium queenslandicum</i>	King blue- grass	V	E	116.65	0.00	5.29	121.94	11.79	0.00	22.25	12.03	Moderate
<i>Dichanthium setosum</i>	Bluegrass	LC	V	60.49	0.00	0.00	60.49	8.72	0.00	0.00	8.72	Moderate
<i>Eucalyptus virens</i>	Shiny-leaved ironbark	V	V	292.55	0.00	0.00	292.55	5.73	0.00	0.00	5.73	Moderate
<i>Homopholis belsonii</i>	Belson's panic	V	V	287.69	0.00	3.19	290.88	6.40	0.00	23.00	6.45	Moderate
<i>Lepidium monoplacoides</i>	Winged peppercress	LC	E	329.61	0.00	40.91	370.52	5.59	0.00	16.74	6.04	Moderate
<i>Lepidium peregrinum</i>	Wandering pepper-cress	LC	E	50.39	0.00	0.00	50.39	6.20	0.00	0.00	6.20	Moderate
<i>Leucopogon</i> sp. Coolmunda (D. Halford Q 1635)	Coolmunda leucopogon	E	E	48.20	0.00	0.00	48.20	7.38	0.00	0.00	7.38	Moderate

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the Project footprint (ha) ^{1, 2, 3, 4}				Percentage (%) disturbance to MNES within the impact assessment area				Magnitude of disturbance area ^{5,6}
				Potential habitat	Important habitat	Habitat critical to the survival of the species	Total Habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species	Total Habitat	
<i>Macrozamia machinii</i>	-	V	V	77.72	0.00	0.00	77.72	5.20	0.00	0.00	5.20	Moderate
<i>Picris evae</i>	Hawkweed	V	V	575.31	0.00	18.68	593.99	10.95	0.00	11.11	10.95	Moderate
<i>Prostanthera sp. Dunmore</i>	Dunmore Prostanthera	V	V	105.84	0.00	0.00	105.84	8.60	0.00	0.00	8.60	Moderate
<i>Rhaponticum australe</i>	Austral cornflower	V	V	220.24	0.00	2.29	222.53	9.54	0.00	3.56	9.38	Moderate
<i>Sophora fraseri</i>	Brush Sophora	V	V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Negligible
<i>Thesium australe</i>	Austral toadflax	V	V	202.59	0.00	0.00	202.59	9.22	0.00	0.00	9.22	Moderate
<i>Tylophora lineari</i>	Slender Tylophora	E	E	229.42	0.00	0.00	229.42	6.23	0.00	0.00	6.23	Moderate
<i>Xerothamnella herbacea</i>	-	E	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Negligible
<i>Westringia parvifolia</i>	<i>Westringia</i>	V	V	66.97	0.00	0.00	66.97	10.86	0.00	0.00	10.86	Moderate
Fauna (threatened)												
<i>Anthochaera phrygia</i>	Regent honeyeater	E	CE	157.39	0.00	0.00	157.39	7.49	0.00	0.00	7.49	Moderate
<i>Botaurus poiciloptilus</i>	Australasian bittern	LC	E	44.98	0.00	0.00	44.98	4.87	0.00	0.00	4.87	Moderate
<i>Calidris ferruginea</i>	Curlew sandpiper	E	CE, M	13.80	0.00	0.00	13.80	8.24	0.00	0.00	8.24	Moderate
<i>Erythrotriorchis radiatus</i>	Red goshawk	E	V	224.63	0.00	114.71	339.34	5.37	0.00	5.40	5.38	Moderate
<i>Falco hypoleucos</i>	Grey falcon	V	V	838.71	0.00	0.00	838.71	6.28	0.00	0.00	6.28	Moderate
<i>Geophaps scripta scripta</i>	Squatter pigeon - southern subspecies	V	V	339.34	0.00	0.00	339.34	5.41	0.00	0.00	5.41	Moderate
<i>Grantiella picta</i>	Painted honeyeater	V	V	432.99	0.00	0.00	432.99	5.91	0.00	0.00	5.91	Moderate
<i>Lathamus discolor</i>	Swift parrot	E	CE	20.12	0.00	243.54	263.66	9.14	0.00	5.61	5.78	Moderate
<i>Rostratula australis</i>	Australian painted snipe	E	E	0.00	0.00	44.98	44.98	0.00	0.00	4.87	4.87	Moderate
<i>Turnix melanogaster</i>	Black-breasted button-quail	V	V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Negligible
<i>Maccullochella peelii</i>	Murray cod	-	V	7.76	0.00	5.06	12.82	4.16	0.00	3.12	3.67	Moderate

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the Project footprint (ha) ^{1, 2, 3, 4}				Percentage (%) disturbance to MNES within the impact assessment area				Magnitude of disturbance area ^{5,6}
				Potential habitat	Important habitat	Habitat critical to the survival of the species	Total Habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species	Total Habitat	
<i>Chalinolobus dwyeri</i>	Large-eared pied bat	V	V	54.95	0.00	0.00	54.95	5.16	0.00	0.00	5.16	Moderate
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed quoll	V	E	65.93	0.00	15.49	81.42	7.04	0.00	2.73	5.41	Moderate
<i>Nyctophilus corbeni</i>	South-eastern long-eared bat	V	V	344.10	0.00	0.00	344.10	5.41	0.00	0.00	5.41	Moderate
<i>Petauroides volans volans</i>	Greater glider	V	V	198.42	0.00	0.00	198.42	7.40	0.00	0.00	7.40	Moderate
<i>Petrogale penicillata</i>	Brush-tailed rock-wallaby	V	V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Negligible
<i>Phascolarctos cinereus</i>	Koala	V	V	11.91	0.00	481.15	493.06	6.62	0.00	6.08	6.09	Moderate
<i>Pteropus poliocephalus</i>	Grey-headed flying-fox	LC	V	110.38	0.00	0.10	110.48	11.44	0.00	0.13	10.58	Moderate
<i>Anomalopus mackayi</i>	Five-clawed worm-skink	E	V	161.58	16.68	0.00	178.26	6.03	8.58	0.00	6.20	Moderate
<i>Delma torquata</i>	Collared delma	V	V	0.00	295.76	0.00	295.76	0.00	6.29	0.00	6.29	Moderate
<i>Egernia rugosa</i>	Yakka skink	V	V	364.47	0.00	0.00	364.47	5.15	0.00	0.00	5.15	Moderate
<i>Furina dunmalli</i>	Dunmall's snake	V	V	0.00	298.85	0.00	298.85	0.00	5.30	0.00	5.30	Moderate
<i>Tympanocryptis condaminensis</i>	Condamine earless dragon	E	E	227.66	0.00	17.93	245.59	7.50	0.00	5.11	7.25	Moderate
<i>Adclarkia cameroni</i>	Brigalow woodland snail	V	E	131.46	0.00	0.00	131.46	10.01	0.00	0.00	10.01	Moderate

Table notes:

CE = Critically endangered E = Endangered V = Vulnerable M = Migratory LC = Least concern - = Not listed

1 Area of Project footprint: 3,203.78 ha

2 No value (i.e. 0) represents areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design. MNES that recorded a magnitude of "Not applicable" were not subject to an assessment of impact significance as the Sensitive environmental receptor was not subject to impacts.

3 There is potential for each of the Sensitive environmental receptor impacts to overlap spatially. As a result, addition of disturbance values presented in the above table would not represent a true reflection of the total Project footprint.

4 Refer Table 4.4 for areas of habitat within the impact assessment area

5 Based on total habitat available

6 Refer Table 3.6 for magnitude criteria

7.2 Initial significance assessment

The impact assessment of the Project on MNES values is provided in Table 7.2 for TECs, Table 7.3 for threatened flora and Table 7.4 for threatened fauna. these tables present both the initial impact significance (i.e. application of mitigation measures already incorporated into the reference design) and the residual significance of impact following the application of Project mitigation measures.

In addition to the mitigation measures presented in Section 6.2, rehabilitation works may also be an effective mitigation measure to minimise potential impacts over time. However, the potential significant adverse residual impacts are likely to require some level of offset (refer Section 9).

The initial assessment of impacts has taken a conservative approach and those MNES that returned an impact rating of Major, High, Moderate or Low were subsequently re-assessed against the MNES significant impact guidelines to confirm the initial impact assessment results (refer Sections 8, 8.2 and 8.3).

Table 7.2 Initial impact assessment of the Project upon identified matters of national environmental significance – Threatened ecological communities

Sensitivity ¹	Phase	Potential impacts ²	Initial impact significance (application of initial mitigation measures presented in Section 6.1)		Residual impact significance following the application of Project mitigation measures presented in Table 6.1 and Table 6.2 ³	
			Magnitude ¹	Significance	Magnitude	Significance
TECs - Brigalow (<i>Acacia harpophylla</i> dominant and codominant), Weeping Myall woodlands, White box-Yellow box woodlands, Natural grasslands and Poplar box grassy woodlands						
High	Construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora and fauna species from invasion of weed and pest species Edge effects Dust impacts Erosion and sedimentation Flooding	Moderate	High	Low	Moderate (refer to Section 8 for assessment against MNES Impact guidelines)
	Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation Flooding	Low	Moderate	Negligible	Low
	Operation	Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation Flooding	Negligible	Low	Negligible	Low

Table notes:

- 1 Refer Section 3.4 for 'sensitivity' and 'magnitude' criteria.
- 2 Potential impacts to MNES in the above table are based upon those presented in Section 5.2, derived from predictive habitat mapping
- 3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer Section 9 for information relating to the use of offset to compensate Project related impacts that are not sufficiently reduced in the above table.

Table 7.3 Initial impact assessment of the Project upon identified matters of national environmental significance – threatened flora

Sensitivity ¹	Phase	Potential impacts ²	Initial impact significance (application of initial mitigation measures presented in Section 6.1)		Residual impact significance following the application of Project mitigation measures presented in Table 6.1 and Table 6.2 ³	
			Magnitude ¹	Significance	Magnitude	Significance
King bluegrass (<i>Dichanthium queenslandicum</i>), Winged peppercress (<i>Lepidium monolocoides</i>), <i>Xerothamnella herbacea</i> , Belson’s panic (<i>Homopholis belsonii</i>), Hawkweed (<i>Picris evae</i>), Austral cornflower (<i>Rhaponticum australe</i>), and <i>Westringia parvifolia</i>						
High	Construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation Flooding	High	Major	Moderate	High (refer to Sections 8.2.1 and 8.2.3 for assessment against MNES Guidelines)
	Commissioning and reinstatement	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation Flooding	Negligible	Low	Negligible	Low
	Operation	Erosion and sedimentation Flooding	Negligible	Low	Negligible	Low
Wandering peppercress (<i>Lepidium peregrium</i>), Coolmunda leaucopogon (<i>Leucopogon</i> sp. Coolmunda), Slender tylophora (<i>Tylophora linearis</i>), Hairy-joint grass (<i>Arthraxon hispidus</i>), <i>Bertya opposens</i> , Ooline (<i>Cadellia pentastylis</i>), Bluegrass (<i>Dichanthium setosum</i>), Shiny-leaved ironbark (<i>Eucalyptus virens</i>), Dunmore Prostanthera (<i>Prostanthera</i> sp. Dunmore), <i>Macrozamia machinii</i> and Austral toadflax (<i>Thesium australe</i>)						
High	Construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation Flooding	Moderate	High	Low	Moderate (refer to Section 8.2 for assessment against MNES Guidelines)

Sensitivity ¹	Phase	Potential impacts ²	Initial impact significance (application of initial mitigation measures presented in Section 6.1)		Residual impact significance following the application of Project mitigation measures presented in Table 6.1 and Table 6.2 ³	
			Magnitude ¹	Significance	Magnitude	Significance
	Commissioning and reinstatement	Displacement of flora species from invasion of weed species Edge effects Erosion and sedimentation Flooding	Negligible	Low	Negligible	Low
	Operation	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation Flooding	Negligible	Low	Negligible	Low

Table notes:

- 1 Refer Section 3.4 for 'sensitivity' and 'magnitude' criteria.
- 2 Potential impacts to MNES in the above table are based upon those presented in Section 5.2.
- 3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer Section 9 for information relating to the use of offset to compensate Project related impacts that are not sufficiently reduced in the above table.

Table 7.4 Initial impact assessment of the Project upon identified matters of national environmental significance – threatened fauna

Sensitivity ¹	Phase	Potential impacts ²	Initial impact significance (application of initial mitigation measures presented in Section 6.1)		Residual impact significance following the application of Project mitigation measures presented in Table 6.1 and Table 6.2 ³	
			Magnitude ¹	Significance	Magnitude	Significance
Murray cod						
High	Construction	Habitat loss from temporary waterway impoundment Displacement of fauna species from invasion of weed and pest species Barrier effects Dust impacts Aquatic habitat degradation Erosion and sedimentation Flooding	Moderate	High	Low	Moderate (refer to Section 8.3.3 for assessment against MNES Impact guidelines)
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Aquatic habitat degradation Erosion and sedimentation	Low	Moderate	Negligible	Low
	Operation	Erosion and sedimentation	Negligible	Low	Negligible	Low
Wetland birds: Australian painted snipe, Australasian bittern and Curlew sandpiper						
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation Flooding	Moderate	High	Low	Moderate (refer to Section 8.3.1 for assessment against MNES Guidelines)
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation Flooding	Low	Moderate	Negligible	Low

Sensitivity ¹	Phase	Potential impacts ²	Initial impact significance (application of initial mitigation measures presented in Section 6.1)		Residual impact significance following the application of Project mitigation measures presented in Table 6.1 and Table 6.2 ³	
			Magnitude ¹	Significance	Magnitude	Significance
	Operation	Displacement of fauna species from invasion of weed and pest species Light impacts Erosion and sedimentation Flooding	Negligible	Low	Negligible	Low
Condamine earless dragon, Five-clawed worm-skink, Dunmall's snake, Squatter pigeon, South-eastern long-eared bat and Koala						
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts Flooding	High	Major	Moderate	High (refer to Sections 8.3.1 and 8.3.3 for assessment against MNES Guidelines)
	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts Flooding	Low	Moderate	Negligible	Low
	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts Flooding	Negligible	Low	Negligible	Low

Sensitivity ¹	Phase	Potential impacts ²	Initial impact significance (application of initial mitigation measures presented in Section 6.1)		Residual impact significance following the application of Project mitigation measures presented in Table 6.1 and Table 6.2 ³	
			Magnitude ¹	Significance	Magnitude	Significance
Collared delma, Yakka skink, Spotted-tail quoll, Greater glider and Large-eared pied bat and Brigalow woodland snail						
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts Flooding	Moderate	High	Low	Moderate (refer to Section 8.3 for assessment against MNES Guidelines)
	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts Flooding	Low	Moderate	Negligible	Low
	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts Flooding	Low	Moderate	Negligible	Low
Grey-headed flying-fox						
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Noise, dust, and light impacts Aquatic habitat degradation	Moderate	High	Low	Moderate (refer to Section 8.3 for assessment against MNES Guidelines)

Sensitivity ¹	Phase	Potential impacts ²	Initial impact significance (application of initial mitigation measures presented in Section 6.1)		Residual impact significance following the application of Project mitigation measures presented in Table 6.1 and Table 6.2 ³	
			Magnitude ¹	Significance	Magnitude	Significance
	Commissioning and reinstatement	Noise, dust, and light impacts Aquatic habitat degradation	Negligible	Low	Negligible	Low
	Operation	Light impacts	Negligible	Low	Negligible	Low
Woodland birds: Swift parrot, Painted honeyeater, Regent honeyeater and Red goshawk, Grey falcon						
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation	Moderate	High	Low	Moderate (refer to Section 8.3 for assessment against MNES Guidelines)
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation	Negligible	Low	Negligible	Low
	Operation	Displacement of fauna species from invasion of weed and pest species Noise and light impacts	Negligible	Low	Negligible	Low

Table notes:

- 1 Refer Section 3.4 for 'sensitivity' and 'magnitude' criteria.
- 2 Potential impacts to MNES in the above table are based upon those presented in Section 5.2.
- 3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer Section 9 relating to the use of offset to compensate Project related impacts that are not sufficiently reduced in the above table.

8 Significant residual impact assessment

8.1 Significant residual impact assessment for threatened ecological communities

Of the eight TECs identified from the desktop assessment, five have potential to occur within the impact assessment area. These TECs consist of the following:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland
- Weeping Myall Woodlands
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland)
- Poplar Box Grassy Woodland on Alluvial Plains.

Assessment of the significance of impact in accordance with the criteria contained within the MNES Guidelines has been undertaken for all TECs that are known or have potential to occur within the impact assessment area. In accordance with the guidelines an action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
- Adversely affect habitat critical to the survival of an ecological community
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
 - Assisting invasive species, that are harmful to the listed ecological community, to become established, or
 - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community
- Interfere with the recovery of an ecological community.

Detailed surveys throughout the Project footprint have not been carried out as yet. The extent of each TEC within the Project footprint detailed in the following impact assessments has been based on the results of the desktop review which relies on State-based vegetation mapping. As noted in Section 4.2.1.2 the current State-based mapping will likely not reflect the actual extent of the TECs on the ground. Further surveys (including pre-clearing surveys) will be carried out as part of the Project development process to verify the accuracy of the vegetation mapping and the extent to which TEC vegetation actually occurs within the Project disturbance footprint, as confirmed through detail design. Surveys will assess the potential presence of TECs using the diagnostic criteria and condition thresholds detailed in the relevant approved conservation advice for each community (refer Table 6.2 and Section 10). The significant residual impact assessment for TECs will be updated, as necessary, following the conclusion of detailed ecological surveys of the Project footprint. Conclusions from the updated significant residual impact assessments will be used to refine the currently conservative quantification of significant residual impacts and confirm the biodiversity offset requirements for the Project.

A range of mitigation measures have been proposed to ameliorate potential impacts to occurrences of TEC (where they are found to occur) wherever possible (refer specific measures in Table 6.2). These include measures considered as effective in addressing the recognised threats for the occurrences of TEC as recognised in the approved conservation advice, and DAWE-adopted threat abatement plans including but not restricted to:

- MNES Monitoring Plan will incorporate monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent occurrences of TEC is not occurring as a result of the Project
- Biosecurity Management Sub-Plan to protect flora habitats adjacent to the Project from deleterious impacts including weed invasion, pest fauna and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*)
- Erosion and Sediment Control Plan including soil conservation measures and erosion and sediment controls with specific reference/controls to identified TEC areas
- Rehabilitation and Landscaping Management Sub-plan to detail rehabilitation of temporary construction areas not required for Project operation.

The assessment of significant impacts on the identified MNES flora species from the Project is based on:

- Habitat modelling based on existing vegetation mapping and TEC descriptions (Section 4.3.1.3)
- The design and layout of the Project (Section 1.8)
- Information on potential impacts of Project during construction and operation (Section 5.2)
- Proposed Project mitigation measures (Section 6 and Table 7.2).

The significant impact criteria was applied to each TEC in order to assess the potential for significant residual impact to the identified TECs. Assessment against the significant impact criteria for each TEC is presented in the following tables:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (refer Table 8.1),
- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC (refer Table 8.2),
- Weeping Myall Woodlands TEC (refer Table 8.3)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland) TEC (refer Table 8.4)
- Poplar Box Grassy Woodland on Alluvial Plains TEC (refer Table 8.5).

Table 8.1 **Assessment of the Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC**

Significant impact criteria	Potential impact to TEC ¹
Reduce the extent of an ecological community	Yes – This TEC has been confirmed as present in southern sections of the Project footprint. Current vegetation mapping suggests tracts of this TEC (62.89 ha in total) may be removed as part of the proposed works. The actual extent of this TEC within the footprint will be confirmed through detailed ecological surveys of the Project footprint in parallel to the development of the detail design.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	Yes – This TEC has been confirmed as present in southern sections of the Project footprint. The project is linear in nature and will cause fragmentation to this TEC
Adversely affect habitat critical to the survival of an ecological community	Yes – Areas of land currently containing this TEC will be used to construct the Project.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	No – The Project is not considered likely to alter hydrology and or modify abiotic factors essential to the survival of the TEC
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	No – Land rehabilitation and management of weeds will be undertaken as part of the Project mitigation measures. It is expected that these activities will reduce the likelihood of significant alterations to species diversity associated with the TEC
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - Assisting invasive species, that are harmful to the listed ecological community, to become established, or - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	No - The Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (DSEWPaC 2011d) is considered applicable to this community. Cane toads are already likely to be present in the Project impact assessment area. Threats, will be managed by the following measures: Land rehabilitation and management of pests and weeds will be undertaken as part of the Project mitigation measures (refer Table 7.2). In addition, management measures will be in place to reduce the risk of herbicides, chemicals, run-off and sediment entering the TEC. These control measures are likely to remove any chance of a substantial reduction in the quality or integrity of an occurrence of an ecological community.
Interfere with the recovery of an ecological community	Yes – Predictive habitat mapping indicates that the Project may result in the removal of up to 62.89 ha of this TEC. Any removal of this TEC will affect the recovery of the ecological community
Likelihood of significant residual impact	Significant residual impact likely

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

Table 8.2 Assessment of the Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC

Significant impact criteria	Potential impact to TEC ¹
Reduce the extent of an ecological community	No – Although this community is mapped as occurring within the impact assessment area (0.95 ha) no areas of this TEC are mapped as occurring within the Project footprint. This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design. If the absence of this TEC is confirmed by surveys, the Project will not reduce the extent of an occurrence of this community. Where field surveys confirm the presence of this TEC, then during detail design consideration will be given to measures to avoid or minimise the impact to the TEC, and then an offset will be provided for any significant residual impact in accordance with the Environmental Offset Delivery Strategy for the Project
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	No – Based on the mapped extent of this TEC, the Project is not expected to fragment or increase fragmentation of the TEC.
Adversely affect habitat critical to the survival of an ecological community	No – Mapping indicates that there are no areas of land comprising this TEC that will be used to construct the Project
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	No – Based on the mapped extent of this TEC, the Project is not expected to result in the modification of abiotic factors essential to the survival of an occurrence of the TEC
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	No – Land rehabilitation and management of weeds will be undertaken as part of the Project mitigation measures. It is expected that these activities will reduce the likelihood of any potential substantial alterations to species diversity associated with the TEC
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - Assisting invasive species, that are harmful to the listed ecological community, to become established, or - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	No – Land rehabilitation and management of pests and weeds will be undertaken as part of the Project mitigation measures. In addition, management measures will be in place to reduce the risk of herbicides, chemicals, run-off and sediment impacting an occurrence of the TEC. Therefore, the Project is not expected to cause a substantial reduction in the quality or integrity of an occurrence of an ecological community
Interfere with the recovery of an ecological community	No – Based on the mapped extent of this TEC, the Project is not expected to directly or indirectly interfere with the recovery of this TEC.
Likelihood of significant residual impact	Significant residual impact unlikely

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

Table 8.3 Assessment of the Weeping Myall Woodlands TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC

Significant impact criteria	Potential impact to TEC ¹
Reduce the extent of an ecological community	Yes – Current vegetation mapping suggests tracts of this TEC (a maximum of 81.92 ha in total) may be removed as part of the proposed works. The occurrence and/or extent of this TEC within the footprint will be confirmed by detailed ecological surveys undertaken in parallel to development of the detail design.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	Yes – Mapping indicates that 81.92 ha of this TEC may occur within the Project footprint. The Project is linear in nature and will cause fragmentation to this TEC should it be found to occur.
Adversely affect habitat critical to the survival of an ecological community	Yes – Mapping indicates that 81.92 ha of this TEC may occur within the Project footprint. Areas of land potentially containing this TEC may be used to construct the Project. Should the TEC be present the Project will adversely affect habitat critical to the survival of the TEC
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	No – The Project is not considered likely to alter hydrology and or modify biotic or abiotic factors essential to the survival of the TEC
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	No – Land rehabilitation and management of weeds will be undertaken as part of the Project mitigation measures. It is expected that these activities will reduce the likelihood of significant alterations to species diversity associated with the TEC
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - Assisting invasive species, that are harmful to the listed ecological community, to become established, or - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	No - The Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (DEWHA 2011) is considered applicable to this community. Cane toads are already likely to be present in the Project impact assessment area. Threats, will be managed by the following measures: Land rehabilitation and management of pests and weeds will be undertaken as part of the Project mitigation measures (refer Table 7.2). In addition, management measures will be in place to reduce the risk of herbicides, chemicals, run-off and sediment entering the TEC. These control measures are likely to remove any chance of a substantial reduction in the quality or integrity of an occurrence of an ecological community.
Interfere with the recovery of an ecological community	Yes – Predictive habitat mapping indicates that the Project may result in the removal of 81.92 ha of this TEC. Any removal of this TEC will affect the recovery of the ecological community
Likelihood of significant residual impact	Significant residual impact possible (TEC presence requires confirmations)

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

Table 8.4 **Assessment of the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland) TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC**

Significant impact criteria	Potential impact to TEC ¹
Reduce the extent of an ecological community	No – Although this community is mapped as occurring within the impact assessment area (36.31 ha) no areas of this TEC are mapped as occurring within the Project footprint. This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design. If the absence of this TEC is confirmed by surveys, the Project will not reduce the extent of an occurrence of this community. Where field surveys confirm the presence of this TEC, then during detail design consideration will be given to measures to avoid or minimise the impact to the TEC, and then an offset will be provided for any significant residual impact in accordance with the Environmental Offset Delivery Strategy for the Project
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	No – Based on the mapped extent of this TEC, the Project is not expected to fragment or increase fragmentation of this TEC
Adversely affect habitat critical to the survival of an ecological community	No – Mapping indicates that there are no areas of land comprising this TEC that will be used to construct the Project
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	No – Based on the mapped extent of this TEC, the Project is not expected to result in the modification of abiotic factors essential to the survival of an occurrence of the TEC
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	No – Land rehabilitation and management of weeds will be undertaken as part of the Project mitigation measures. It is expected that these activities will reduce the likelihood of any potential substantial alterations to species diversity associated with the TEC
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - Assisting invasive species, that are harmful to the listed ecological community, to become established, or - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	No – Land rehabilitation and management of pests and weeds will be undertaken as part of the Project mitigation measures. In addition, management measures will be in place to reduce the risk of herbicides, chemicals, run-off and sediment impacting an occurrence of the TEC. Therefore, the Project is not expected to cause a substantial reduction in the quality or integrity of an occurrence of an ecological community
Interfere with the recovery of an ecological community	No – Based on the mapped extent of this TEC, the Project is not expected to directly or indirectly interfere with the recovery of this TEC
Likelihood of significant residual impact	Significant residual impact unlikely

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

Table 8.5 Assessment of the Poplar Box Grassy Woodland on Alluvial Plains TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered TEC

Significant impact criteria	Potential impact to TEC ¹
Reduce the extent of an ecological community	Yes – Current vegetation mapping suggests tracts of this TEC (a maximum of 81.92 ha in total) may be removed as part of the proposed works. The occurrence and/or extent of this TEC within the footprint will be confirmed by detailed ecological surveys undertaken in parallel to development of the detail design.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	Yes – Mapping indicates that 81.92 ha of this TEC may occur within the Project footprint. The Project is linear in nature and will cause fragmentation to this TEC should it be found to occur.
Adversely affect habitat critical to the survival of an ecological community	Yes – Mapping indicates that 81.92 ha of this TEC may occur within the Project footprint. Areas of land potentially containing this TEC may be used to construct the Project. Should the TEC be present the Project will adversely affect habitat critical to the survival of the TEC
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	No – The Project is not considered likely to alter hydrology and or modify biotic or abiotic factors essential to the survival of the TEC
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	No – Land rehabilitation and management of weeds will be undertaken as part of the Project mitigation measures. It is expected that these activities will reduce the likelihood of significant alterations to species diversity associated with the TEC
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - Assisting invasive species, that are harmful to the listed ecological community, to become established, or - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	No – Land rehabilitation and management of pests and weeds will be undertaken as part of the Project mitigation measures (refer Table 7.2). In addition, management measures will be in place to reduce the risk of herbicides, chemicals, run-off and sediment entering the TEC. These control measures are likely to remove any chance of a substantial reduction in the quality or integrity of an occurrence of an ecological community.
Interfere with the recovery of an ecological community	Yes – Predictive habitat mapping indicates that the Project may result in the removal of 81.92 ha of this TEC. Any removal of this TEC will affect the recovery of the ecological community
Likelihood of significant residual impact	Significant residual impact possible (TEC presence requires confirmations)

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

In consideration of Table 8.1 significant adverse residual impacts **are likely to occur**, based on predictive habitat modelling and mapping, to the following TEC:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC: estimated quantum of significant residual impacts = 62.89 ha.

In consideration of Table 8.3 and Table 8.5 significant adverse residual impacts **have potential to occur**, based on predictive habitat modelling and mapping, to the following TECs:

- In Weeping Myall Woodlands TEC: estimated quantum of significant residual impact = 81.92 ha
- Poplar Box Grassy Woodland on Alluvial Plains TEC: estimated quantum of significant residual impact = 81.92 ha.

In consideration of Table 8.2 and Table 8.4 significant adverse residual impacts **are not likely to occur**, based on predictive habitat modelling and mapping, to the following TECs:

- Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland).

ARTC are committed to undertaking detailed ecological surveys throughout the Project footprint to further verify and delineate the vegetation communities that are present, including TECs and their relevant thresholds and diagnostic characteristics. The significant residual impact assessment for TECs will be updated, as necessary, following the conclusion of detailed ecological surveys of the Project footprint (refer Table 6.1). Conclusions from the updated significant residual impact assessments will be used to refine the quantification of significant residual impacts and confirm the biodiversity offset requirements for the Project.

8.2 Significant residual impact assessment for threatened flora

This section assesses the potential for significant residual impacts from the Project on each MNES using the relevant criteria outlined in the MNES Guidelines. Within the MNES Guidelines there are specific criteria depending on whether the species is listed as critically endangered or endangered compare to a species listed as vulnerable. Key terms relevant to the assessment include:

- A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable species, occurrences include but are not limited to:
 - A geographically distinct regional population, or collection of local populations, or
 - A population, or collection of local populations, that occurs within a particular bioregion.
- An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.
- 'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:
 - For activities such as foraging, breeding, roosting, or dispersal
 - For long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
 - To maintain genetic diversity and long-term evolutionary development
 - For the reintroduction of populations or recovery of the species or ecological community.

Such habitats may be, but are not limited to:

- Habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community
- Habitat listed on the register of Critical Habitat maintained by the minister under the EPBC Act.

The following sections assess the potential for significant residual impacts on the six endangered and 15 vulnerable flora species identified as potentially occurring within the Project footprint using the criteria set out in the MNES Guidelines.

The ecology, life history and distribution of these species are summarised in Appendix B. Relevant Commonwealth documents applicable to each species including threat abatement plans, approved conservation advice, and recovery plans are also summarised in Appendix B.

Key impacts to terrestrial threatened flora are considered to be restricted to direct clearing of individuals/populations. Given the degraded nature of the majority of the woodlands within the Project footprint (due to vegetation clearance, previous tree thinning and weed invasion) indirect impacts such as edge effects (such as dust deposition) are considered to be suitably mitigated under the Projects mitigation measures and restricted to the construction period (refer Section 6.2). These include measures considered as effective in addressing the recognised threats for the occurrences of TEC as recognised in the approved conservation advice, and DAWE-adopted threat abatement plans including but not restricted to:

- MNES Monitoring Plan will incorporate monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent occurrences of TEC is not occurring as a result of the Project
- Biosecurity Management Plan to protect flora habitats adjacent to the Project from deleterious impacts including weed invasion, pest fauna and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*)
- Erosion and Sediment Control Plan including soil conservation measures and erosion and sediment controls with specific reference/controls to identified TEC areas

Rehabilitation and Landscaping Management Sub-plan to detail rehabilitation of temporary construction areas not required for Project operation. The assessment of significant impacts on the identified MNES species from the Project is based on:

- The current understanding and layout of the Project (refer Section 1)
- Currently known information about the MNES affected (refer Appendix B)
- Predictive habitat modelling for each species (refer Table 7.1) based on the habitat assumptions associated with each species (refer Appendix A)
- The design and layout of the Project (refer Section 1.8 and EIS Chapter 5: Project Description)
- Information on potential impacts of Project construction and operation (refer Section 5.2)
- Proposed Project mitigation measures (refer Sections 6.1 and 6.2).

A summary of the findings of the assessment of the significant residual impact assessment for threatened flora is provided in Table 8.6. Section 8.2.1 provides the significant impact assessment for Critically endangered and endangered species, and Section 8.2.3 provides the significant impact assessment for vulnerable species.

Table 8.6 Summary of the results of the significant impact assessment for matters of national environmental significance flora species

Flora species	EPBC Act status ¹	Results of assessment ²	Table containing assessment against MNES guidelines
King blue-grass (<i>Dichanthium queenslandicum</i>)	Endangered	Likely significant residual impact	Table 8.7
Winged peppercress (<i>Lepidium monoplacoides</i>)	Endangered	Potential significant residual impact	Table 8.8
Wandering pepper-cress (<i>Lepidium peregrium</i>)	Endangered	No significant residual impact expected	Table 8.9
Coolmunda leucopogon (<i>Leucopogon</i> sp. Coolmunda) (D. Halford Q 1635)	Endangered	No significant residual impact expected	Table 8.10
Slender tylophora (<i>Tylophora linearis</i>)	Endangered	No significant residual impact expected	Table 8.11
<i>Xerothamnella herbacea</i>	Endangered	No significant residual impact expected	Table 8.12

Flora species	EPBC Act status ¹	Results of assessment ²	Table containing assessment against MNES guidelines
Tara wattle (<i>Acacia lauta</i>)	Vulnerable	No significant residual impact expected – no important populations or Habitat critical to the survival of the species are mapped as present	Table 8.13
Hairy-joint grass (<i>Arthraxon hispidus</i>)	Vulnerable	No significant residual impact expected – no important populations or Habitat critical to the survival of the species are mapped as present	Table 8.13
<i>Bertya opposens</i>	Vulnerable	No significant residual impact expected – no important populations or Habitat critical to the survival of the species are mapped as present	Table 8.13
Ooline (<i>Cadellia pentastylis</i>)	Vulnerable	No significant residual impact expected – no important populations or Habitat critical to the survival of the species are mapped as present	Table 8.13
Stream clematis (<i>Clematis fawcettii</i>)	Vulnerable	No significant residual impact expected	Table 8.13
Bluegrass (<i>Dichanthium setosum</i>)	Vulnerable	No significant residual impact expected – no important populations or Habitat critical to the survival of the species are mapped as present	Table 8.13
Shiny-leaved ironbark (<i>Eucalyptus virens</i>)	Vulnerable	No significant residual impact expected	Table 8.14
Belson's panic (<i>Homopholis belsonii</i>)	Vulnerable	Likely significant residual impact	Table 8.15
<i>Macrozamia machinii</i>	Vulnerable	No significant residual impact expected	Table 8.16
Hawkweed (<i>Picris evae</i>)	Vulnerable	Likely significant residual impact	Table 8.17
Dunmore Prostanthera (<i>Prostanthera</i> (sp. Dunmore))	Vulnerable	No significant residual impact expected – no important populations or Habitat critical to the survival of the species are mapped as present	Table 8.13
Austral cornflower (<i>Rhaponticum australe</i>)	Vulnerable	Likely significant residual impact	Table 8.18
(Brush sophora (<i>Sophora fraseri</i>))	Vulnerable	No significant residual impact expected	Table 8.13
Austral toadflax (<i>Thesium australe</i>)	Vulnerable	No significant residual impact expected – no important populations or Habitat critical to the survival of the species are mapped as present	Table 8.13
<i>Westringia parvifolia</i>	Vulnerable	No significant residual impact expected	Table 8.13

Table notes:

1 CE = Critically endangered, E = Endangered, V = Vulnerable.

2 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

ARTC are committed to undertaking detailed ecological surveys throughout the Project footprint. The significant residual impact assessment for threatened flora will be updated, as necessary, following the conclusion of detailed ecological surveys of the Project footprint (refer Table 6.1). Conclusions from the updated significant residual impact assessments will be used to refine the quantification of significant residual impacts and confirm the biodiversity offset requirements for the Project.

8.2.1 Critically endangered and endangered flora species

Under the Guidelines an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population
- Reduce the area of occupancy of the species
- Fragment an existing population into two or more populations
- Adversely affect habitat critical to the survival of the species
- Disrupt the breeding cycle of a population
- Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- Introduce disease that may cause the species to decline, or
- Interfere with the recovery of the species.

The following sections assess the potential for significant residual impacts on the six endangered flora species identified as potentially occurring within the Project footprint using the criteria set out in the MNES Guidelines.

8.2.1.1 King blue-grass (*Dichanthium queenslandicum*) - endangered

Ecology and distribution

King blue-grass is endemic to central and southern Queensland. This species occurs on black cracking clay in tussock grasslands mainly in association with other species of Bluegrass (*Dichanthium* spp. and *Bothriochloa* spp.) but also with other grasses restricted to this soil type. It is mostly confined to natural bluegrass grasslands of central and southern Queensland, including the endangered EPBC ecological community: Natural Grasslands on Basalt and Fine-textured Alluvial Plains of northern NSW and southern Queensland.

King blue-grass is endemic to central and southern Queensland where it occurs in three disjunct populations; Hughenden district; Nebo to Monto and west to Clermont and Rolleston; and Dalby district, Darling Downs. The extent of the species occurrence is thought to be reduced from 1,100 km² to 245 km² (Accad et al. 2008; DAWE 2020).

King blue-grass occurs within the southeast Queensland, Brigalow Belt South, Brigalow Belt North, Central Mackay Coast, Desert Uplands, Mitchell Grass Downs and Einasleigh Uplands Bioregions; and the southeast Queensland, Condamine, Border Rivers Maranoa-Balonne, Burnett Mary, Fitzroy, Burdekin, Mackay Whitsunday, Southern Gulf and Desert Channels Natural Resource Management regions (DAWE 2020).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Two recent records (2015 and 2016) occur on the southern edge of the Project footprint north-east of the township of Pittsworth. These records occur near the junction of the Gore Highway and Toowoomba Road and are the most southerly records of the species. The next nearest records occur along the Warrego Highway between Oakey and Dalby, approximately 30 km north-west of the northern section of the Project footprint. The majority of records for this species occur outside of a 50 km buffer north of the Project from Taroom to Collinsville. The Project associated database records occur at the southern limit of the species distribution (refer Figure 2.20 in Appendix B).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan applicable to this species. The following threat abatement plan has been identified as relevant to this species:

- *Threat abatement plan for competition and land degradation by rabbits* (DotE 2016b).

The DAWE Approved Conservation advice (DSEWPaC 2013) notes the following potentially threatening processes identified for Queensland blue-grass

- Loss of habit through agricultural and mining activities, road construction and other infrastructure developments
- Agricultural (cropping) and grazing associated activities. The species is susceptible to continuous heavy grazing regimes.
- Invasion from weeds including Parthenium (*Parthenium hysterophorus*) and Parkinsonia (*Parkinsonia aculeata*).

Important populations and Habitat critical to the survival of the species

No Habitat critical to the survival of the species has been noted in published information. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records (less than 30 years old) that intersect 'potential habitat' (refer Appendix A for methodology).

Predictive mapping indicates the impact assessment area incorporates 116.65 ha of potential habitat, and 5.29 ha of Habitat critical to the survival of the species for this species (refer Table 7.1). This habitat occurs patchily from the Pittsworth area north to Gowrie (refer habitat figure in Appendix G). The species is known from the Pittsworth area but is not known to occur elsewhere within or close to the Project alignment. Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for endangered species is shown in Table 8.7.

Table 8.7 **Assessment against the significant impact criteria: King blue-grass (*Dichanthium queenslandicum*)**

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	The Project footprint occurs on the southernmost edge of the species distribution. The species was not observed during Project-associated surveys, however recent records from 2015 and 2016 have been found to occur on the edge of the Project footprint to the north of Pittsworth. All other records of the species are from much further north of the Project. Predictive modelling indicates 116.65 ha of potential habitat, and 5.29 ha of Habitat critical to the survival of the species may occur within the Project footprint. This habitat occurs from Pittsworth area north to the northern extent of the Project, although it is uncertain to what extent the species may actually occur within this area. There is no evidence that the Project will result in a long-term decrease in the size of a population.

Criterion	Assessment against significance criteria ¹
Reduce the area of occupancy for the species	Recent records have been found to occur on the edge of the Project footprint indicating a population likely occurs in the Pittsworth area. The species is at the limit of its distribution in relation to the Project. Impacts to local populations at the limit of their distribution could result in further range contraction for the species. Predictive modelling indicates 116.65 ha of potential habitat, and 5.29 ha of Habitat critical to the survival of the species may occur within the Project footprint from Pittsworth area north to the northern extent of the Project. There is the potential for the Project to impact the area of occupancy for the species though the loss of habitat critical to the survival of the species.
Fragment an existing population into two or more populations	No records have been found to occur within the Project footprint, the species is known to occur nearby, and suitable habitat (116.65 ha of potential habitat, and 5.29 ha of critical habitat) is predicted to occur within the Project footprint. The Project is linear and relatively narrow, although it is uncertain whether this may represent a barrier for dispersal or cross-pollination for the species. There is no evidence that the Project will fragment an existing population into two or more populations the size of a population.
Adversely affect habitat critical to the survival of the species	This species is largely associated with native grasslands on dark clay soils which have been heavily impacted in the region. Predictive mapping indicates 5.29 ha of habitat considered as 'critical' to the species (for the purposes of this assessment) occurs within the Project footprint as well as a further 116.65 ha of 'potential' habitat. As such, there is potential the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	The species is known to occur on the edge of the Project footprint near Pittsworth and suitable habitat (116.65 ha of potential habitat, and 5.29 ha of critical habitat) is predicted to occur within the Project footprint. This species has been recorded flowering all year round, particularly in March. The Project may disturb individuals during construction but is considered unlikely to disrupt the breeding cycle of a population as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species is known to occur on the edge of the Project footprint near Pittsworth and suitable habitat (116.65 ha of potential habitat, and 5.29 ha of critical habitat) is predicted to occur within the Project footprint. The species occurs in scattered locations across a wide area of Queensland to the north of the Project. Given the relatively small area the Project occupies on the edge of this area the Project is not considered to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Weed invasion, particularly by <i>Parthenium hysterophorus</i> and <i>Parkinsonia aculeata</i> is a potential threat to the species (DSEWPaC 2013). Neither of these species is known from the area. Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as Weeds of national Significance (WoNS) (Eco Logical Australia 2016/2017 and Aurecon 2018). Grasslands in the area are already subject to significant invasion by introduced pastoral grass species. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	There are no identified introduced diseases associated with this species. The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice (DSEWPaC 2013) for the species identifies research priorities and regional priority actions including: ■ Design and implement a monitoring program on known populations, to identify threats, management program success and identify high conservation priority areas ■ More precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes. ■ Undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants. ■ Investigate management options including optimal fire regimes for regeneration and grazing management practices

Criterion	Assessment against significance criteria ¹
	- Ensure there is no disturbance in areas where king blue-grass occurs, excluding necessary actions to manage the conservation of the species/ecological community - Manage any other known, potential or emerging threats, including mining practices, grazing, weed invasion and climate change. Should the species be found to occur within the Project footprint the Project may conflict with priority actions ensuring no disturbance occurs where the species occurs but will add to information known about the distribution of the species in the area. Nevertheless, the Project footprint occupies a relatively small area within the overall distribution of the species and is considered unlikely to substantially interfere with the recovery of the species. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is potential for the Project to cause 'significant residual impacts' on a population of King bluegrass

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.1.2 Winged peppercress (*Lepidium monolocoides*) - endangered

Ecology and distribution

Winged pepper-cress (*Lepidium monolocoides*) is an erect annual herb or perennial forb, growing 15 cm to 20 cm high. It occurs on seasonally moist to waterlogged sites and on heavy fertile soils with a mean annual rainfall of around 300 to 500 mm. Predominant vegetation in the south of its range is usually an open woodland dominated by Bullock (Allocasuarina luehmannii) and/or eucalypts, particularly Black Box (*Eucalyptus largiflorens*) or Poplar Box (*Eucalyptus populnea*). The ground layer tends to be dominated by herbs and tussock grasses (OEH 2018a). The species tends to occur ephemerally at known sites indicating the species may opportunistically take advantage of favourable seasonal conditions (Mavromihalis 2010).

Winged pepper-cress is widespread in the semi-arid western plains regions of NSW into north-western Victoria. It has been recorded from widely scattered localities. In Queensland, several specimens have been recorded near the border of NSW around Goondiwindi and Yelarbon.

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys along the alignment (Eco Logical Australia 2016/2017; Aurecon 2018). Only six records for this species occur in Queensland, all of which have been identified within the impact assessment area around Yelarbon township. Three of these records are older (dated 1919 to 1935). The three recent records are from 2005 and 2011 occurring almost on the southern edge of the Project footprint (two records from 2005) and 1 km north of the footprint (2011). These records appear to occur within a road reserve adjacent to Yelarbon Keetah Road/Wondalli Street at the western edge of the Yelarbon township. The record to the north of the Project footprint occurs in remnant habitat that exists between the Cunningham Highway and Merton Road. These records occur at the northern limit of the species distribution (refer Figure 2.39 in Appendix B).

Recovery plans/threat abatement plans

The *National Recovery Plan for the Winged Peppercress (Lepidium monolocoides)* (Mavromihalis 2010) has been adopted by DAWE and has been in effect since July 2010. The plan identifies the following threatening process as applicable to the species:

- Grazing from natural and introduced herbivores, including livestock

- Changes to flooding regimes across suitable floodplain habitat
- Increased salinity levels
- Erosion and disturbance from vehicles
- Encroachment from exotic flora particularly Patterson's curse (*Euchium plantagineum*), Horehound (*Marrubium vulgare*) and African boxthorn (*Lycium ferocissimum*) and introduced grasses.

The following threat abatement plans have also been identified as relevant to this species:

- *Threat abatement plan for competition and land degradation by rabbits* (DotEE 2016)
- *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs* (*Sus scrofa*) (DotEE 2017a)

Important populations and Habitat critical to the survival of the species

The *National Recovery Plan for the Winged Peppercress* (*Lepidium monoplacoides*) (Mavromihalis 2010) does not identify Habitat critical to the survival of the species for the Winged peppercress and does not refer to the species occurring in Queensland. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records (less than 30 years old) that intersect 'potential habitat' for the species (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 7.3. Predictive habitat mapping indicated the Project may impact 329.61 ha of potential habitat and 40.91 ha of Habitat critical to the survival of the species (refer Table 7.1 and habitat figure in Appendix F). This habitat occurs from the southern extent of the Project north to Bringalily State Forest. The predictive mapping has taken a conservative approach and includes all vegetation communities (based on analogous REs) in which the species may occur including mapped vegetation polygons that may include other communities the species is not associated with. The species is only known locally from the Yelarbon area in Queensland and as such the predictive mapping area is likely a substantial overestimation of the actual extent of the species. Assessment against the significant impact criteria for endangered species is shown in Table 8.8

Table 8.8 Assessment against the significant impact criteria: Winged peppercress (*Lepidium monoplacoides*)

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	The Project footprint occurs within the northernmost edge of the species distribution. In Queensland the species is only known to occur adjacent or close to the Project footprint around Yelarbon township. All other records are located in NSW and Victoria. Predictive modelling indicates 329.61 ha of potential habitat and 40.91 ha of Habitat critical to the survival of the species may occur within the Project footprint, although this is likely to be a substantial over-estimate. It is unknown to what extent the species occurs outside the Yelarbon area. Changes to flooding regimes are a potential impact on the species (Mavromihalis 2010) which is extremely localised in Queensland. Flood modelling for the Project indicates a variation in peak water levels of 0.2 m on suitable habitat for Winged peppercress only during extreme flood events (refer Section 5.2.1.15) which is considered unlikely to significantly impact the species. There is no evidence that the Project will result in a long-term decrease in the size of a population.
Reduce the area of occupancy for the species	In Queensland the species is only known to occur adjacent or close to the Project footprint around Yelarbon township. Predictive modelling indicates 329.61 ha of potential habitat and 40.91 ha of Habitat critical to the survival of the species may occur within the Project footprint, although this is likely to be a substantial over-estimate. It is unknown to what extent the species occurs outside the Yelarbon area. There is the potential for the Project to impact the area of occupancy for the species though the loss of habitat critical to the survival of the species.

Criterion	Assessment against significance criteria ¹
Fragment an existing population into two or more populations	Although it is unknown at this stage if any individuals occur within the Project footprint, the species has been known to occur nearby in the past and suitable habitat is predicted to occur within the Project footprint. The Project is linear and relatively narrow, although it is uncertain whether this may represent a barrier for dispersal or cross-pollination for the species. The species recorded occurrence in the Yelarbon area is already intersected by existing rail and road infrastructure. There is no evidence that the Project will further fragment this population or any other populations.
Adversely affect habitat critical to the survival of the species	In the south of its range the species occurs in a variety of vegetation types, including grasslands, wetlands and floodplain woodlands. Predictive mapping indicates 40.61 ha of habitat considered as 'critical' to the species (for the purposes of this assessment) occurs within the Project disturbance area as well as a further 326.91 ha of 'potential' habitat (although this is likely a substantial overestimate). As such, there is potential the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	No records have been found to occur within the Project footprint itself, although the species has been known to occur nearby in the past and suitable habitat is predicted to occur within the Project footprint. This species has been recorded flowering from August to October. The local population already occurs in a disturbed landscape being intersected by road and rail infrastructure. The Project may disturb individuals (should the species occur) during construction but is considered unlikely to disrupt the breeding cycle of a population as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species is known to occur on the edge of the Project footprint near Yelarbon and suitable habitat (329.61 ha of potential habitat and 40.91 ha of critical habitat) is predicted to occur within the Project footprint. The species is only known to occur around Yelarbon in Queensland. The vast majority of the species distribution is in NSW and Victoria. Changes to flooding regimes are a potential impact on the species (Mavromihalis 2010) which is extremely localised in Queensland. Flood modelling for the Project indicates a variation in peak water levels of 0.2 m on suitable habitat for Winged peppergrass only during extreme flood events (refer Section 5.2.1.15) which is considered unlikely to significantly impact the species. Given the relatively small area the Project occupies on the edge of the species distribution the Project is not considered to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Weed invasion, particularly by African boxthorn (<i>Lycium ferocissimum</i>) and introduced grasses is a potential threat to the species (Mavromihalis 2010). African boxthorn was reported as widespread and common during Project surveys. Grasslands in the area are already subject to significant invasion by introduced pastoral grass species. Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). Impact from rabbits and wild pigs are also recognised threats to the species. Both of these pests were found to be widespread in the impact assessment area during Project surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Control measures will ensure Project infrastructure is not utilised for shelter by introduced pest species. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	There are no introduced diseases identified for this species. The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The <i>National Recovery Plan for the Winged Peppergrass (Lepidium monoplacoides)</i> (Mavromihalis 2010) identifies the following priority actions: ■ Determine distribution, abundance and population structure ■ Determine habitat requirements ■ Manage threats to populations ■ Identify key biological functions

Criterion	Assessment against significance criteria ¹
	■ Determine growth rates and viability of populations ■ Establish a seed bank ■ Build community support for conservation The Project is considered unlikely to interfere with the recovery strategies listed above and is unlikely to interfere with the recovery of the species. The Project will necessarily reduce known threats such as grazing by livestock (on land within the Project footprint) and through weed controls under the Project's Biosecurity Management Sub-plan. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is potential for the Project to cause 'significant residual impacts' on a population of Winged peppergrass.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.1.3 Wandering pepper-creep (*Lepidium peregrium*) - endangered

Ecology and distribution

Wandering pepper-creep (*Lepidium peregrium*) is a perennial plant that grows to 10 to 80 cm tall, sometimes ascending to 2 m in surrounding vegetation. The species has been recorded growing in riparian open forest dominated by *Eucalyptus camaldulensis* and *Casuarina cunninghamiana* with variably dense shrubby understorey. The species was most abundant in the tussock grassland fridge of the riparian open forest, with some plants reaching a height of 2 m in thickets of *Hymenanthera*. It has also been recorded in shade under shrubs close to the creek bank, in which cases most plants have been small, approximately 30 cm in height. Herbarium records and observations in the wild suggest this species responds to disturbance events, due to observations along walking tracks, native pine plantations and car parks, and therefore population densities may fluctuate as a response to such events (Scarlett 2000; OEH 2018b; DAWE 2020).

Wandering pepper-creep occurs from the Bunya Mountains, southeast Queensland, to near Tenterfield, in northern NSW. This species occurs within the New England Tableland and southeast Queensland Bioregions and the southeast Queensland, Condamine and Border-Rivers Maranoa-Balonne Natural Resource Management regions (OEH 2018b; DAWE 2020).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Wandering pepper-creep has not been identified within or near the Project footprint or the impact assessment area. The nearest database record is from Highfield Falls north of Toowoomba (2007) approximately 10 km east of the north-eastern extent of the Project footprint. Several records exist at this location, potentially for the same group of plants. Records note several plants growing at the location 10 m uphill from the edge of the walking track. There are also records (collected in 2007) on the eastern edge of Toowoomba (Picnic Point Park) approximately 15 km south-east of the Project. Several records exist approximately 40 km north-east of the northern end of the Project footprint east of Hampton dated between 2007 to 2011 (see Figure 2.35 Appendix B). This species is known from numerous locations outside of a 50 km buffer from the Project footprint north of Kumburilla State Forest, at Bunya Mountains National Park, south of Yarraman State Forest, Deer Reserve State Forest, D'Aguilar National Park and at Main Range National Park (AoLA 2020).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species. The following threat abatement plan has been identified as relevant to this species:

- *Threat abatement plan for competition and land degradation by rabbits* (DotEE 2016)

The DAWE Approved Conservation advice (TSSC 2014) notes the following potentially threatening processes identified for Wandering pepper-cress

- Loss of habitat through agricultural activities
- Grazing from livestock and rabbits
- Invasion from weeds

Important populations and Habitat critical to the survival of the species

No Habitat critical to the survival of the species for this species has been noted in published information such as the approved conservation advice for the species. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records (less than 30 years old) that intersect 'potential habitat' (refer Appendix A for methodology).

Predictive habitat mapping indicates that the Project may impact 50.39 ha of potential habitat in which this species may occur (refer Table 7.1). It is noted the predictive mapping has used a conservative approach and this is likely a substantial overestimate given the lack of nearby database records in the context of the Project. The species is only known to occur along the more coastal ranges to the east of the Project.

Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for endangered species is shown in Table 8.9.

Table 8.9 Assessment against the significant impact criteria: Wandering pepper-cress (*Lepidium peregrium*)

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	The species is not known to occur within or near the impact assessment area and no individuals were observed during field investigations. Predictive mapping indicates there is 50.39 ha of potential habitat for the species within the Project footprint, although this is likely a substantial overestimate. It is uncertain if any individuals occur in the local area within or surrounding the Project footprint. No historical records exist within or near the impact assessment area. The Project is located west of the species known distribution. There is no evidence that the Project will result in a long-term decrease in the size of a population.
Reduce the area of occupancy for the species	Predictive mapping indicates there is 50.39 ha of potential habitat for the species within the Project footprint. Nevertheless, it is uncertain if any individuals occur within the local area surrounding the Project footprint. No historical records exist within or near the impact assessment area. No individuals were observed during field investigations. The species occurs across a wide area to the west of the Project. The Project is considered unlikely to reduce the area of occupancy for the species.
Fragment an existing population into two or more populations	No records have been found to occur within the Project footprint. The nearest database records are located at least 10 km east of the northern extent of the Project footprint. There is no evidence the Project would fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of the species	The species occurs in riparian open forest particularly on the fringes of tussock grasslands and under shrubs along creek banks. Predictive mapping indicates 50.39 ha of potential habitat occurs within the Project disturbance area although this is likely a substantial overestimate. The species occurs across a wide area from Bunya Mountains south to Tenterfield. The species is not known to occur within or near the Project footprint. As such, it is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	There is little information available regarding the species reproductive cycle. Nevertheless, the species has not been recorded within, or near the Project footprint. The Project is considered unlikely to disrupt the breeding cycle of a population.

Criterion	Assessment against significance criteria ¹
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive mapping indicates 50.39 ha of potential habitat occurs within the Project disturbance area, although this is likely a substantial overestimate. The species occurs across a wide area from Bunya Mountains south to Tenterfield. Nevertheless, the species has not been recorded within, or near the Project footprint. Given the relatively small area the Project occupies on the edge of the known distribution the Project is not considered to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Weed invasion is a potential threat to the species (TSSC 2014). Neither of these species is known from the area. Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). Grazing pressure particularly by cattle and rabbits (<i>Oryctolagus cuniculus</i>), is a potential threat to the species. Rabbits were recorded during Project surveys and identified as widespread throughout the impact assessment area. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice (TSSC 2014) for the species identifies research priorities and regional priority actions including: ■ Monitor known populations to identify key threats, identify high priority populations and manage current or potential threats. ■ Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. ■ Ensure there is no inappropriate disturbance in areas where Wandering Pepper-cress occurs, excluding necessary actions to manage the conservation of the species. The Project is considered unlikely to interfere with the recovery strategies listed above and is unlikely to interfere with the recovery of the species. The Project will necessarily reduce known threats such as grazing by livestock (on land within the Project footprint) and through weed controls under the Project's Biosecurity Management Sub-plan. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, it is currently considered unlikely the Project could cause 'significant residual impacts' on a population of Wandering pepper-cress.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.1.4 Coolmunda leucopogon (*Leucopogon* sp. Coolmunda) (D. Halford Q 1635) - endangered

Ecology and distribution

Leucopogon sp. Coolmunda (D. Halford Q 1635), is a small shrub up to 70 cm high. It occurs in undulating terrain between 300 and 340 metres above sea level. The area is subtropical with hot, moist summers and mild dry winters and an annual rainfall of 640 mm, predominantly in summer. The soils are shallow to 1 m in depth, light coloured sandy loams with mottled orange clayey subsoils (Halford, 1993). The vegetation is predominantly open forest to woodland with a dense lower stratum of heath to 1.5 m high. *Eucalyptus terrica*, *Corymbia trachyphloia*, *E. virens* and *Callitris endlicheri* co-dominate the upper storey, while the lower stratum is very diverse with common species being *Calytrix tetragona*, *Triodia* sp., *Grevillea floribunda*, *Boronia glabra*, *Xanthorrhoea johnsonii*, *Brachyloma daphnoides*, *Ricinocarpus linearifolius* and *Melichrus urceolatus* (DEWHA 2008a).

This species is known from a small area south-east of Inglewood, within the McIntyre River catchment, occurring within the Border Rivers Maranoa–Balonne (Queensland) Natural Resource Management Region. The total population in the Coolmunda could be as high as 67,000 individuals. It is also known to occur in Yelarbon State Forest (DEWHA 2008a).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment (Eco Logical Australia 2016; Aurecon 2018). *Leucopogon* sp. Coolmunda has not been identified within or near the impact assessment area. The nearest database record (i.e. AoLA, Wildlife Online) is from 1993 occurring near Inglewood approximately 10 km south-east of the southern section of the Project footprint (refer Figure 4.1 and Appendix B). This record is located approximately one kilometre downstream from the MacIntyre Brook overflow between Coolmunda Access and Tobacco Road. Several records occur at the north-eastern corner of the Coolmunda Conservation Park. Other records exist between Yelarbon State Forest and Lake Coolmunda within 20 km of the Project footprint including recent and old records dated between 1977-2013. There are no records north of the Project. The records are predominately associated with remnant communities. The only other database record for this species outside of a 50 km buffer from the Project footprint occurs in north Brisbane dated 2003. This record is likely unreliable as the record occurs well outside the species natural distribution.

Recovery plans/threat abatement plans

This species has not been recognised as requiring a recovery plan nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (DEWHA 2008a) identifies the following threats:

- Habitat loss as a result of land clearing
- Loss of remnant vegetation where the species exists particularly in road reserves
- Increased fire frequency and intensity

Important populations and Habitat critical to the survival of the species

There is no Habitat critical to the survival of the species of *Leucopogon* sp. Coolmunda identified in published information. Nevertheless, given the restricted area of occurrence of the species it may be inferred that habitat occupied by the known population occurring between Devine State Forest and Coolmunda Conservation Park could be considered as Habitat critical to the survival of the species. In the absence of a definition for Habitat critical to the survival of the species for the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 7.3. Predictive habitat mapping indicates that the Project may impact 48.2 ha of potential habitat for this species as identified under the predictive mapping approach used for this assessment (refer Section 3.2.4, Appendix A and habitat figure in Appendix F). However, the mapping has taken a highly conservative approach which includes associated identified habitat REs that are located within mixed vegetation polygons. State vegetation mapping (DES) indicates the identified REs comprise approximately 27 per cent of the overall estimated habitat area.

Assessment against the significant impact criteria for endangered species is shown in Table 8.10.

Table 8.10 **Assessment against the significant impact criteria: Coolmunda leucopogon (*Leucopogon* sp. Coolmunda) (*D. Halford Q 1635*)-**

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	The species is not known to occur within or near the impact assessment area and no individuals were observed during field investigations. No historical records exist within or near the impact assessment area. The Project is located north of the known distribution of the species in the Inglewood area. Predictive mapping indicates there is 48.2 ha of potential habitat for the species within the Project footprint, although this is likely a substantial overestimate. There is no evidence the Project would lead to a long-term decrease in the size of a population.
Reduce the area of occupancy for the species	Predictive mapping indicates there is 48.2 ha of potential habitat for the species within the Project footprint. However, no individuals (historic and ground-truthed) have been recorded within or near the impact assessment area.. The species known range is located south of the Project. The Project is considered unlikely to reduce the area of occupancy for the species.
Fragment an existing population into two or more populations	No records have been found to occur within the Project footprint. The nearest database records are located south of the Project footprint in the Inglewood area. There is no evidence the Project would fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of the species	Predictive mapping indicates 48.2 ha of suitable habitat occurs within the Project disturbance area, although this is likely to be a substantial overestimate. Nevertheless, the species distribution appears to occur well outside of the Project footprint. As such, it is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	No records have been found to occur within the Project footprint. The species distribution appears to occur well outside of the Project footprint. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive mapping indicates 48.2 ha of potential habitat occurs within the Project disturbance area, although this is likely an overestimation. The species is thought to have a small area of occupancy located well outside of the Project footprint. Given the Project is located outside the species distribution, the Project is unlikely to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Invasive weeds have not been listed as a possible threat to this species (DEWHA 2008a). Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed species across the Project footprint. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criterion	Assessment against significance criteria ¹
Interfere with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice (DEWHA 2008a) for the species identifies research priorities and regional priority actions including: - Identify populations of high conservation priority. - Ensure that road widening and maintenance activities (or other infrastructure or development activities as appropriate) involving substrate or vegetation disturbance in areas where <i>Coolmunda leucopogon</i> occurs do not adversely impact on known populations. - Develop and implement a suitable fire management strategy for <i>Coolmunda leucopogon</i> - Undertake appropriate seed collection and storage. - Investigate options for linking, enhancing or establishing additional populations. The Project is considered unlikely to interfere with the recovery strategies listed above and is unlikely to interfere with the recovery of the species. While the Project may be a potential point source of ignition for fires this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, it is currently considered unlikely the Project could cause 'significant residual impacts' on a population of <i>Coolmunda leucopogon</i>

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.1.5 Slender tylophora (*Tylophora linearis*) - endangered

Ecology and distribution

Tylophora linearis is a slender, almost hairless twining plant with a clear sap. It grows in dry scrub and open forest. It has been recorded in low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *Eucalyptus sideroxylon*, *Eucalyptus albens*, *Callitris endlicheri*, *Callitris glaucophylla* and *Allocasuarina luehmannii*. It also grows in association with *Acacia hakeoides*, *Acacia lineata*, *Melaleuca uncinata*, *Myoporum* species and *Casuarina* species (OEH 2017a).

There are records of *T. linearis* from Goonoo, Pillaga West, Pillaga East, Bibblewindi, Cumbil and Eura State Forests, Coolbaggie Nature Reserve, Goobang National Park and Beni Strategic Cropping Area. There has also been records near Glenmorgan in the western Darling Downs, Queensland (OEH 2017a).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). There are no database records of *c* (i.e. AoLA, Wildlife Online) within or close to the impact assessment area. The nearest record (2001) occurs in New South Wales near Dthinna Dthinnawan National Park approximately 42 km south of the Project. The record is located to the south of the Bruxner Highway and east of Middle Creek towards the southern section of the National Park. In Queensland the species was only recently rediscovered in the Surat region, with the only records prior to this discovery over 60 years old and approximately 175 km north-west of the Project to the north of Glenmorgan (refer Figure 2.32 Appendix B). DAWE habitat mapping for the species indicates the species as 'may occur' within the impact assessment area to the south of Millmerran.

Recovery plan/threat abatement plans

This species has not been recognised as requiring a recovery plan, nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (DEWHA 2008b) identifies the following threats:

- Disturbance, alteration and loss of habitat for the species
- Inappropriate fire regimes
- Trampling and herbivory from livestock
- Encroachment from exotic flora including *Lantana camara*.

Important population and Habitat critical to the survival of the species

There are no definitions of Habitat critical to the survival of the species for Slender tylophora identified in published information. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 7.3. Predictive habitat mapping indicates that the Project may impact 229.42 ha of potential habitat for this species as identified under the predictive mapping approach used for this assessment (refer Section 3.2.4, Appendix A and habitat figure in Appendix F). However, the mapping has taken a highly conservative approach which includes associated identified habitat REs that are located within mixed vegetation polygons. State vegetation mapping (DES) indicates the identified REs comprise approximately 50 per cent of the overall estimated habitat area. In addition, the mapping includes suitable vegetation communities that occur well outside the species known range. As such, estimated habitat area is likely a substantial overestimate. Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for endangered species is shown in Table 8.11.

Table 8.11 Assessment against the significant impact criteria: Slender tylophora (*Tylophora linearis*)

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	The species is not known to occur within or near the impact assessment area and no individuals were observed during field investigations. Predictive mapping indicates there is 229.42 ha of potential habitat for the species within the Project footprint, although this is likely a substantial overestimate given the species distribution. No historical records exist within or near the impact assessment area. The nearest database record (2001) is located approximately 40 km south of the Project footprint in New South Wales where the vast majority of records occur. There is no evidence the Project would lead to the long-term decrease in the size of a population.
Reduce the area of occupancy for the species	Predictive mapping indicates there is 229.42 ha of suitable habitat for the species within the Project footprint, although this is likely a substantial overestimate given the species distribution. Nevertheless, it is uncertain if any individuals occur in the local area surrounding the Project footprint. No historical records exist within or near the impact assessment area. No individuals were observed during field investigations. The species is almost entirely known from records in New South Wales. The Project is considered unlikely to reduce the area of occupancy for the species.
Fragment an existing population into two or more populations	It is unknown at this stage if any individuals occur within or near the Project footprint. The nearest database record is located approximately 40 km south of the Project footprint. There is no evidence the Project would fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of the species	The species occurs in dry scrub, open forest and woodlands, and as such may occur in a wide range of habitats. Predictive mapping indicates 229.42 ha of potential habitat occurs within the Project disturbance area, with 3,683.47 ha predicted to occur in the impact assessment area. As such, given the widespread occurrence of suitable habitat it is considered unlikely the Project will adversely affect habitat critical to the survival of the species.

Criterion	Assessment against significance criteria ¹
Disrupt the breeding cycle of a population	It is uncertain what the breeding requirements of the species may entail. Predictive mapping indicates there is 229.42 ha of suitable habitat for the species within the Project footprint, although this is likely a substantial overestimate given the species distribution, although this is likely a substantial overestimate given the species distribution. No historical records exist within or near the impact assessment area. The species is almost entirely known from records in New South Wales. No individuals were observed during field investigations. It is considered unlikely the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive mapping indicates there is 229.42 ha of suitable habitat for the species within the Project footprint, although this is likely a substantial overestimate given the species distribution. Nevertheless, it is uncertain if any individuals occur in the local area surrounding the Project footprint. The majority of the species distribution is located in New South Wales. The Project is unlikely to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	The invasive weed <i>Lantana camara</i> has been listed as a possible threat to this species (DEWHA 2008b). Neither of these species is known from the area. Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018) including <i>Lantana camara</i>. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed species across the Project footprint. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice (DEWHA 2008b) for the species identifies research priorities and regional priority actions including: ■ Protect all known sites from disturbance (fire, grazing, forestry activities, etc.) until conservation status is fully established and recovery actions are better developed (DECC, 2005b). ■ Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. ■ Ensure local government, Department of Primary Industries, and other planning agencies are informed of all known populations in order to assist in planning decisions regarding clearing, forestry, and other development activities (DECC, 2005b). ■ Ensure track widening and maintenance activities (or other infrastructure or development activities) involving substrate or vegetation disturbance in areas where <i>T. linearis</i> occurs do not adversely impact on known populations. ■ Develop and implement a suitable fire management strategy for Slender tylophora ■ Provide maps of known occurrences to local and State Rural Fire Services and seek inclusion of mitigative measures in bush fire risk management plans, risk register and/or operation maps. The Project will necessarily reduce known threats such as grazing by livestock (on land within the Project footprint) and through weed controls under the Project's Biosecurity Management Sub-plan. While the Project may be a potential point source of ignition for fires this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. The Project is considered unlikely to interfere with the recovery strategies listed above or interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, it is currently considered unlikely the Project could cause 'significant residual impacts' on a population of Slender tylophora

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.1.6 *Xerothamnella herbacea* – endangered

Ecology and distribution

Xerothamnella herbacea is a sparse, sprawling, perennial herb growing to a height of 30 cm. The species is found in Brigalow (*Acacia harpophylla*) dominated communities in shaded situations, often in leaf litter and in association with gilgai, on heavy, grey to dark brown clay soils.

Xerothamnella herbacea is known from the Banana-Theodore area, north of Injune, Durong-Chinchilla area, and north of Yelarbon (Queensland Herbarium 2012).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). There are no database records (i.e. AoLA, Wildlife Online) that occur for *Xerothamnella herbacea* within the Project footprint or within the impact assessment area. A 2006 record occurs approximately 5 km from the Project north of Yelarbon. The record details the occurrence as 5.59 km along Merton Road, in a shallow gilgai depression with occasional plants scattered amongst Brigalow along the road reserve. A second recent record occurs approximately 40 km from the Project within a road reserve along the Gore Highway located at the southern end of the Western Creek State Forest. Further details of this record state approximately 10 individuals at this location growing amongst Brigalow and Belah dominated vegetation. Brigalow and Belah dominated vegetation is known from the impact assessment area and Project footprint. These are the only records for this species within 50 km of the Project (refer Figure 2.41 in Appendix B). The majority of records occur much further north along the southern and south-eastern boundary of Barakula and Jarrah State Forests. These records occur more than 145 km north of the Project.

Recovery plan/threat abatement plans

This species has not been recognised as requiring a recovery plan, nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (DEWHA 2008c) identifies the following threats:

- Disturbance, alteration and loss of habitat for the species
- Inappropriate fire regimes
- Trampling and herbivory from livestock
- Encroachment from exotic flora.

Important population and Habitat critical to the survival of the species

There are no definitions of habitat critical to the survival of *Xerothamnella herbacea* identified in published information. As such, for the purpose of this assessment, given the species limited distribution, habitat in which this population occurs is considered as potentially comprising individuals within an 'important population'. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology).

Predictive habitat mapping indicates that the Project may impact 66.97 ha of potential habitat in which this species is likely to occur (refer Table 7.1). However, the mapping has taken a highly conservative approach which includes associated identified habitat REs that are located within mixed vegetation polygons. State vegetation mapping (DES) indicates the identified REs comprise approximately 68 per cent of the overall estimated habitat area. It is also uncertain whether all Brigalow habitat in the Project footprint occurs on gilgai suitable for the species. Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for endangered species is shown in Table 8.12.

Table 8.12 Assessment against the significant impact criteria: *Xerothamnella herbacea*

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	No records have been found to occur within the Project footprint. The nearest database record is relatively recent and approximately 5 km north of the Project footprint. No individuals were observed during field investigations. Predictive mapping indicates there is 66.97 ha of potential habitat for the species within the Project footprint, although this may be an overestimate. A further 616.4 ha is predicted to occur in the surrounding Impact assessment area. It is considered unlikely the Project will result in a long-term decrease in the size of a population.
Reduce the area of occupancy for the species	No records have been found to occur within the Project footprint. The nearest database record is relatively recent and approximately 5 km north of the Project footprint. No individuals were observed during field investigations. Predictive mapping indicates there is 66.97 ha of potential habitat for the species within the Project footprint although this may be an overestimate given the species known distribution. There is the potential for the Project to impact the area of occupancy for the species though the loss of habitat critical to the survival of the species should the species be identified within the Project disturbance area. However, given that the species was not observed, the project is unlikely to reduce the area of occupancy for this species
Fragment an existing population into two or more populations	No records have been found to occur within the Project footprint. The nearest database record is relatively recent and approximately 5 km north of the Project footprint. No individuals were observed during field investigations. Predictive mapping indicates there is 66.97 ha of potential habitat for the species within the Project footprint. The Project is linear and relatively narrow, although it is uncertain whether this may represent a barrier for dispersal or cross-pollination for the species. The species is only known from the Yelarbon area to the north of the Project. The Project alignment follows the existing South Western System rail line in this area. The Project is considered unlikely to fragment an existing population.
Adversely affect habitat critical to the survival of the species	The species occurs in Brigalow dominated communities. Predictive mapping indicates 66.97 ha of potential habitat occurs within the Project disturbance area, with 616.4 ha predicted to occur in the impact assessment area. The species occurs in scattered locations from Moura south to the Project footprint. It is unknown if the species occurs within the Project footprint at all. As such, it is considered unlikely the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	No records have been found to occur within the Project footprint. No individuals were observed during field investigations. Predictive mapping indicates there is 66.97 ha of potential habitat for the species within the Project footprint. It is uncertain what the breeding requirements of the species may entail. The Project may disturb individuals (should the species occur) during construction but is considered unlikely to disrupt the breeding cycle of a population as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive mapping indicates 66.97 ha of potential habitat occurs within the Project disturbance area, with 616.4 ha predicted to occur in the impact assessment area. The species occurs in scattered locations from Moura south to the Project footprint. It is unknown if the species occurs within the Project footprint at all. It is considered unlikely the Project will impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Green panic (<i>Megathyrsus maximus var. pubiglumis</i>) and Buffel grass (<i>Cenchrus ciliaris</i>) have been listed as possible threats to this species (DEWHA 2008c). Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). Grasslands in the area are already subject to significant invasion by introduced pastoral grass species and Buffel grass was observed to be present although uncommon during Project surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.

Criterion	Assessment against significance criteria ¹
Introduce disease that may cause the species to decline	There are no identified introduced disease species associated with this species. The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice (DEWHA 2008c) for the species identifies research priorities and regional priority actions including: ■ Monitor known populations to identify key threats and the progress of management actions ■ Ensure road widening and maintenance activities (or other infrastructure or development activities) involving substrate or vegetation disturbance in areas where <i>X. herbacea</i> occurs do not adversely impact on known populations. ■ Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on <i>Xerothamnella herbacea</i>. ■ Develop and implement a management plan for the control of Green Panic and Buffel Grass in the local region. ■ Develop and implement a suitable fire management strategy to minimise the intensity and frequency of fires in remnant Brigalow and Semi-evergreen vine thicket communities. The Project will necessarily reduce known threats such as grazing by livestock (on land within the Project footprint) and through weed controls under the Project's Biosecurity Management Sub-plan. While the Project may be a potential point source of ignition for fires this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. The Project is considered unlikely to interfere with the recovery strategies listed above and is unlikely to interfere with the recovery of the species. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, it is currently considered unlikely that the Project will cause 'significant residual impacts' on a population of <i>Xerothamnella herbacea</i>

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.2 Vulnerable flora species populations

In accordance with the MNES Guidelines, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species
- Reduce the area of occupancy of an important population
- Fragment an existing important population into two or more populations
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of an important population
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- Introduce disease that may cause the species to decline
- Interfere substantially with the recovery of the species.

As evident the criteria, the impact is only applicable if the population is important. An 'important population' as defined within the MNES Guidelines is:

'An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- *Key source populations either for breeding or dispersal;*
- *Populations that are necessary for maintaining genetic diversity; and/or*
- *Populations that are near the limit of the species range.'*

An initial assessment was undertaken to determine whether an 'important population' is present in the impact assessment area. Where an 'important population' is considered not to be present an assessment against the above criteria was not undertaken.

Given the specificity of the above definition and the scarcity of information and records available for most listed species and populations in the region (and Australia), it is difficult to determine: 1) attributes such as breeding and dispersal behaviour and whether the population is a 'key source' and 2) the genetic diversity of individuals inhabiting a population or sub-population. It is noted the Project is linear and is not expected to impact the potential distribution of local pollinators for most (if not all) plant species and as such is not considered likely to impact dispersal or genetic exchange within a plant population.

Given the paucity of information available, significance of impacts to threatened species has been based on experience of the assessment team and the latest available information.

Impacts and mitigation measures associated with the species are identified within Table 7.3 and Table 8.13 provides an evaluation of the populations of vulnerable flora species considered as potentially associated with the impact assessment area.

Table 8.13 Assessment of status of vulnerable flora species population against Guideline criteria

Species name	Common name	Project footprint population evaluation ¹
<i>Acacia lauta</i>	Tara wattle	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys along the alignment (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) indicate the species has been recorded in the wider region surrounding the Project. The nearest database record is located approximately 16 km south of the Project footprint at the south-eastern section of Coolmunda Conservation Park. This record is over 30 years old (1989) and the only one within a 50 km radius of the Project. Other records for the species occur to the north of the Project at Vickery and Condamine State Forests. These consist of recent (1994) and older (1961) records and are located approximately 105 km north of the Project. A single record also exists at Barakula State Forest approximately 165 km north of the Project (refer Figure 2.30 Appendix B). DAWE (2020) mapping is not provided for this species. A description of the species distribution describes the species as occurring within a small region (over 140 km) at Inglewood and Tara with herbarium specimen collections from three locations. These locations include Spinifex Corner (15 km north of Tara), a non-descript location 16 km east of Tara and at Marrow Glen (15 km south-east of Inglewood). There is no recovery plan adopted by the Commonwealth for this species. Review of the available literature including the approved conservation advice for the species (DEWHA 2008d) has not revealed any important populations or Habitat critical to the survival of the species. The population near Inglewood could be considered to be at the limit of the species' range however, this location is substantially south of the impact assessment area. No populations that are important for the long-term survival and recovery of the species have been identified. This species has a limited distribution consisting of small populations within its range. As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). The Project is linear and is not expected to impact dispersal or breeding capacity.

Species name	Common name	Project footprint population evaluation ¹
		Predictive habitat mapping indicates there is potential for 298.85 ha of potential habitat for this species within the Project footprint (refer Table 7.1 and habitat figure in Appendix I). However, the predictive habitat areas are based on conservative estimates including mapped vegetation polygons that includes other communities the species is not associated with. The estimate is not considered representative of the true area of potential occupancy for a species. No important populations or Habitat critical to the survival of the species have been identified for this species in relation to the Project. The species occurs as scattered populations with the closest population located 16 km from the Project and no other records within 50 m. As such, the Project is not likely to conceivably impact the species such that it is likely to cause declines in a population or impact the recovery of the species. Therefore, the Project is currently considered unlikely to significantly impact this species and it is not considered further.
<i>Arthraxon hispidus</i>	Hairy-joint grass	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur at Toowoomba approximately 13 km from the Project (refer Figure 2.43 Appendix B). Most of these records are recent from within the last 15 years. Outside of a 50 km radius records occur throughout south-east Queensland and north-east New South Wales from Port Macquarie to Cooloola. Inland in Queensland scattered database records exist from Abercorn to Carnarvon Park (AOLA 2020). No important populations have been identified for the species. Hairy-joint grass can be found on the edge of rainforest, wet eucalypt forest and woodland where it occurs near creeks, swamps, freshwater springs, coastal foreshore dunes, shaded gullies and creek beds. There is no recovery plan for this species. The approved conservation advice for the species does not identify habitat critical for the species (DEWHA 2008e). As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). Predictive habitat mapping indicates that the Project may disturb 33.09 ha of potential habitat for this species (refer Table 7.1 and habitat figure in Appendix I). However, the species has not been detected/recorded within or near the Project footprint and the species distribution is west of the Project. The Project is not likely to impact any area the species may occur in given the distance of records from the impact assessment area and Project footprint (AoLA 2020). Habitat in the northern most extent of the Project (north of Toowoomba) is highly modified and unlikely to be suitable. This species is not considered to be at the limit of its distribution in relation to the Project nor have any important populations been identified in the available literature. Therefore, the Project is currently considered unlikely to significantly impact an important population of this species and not likely to conceivably impact the species such that it is likely to cause declines in a population or impact the recovery of the species. As such it is not considered further.
<i>Bertya opposens</i>	A shrub	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur at Devine State Forest approximately 13 km east of the Project. Most of these records are recent from within the last 14 to 26 years. These records occur in woodland consisting of <i>Eucalyptus panda</i>, <i>E. curtisii</i>, <i>E. fibrosa</i> subsp. <i>nubila</i> and <i>Corymbia trachyphloia</i> around the edges of a sandstone jump-up formation. A number of records from the late 1980s early 1990s occur between Mount Whitestone and West Haldon approximately 35 km north-east of the Project. No other records occur for this species within a 50 km radius of the Project (refer Figure 2.10 in Appendix B). Outside of a 50 km radius this species occurs throughout inland Queensland north to Torrens Creek and west to Charleville (AOLA 2020). This species occurs in a variety of vegetation communities from mixed shrubland, lancewood woodland, mallee woodland, eucalypt/acacia open forest with shrubby understorey to eucalypt/callitris open woodland and semi-evergreen vine-ticket (Halford and Henderson 2002).

Species name	Common name	Project footprint population evaluation ¹
		The adopted recovery plan does not identify habitat critical for the species (NSW NPWS 2002). This adopted recovery plan is specific to New South Wales and does not highlight any populations that occur in Queensland. As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). The Project is linear and is not expected to impact dispersal or breeding capacity. Predictive habitat mapping indicates that the Project may disturb 10.6 ha of potential habitat for this species (refer Table 7.1 and habitat figure in Appendix I), although the species has not been detected/recorded within or near the Project footprint. The Project is not likely to impact the nearest population given the distance from the impact assessment area and Project footprint (AoLA 2020). This species is not considered to be at the limit of its distribution in relation to the Project nor have any important populations been identified in the available literature. Therefore, the Project is currently considered unlikely to significantly impact an important population of this species and it is not considered further.
<i>Cadellia pentastylis</i>	Ooline	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur at Bendidee State Forest and Kindon Station approximately 42 km east of the Project. These records are very old as they are dated from more than 80 years ago. A record occurs at Goondiwindi approximately 17 km west the Project. The record is in New South Wales to the south of the MacIntyre River (refer Figure 2.22 in Appendix B). Outside of a 50 km radius of the Project records are scattered throughout inland Queensland and New South Wales north to Claireview along the Queensland Coast, inland to Idalia National Park and south to Gunnedah in New South Wales. Ooline occurs in a range of habitats including dry rainforest, semi-evergreen vine thicket brigalow-belah, poplar box, bendee and sclerophyll communities. The species is of biogeographical importance as it is a relic of rainforest vegetation that once occurred across much of the Australian landscape (DEWHA 2008f). There is no recovery plan for this species. The approved conservation advice for the species does not identify habitat critical for the species (DEWHA 2008f). As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). The Project is linear and is not expected to impact dispersal or breeding capacity. Predictive habitat mapping indicates that the Project may disturb 4.56 ha of potential habitat for this species (refer Table 7.1 and habitat figure in Appendix I). However, the species has not been detected/recorded within or near the Project footprint including during Project surveys despite it being an obvious vegetation component where it occurs. The Project is not likely to impact any area where the species is known given the distance from the impact assessment area and Project footprint (AoLA 2020). This species is not considered to be at the limit of its distribution in relation to the Project nor have any important populations or Habitat critical to the survival of the species been identified in the available literature. Therefore, the Project is currently considered unlikely to significantly impact an important population and not likely to conceivably impact the species such that it is likely to cause declines in a population or impact the recovery of the species. As such the species is not considered further.
<i>Clematis fawcettii</i>	Stream clematis	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment (Eco Logical Australia; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Database records across the wider area are few. The nearest records were identified approximately 7 km north of the Project footprint in 2011 from a patch of semi-evergreen vine thicket in the Mount Tyson area (north of Pittsworth) (refer Figure 2.28 in Appendix B). Other records are located approximately 20 km north of the northern extent of the Project footprint at Goombungee, and 20 km south-east in the foothills of the Toowoomba Range. The species is restricted to dry rainforest, complex notophyll vine forest (warm and cool subtropical rainforest), on the margins of semi-evergreen vine thickets (DAWE 2020).

Species name	Common name	Project footprint population evaluation ¹
		There is no recovery plan for this species. The approved conservation advice for the species does not identify habitat critical for the species (DEWHA 2008g). As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). Predictive habitat mapping indicates the Project will not impact potential habitat for this species (refer Table 7.1 and habitat figure in Appendix I), with no habitat predicted to occur within the impact assessment area. As such the species is not considered further.
<i>Dichanthium setosum</i>	Bluegrass	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur approximately 10 km south of the southern end of the Project in New South Wales. This is a recent record from 2018 and is located between North Star Road and the Bruxner Highway along an existing rail corridor. To the north and north-east of the northern end of the Project three records occur at the Toowoomba Range approximately 15 km from the Project footprint (refer Figure 2.14 Appendix B). These records are from within the last 24 years and are located at Preston Peak, Picnic Point and the Holmes railway easement. Specimen backed records for this species outside of a 50 km radius of the Project occur as far north as Gamboola in north Queensland, inland to Mount Isa and south to Willandra National Park in New South Wales with most records occurring west of the Great Dividing Range. Bluegrass is a warm season perennial grass, that commences growing in spring, flowers in summer and becomes dormant in late autumn (DotEE 2019). It is associated with associated with heavy basaltic black soils and stony red-brown hardsetting loam with clay subsoil (DEWHA 2008h). In Queensland, it has been documented to occur from the Leichhardt, Morton, North Kennedy and Port Curtis regions. This species occurs in the Mistake Range, in Main Range National Park, and possibly in Glen Rock Regional Park, adjacent to the Main Range National Park (DAWE 2020). There is no recovery plan for this species. The approved conservation advice for the species does not identify habitat critical for the species (DEWHA 2008h). As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). The Project is linear and is not expected to impact dispersal or breeding capacity. Predictive habitat mapping indicates that the Project may disturb 60.49 ha of potential habitat for this species (refer Table 7.1 and habitat figure in Appendix I). However, the species has not been detected/recorded within or near the Project footprint and will not impact known areas in which the species occurs. This species is not considered to be at the limit of its distribution in relation to the Project nor have any important populations been identified in the available literature. The Project will not impact Habitat critical to the survival of the species and is not likely to conceivably impact the species such that it is likely to cause declines in a population or impact the recovery of the species. As such the species is not considered further.
<i>Eucalyptus virens</i>	Shiny-leaved ironbark	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur approximately 11 km north of the Project in Bringalily State Forest and approximately 15 km to the south at Coolmunda and have been recorded between the early 1980s to early 1990s (refer Figure 2.26 Appendix B). The Shiny-leaved ironbark is endemic to southeast Queensland and is restricted to four disjunct localities near Mt Moffatt in the Carnarvon area, Brovinia area south of Mundubbera, Tara area west of Dalby and Coolmunda Dam east of Inglewood in southern Queensland (Brooker and Kleinig 1994).

Species name	Common name	Project footprint population evaluation ¹
		There is no Commonwealth recovery plan adopted for this species. The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008i). As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). Predictive habitat mapping indicates that the Project may impact 292.55 ha of potential habitat in which this species is predicted to occur (refer Table 7.1 and habitat figure in Appendix I). Although it is noted the mapping does not necessarily reflect the actual potential occurrence of the species. Should the species be found to occur, the Project footprint may be considered to be within a disjunct population (given the species restricted range of occurrence) and considered as part of an 'important population' (as defined under the MNES Guidelines). Therefore, there is potential for significant residual impacts on an important population of Shiny-leaved ironbark and it is assessed under the MNES Guidelines in Table 8.14.
<i>Homopholis belsonii</i>	Belson's panic	This species was identified during Project-associated field investigations in 2018 between Bringalily and Millmerran. The species was located along a section of Millmerran-Inglewood Road between Paton and Nicol Creek Road. More than 100 individuals were found growing in a non-remnant road reserve on poor dark brown soils in large clumps at this location. The second record is located to the south-east of Millmerran at the junction of Owens Scrub Road and Lovell Road. Database records (i.e. AoLA) indicate a further two records within the impact assessment area (refer Figure 2.8 in Appendix B). The species occurs from Dalby west to Roma in Queensland and south to Gunnedah in New South Wales. There is no Commonwealth adopted recovery plan for the species. The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008j). The identified populations are not on the extremity of the species distribution and are therefore not considered as an important population. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). It is estimated that the Project is likely to impact 287.69 ha of potential habitat and 3.19 ha of Habitat critical to the survival of the species in which this species is predicted to occur (refer Table 4.4). The potential for significant residual impacts on Belson's panic is assessed under the MNES guidelines in Table 8.15.
<i>Macrozamia machinii</i>	-	This species was not identified during Project-associated field investigations. Database records indicate that the nearest record (i.e. AoLA) is from 1922 and is located approximately 2.5 km south of the Project footprint near Inglewood. It is noted available records have all been generalised in order to protect the species. Additional records (all from the 1990s) are located within 25 km to the north-west of the Project in the surrounds of Bringalily State Forest and Wondul Range National Park. There are four records from the 1980s and 1990s located within 35 km south of the Project in the area surrounding Texas State Forest 1, Greenup State Forest, and Yelarbon State Forest. The species is known from a restricted area located to north (Wondul Range) and south of Inglewood in southeast Queensland, where it occurs on flat plains and breakaways in deep sandy soils and in flat areas of open forest. There is no Commonwealth adopted recovery plan for the species. The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008k). There is no definition of important habitat or Habitat critical to the survival of the species. Given the small known area of occurrence of the species any population may be considered an important population. As such, for the purpose of this assessment, given the species limited distribution, habitat in which the population occurs is considered as potentially comprising individuals within an 'important population'. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known recent records that intersect 'potential habitat' (refer Appendix A for methodology).

Species name	Common name	Project footprint population evaluation ¹
		Predictive habitat mapping indicates that the Project may impact 77.72 ha of potential habitat for the species (refer Table 7.1). Should the species be found to occur the Project footprint may be considered to be within a disjunct population (given the species restricted range of occurrence) and considered as part of an 'important population' (as defined under the MNES Guidelines). Given the Project may impact an important population an assessment against the significant impact criteria for the species has carried out (refer Table 8.16).
<i>Picris evae</i>	Hawkweed	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment during surveys by Eco Logical Australia in 2016. Further specimen backed records have been identified from database searches (i.e. AoLA) further indicating this species occurs within and adjacent to the Project footprint in the Pittsworth and Brookstead areas. The species is also known to occur in the northern extent of the Project in the Gowrie Creek area as identified during surveys for the Toowoomba Second Range Crossing Project (pers. comm C Schell). The species occurs on the Darling Downs in Queensland and around Inverell in NSW. There is no Commonwealth adopted recovery plan for the species. The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008I). The overall population is relatively restricted in occurrence and local occurrences within the Project footprint may therefore be considered as part of an important population. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). Predictive habitat mapping indicates that the Project may impact 575.31 ha of potential habitat and 18.68 ha of Habitat critical to the survival of the species in which this species is predicted to occur (refer Table 4.4). Under the MNES Guidelines the Project may impact an important population and 'critical habitat' for the species (as adopted for this assessment). The potential for significant residual impacts on an important population of <i>Picris evae</i> is assessed under the MNES Guidelines in Table 8.17
<i>Prostanthera</i> (sp. Dunmore)	Dunmore prostanthera	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area or within a 50 km radius of the Project. The only database record that is available is located within state forest between Boondandilla and Western Creek State Forest at the southern end of the reserve along Boondandilla Road approximately 50 km west of the Project (refer Figure 2.23 in Appendix B). <i>Prostanthera</i> sp. Dunmore (Gordon 1984) is known from four locations in a small area west of Millmerran in southern Queensland. One population occurs on private land and three in state forest, including one on the border with Wondul Range National Park (DEWHA 2008m). DAVE mapping does not indicate the species as occurring within the Project impact assessment area (refer Figure 2.23 in Appendix B). The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008m). However, given the small range of occurrence of the species any population may be considered an important population and associated habitat as critical to the survival of the species. Predictive habitat mapping indicated that the Project may disturb 105.84 ha of potential habitat for this species (refer Table 7.1 and habitat figure in Appendix I). However, the mapping has taken a highly conservative approach which includes associated identified habitat REs that are located within mixed vegetation polygons. State vegetation mapping (DES) indicates the identified REs comprise less than 25 per cent of the overall estimated habitat area. The mapping also does not necessarily reflect the actual occurrence of the species. The species has not been detected/recorded within or near the Project footprint and DAVE species habitat mapping does not predict the species as occurring. The Project is not likely to impact the known populations given their distance from the impact assessment area and Project footprint (AoLA 2020). Therefore, the Project is currently considered unlikely to significantly impact an important population of this species and it is not considered further.

Species name	Common name	Project footprint population evaluation ¹
<i>Rhaponticum australe</i>	Austral cornflower	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint however there are several nearby records within the impact assessment area. A 2003 record from exists to the west of Pittsworth at the Gore Highway and Tip Road junction. There are several other records in the Pittsworth area located between 2 km to 4 km from the Project footprint. Another 2016 record occurs at the eastern end of the Project adjacent to the north of the Project footprint 4 km west of Gowrie township. Records from within a 50 km radius of the Project occur as far north as Jondaryan, west to Pittsworth, south to Allora and east to Helidon Spa (refer Figure 2.4 Appendix B). Austral cornflower is currently confined to Queensland. The species was known to previously occur in NSW and Victoria but is now presumed extinct in those states. The current distribution of <i>R. australe</i> extends from Allora (north of Warwick) to Callide (northwest of Biloela), Queensland (DEWHA 2008n). The overall population is relatively restricted in occurrence and local occurrences within the Project footprint may therefore be considered as part of an important population. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). Predictive habitat mapping indicates that the Project may impact 220.24 ha of potential habitat and 2.29 ha of Habitat critical to the survival of the species in which this species is predicted to occur (refer Table 4.4 and habitat figure in Appendix I). Under the MNES Guidelines the Project may impact an important population and 'critical habitat' for the species (as adopted for this assessment). The potential for significant residual impacts on an important population of <i>Rhaponticum australe</i> is assessed under the MNES Guidelines in Table 8.18.
<i>Sophora fraseri</i>	Brush sophora	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. The nearest records in relation to the Project occur approximately 1.3 km north of the eastern end of the Project footprint at Mount Kingsthorpe Reserve east of Kingsthorpe. Two records from this site indicate the species was recorded relatively recently from 1997 and recently in 2011. Other records from within a 50 km radius of the Project occur sporadically at Coalbank, Kilbirnie, Ballard north-east of Toowoomba, Iredale to the east of Toowoomba Range and two records near Fordsdale (refer Figure 2.16 Appendix B). Brush sophora normally grows in wet sclerophyll forest and a range of rainforest types. It has been reported growing in hilly terrain on hillslopes at altitudes at altitudes from 60 m to 660 m, in mostly shallow stony to shaly soils, of loam to clay texture derived from sandstone or basalt rocks. The shrub appears to prefer growing along rainforest margins, in eucalypt forests in the vicinity of rainforests or in large canopy gaps in closed forest communities (Barker and Borsboom 1997; WetlandInfo 2018). There is no Commonwealth adopted recovery plan for the species. The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008o). As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). Predictive habitat mapping indicates the Project will not impact potential habitat for this species (refer Table 7.1 and habitat figure in Appendix I). Given no potential habitat for the species is predicted to be impacted by the Project, Brush sophora is not considered further in this assessment.

Species name	Common name	Project footprint population evaluation ¹
<i>Thesium australe</i>	Austral toadflax	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any records within the Project footprint or impact assessment area. The nearest record in relation to the Project is from 2000 and occurs approximately 12 km east of the eastern end of the Project footprint in the Toowoomba area. The record at this location is recent from 2000. Other records from within a 50 km radius of the Project are sparsely scattered from Bowenville, to Grapetree to the north, to Gatton east of the Project, Allora south of the Project and west to Ellangowan (refer Figure 2.6 Appendix B). Its current distribution is sporadic but widespread, occurring from the Bunya Mountains in southeast Queensland to northeast Victoria and as far inland as the southern, central and northern tablelands in NSW and the Toowoomba region and Dalby (DAWE 2020). This species is not considered to be at the limit of its distribution in relation to the Project Austral toadflax is semi-parasitic on the roots of certain grass species; occurring in shrubland, grassland or woodland, often on damp sites. It occurs in subtropical, temperate and subalpine climates over a wide range of altitudes. It occurs on soils derived from sedimentary, igneous and metamorphic geology on a range of soils, including black clay loams to yellow podzolics and peaty loams (Leigh et al.1984; Hunter et al. 1999; Cohn 2004). Vegetation types include open grassy heath dominated by Swamp myrtle (<i>Leptospermum myrtifolium</i>), Small-fruit hakea (<i>Hakea microcarpa</i>), Alpine bottlebrush (<i>Callistemon sieberi</i>), Woolly grevillea (<i>Grevillea lanigera</i>), Coral heath (<i>Epacris microphylla</i>) and <i>Poa</i> spp., Kangaroo grass (<i>Themeda triandra</i>) grassland surrounded by Eucalypt woodland and grassland dominated by Barbed-wire grass (<i>Cymbopogon refractus</i>) (DAWE 2020). There is no Commonwealth adopted recovery plan for the species. The approved conservation advice for the species does not identify important populations or habitat critical for the species (DotE 2013b). As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). It is estimated that the Project is likely to impact 202.59 ha of potential habitat in which this species is predicted to occur (refer Table 4.4 and Appendix I). The predictive mapping has taken a conservative approach and includes habitat where relevant REs once occurred but have been subject to vegetation clearing. As such, estimated habitat area is likely a substantial over-estimate. Predictive habitat mapping indicates that there is no potential habitat for this species within the Project footprint. This species is not considered to be at the limit of its distribution in relation to the Project nor have any important populations been identified in the available literature. The Project is not expected to impact Habitat critical to the survival of the species and is not likely to conceivably impact the species such that it is likely to cause declines in a population or impact the recovery of the species. As such the species is not considered further.
<i>Westringia parvifolia</i>	-	This species was not identified during Project-associated field investigations. Database records (i.e. AoLA) indicate that two records from 1919 and 1948 are present within the impact assessment area at Yelarbon (refer Figure 2.37 in Appendix B). Additional older records are located southeast of the Project footprint near Inglewood (1910 - 4 km south of the Project footprint) and Yelarbon State Forest (1974 – 8 km south). Another record (1977) is also located approximately 23 km to the west near Goondiwindi. More recent records (20007 and 2014) are also located approximately 25 km south across the border in New South Wales near Dthinna Dthinnawan Nationa Park. There are no other records of the species. The species is known from a small area near Yelarbon and Inglewood in southeast Queensland. More recent records in NSW would indicate its distribution extends beyond this. There is no Commonwealth adopted recovery plan for the species. The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008p). Given the small known area of occurrence of the species any population may be considered an important population. As such, for the purpose of this assessment the habitat, given the species limited distribution, habitat in which this population occurs is considered as potentially comprising individuals within an 'important population'. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known recent records that intersect 'potential habitat' (refer Appendix A for methodology).

Species name	Common name	Project footprint population evaluation ¹
		Predictive habitat mapping indicates that there is no potential habitat for this species within the Project footprint (refer Table 7.1). The mapping has been based on known habitat requirements for the species and existing vegetation mapping. Given the Project is not expected to impact habitat for the species it is not considered further in this assessment

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.3 Significant impact assessment – Vulnerable flora

8.2.3.1 Shiny-leaved ironbark (*Eucalyptus virens*) - vulnerable

Ecology and distribution

Shiny-leaved ironbark is a tree that grows up to 25 m tall with persistent, grey to black and often somewhat soft and flaky bark. It is found in woodlands dominated by Queensland peppermint (*Eucalyptus exserta*), Smooth-barked apple (*Angophora costata*), Tom Russell's mahogany (*Lysicarpus ternifolius*) and Woolly she-oak (*Allocasuarina inophloia*), in coarse sandy, skeletal soils on outcropping sandstone escarpments. Shiny-leaved ironbark is also found in forests dominated by Bulloak (*Allocasuarina luehmannii*) and Mugga ironbark (*Eucalyptus sideroxylon*) in shallow, grey sandy soils on flat lands and woodlands dominated by similar species, in coarse white sandy soils over sandstone on undulating lands (DoE 2008).

The Shiny-leaved ironbark is endemic to southeast Queensland and is restricted to four disjunct localities near Mt Moffatt in the Carnarvon area, Brovinia area south of Mundubbera, Tara area west of Dalby and Coolmunda Dam east of Inglewood in southern Queensland (Brooker and Kleinig 1994).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur approximately 11 km north of the Project in Bringalily State Forest and approximately 15 km to the south at Coolmunda and have been recorded between the early 1980s to early 1990s (refer Figure 2.26 Appendix B). Outside of a 50 km radius of the Project records for this species occur at Condamine State Forest, Beeron National Park, Dalgangal State Forest, Nour National Park and Mount Moffatt.

Recovery plans/threat abatement plans

This species has not been recognised as requiring a recovery plan, nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (DEWHA 2008i) identifies the following threats:

- Habitat loss and degradation due to timber harvesting (the species occurs in State Forests subject to harvesting)
- Habitat loss through general vegetation clearing practises.

Important populations and Habitat critical to the survival of the species

There is no Commonwealth recovery plan adopted for this species. The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008i). As such, no habitat can be identified as critical in the absence of the species' presence. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). It is estimated that the Project is likely to impact 292.55 ha of potential habitat in which this species is predicted to occur (refer Table 4.4). However, the mapping has taken a highly conservative approach which includes associated identified habitat REs that are located within mixed vegetation polygons. State vegetation mapping (DES) indicates the identified REs comprise approximately 67 per cent of the overall estimated habitat area. The mapping also does not necessarily reflect the actual occurrence of the species.

This mapped habitat is largely located where the Project intersects habitat within or adjacent to the State Forest areas around Inglewood. The species has not been detected previously but is known from north and south of the Project. Should the species be found to occur (given the species restricted range of occurrence) the Project footprint may be considered to be within part of an 'important population' (as defined under the MNES Guidelines) for the species.

Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for vulnerable species is shown in Table 8.15.

Table 8.14 Assessment against the significant impact criteria: Shiny-leaved ironbark

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population	The species was not recorded within the Project footprint during Project-associated surveys. The nearest records of the species are 11 km north of the Project footprint in Bringalilly State Forest and the known population in the Coolmunda Dam area 15 km to the south of Inglewood. The species is thought to be endemic to four localities including the Tara area (west of Dalby) and Coolmunda Dam area. Whilst the species has not been identified within the Project disturbance area, if the species is observed, there is some potential that these individuals will be part of an 'important population'. Predictive mapping indicates there is 292.55 ha of potential habitat for the species within the Project footprint although this does not necessarily reflect the actual occurrence of the species. This habitat is largely contained within State Forests which are subject to existing timber harvesting regimes. As part of the Project Biodiversity Management Sub-plan, protected plant surveys targeting this species will be undertaken where suitable habitat is observed prior to construction to confirm whether the species occurs and if so, to what extent it occurs within the Project footprint (refer Table 7.3). The Project is not considered likely to lead to a long-term decrease in the size of an important population (as defined under the MNES Guidelines).
Reduce the area of occupancy of an important population	The species has not been recorded within or near the Project footprint, however there is potential for the species to occur. An 'important population' has not been identified as occurring within the Project footprint presently. The species is known to occur to the south (Coolmunda Dam) and there is a single record in Bringalilly State Forest to the north. Predictive mapping indicates there is 292.55 ha of potential habitat for the species within the Project footprint although this does not necessarily reflect the actual occurrence of the species. This habitat is largely contained within State Forests which are subject to existing timber harvesting regimes. Protected plant surveys targeting this species will be carried out to assess whether the species occurs prior to construction. There is no evidence that the Project will reduce the area of occupancy for the species.
Fragment an existing important population into two or more populations	The species has not been recorded within or near the Project footprint, however there is potential for the species to occur. An 'important population' has not been identified as occurring within the Project footprint presently. The species is known to occur to the south (Coolmunda Dam) and there is a single record in Bringalilly State Forest to the north. These areas are already separated by cleared habitat. Predictive mapping indicates there is 292.55 ha of potential habitat for the species within the Project footprint. This habitat is largely contained within State Forests which are subject to existing timber harvesting regimes. The Project is considered unlikely to fragment an existing important population into two populations.

Criterion	Assessment against significance criteria ¹
Adversely affect habitat critical to the survival of the species	The species has not been recorded within or near the Project footprint, however there is potential for the species to occur. The species is known to occur to the south (Coolmunda Dam) and there is a single record in Bringalily State Forest to the north. Predictive mapping indicates there is 292.55 ha of potential habitat for the species within the Project footprint although this does not necessarily reflect the actual occurrence of the species. Habitat critical to the survival of the species (as defined for this assessment) has not been identified as present. The Project will not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	The species has not been recorded within or near the Project footprint, however there is potential for the species to occur. An 'important population' has not been identified as occurring within the Project footprint presently. It is uncertain what the breeding requirements are for the species. Potential habitat within the Project footprint is largely located within State Forests subject to existing timber harvesting regimes. The Project is considered unlikely to disrupt the breeding cycle of an 'important population' as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species has not been recorded within or near the Project footprint, however there is potential for the species to occur. An 'important population' has not been identified as occurring within the Project footprint presently. The species is known to occur to the south (Coolmunda Dam) and there is a single record in Bringalily State Forest to the north. These areas are already separated by cleared habitat. Predictive mapping indicates there is 292.55 ha of potential habitat for the species within the Project footprint although this does not necessarily reflect the actual occurrence of the species. This habitat is largely contained within State Forests which are subject to existing timber harvesting regimes. As such, it is considered unlikely that the Project will decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion is not considered as a threat to the species (DEWHA 2008i). Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	There are no identified introduced disease species associated with this species. The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice for the species (DEWHA 2008i) identifies research priorities including: ■ Design and implement a monitoring program or, if appropriate, support and enhance existing programs. ■ More precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes. ■ Manage forestry operations and road maintenance activities to protect known populations. The Project is considered unlikely to interfere with the recovery strategies listed above. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes. Should the species be found to occur in the area as a result of Project activities it may be argued the Project is increasing knowledge on the species distribution. The Project is considered unlikely to substantially interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, the Project is currently considered unlikely to cause 'significant residual impacts' on an <i>important population</i> of <i>Eucalyptus virens</i> through impacts to the occupancy of an important population. However, should the species be identified within the Project disturbance footprint, there may be some potential for significant residual impacts to occur to this species

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.3.2 Belson's panic (*Homopholis belsonii*) – vulnerable

Ecology and distribution

Belson's panic (*Homopholis belsonii*) is a perennial grass capable of growing up to 0.5 m high. It is known to occur in isolated areas of remnant vegetation with an ability to recolonise cleared or highly disturbed environments. The species is often found in regenerating vegetation along roadsides in sufficiently large populations producing seeds, despite viability time not known. Flowering of the species usually occurs between February to May and possibly in November to December as fruiting has been recorded in February. (DAWE, 2020).

Belson's panic has been known to grow often in poor soils in dry woodlands specially in NSW as well as in areas which receive irregular or intermittent flooding, where Belson's panic can be found on higher, well-drained rises. In Queensland, the species grows at an elevational range of 342 m to 500 m elevation (DAWE, 2020).

The species can be found in the following habitats:

- Rocky and basaltic hills featuring White Box (*Eucalyptus albens*) and Wilga (*Geijera parviflora*) woodlands with various shrub and grass species
- Flat to gently undulating alluvial areas featuring Belah (*Casuarina cristata*) forests and occasionally Brigalow (*Acacia harpophylla*) forests
- Drainage lines featuring Belah and sandy country dominated by Cypress Pine-Bloodwood-Ironbark-She-Oak Forest (DEWHA, 2008j).

Belson's panic is known to the Darling Downs region between Oakey and Dalby and also around the Millmerran area. It is also known from north-west NSW, from south of Goondiwindi to Warialdra.

Distribution in context to the Project

This species was identified during Project-associated field investigations in 2018 between Bringalily State Forest and Millmerran (refer Figure 4.3). The species was located along a section of Millmerran-Inglewood Road between Paton and Nicol Creek Road. More than 100 individuals were found growing in a non-remnant road reserve on poor dark brown soils in large clumps at this location (refer Photograph 4.7 and Photograph 4.8). The species was also located to the south-east of Millmerran at the junction of Owens Scrub Road and Lovell Road.

There are a number of historical records for this species near Millmerran with occurrences from between 2002 and 2016. Three of these records lie within 1.5 km of the Project footprint, from 5 km east and extending as far as 23 km south of Millmerran. Other records for this species occur within the impact assessment area to the north of the Project footprint between Brookstead and Pittsworth from 2016. Occurrences exist from within 50 km of the Project footprint north and north-west of Oakey between 1938-2017. A single record exists from 2016 west of Bulli State Forest and from 1992 near Bendidee State Forest.

Recovery plans/threat abatement plans

This species has not been recognised as requiring a recovery plan, nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (DEWHA 2008j) identifies the following threats:

- Habitat loss due to agricultural development and mining projects
- Overgrazing by livestock
- Weed invasion, particularly by Green Panic Grass (*Panicum maximum* var. *trichoglume*), Coolatai Grass (*Hyparrhenia hirta*) and Tiger Pear (*Opuntia aurantiaca*).

Important populations and Habitat critical to the survival of the species

The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008j). The population within the Project footprint is not on the extremity of the species distribution. The species occurs as far south as Gunnedah (in NSW) and west to Miles/Roma. There is no evidence to say the population is key for breeding, dispersal or maintaining genetic diversity and is therefore not considered as an important population. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). It is estimated that the Project may impact 287.69 ha of potential habitat and 3.19 ha of Habitat critical to the survival of the species in which this species is predicted to occur (refer Table 4.4). The predictive mapping has taken a conservative approach and includes habitat where relevant REs once occurred but have been subject to vegetation clearing. Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for vulnerable species is shown in Table 8.15.

Table 8.15 Assessment against the significant impact criteria: Belson's panic (*Homopholis belsonii*)

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population	The species was recorded within the Project footprint around and south of Millmerran during Project-associated surveys. An 'important population' has not been identified as occurring within the Project footprint. The species is known to recolonise highly modified habitat. The species was recorded in non-remnant road reserves close to Millmerran during Project surveys. The species occurs across a broad inland swathe of southern Queensland (west to Roma) and northern NSW (south to Gunnedah in NSW). The Project is not considered likely to lead to a long-term decrease in the size of an important population (as defined under the MNES Guidelines).
Reduce the area of occupancy of an important population	The species was recorded within the Project footprint around and south of Millmerran during Project-associated surveys. An 'important population' has not been identified as occurring within the Project footprint. Predictive mapping indicates there is 287.69 ha of potential habitat and 3.19 ha of Habitat critical to the survival of the species within the Project footprint. The species is known to recolonise heavily modified habitats and was recorded in non-remnant road reserves. The species occurs across a wide area from inland southern Queensland to inland northern NSW. The Project has potential to reduce the area of occupancy of a population of the species within the Project footprint.
Fragment an existing important population into two or more populations	The species was recorded within the Project footprint around and south of Millmerran during Project-associated surveys. An 'important population' has not been identified as occurring within the Project footprint. Predictive mapping indicates there is 287.69 ha of potential habitat and 3.19 ha of Habitat critical to the survival of the species within the Project footprint. The Project is linear and relatively narrow. The species is already known to occur on and recolonise areas such as road reserves and as such does not appear to be adversely impacted by linear infrastructure. The Project footprint largely aligns with existing road and rail alignments. The Project is considered unlikely to fragment an existing important population into two populations.
Adversely affect habitat critical to the survival of the species	Grassy woodlands dominated by Poplar box (<i>Eucalyptus populnea</i>) and other suitable habitat types are widespread. Predictive mapping indicates 3.19 ha of Habitat critical to the survival of the species (as defined under this assessment) and an additional 287.66 ha of potential habitat occurs within the Project footprint. As such, it is considered the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	The species has been identified as occurring in the Project footprint, although this is very unlikely to be restricted to this area. An 'important population' has not been identified as occurring within the Project footprint. It is uncertain what the breeding requirements are for the species. However, the species is known to recolonise modified habitats and was identified in non-remnant road reserves during Project surveys. The Project may disturb individuals during construction but is considered unlikely to disrupt the breeding cycle of an 'important population' as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species is known to occur within the Project footprint and suitable habitat is predicted to occur. Predictive mapping indicates 290.88 ha of suitable habitat (287.69 ha of potential habitat and 3.19 ha of critical habitat) occurs within the Project footprint, with 4,509.81 ha predicted to occur within the immediate surrounds within the impact assessment area. The species occurs in highly modified habitats such as road reserves. As such, it is considered unlikely that the Project will decrease the availability or quality of habitat to the extent that the species is likely to decline.

Criterion	Assessment against significance criteria ¹
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion, particularly by Green Panic Grass, Coolatai Grass and Tiger Pear is a potential threat to the species (DEWHA 2008j). Tiger pear is known from the area and dense infestations were observed along the Condamine River east of the Project footprint (Eco Logical Australia 2016). Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). Grasslands in the area are already subject to significant invasion by introduced pastoral grass species. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	There are no identified introduced disease species associated with this species. The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice for the species (DEWHA 2008j) identifies research priorities including: ■ Design and implement a monitoring program or, if appropriate, support and enhance existing programs. ■ More precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes. ■ Undertake seed germination and/or vegetative propagation trials to determine the requirements for successful establishment. The Project will necessarily reduce known threats such as grazing by livestock (on land within the Project footprint) and through weed controls under the Project's Biosecurity Management Sub-plan. The Project is considered unlikely to interfere with the recovery strategies listed above. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes. The Project is considered unlikely to substantially interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, the Project is likely to cause 'significant residual impacts' on <i>an important population of Homopholis belsonii</i> due to impacts to habitat identified as critical to the species.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.3.3 *Macrozamia machinii* - vulnerable

Ecology and distribution

Macrozamia machinii is a cycad with a subterranean trunk. Most populations occur in deep sandy soils in flat areas of open forest dominated by *Angophora leiocarpa*, *Allocasuarina inophloia*, White Cypress-pine (*Callitris glaucophylla*), Budgeroo (*Lysicarpus angustifolius*) and Crowded-leaf Wattle (*Acacia conferta*). However, they can occur on red lateritic ridges at about 320 to 460 m above sea level (Jones and Forster 1994; Hill 1998).

Macrozamia machinii cones mature in September to December and seeds ripen February to April. Beetles are thought to affect cross-pollination between individuals. Populations show little obvious recruitment, perhaps because the putative pollinators are not present. Fires have also been known to create large cone and seed production some years later (Forster 2004).

Macrozamia machinii occurs only in the southern Darling Downs in Queensland between Texas and Wondul Range National Park, in around Inglewood (DEWHA 2008k).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database records indicate that the nearest record (i.e. AoLA) is from 1922 and is located approximately 2.5 km south of the Project footprint near Inglewood. It is noted available records have all been generalised in order to protect the species. Additional records (all from the 1990s) are located within 25 km to the north-west of the Project in the surrounds of Bringalily State Forest and Wondul Range National Park. There are four records from the 1980s and 1990s located within 35 km south of the Project in the area surrounding Texas State Forest 1, Greenup State Forest, and Yelarbon State Forest (refer Figure 2.57 in Appendix B).

Recovery plans/threat abatement plans

This species has not been recognised as requiring a recovery plan, nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (DEWHA 2008k) identifies the following threats:

- Habitat loss and damage from existing forestry operations
- Inappropriate fire regimes
- Vulnerability to collecting for private collections.

Important populations and Habitat critical to the survival of the species

The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008k). Nevertheless, the overall population is relatively restricted in occurrence and local occurrences within the Project footprint may therefore be considered as part of an important population. In the absence of a definition for critical habitat for the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology).

It is estimated that the Project may impact 77.72 ha of potential habitat in which this species is predicted to occur (refer Table 4.4) although this does not reflect the actual occurrence of the species. Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for vulnerable species is shown in Table 8.16.

Table 8.16 Assessment against the significant impact criteria: *Macrozamia machinii*

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population	The species was not recorded during Project surveys despite cycads being a readily visible plant in the communities they occur in. Nevertheless, the species may occur in the Project footprint where the alignment intersects the State Forests in the Inglewood area. There are a number of database records to the north and south of Inglewood. Predictive habitat mapping indicates that the Project may impact 77.72 ha of potential habitat and for the species, although this may be an overestimate of the actual occurrence of the species. Should the species be found to occur it would be part of an 'important population'. It is considered unlikely the Project will result in a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	An 'important population' has been identified as potentially occurring within the Project footprint. Database records indicate the species occurs in the wider area, although site investigations for the Project did not record the species despite cycads being a readily visible plant in the communities they occur in. Predictive habitat mapping indicates that the Project may impact 77.22 ha of potential habitat although this may overestimate the potential occurrence of the species. Should the species be found to occur then the Project has potential to reduce the occupancy of an important population although this will be dependent on the actual extent of presence of the species within the Project footprint.

Criterion	Assessment against significance criteria ¹
Fragment an existing important population into two or more populations	An 'important population' has been identified as potentially occurring in the wider area, although the species has not been recorded within the Project footprint during Project surveys. The Project is linear and relatively narrow, although it is unlikely this represent a barrier for dispersal or cross-pollination for the species. The species naturally occurs as fragmented populations in the wider area. The species occurs in State Forests which are subject to ongoing disturbance from forestry operations. The Project largely traverses the edge of these areas. The Project is not considered likely to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	The species occurs in woodlands on sandy soils which are widespread in the local area. Predictive habitat mapping indicates that the Project may impact 77.72 ha of potential habitat for the species. No Habitat critical to the survival of the species has been identified (under the approach used for this assessment). As such, the Project will not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	An 'important population' has been identified as potentially occurring within the Project footprint and surrounds. The species has not been recorded within the Project footprint during Project surveys despite cycads being a readily visible plant in the communities they occur in. It is uncertain what the breeding requirements are for the species. The species occurs in State Forests which are already subject to ongoing disturbance from forestry operations. The Project may disturb individuals during construction (should they be identified within the Project disturbance footprint) but is considered unlikely to disrupt the breeding cycle of an 'important population' as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive habitat mapping indicates that the Project may impact 77.72 ha of potential habitat although may overestimate of the actual occurrence of the species. A further 1,495 ha of suitable habitat is predicted to occur within the immediate surrounds within the impact assessment area. As such, it is considered unlikely that the Project will decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion is not considered a threat to the species (DEWHA 2008k). Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	There are no identified introduced disease species associated with this species. The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There are no identified introduced disease species associated with this species. There is no recovery plan for the species. The approved conservation advice for the species (DEWHA 2008k) identifies research priorities and priority actions including: ■ Design and implement monitoring and research programs to assess population characteristics, distribution and ecological attributes of the species ■ Develop management strategies (including genetic tagging) to monitor/prevent illegal collecting ■ Ensure populations are not impacted by forestry operations ■ Ensure chemicals used for weed control do not impact populations ■ Minimise impacts from land use at known population sites The species has not been observed within the Project footprint and the Project is will not interfere with the actions listed above. While the Project may be a potential point source of ignition for fires this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. The Project is considered unlikely to substantially interfere with the recovery of the species.

Criterion	Assessment against significance criteria ¹
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, the Project is currently considered unlikely to cause 'significant residual impacts' on an <i>important population</i> of <i>Macrozamia machinii</i> .

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.3.4 Hawkweed (*Picris evae*) - vulnerable

Ecology and distribution

Hawkweed (*Picris evae*) is a soft-stemmed annual plant, up to 130 cm tall. The species typically occurs in eucalypt open woodlands with a grassy understorey, characteristically represented by *Dichanthium* spp. Canopy species include *Eucalyptus melliodora*, *E. crebra*, *E. populnea*, *E. albens*, *Angophora subvelutina*, *Allocasuarina torulosa*, and *Casuarina cunninghamiana*. This species has been collected along roadsides, and in cultivated areas (i.e. paddocks), on black, dark grey or red-brown soils, reddish clay-loam or medium clay soils (Holzapfel 1994; DEWHA 2008I).

Hawkweed is known to occur in two distinct areas: northern NSW (e.g. Inverell, Elsmore, Tamworth); and the Darling Downs and Moreton pastoral districts in south-east Queensland (Bostock and Holland 2007).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database. Database records indicate that *Picris evae* has been identified as potentially occurring within the Project footprint. Two records from 2002 are present within the Project footprint approximately 2 km southwest of Brookstead dated 2002. They were recorded in *Dichanthium sericeum* grassland adjacent to cultivated land growing on black clay soil. Another seven records are located within the impact assessment area, one approximately 3 km northeast of Pittsworth and another six in the surrounds of Southbrook dated from 1983 to 2016. Several of these records (including the 2016 record) are associated with road reserves adjacent to the Gore Highway (refer Figure 4.1). Numerous other records are present near the northern section of the Project footprint including in the area to the southeast between the Project and Allora and to the northwest in the area between the Project, Bongeen and Brymaroo Airfield. Additional records are also present in the surrounds of Toowoomba and further southeast towards Gatton (AoLA 2020) (refer Figure 2.17 in Appendix B).

Hawkweed is also known to occur approximately 9 km east of the northern extent of the Project along Gowrie Creek as identified during surveys for the recent Toowoomba second range crossing project. The northern extent of the Project is located adjacent to Gowrie Creek. Large numbers of individuals (>500) were observed inhabiting heavily disturbed habitat including a woody weed layer (pers. comm C Schell).

Recovery plans/threat abatement plans

This species has not been recognised as requiring a recovery plan, nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (DEWHA 2008I) identifies the following threats:

- Habitat loss and fragmentation due to agricultural and grazing development
- Inappropriate fire regimes
- Overgrazing by livestock
- Weed invasion.

Important populations and Habitat critical to the survival of the species

The approved conservation advice for the species does not identify important populations or habitat critical for the species (DEWHA 2008I). The overall population is relatively restricted in occurrence and local occurrences within the Project footprint may therefore be considered as part of an important population. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology).

It is estimated that the Project is likely to impact 575.31 ha of potential habitat and 18.68 ha of Habitat critical to the survival of the species in which this species is predicted to occur (refer Table 4.4). The predictive mapping has taken a conservative approach and includes habitat where relevant REs once occurred but have been subject to vegetation clearing and as such, overestimates the likely occurrence of the species. Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for vulnerable species is shown in Table 8.17.

Table 8.17 Assessment against the significant impact criteria: Hawkweed (*Picris evae*)

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population	The species was not recorded during Project surveys but may occur in the Project footprint, largely on the black clay soils commonly occurring north of Pittsworth. An 'important population' has been identified as potentially occurring within the Project footprint. There are a number of database records to the north of Pittsworth and the species is known to occur in the Gowrie Creek area. Observations of the species occurrence in the Gowrie Creek area indicate it may grow in heavily disturbed habitats. Predictive habitat mapping indicates that the Project may impact 575.31 ha of potential habitat and 18.68 ha of Habitat critical to the survival of the species, although this is a likely overestimate of the actual occurrence of the species. Given there are no records of this species within the impact assessment area and that species can occur within highly degraded habitats the Project is not considered result in a long-term decrease in the size of an important population (should the species be found to occur).
Reduce the area of occupancy of an important population	An 'important population' has been identified as potentially occurring within the Project footprint. Database records indicate the species occurs in the area, although site investigations for the Project did not record the species. Predictive habitat mapping indicates that the Project may impact 575.31 ha of potential habitat and 18.68 ha of Habitat critical to the survival of the species although this is a likely overestimate of the actual occurrence of the species. The Project has potential to reduce the occupancy of an important population through the loss of habitat critical to the survival of the species
Fragment an existing important population into two or more populations	An 'important population' has been identified as occurring in the wider area, although the species has not been recorded within the Project footprint during Project surveys. The Project is linear and relatively narrow, although it is uncertain whether this may represent a barrier for dispersal or cross-pollination for the species. The species has been recorded in road reserves in the impact assessment area and would appear tolerant of linear infrastructure impacts. The species is also known to occur in heavily degraded habitats. The Project is not considered likely to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	The species occurs in grassy open woodlands, roadsides and other suitable habitat types which are widespread. Predictive habitat mapping indicates that the Project may impact 18.68 ha of Habitat critical to the survival of the species (under the approach used for this assessment), and a further 575.31 ha of potential habitat, although this is likely an overestimate. As such, the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	An 'important population' has been identified as potentially occurring within the Project footprint and surrounds. The species has not been recorded within the Project footprint during Project surveys but likely occurs. It is uncertain what the breeding requirements are for the species. The species is known to occur in existing road reserves and would appear tolerant of linear infrastructure impacts. The Project may disturb individuals during construction but is considered unlikely to disrupt the breeding cycle of an 'important population' as a whole.

Criterion	Assessment against significance criteria ¹
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive habitat mapping indicates that the Project may impact 575.31 ha of potential habitat and 18.68 ha Habitat critical to the survival of the species although this is a likely overestimate of the actual occurrence of the species. A further 5,422.49 ha of suitable habitat is predicted to occur within the immediate surrounds within the impact assessment area. As such, it is considered unlikely that the Project will decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion is a potential threat to the species (DEWHA 2008I) although no particular weed species have been identified. Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). The species is known to occur along Gowrie Creek under an overstorey of woody weeds (pers. comm. C Schell). Grasslands in the area are already subject to significant invasion by introduced pastoral grass species. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	There are no identified introduced disease species associated with this species. The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The approved conservation advice for the species (DEWHA 2008I) identifies research priorities including: ■ Design and implement a monitoring program or, if appropriate, support and enhance existing programs. ■ More precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes. ■ Undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants. The Project is considered unlikely to interfere with the recovery strategies listed above. The Project will necessarily reduce known threats such as grazing by livestock (on land within the Project footprint) and through weed controls under the Project's Biosecurity Management Sub-plan. While the Project may be a potential point source of ignition for fires this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, should the species be found to occur within the Project footprint there is potential for the Project to cause 'significant residual impacts' on an <i>important population of Picris evae</i> based on a reduction in the area of occupancy of the species and impacts to Habitat critical to the survival of the species.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.2.3.5 Austral cornflower (*Rhaphonticum australe*) – vulnerable

Ecology and distribution

Austral cornflower (*Rhaphonticum australe*) is an erect perennial herb that grows to 60 cm in height. The species typically grows in Eucalypt open forests, with grassy understory. This species often occurs on roadsides and on road reserves alongside Rhodes grass (*Chloris gayana*), Spear thistle (*Cirsium vulgare*), Queensland blue gum (*Eucalyptus tereticornis*) and Rough-barked apple (*Angophora floribunda*) on black clay soil derived from basalt. This species is considered to be a poor competitor and prefers habitat where grass competition has been reduced by fire, or other forms of disturbance. However, Austral cornflower is unlikely to benefit from disturbance that allows the development of a dense cover of exotic grasses (DAWE 2020).

Austral cornflower is currently confined to Queensland. The species was known to previously occur in NSW and Victoria but is now presumed extinct in those states. The current distribution extends from Allora (north of Warwick) to Callide (northwest of Biloela), Queensland (DEWHA 2008n).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco Logical Australia 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint however there are several nearby records within the impact assessment area. A 2003 record exists to the west of Pittsworth at the Gore Highway and Tip Road junction and is located adjacent to the Project footprint. There are several other records in the Pittsworth area located between 2 km to 4 km from the Project footprint to the north and south. Another 2016 record occurs adjacent to the north of the Project footprint 4 km west of Gowrie township (northern extent of the Project). Records from within a 50 km radius of the Project occur as far north as Jondaryan, west to Pittsworth, south to Allora and east to Helidon Spa (refer Figure 2.4 Appendix B). Many records are associated with occurrences in road and rail reserves.

Recovery plan/threat abatement plans

This species has not been recognised as requiring a recovery plan, nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (DEWHA 2008n) identifies the following threats:

- Broad—scale land clearing
- Road maintenance works impacting populations in road reserves
- Overgrazing by livestock
- Weed invasion.

Important populations and Habitat critical to the survival of the species

The approved conservation advice does not identify important populations or critical habitat for the species. The most significant population of this species occurs in the Toowoomba-Aubigny region which the Project footprint intersects at its northern extent (DAWE 2020). The overall population is relatively restricted in occurrence and local occurrences within the Project footprint may therefore be considered as part of an important population. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). It is estimated that the Project is likely to impact 220.24 ha of potential habitat and 2.29 ha of Habitat critical to the survival of the species in which this species is predicted to occur (refer Table 4.4 and habitat figure in Appendix F). The predictive mapping has taken a conservative approach and includes habitat where relevant REs once occurred but have been subject to vegetation clearing and as such, is likely to be a substantial overestimate of the likely occurrence of the species.

Impacts and mitigation measures associated with this species are identified within Table 7.3. Assessment against the significant impact criteria for critically endangered species is shown in Table 8.18.

Table 8.18 **Assessment against the significant impact criteria: *Rhaponticum australe***

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population	The species was not recorded during Project surveys but may occur in the Project footprint, largely on the black clay soils commonly occurring north of Pittsworth. An 'important population' has been identified as potentially occurring within the Project footprint. There are a number of database records to the north of Pittsworth and the species is known to occur in the Gowrie area. Many records are associated with existing road and rail reserves and the species is considered a poor competitor with introduced grass species. Predictive habitat mapping indicates that the Project may impact 220.24 ha of potential habitat and 2.29 ha of Habitat critical to the survival of the species, although this is a likely overestimate of the actual occurrence of the species. An additional 2,371.89 ha is predicted to occur in the immediate surrounds within the impact assessment area. As part of the Project's Biodiversity Management Sub-plan, additional protected plant surveys targeting this species will be undertaken where suitable habitat is observed prior to vegetation clearing to confirm whether the species occurs (refer Table 7.3). Given the extent of similar available habitat surrounding the Project footprint the Project is not considered result in a long-term decrease in the size of an important population (should the species be found to occur).
Reduce the area of occupancy of an important population	An 'important population' has been identified as potentially occurring within the Project footprint. Database records indicate the species occurs in the area, although site investigations for the Project did not record the species. Predictive habitat mapping indicates that the Project may impact 220.24 ha of potential habitat and 2.29 ha of Habitat critical to the survival of the species although this is a likely overestimate of the actual occurrence of the species. Should the species be found to occur within the Project footprint then the Project has potential to reduce the occupancy of an important population.
Fragment an existing important population into two or more populations	An 'important population' has been identified as occurring in the area. The Project is linear and relatively narrow. The species is wind-dispersed, and the Project is not considered to create a barrier to dispersal. The species has been recorded in road and rail reserves in the surrounding area and would appear tolerant of linear infrastructure impacts. The species is also known to occur in heavily degraded habitats. The Project is not considered likely to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	The species occurs in grassy open woodlands including road reserves. Predictive habitat mapping indicates that the Project may impact 2.29 ha of Habitat critical to the survival of the species with a further 575.31 ha of potential habitat (although this may be an overestimate). As such, it is considered likely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	An 'important population' has been identified as potentially occurring in the Project footprint. The species occurs in grassy open woodlands including road and rail reserves. Predictive habitat mapping indicates that the Project may impact 220.24 ha of potential habitat and 2.29 ha of Habitat critical to the survival of the species (although this may be an overestimate), with 2,371.89 ha predicted to occur in the immediate surrounds within the impact assessment area. It is uncertain what the breeding requirements are for the species. The Project may disturb individuals during construction but is considered unlikely to disrupt the breeding cycle of an 'important population' as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species occurs in grassy open woodlands including road reserves. Predictive habitat mapping indicates that the Project may impact 220.24 ha of potential habitat and 2.29 ha of Habitat critical to the survival of the species (although this may be an overestimate), with 2,371.89 ha predicted to occur in the immediate surrounds within the impact assessment area. As such, it is considered unlikely that the Project will decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion is a potential threat to the species (DEWHA 2008n) although no particular weed species have been identified. Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). The species is thought to be a poor competitor with introduced grass species. Grasslands in the area are already subject to significant invasion by introduced pastoral grass species including.

Criterion	Assessment against significance criteria ¹
	Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project CEMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	There are no identified introduced disease species associated with this species. The Project Biosecurity Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice for the species (DEWHA 2008n) identifies research priorities including: ■ Design and implement a monitoring program for known populations including monitoring the success of management actions and identify priority populations ■ Ensure road maintenance/upgrade activities do not adversely impact populations ■ Address management of weeds and stock management at known sites. The Project will necessarily reduce known threats such as grazing by livestock (on land within the Project footprint) and through weed controls under the Project's Biosecurity Management Sub-plan. The Project is considered unlikely to substantially interfere with the recovery of the species. The additional protected plant surveys will also align with the priority actions for the species, including additional survey work in suitable and potential habitat, and if encountered present an opportunity to understand population size, distribution, ecological requirements and the relative impacts of threatening processes.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is potential for the Project to cause 'significant residual impacts' on an <i>important population of Rhaponticum austral</i> based on a reduction in the area of occupancy of the species and impacts to critical habitat.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3 Significant residual impact assessment for threatened fauna

There are 24 threatened fauna species listed as MNES relevant to the impact assessment area including 15 species listed as vulnerable and a further eight species listed as endangered or critically endangered. The ecology, life history and distribution of these species are summarised in Appendix B. Relevant Commonwealth documents applicable to each species including threat abatement plans, Approved Conservation Advice, and recovery plans are also summarised in Appendix B. This section of the MNES report assesses the potential for significant residual impacts from the Project using the MNES Guidelines.

A range of mitigation measures have been proposed to ameliorate potential impacts wherever possible (refer species-specific measures in Table 6.2). These include measures considered as effective in addressing the recognised threats for each species as recognised in recovery plans, approved conservation advice, and DAWE-adopted threat abatement plans (as identified in the following sections for each species) including but not restricted to:

- Biodiversity Management Sub-plan will incorporate species-specific monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent habitats is not occurring as a result of the Project – applicable to all species
- Biosecurity Management Plan to protect fauna habitats adjacent to the Project from deleterious impacts including weed invasion, proliferation of pest predators and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*) – applicable to all species

- Erosion and Sediment Control Plan and Surface Water management Sub-plan to protect water quality values associated with wetlands and waterways – applicable to aquatic species/wetland birds
- Fauna crossing structures and associated fencing and site-specific (crossing) vegetation rehabilitation to allow continued landscape connectivity for fauna across the alignment – applicable to terrestrial fauna
- Rehabilitation and Landscaping Management Sub-plan to detail rehabilitation of temporary construction areas not required for Project operation – applicable to all species.

The assessment of significant impacts on the identified MNES species from the Project is based on:

- The design and layout of the Project (Section 1.8)
- Currently known information about the MNES affected (Appendix B)
- Predictive habitat modelling for MNES species (Section 3.2.4) based on the habitat assumptions associated with each species (Appendix A)
- Information on potential impacts of Project construction and operation (Section 5.2.1)
- Proposed Project mitigation measures (Section 6).

A summary of the findings of the assessment of the significant residual impact assessment for threatened fauna is provided in Table 8.19. Section 8.3.1 provides the significant impact assessment for Critically endangered and Endangered species, and Section 8.3.3 provides the significant impact assessment for vulnerable species.

Table 8.19 Summary of the results of the significant impact assessment for matters of national environmental significance fauna species

Fauna species	EPBC Act status ¹	Results of assessment ²	Table containing assessment against MNES guidelines
Brigalow woodland snail (<i>Adclarkia cameroni</i>)	Endangered	No significant residual impact expected	Table 8.20
Regent honeyeater (<i>Anthochaera phrygia</i>)	Critically endangered	No significant residual impact expected	Table 8.21
Australasian bittern (<i>Botaurus poiciloptilus</i>)	Endangered	No significant residual impact expected	Table 8.22
Curlew sandpiper (<i>Calidris ferruginea</i>)	Critically endangered	No significant residual impact expected	Table 8.23
Swift parrot (<i>Lathamus discolor</i>)	Critically endangered	Likely significant residual impact	Table 8.24
Australian painted snipe (<i>Rostratula australis</i>)	Endangered	No significant residual impact expected	Table 8.25
Spotted-tail quoll (mainland) (<i>Dasyurus maculatus maculatus</i>)	Endangered	Minor potential for significant residual impact	Table 8.26
Condamine earless dragon (<i>Tympanocryptis condaminensis</i>)	Endangered	Likely significant residual impact	Table 8.27
Five-clawed worm-skink (<i>Anomalopus mackayi</i>)	Vulnerable	Likely significant residual impact	Table 8.39
Large-eared pied bat (<i>Chalinolobus dwyeri</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.28
Collared delma (<i>Delma torquata</i>)	Vulnerable	Likely significant residual impact	Table 8.29
Yakka skink (<i>Egernia rugosa</i>)	Vulnerable	No significant residual impact expected	Table 8.30
Red goshawk (<i>Erythrorhynchus radiatus</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.28

Fauna species	EPBC Act status ¹	Results of assessment ²	Table containing assessment against MNES guidelines
Grey falcon (<i>Falco hypoleucos</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.28
Dunmall's snake (<i>Furina dunmalli</i>)	Vulnerable	Likely significant residual impact	Table 8.31
Squatter pigeon - southern subspecies (<i>Geophaps scripta scripta</i>)	Vulnerable	No significant residual impact expected	Table 8.32
Painted honeyeater (<i>Grantiella picta</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.28
Murray cod (<i>Maccullochella peelii</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.34
South-eastern long-eared bat (<i>Nyctophilus corbeni</i>)	Vulnerable	No significant residual impact expected	Table 8.35
Greater glider (<i>Petauroides volans volans</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.28
Brush-tailed rock-wallaby (<i>Petrogale penicillata</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.28
Koala (<i>Phascolarctos cinereus</i>)	Vulnerable	Likely significant residual impact	Table 8.38
Grey-headed flying-fox (<i>Pteropus poliocephalus</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.28
Black-breasted button-quail (<i>Turnix melanogaster</i>)	Vulnerable	No significant residual impact expected – no important populations mapped as present	Table 8.28

Table notes:

- 1 CE = Critically endangered, E = Endangered, V = Vulnerable; # Species processed using the MNES Significant impact assessment
- 2 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

ARTC are committed to undertaking detailed ecological surveys throughout the Project footprint. The significant residual impact assessment for threatened fauna will be updated, as necessary, following the conclusion of detailed ecological surveys of the Project footprint. Conclusions from the updated significant residual impact assessments will be used to refine the quantification of significant residual impacts and confirm the biodiversity offset requirements for the Project.

8.3.1 Critically endangered and endangered fauna species

Under the Guidelines an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population
- Reduce the area of occupancy of the species
- Fragment an existing population into two or more populations
- Adversely affect habitat critical to the survival of the species
- Disrupt the breeding cycle of a population
- Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline

- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- Introduce disease that may cause the species to decline, or
- Interfere with the recovery of the species.

The following sections assess the potential for significant residual impacts on the 10 endangered or critically endangered fauna species identified as potentially occurring within the Project footprint using the criteria set out in the Guidelines.

8.3.1.1 Brigalow woodland snail (*Adclarkia cameroni*) - endangered

Ecology and distribution

The Brigalow woodland snail (*Adclarkia cameroni*) has a medium to large shell (diameter 20 mm) that is thin and light brownish-yellow, with a reddish band on the whorls. The species is found primarily in Brigalow and eucalypt woodlands forest occurring on alluvial black soils within the Condamine River floodplain. It likely feeds on fungi, lichen, algae and other detritus/biofilm growing on and underneath forest debris (DAWE 2020).

It occurs in a small number of scattered and highly fragmented remnant patches of Brigalow (*Acacia harpophylla*) and eucalypt woodlands generally associated with road reserves and riparian corridors. The narrow riparian corridor associated with the Condamine River is identified as an important refuge for the species due to stable environmental conditions. Dalby and Chinchilla are identified as important areas. Based on the small number of known locations for the species it is thought to occupy an area of 76 km² within the wider environs of the Condamine River floodplain (TSSC 2016a).

Distribution in context to the Project

DAWE habitat mapping for the species (2020) within the impact assessment area indicates the species as 'likely to occur' on the Condamine River floodplain (south of Pittsworth), and as 'may occur' from Millmerran to approximately Southbrook (north of Pittsworth) (refer Figure 3.1 in Appendix B). However, there is only one current database record (i.e. AoLA, WildNet) (approximately 38 km north-west of Toowoomba) for this species within 50 km of the Project footprint. Records of the species are concentrated between Dalby and Miles (refer Figure 3.2 in Appendix B).

Recovery plans/threat abatement plans

This species has not been recognised as requiring a recovery plan, nor has a threat abatement plan been identified as being relevant for this species. The approved conservation advice for the species (TSSC 2016a) identifies the following threats:

- Broad-scale land clearing and disturbance/removal of habitat features used for shelter (ground debris)
- Road maintenance works impacting populations in road reserves
- Trampling by livestock
- Invasion by Buffel grass (*Cenchrus ciliaris*)
- High intensity fires.

Important populations and Habitat critical to the survival of the species

The approved conservation advice observes the riparian corridor along the Condamine River floodplain around Dalby and Chinchilla as important refugial areas for the species and may be considered as Habitat critical to the survival of the species. Dalby (the closer of the two locations) is located over 60 km north-west of the Project.

Impact assessment for this species estimates that 131.46 ha of potential habitat may be impacted under the current Project footprint (refer Table 7.1 and habitat figure in Appendix I). This habitat is associated with riparian corridors along the Condamine River and associated floodplain tributaries. This is a conservative estimate based on predictive mapping which includes all remnant habitat within the floodplain (refer Appendix A for methodology) and is very likely a substantial overestimate of the actual habitat available for the species (if it occurs at all in the area). Impacts and mitigation measures associated with this species are identified within Table 7.4.

Assessment against the significant impact criteria for endangered species is shown in Table 8.20.

Table 8.20 Assessment against the significant impact criteria: Brigalow woodland snail

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	This species has not been identified as occurring within at least 38 km from the northern edge of the Project footprint. Potentially important habitat in the Dalby area is at least 50 km north-west of the Project footprint. Predictive habitat mapping indicates that the Project may impact 131.46 ha of potential habitat for the species. The Project footprint is linear and relatively narrow, although this represents predicted habitat and is likely an overestimation. There is an estimated 1,313.25 ha of potential habitat in the immediate surrounds within the impact assessment area. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify whether the species actually occurs or not as part of the Project Biodiversity Management Sub-plan. Survey methods will follow relevant survey guidelines on advice from experts with experience in searching for the species (it is noted there are no Commonwealth guidelines relevant to the species). Should the species be found individuals will be relocated from the area of disturbance prior to construction/disturbance activities (refer Table 7.4). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the east and west of the Project footprint. The Project is considered unlikely to lead to a long-term decrease in a population.
Reduce the area of occupancy of the species	Predictive habitat mapping indicates that the Project will result in the loss of 131.46 ha of suitable habitat for the species, although this represents predicted habitat and is likely an overestimation. The nearest database records are at least 38 km from the Project footprint. Potentially important habitat in the Dalby area is at least 50 km north-west of the Project footprint. Therefore, no areas of known occupancy are considered to occur within the Project footprint. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify whether the species actually occurs. The Project is linear and relatively narrow and there is extensive similar habitat surrounding the Project. The Project is not considered likely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	Predictive habitat mapping indicates that the Project will result in the loss of 131.46 ha of suitable habitat for the species, although this represents predicted habitat and is likely an overestimation. the species is not from within or near the Project. It is considered unlikely the Project will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of the species	The Project footprint does not include any habitat areas considered critical to the survival of the species (as described in this assessment). It is not known if the species occurs in or near the Project. It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	There is no evidence the species occurs within or near the Project footprint. It is considered unlikely that the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive habitat mapping indicates that the Project will result in the loss of 131.46 ha of suitable habitat for the species, although this represents predicted habitat and is likely an overestimation. This habitat is located at least 50 km from identified important habitat in the Dalby area. The Project footprint is linear and there will be extensive tracts of suitable habitat remaining undisturbed in the surrounding landscape adjacent to the east and west of the Project footprint. This impact is not considered to be of the extent that the species is likely to decline.

Criterion	Assessment against significance criteria ¹
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Habitat invasion by Buffel grass is identified as a potential threat to the species (TSSC 2016a). Project-associated surveys (Aurecon 2018) recorded Buffel grass within the footprint although it was found to be uncommon on the dark soils in which Brigalow woodland snail occurs. Grasslands in the area are already subject to significant invasion by introduced pastoral grass species. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	There is no recovery plan for the species. The approved conservation advice (TSSC 2016a) for the species includes the following management/conservation actions: ■ Prevent further clearing of brigalow habitat within the species range and investigate conservation and management agreements on lands where the species occurs ■ Manage known and likely threats including management actions such as maintaining native vegetation buffers around populations and managing weeds and firewood collection ■ Control threatening pest and weed species such as Buffel grass and feral pigs ■ Manage fires and domestic stock at known sites. The Project is considered unlikely to interfere with any of the actions listed above. The Project will remove livestock on Project lands. While the Project may be a potential point source of ignition for fires this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. Should Brigalow woodland snail be identified during Project activities this will contribute to current information on the distribution of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is currently unlikely to be a 'significant residual impact' on Brigalow woodland snail as a result of the Project.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.1.2 Regent honeyeater (*Anthochaera phrygia*) – critically endangered

Ecology and distribution

Regent honeyeater is largely known to occur in box-ironbark eucalypt woodlands. The preferred habitat is wet areas containing fertile soils that provide reliable nectar seasonally in areas of creek flats, river valleys and lower slopes. They are also found in dry eucalypt woodland and open forest in both rural and urban environments with mature eucalypts (DES 2017a). The Regent honeyeater's diet consists of nectar from key species such as Yellow Box (*Eucalyptus melliodora*), White Box (*Eucalyptus albens*) and Mugga Ironbark (*Eucalyptus sideroxylon*) as well as sugary exudates. It also forages in Swamp mahogany (*Eucalyptus robusta*) and Spotted gum (*Corymbia maculata*) close to the coast. The species is also known to consume insects particularly when breeding (Birdlife International 2016a). The species prefers mature large trees that produce more flowers, particularly those on fertile soils and in riparian areas (DotE 2016). The species breeds as individual pairs or sometimes in loose colonies with the female honeyeater incubating eggs whilst both parents feed the young.

Breeding

The Regent honeyeater is endemic to south-east Australia, ranging from SEQ to central Victoria. In SEQ, the Regent Honeyeater's distribution ranges from the Cooloolo Plains in the north to inland areas such as Dalby, and further south into areas such as Narrabri (NSW). Regent honeyeater is known to breed in small numbers regularly to the west of Warwick in Durikai State Forest (100 km south-west of the Project). The species is considered to comprise one population with some movements of individuals between regularly used areas (Garnett et al 2011).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys within the impact assessment area. Regent honeyeater is not known from within or near the impact assessment area. It is noted AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. The nearest records to the Project footprint are two records east of Toowoomba from the 1980s (24 km and 27 km away from the Project footprint). There are a number of records (including recent sightings) from the Durikai area (considered as 'critical habitat' for the species as noted below) which is located approximately 35 km east of the Project footprint (AoLA 2020). Almost all records are located substantially east of the Project (refer Figure 7.14 Appendix B). The only records west of the Project are from Dalby (60 km north-west of the Project), Chinchilla (140 km away) and near Saint George (over 200 km away).

Recovery plans/threat abatement plans

The *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016a) has been adopted by DAWE and has been in effect since May 2016. The Plan identifies the following threatening processes as applicable to the species:

- Small population size
- Habitat loss, fragmentation and degradation
- Competition with other nectivorous bird species as well as European honeybees (*Apis mellifera*).

Other identified threats include:

- Suppression of natural regeneration of overstorey tree species and shrub species as a result of overgrazing
- Disturbance to nesting sites leading to abandonment (DES 2017a).

The following threat abatement plan has been identified has been adopted as relevant to this species:

- *Threat abatement plan for competition and land degradation by rabbits* (DotE 2016b).

Important populations and Habitat critical to the survival of the species

The species is considered to occur as single widespread inter-breeding population (Garnett et al 2011). The overall population is difficult to define due to fluctuating numbers between years but is estimated at 350 to 400 mature individuals. The *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016a) identifies the following as habitat critical to the survival of the Regent honeyeater:

- Any breeding or foraging area where the species is likely to occur
- Any newly discovered breeding or foraging areas.

Three known key breeding regions include:

- North-east Victoria (Chiltern-Albury)
- Capertee Valley NSW
- Bundarra-Barraba region NSW (DotE 2016a).

The nearest breeding site to the Project is the Durikai area located 35 km east of the Project footprint. The species may occasionally occur as foraging individuals/pairs within the Project footprint during flowering events, but it is not considered 'likely to occur'. There is no evidence the species occurs regularly/seasonally anywhere within the impact assessment area or surrounds. The species forages widely and may as easily occur in modified urban environments as well as natural woodlands. This assessment has defined Habitat critical to the survival of the species by applying a 1 km buffer on known records that intersect 'potential habitat' for the species (refer Appendix A for methodology). As such, the Project footprint is not considered to comprise habitat 'critical to the survival of the species'.

Impact assessment for this species predicts that 157.39 ha of potential habitat used for foraging may be impacted under the current Project footprint (refer Table 7.1 and habitat figure in Appendix I).

In regard to the Regent honeyeater, the draft *Guide to nationally protected species significantly impacted by paddock tree removal* (DoEE 2020) notes that significant impacts may arise due to the removal of Ironbark paddock trees within known breeding areas or frequented visitation sites. The nearest breeding site for this species is Durikai State Forest over 80 km south-west of the Project. There is no evidence to suggest the species frequently visits the Project footprint or surrounds. The nearest recent records of the species occurring in the wider area is 25 km east of the Project footprint.

Impacts and mitigation measures associated with this species are identified within Table 7.4. Assessment against the significant impact criteria for critically endangered species is shown in Table 8.21.

Table 8.21 Assessment against the significant impact criteria: Regent honeyeater

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	As noted above there are no identified important breeding locations or habitat critical to the survival of the species as identified in the National Recovery Plan for the Regent Honeyeater (<i>Anthochaera phrygia</i>) (DotE 2016a) which are within or near the MNES assessment area. The nearest known breeding location is Durikai State Forest which is over 35 km east of the Project. However, the species now rarely visits the Gore-Karara (Durikai) region (NESPTSRH 2019). Key breeding regions include: ■ North-east Victoria (Chiltern-Albury) ■ Capertee Valley NSW ■ Bundarra-Barraba region NSW (DotE 2016). The species is considered to occur as a single interbreeding population across its range. The species is only likely to occur in the impact assessment area transiently (in winter during flowering events) in small numbers, if the species occurs in the area at all. No individuals have been observed during field investigations associated with the Project and there are no database records within 24 km, the majority of which are located east of the Project footprint. There is no evidence the species occurs in the area. It is considered likely that potential foraging individuals disturbed by construction activities will temporarily move away from the area of disturbance and return post-construction. Predictive mapping for this species predicts that 157.39 ha of potential foraging habitat may be impacted under the current Project footprint. Nevertheless, the species can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. The Project is considered unlikely to result in a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	The area of occupancy is estimated to be 300 km², with the species mainly occurring in dry box ironbark open-forest and woodland areas inland of the Great Dividing Range, particularly favouring those on the wettest, most fertile soils, such as along creek flats and broad river valleys.

Criterion	Assessment against significance criteria ¹
	Predictive habitat mapping indicates that the Project will result in the loss of 157.39 ha of suitable habitat for the species, although this represents predicted habitat. The nearest database record (AoLA) is located approximately 24 km from the Project footprint and no individuals were observed during field investigations associated with the Project. The nearest known breeding location is Durikai State Forest which is over 35 km east of the Project. However, the species now rarely visits the Gore-Karara (Durikai) region (NESPTSRH 2019). The species is only likely to occur in the impact assessment area transiently (in winter during flowering events) in small numbers, if the species occurs in the area at all. Therefore, no areas of known occupancy are considered to occur within the Project footprint and the Project is not likely to reduce the potential area of occupancy for the species.
Fragment an existing population into two or more populations	The species is highly mobile, and the Project is not considered to represent a barrier to movement for the species. It is considered unlikely the Project will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of the species	The <i>National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)</i> (DotE 2016) identifies the following as habitat critical to the survival of the Regent honeyeater: - Any breeding or foraging area where the species is likely to occur - Any newly discovered breeding or foraging areas. The Project is also located to the north-east of a key region known to support this species (breeding and foraging) in Queensland (i.e. Durikai State Forest). No individuals have been observed foraging or breeding within or adjacent to the Project footprint, with the nearest database record (AoLA) located approximately 24 km east of the Project (generalised to 0.1 degrees) and few records located west of the Project. Recent studies have however noted that this species rarely visits the Durikai region, much less the area associated with the Project. The Project disturbance area does not include any habitat areas considered critical to the survival of the species. It is not known if the species occurs in the area. It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	It is uncertain how many individuals occur in the area or if the species occurs in the area at all. The nearest breeding records are located in Durikai State Forest and are over 35 km east of the Project footprint. No individuals were observed during field investigations associated with the Project. No breeding sites are known to the impact assessment area. Three known key breeding regions include: - North-east Victoria (Chiltern-Albury) - Capertee Valley NSW - Bundarra-Barraba region NSW (CoA 2016). The nearest breeding records are located in Durikai State Forest and are at least 35 km east of the Project. This area is considered to be habitat critical for the species given the area is known to support the species. No breeding habitat is likely to occur within or adjacent the Project. It is considered unlikely that the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historical records of the species within the impact assessment area or immediate surrounds. The 157.39 ha of predicted habitat that is estimated to be cleared is not considered critical to the survival of the species. The nearest 'Habitat critical to the survival of the species' is in Durikai State Forest over 35 km west of the Project footprint. The Project alignment is linear and there will be extensive tracts of suitable habitat remaining undisturbed in the surrounding landscape adjacent to the east and west of the Project footprint. This impact is not considered to be of the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Habitat degradation by European rabbit (<i>Oryctolagus cuniculus</i>) has been identified as a threatening process for Regent Honeyeater (DotE 2016b). Rabbits were identified as widespread during Project-associated surveys. There are no particular weed species identified as relevant to the species. Project-associated surveys have recorded 15 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018).

Criterion	Assessment against significance criteria ¹
	Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and potential use of Project infrastructure as shelter by pest fauna such as European rabbit. The Plan will be in place for the life of the Project and will minimise the potential for weed and pest invasion or spread. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	Recovery strategies listed in the <i>National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)</i> (DotE 2016a) include: ■ Improve the extent and quality of Regent honeyeater habitat ■ Bolster the wild population with captive-bred birds until the wild population becomes self-sustaining ■ Increase understanding of the size, structure, trajectory and viability of the wild population ■ Maintain and increase community awareness, understanding and involvement in the recovery program The Project is considered unlikely to interfere with any of the recovery strategies listed above to the extent it will interfere with the recovery of the species. The species is only sporadically recorded in the wider area. Should Regent honeyeater be identified during Project activities this will contribute to current information on the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is currently unlikely to be a 'significant residual impact' on Regent honeyeater as a result of the Project.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.1.3 Australasian bittern (*Botaurus poiciloptilus*) - endangered

Ecology and distribution

The Australasian bittern (*Botaurus poiciloptilus*) is a large stocky, partially nocturnal heron which can reach up to a total body length of 75 cm with a wingspan just over 1 m. Australian bittern is largely a solitary species although sometimes can be found in pairs or small dispersed groups. Preferred habitat for the Australasian bittern consists of permanent freshwater wetlands with tall dense vegetation including Bulrushes (*Typha* spp.), Spike rushes (*Eleocharis* spp.) and tall emergent sedges. Rice paddies within the Murray-Darling basin are a known habitat for the species who disperse widely during periods of droughts to coastal wetlands and to ephemeral wetlands. The species breed around summer, between October and February, as solitary pairs and begin building nests in secluded, densely vegetated wetlands on platforms of reeds approximately 30 cm above water level. (Birdlife International 2016b; OEH 2017b).

This species occurs from Bundaberg in SEQ south to Victoria and west into South Australia.

Distribution in context to the Project

Australasian bittern was not identified during any Project-associated field surveys within the impact assessment area, although conditions were dry at the time of surveys and not conducive to the species being present. There are few database records within 50 km of the Project. There are records in the wider area surrounding Toowoomba with two records of indeterminate location (some records have been generalised to protect the species) located 24 km east of the northern extent of the Project, a record from Jondaryan (25 km north-west) and a record near Bowebville (37 km north-west). There is also a record east of Inglewood (40 km east of the Project) (refer Figure 7.2 Appendix B). All of these records are from the 1980s or are older. The nearest recent record (2009) is from Lake Clarendon (near Gatton) approximately 48 km east of the northern extent of the Project (Toowoomba) (AoLA 2020).

Wetland habitats within the impact assessment area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (palustrine). Dams and reservoirs are generally unlikely to provide suitable dense aquatic vegetation for the species. Riverine wetlands through much of the Project footprint are highly degraded with little aquatic vegetation present (such as *Typha* species) suitable for Australasian bittern.

Areas of remnant Palustrine wetland within the impact assessment area are represented by RE 11.3.27b and are considered the most likely wetland habitat present with potentially suitable values for Australian painted snipe although these areas are highly ephemeral in nature and represent a very small portion within the Project footprint (0.97 ha) (refer Section 4.3.4.10). Wetlands considered to be of 'high ecological significance' under State mapping are restricted to two discrete wetlands located at western extent of the impact assessment area (near Kurumbul) but are not intersected by the Project footprint (refer EIS Appendix J: Terrestrial Ecology Technical Report and EIS Appendix K: Aquatic Ecology Technical Report for further detail regarding wetland values).

Recovery plans/threat abatement plans

There is currently a draft *National recovery plan for the Australasian bittern (Botaurus poiciloptilus)* (DotEE 2019a) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Reduced wetland availability due to changed hydrology
- Habitat loss and degradation such as reduced water quality
- Low genetic diversity
- Invasive species including herbivores impacting habitat (horses, pigs, goats and deer) and predators (red fox, cats, rats and pigs).
- Climate variability and change.

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015d)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008q).

Important populations and Habitat critical to the survival of the species

Population estimates of the number of adult birds in Queensland from 2009 – 2010 are 3 to 16 individuals in Queensland (Garnett et al 2011). The draft *National recovery plan for the Australasian bittern (Botaurus poiciloptilus)* (DotEE 2019a) identifies all populations of Australasian bittern should be considered as important. Habitat 'critical to the survival of the species' is described as:

- Any wetland habitat where the species is known or likely to occur (breeding or foraging habitat) within the indicative distribution map
- Any location with suitable habitat outside the above area that may be periodically occupied by Australasian bittern.

The Project footprint is located outside of the known or likely to occur habitat mapped within the distribution map and appears to be west of the distribution mapped as 'may occur' for the species.

Predictive habitat modelling for the species estimates that 44.98 ha of suitable habitat may be impacted under the current Project footprint (refer Table 7.1 and habitat figure in Appendix I). The predictive habitat mapping has been approached in a conservative manner and is largely modelled on available vegetation and corresponding wetland community mapping as provided by DES. This includes creek line vegetation which is much less suitable for the species. Given the ephemeral nature of most natural wetlands in the area the predictive habitat figure is likely to be an overestimation of the available habitat suitable for this species in the Project footprint. It is considered unlikely the Project may impact habitat critical to the survival of Australasian bittern.

Impacts and mitigation measures associated with this species are identified within Table 7.4. Assessment against the significant impact criteria for endangered species is shown in Table 8.22.

Table 8.22 Assessment against the significant impact criteria: Australasian bittern

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	The species occurs as a widely dispersed population across south-eastern Australia. As such, no resident population can be attributed to the impact assessment area or immediate surrounds. There are no records of this species within 20 km of Project footprint. The only recent record of the species is located 48 km from the Project. Should the species occur within the footprint it is unlikely to occur as more than one or two individuals at a site (i.e. the Project is unlikely to impact a population). The Project appears located west of habitat mapped for the species potential occurrence in the <i>draft National recovery plan for the Australasian bittern (Botaurus poiciloptilus)</i> (DotEE 2019a). Predictive mapping estimates that 44.98 ha of potential habitat will be impacted by the Project although this is likely to be an overestimation. It is unknown at this stage to what extent the predicted wetland habitat within the Project footprint comprises values suitable for the presence of Australasian bittern. Under the Project Biodiversity Management Sub-plan pre-construction surveys will be carried out following optimal (wet) conditions to assess whether wetland habitat values are suitable for the species, and if so, if the species actually occurs. Surveys will follow Commonwealth survey guidelines for the species (e.g. DEWHA 2010b). If the species or habitat is identified during pre-construction surveys, further pre-clearance surveys will be carried out to assess whether the species is present with mitigation measures in place should this be the case (refer Table 7.4). Should the species be found individuals would be expected to disperse from the construction area. The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of the population.
Reduce the area of occupancy of the species	There are no reliable records of this species within or close to the Project footprint. Predictive mapping estimates that 44.98 ha of suitable habitat will be impacted by the Project although this is likely to be an overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the Project footprint comprises values suitable for the presence of Australasian bittern. No database records of the species occur within the impact assessment area, although there are several records in the wider surrounds. It is unknown to what extent the species may utilise wetland habitats associated with the Project footprint, or if it occurs at all. The species is nomadic and unlikely to use these areas in more than a transient manner dependent on local conditions. The impacts of the Project are considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	The species is highly mobile. Individuals have been shown to disperse over 100 km in response to changing wetland conditions (Bitterns in Rice Project 2016). The Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	There are no reliable records of this species within or close to the Project footprint. Predictive mapping estimates that 44.98 ha of potential habitat will be impacted by the Project, although this is likely to be an overestimation. Habitat critical to the survival of the species is not considered to occur. The Project is considered unlikely to adversely affect habitat critical to the survival of the species.

Criterion	Assessment against significance criteria ¹
Disrupt the breeding cycle of a population	There are no reliable records of this species within or close to the Project footprint. Predictive mapping estimates that 44.98 ha of potential habitat will be impacted by the Project, although this is likely to be an overestimation. The species is known to breed from October to February. Pre-construction surveys will be carried out to assess whether wetland habitat values are suitable for the species, and where suitable habitat is identified whether the species actually occurs. Should the species be observed as nesting measures will be in place within the Project Biodiversity Management Sub-plan to allow nesting to occur undisturbed (refer Table 7.4). It is possible that Australasian bittern individuals could be disrupted during breeding, but it is considered very unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive mapping estimates that 44.98 ha of suitable habitat will be impacted by the Project although this is likely to be an overestimate. Potential impacts to wetland habitat from localised changes to flood regimes or impacts to water quality are considered unlikely to be of a scale that will impact habitat for Australasian bittern (refer 5.2.1.13). It is unknown if the species or preferred habitat even occurs in the area. It is considered unlikely that impacts associated with the Project may result in species decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	There are no particular weed species identified as relevant to Australasian bittern, although invasion of wetland habitat by weeds is considered a potential threat (TSSC 2019). No aquatic weed species were recorded during Project aquatic ecology surveys (refer EIS Appendix K: Aquatic Ecology Technical Report for further information). Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Project is not expected to lead to increased abundances of introduced predator species. Nevertheless, measures will be incorporated to monitor pest species observations associated with Project activities, and pest control actions where considered necessary. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and pest proliferation and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	Conservation objectives listed in the draft Commonwealth recovery plan for the species (DotEEa 2019) include: - Identify the key sites where Australasian Bitterns occur throughout their range and establish a baseline measure of abundance. This baseline will then be used to track change over time. - Manage key sites to ensure habitat is suitable for Australasian Bitterns. This will require measures that primarily target adequate water flow and quality, and measures to ensure weed species and grazing animals do not compromise wetland structure and function. - Improve understanding of foraging and breeding behaviour, in order to better design recovery actions. - Engage community and stakeholders in Australasian Bittern conservation. The Project is considered unlikely to interfere with any of the recovery strategies listed above. Key sites are unlikely to occur and should Australasian bittern be identified during Project activities this will contribute to current information on the species in the SEQ region.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is currently unlikely to be a 'significant residual impact' on Australasian bittern as a result of the Project.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.1.4 Curlew sandpiper (*Calidris ferruginea*) – critically endangered

Ecology and distribution

In Australia, the Curlew sandpiper forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Curlew sandpipers usually forage by pecking and probing in water, near the shore or on bare wet mud at the edge of wetlands. They glean from mud, from the surface of water, or in drier areas above the edge of the water. Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand (Higgins and Davies 1996).

The species breeds in Siberia in the northern hemisphere summer. The species has been recorded in all Australian states and territories. In Queensland, widespread records occur along the coast south of Cairns with sparsely scattered records inland. The species migrates to Australia in the non-breeding season arriving in early September and leaving in March-April. Younger birds may over-winter in Australia (DotE 2015e).

Distribution in context to the Project

Curlew sandpiper was not identified during any Project-associated field surveys within the impact assessment area, although conditions were dry at the time of surveys and not conducive to the species being present. There are few within 50 km of the Project footprint. The closest database record occurs from at Lake Coolmunda to the east of Inglewood (12 km east of the Project footprint), however this record is not dated. There is a recent record (2018) from Lake Cooby located 14 km north of the northern extent of the Project. Other records occur near Oakey (1980 - 15 km north-west), south of Dalby at dam sites (2007 and 1985 – over 50 km west) (refer Figure 7.20 Appendix B). The vast majority of occurrence records for this species occur along the east coast. Virtually all inland sites are on large waterbodies with shallow edges.

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved Conservation Advice (DotE 2015e) notes the following potentially threatening processes identified for Australian habitat as relevant to Curlew sandpiper:

- In non-breeding grounds in Australia, this species mostly occurs in highly populated areas and is therefore vulnerable to possible habitat alteration
- Threats to the Curlew sandpiper include the loss and fragmentation of feeding and roosting habitat from human development, human disturbance at roost and feeding sites, disturbance by wild dogs, water pollution and invasive plants.

Important populations and Habitat critical to the survival of the species

The breeding population of Curlew sandpiper migrating to Australia occurs across much of the Australian coastline as well as some inland sites. As such there is no important population relevant to individual locations. There is no description of Habitat critical to the survival of the species. 'Nationally important habitat' for migratory shorebirds in Australia is described as comprising 0.1 per cent of the flyway population of a single species of migratory shorebird (DotEE 2017b). For Curlew sandpiper this equates to 90 individuals based on current population estimates (Hansen et al 2016). There is no evidence the Project footprint or surrounding impact assessment area comprises any areas of suitable open wetland habitat capable of supporting this many individuals. The species is very unlikely to utilise riverine wetland habitat in the area. All known inland records of the species occurrence in the local region are located on large permanent waterbodies and located well away from the Project footprint. The nearest 'nationally important habitat' for migratory waders to the Project is the Moreton Bay Ramsar wetland area which is located over 100 km east of the northern extent of the Project.

Predictive habitat mapping indicates that the Project may impact 13.89 ha of habitat considered suitable for Curlew sandpiper (refer Table 7.1 and habitat map in Appendix I). However, the predictive habitat mapping has been approached in a conservative manner and is largely modelled on available vegetation and corresponding wetland communities mapping provided by DES. Given the species coastal habits and the ephemeral nature of most natural wetlands in the area the predictive habitat figure is likely to be an overestimation of the available habitat suitable for this species in the Project footprint. Impacts and mitigation measures associated with this species are identified within Table 7.4. Assessment against the significant impact criteria for critically endangered species is shown in Table 8.23.

Table 8.23 Assessment against the significant impact criteria: Curlew sandpiper

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	Based on habitat modelling the Project is predicted to impact 13.89 ha of suitable habitat for Curlew sandpiper although this is likely an overestimation. It is unlikely the Project footprint or surrounds comprises habitat likely to support large numbers of individuals of the species. There are no historic records of this species within the impact assessment area and there are few records from the wider area (none of which are located in close proximity to the Project). The species occurs as a dispersed population around coastal Australia. The Project is unlikely to result in a long-term decrease in the size of a population of Curlew sandpiper.
Reduce the area of occupancy of the species	Based on habitat modelling the Project is predicted to impact 13.89 ha of suitable habitat for Curlew sandpiper although this is likely an overestimation. It is unknown if the species actually occurs within or near the Project footprint, and it is unlikely the Project footprint or surrounds comprises habitat likely to support large numbers of individuals of the species. There are no historic records of this species within or close to the impact assessment area. The species occurrence is largely coastal and occurs as a dispersed population around coastal Australia. The Project is considered unlikely to reduce the potential area of occupancy for the species.
Fragment an existing population into two or more populations	The population of Curlew sandpiper is distributed across much of coastal Australia. It is considered unlikely that the Project will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of a species	Predictive habitat mapping indicates that the Project footprint does not comprise Habitat critical to the survival of the species as described for this assessment (refer Table 7.1), or nationally important habitat as described by DotEE (2017). It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	The species breeds in the northern hemisphere. It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Based on habitat modelling the Project is predicted to impact 13.89 ha of potential habitat for Curlew sandpiper although this is likely an overestimation. There are no records of this species within or close to the impact assessment area. The nearest records and likely habitat are at least 12 km from the Project footprint. Potential impacts to wetland habitat from localised changes to flood regimes or impacts to water quality are considered unlikely to be of a scale that will impact habitat for Curlew sandpiper (refer 5.2.1.13). Nevertheless, the species occurrence is largely coastal. The Project is not considered to impact the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	There are no particular weed species identified as relevant to Curlew sandpiper, although invasion of wetland habitat by weeds is considered a potential threat (DotE 2015e). No aquatic weed species were recorded during Project aquatic ecology surveys (refer EIS Appendix K: Aquatic Ecology Technical Report for further information). Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be a part of the overall Project CEMP. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criterion	Assessment against significance criteria ¹
Interfere with the recovery of the species	There is no recovery plan for Curlew sandpiper or migratory shorebirds in general. The approved conservation advice for this species notes the following management actions: ■ Improve protection, management, and monitoring of roosting and feeding sites ■ Control of invasive species at important sites ■ Manage disturbance at important sites (e.g. horse riding, pet dog controls, and vehicle access) ■ Incorporate coastal planning and management requirements addressing Curlew sandpiper (TSSC 2015a). The Project is considered unlikely to interfere with the management actions listed above and is very unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is currently considered to be no 'significant residual impact' on Curlew sandpiper as a result of the Project.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.1.5 Swift parrot (*Lathamus discolor*) – critically endangered

Ecology and distribution

The Swift parrot feeds mostly on nectar, mainly from Eucalypts, but also eats psyllid insects and lerps (waxy secretion on Eucalypt leaves produced as a protection by young psyllid insects), seeds and fruit. Foraging habitat on the mainland includes inland box-ironbark and grassy woodlands, and coastal Swamp mahogany (*Eucalyptus robusta*) and Spotted gum (*Corymbia maculata*) woodland when in flower. In northern NSW and south-eastern Queensland, Forest red gum (*E. tereticornis*) forests and Yellow box (*E. melliodora*) forest are commonly utilised by Swift parrots (Saunders and Tzaros 2011, OEH 2017b). In northern New South Wales the species is known to use Northern grey box (*E. moluccana*) and Blackbutt (*E. pilularis*) (Saunders and Heinsohn 2008), both of which also occur in south-east Queensland.

The Swift parrot typically inhabits dry eucalypt forests and woodlands, occasionally wet sclerophyll forests, suburban parks and sometimes gardens with flowering fruit trees (Saunders and Tzaros 2011). Coastal forests from eastern Victorian to the central coast of New South Wales are utilised during periods of drought as refuge habitats. The species is found to prefer large mature trees for foraging as these provide more reliable resources than smaller immature trees (Saunders and Tzaros 2011).

The Swift parrot breeds in Tasmania during summer (mid-September to late-January) and migrates north to mainland Australia during the winter. Small numbers of Swift parrots occur in SEQ on a regular basis (TSSC 2016b).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys within the impact assessment area. There are several records from the Toowoomba area, the closest of which is 4.5 km east of the northern extent of the Project footprint (no location or date data attached). It is noted most AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. Glen Lomond Park is a 'priority habitat area' (Saunders and Tzaros 2011) and located approximately 17 km east to south-east of the northern extent of the Project footprint. There are two records near this area from 2000. There are a cluster of records around Durikai State Forest (approximately 40 km east of the central portion of the Project footprint). There are two other records scattered to the east of the southern extent of the Project footprint from Texas (1984) and near Wilga Park Nature Refuge (2017) although neither is within 40 km of the Project footprint. The only records west of the Project are three records that are old and over 100 km north-west of the Project (refer Figure 7.18 in Appendix B). It is noted the northern section of the Project (where the species may be more likely to occur) passes through heavily modified lands that are largely cleared of woody vegetation.

Recovery plans/threat abatement plans

The *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Saunders and Tzaros 2011) identifies the following threatening processes as applicable to the species:

- Habitat loss and alteration from forestry activities (including firewood harvesting), and land developments
- Suppression of tree regeneration and loss/dieback of eucalypts on agricultural land
- Climate change and frequent fires
- Mortality resulting from collision with wire netting or mesh fences
- Competition with noisy miner (*Manorina melanocephala*) and other aggressive honeyeaters

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015d).

Important populations and Habitat critical to the survival of the habitat

The overall population is poorly known but estimated at 2000 mature individuals and is declining (Garnett et al 2011). The wintering population of Swift parrot is spread across much of mainland south-east Australia. As such there is no important population relevant to individual locations. The species' recovery Plan does not define habitat critical to the survival of the species but does identify priority habitats which are used by large proportions of the population (repeatedly between seasons or for prolonged periods of time).

Priority habitat areas identified in SEQ include the following localities:

- Bowman Park, Bardon
- Rafting Ground Reserve, Kenmore
- Glen Lomond Park, Toowoomba (Saunders and Tzaros 2011).

The nearest of these to the impact assessment area (Glen Lomond Park) is located on the south-eastern outskirts of Toowoomba and is 17 km south-east of the northern extent of the Project footprint. Other habitats considered important for the species are nesting and habitats used by a large proportion of the population (Saunders and Tzaros 2011). The species nests in Tasmania and there is no evidence provided by available records indicating the disturbance footprint, Impact assessment area or surrounds provides habitat considered as a 'priority habitat' i.e. regularly used by the species either repeatedly or for extended periods. For the purposes of this assessment habitat considered 'Habitat critical to the survival of the species for Swift parrot has been considered as foraging habitat in mature (remnant) vegetation communities comprising the tree species discussed above as relevant to the Brigalow Belt Region (refer Appendix A for methodology).

The predictive habitat modelling has taken a conservative approach and includes regrowth woodlands as Potential habitat which may not be likely to provide favoured foraging habitat given the species prefers large mature trees (Saunders and Tzaros 2011). There is approximately 243.54 ha of Habitat critical to the survival of the species within the Project Footprint and 20.12 ha of potential habitat. There is approximately 4,339.41 ha identified as Habitat critical to the survival of the species within the immediate surrounds of the Impact assessment area (refer Table 7.1 and habitat figure in Appendix I).

Impacts and mitigation measures associated with this species are identified within Table 7.4. Assessment against the significant impact criteria for critically endangered species is shown in Table 8.24.

Table 8.24 Assessment against the significant impact criteria: Swift parrot

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	The population of Swift parrot is dispersed across mainland south-eastern Australia in the winter months. Small numbers of individuals occur sporadically in SEQ in a variety of habitats including urban areas. The nearest database records of Swift parrot are located in the Toowoomba area with the closest 4.5 km east of the Project footprint. There are no nearby records outside of the Toowoomba area or west of the Project. The northern section of the alignment passes through cleared lands for the most part and is generally unsuitable for the species. There is no evidence the species uses the Impact assessment area or surrounds on a regular basis. It is considered very unlikely the Project will result in direct mortality of individuals of the species. The Project will not impact any of the identified priority habitat areas (where the species is thought to regularly occur) in Queensland. Predictive habitat modelling indicates the project may impact 243.54 ha of foraging habitat for the species (considered as Habitat critical to the survival of the species) and 20.12 ha of potential habitat, although it is uncertain to what extent the species occurs along much of the alignment given the distribution of known records. The species can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is over 4,339.41ha of habitat identified as Habitat critical to the survival of the species adjacent to the Project (within the impact assessment area) that will remain unimpacted by the project activities. The Project is considered unlikely to result in a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	The Project will not impact any identified priority habitat areas in Queensland. The Project has been predicted to impact 243.54 ha of Habitat critical to the survival of the species and 20.12 ha of potential habitat for the species. Although it is uncertain to what extent the species occurs along much of the alignment given the distribution of known records. Small numbers of individuals occur sporadically in SEQ to the east of the Project in a variety of habitats including urban areas. Predictive habitat modelling indicates the project may impact 20.12 ha of potential and 243.54 ha of Habitat critical to the survival of the species (i.e. foraging habitat) , although this may be an overestimate of the potential for the species to occur. Nevertheless, the species ranges widely and can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is over 4,339.41 ha of habitat identified as Habitat critical to the survival of the species adjacent to the Project (within the impact assessment area) that will remain unimpacted by the project activities. In summer the species occurs sporadically across a broad swathe of eastern Australia from south-east Queensland to Victoria. The Project will not reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	This is a highly mobile species. The Project is not considered to represent a barrier to movement for the species. It is considered unlikely the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	Small numbers of individuals regularly occur in SEQ to the west of the Project in winter. The nearest database record (AoLA) of Swift parrot is located 4.5 km east of the Project footprint in the Toowoomba area. The Project will not impact any identified priority habitat areas in Queensland. The species breeds in Tasmania. Predictive habitat modelling indicates the Project may impact 20.12 ha of potential and 243.54 ha of Habitat critical to the survival of the species (i.e. foraging habitat), although this may be an overestimate of the potential for the species to occur. Nevertheless, the species ranges widely and can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is over 4,339.41ha of habitat identified as Habitat critical to the survival of the species adjacent to the Project (within the impact assessment area) that will remain unimpacted by the project activities. Given habitat critical to the survival of the species is likely to be impacted, there is potential for the Project to adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	The species breeds in Tasmania. Small numbers of birds occur in SEQ to the east of the Project each year. The Project will not disrupt the breeding cycle of a population.

Criterion	Assessment against significance criteria ¹
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project will not impact any identified priority habitat areas in Queensland. Predictive habitat mapping indicates that the Project may impact 20.12 ha of potential and 243.54 ha of habitat critical to the survival of the species, although it is uncertain to what extent the species occurs along much of the alignment given the distribution of known records. The species may utilise a wide variety of habitats including urban parklands. The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. The Project will not impact habitat suitable for Swift parrot to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	The relevant threat abatement plan for Swift parrot include management measures to address the impact of feral cats. Feral cat was observed as widespread through the impact assessment area during Project-associated surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The National Recovery Plan for the Swift Parrot <i>Lathamus discolor</i> (Saunders and Tzaros 2011) lists the following recovery actions: - Identify the extent and quality of habitat - Manage and protect Swift Parrot habitat at the landscape scale - Monitor and manage the impact of collisions, competition and disease - Monitor population and habitat. The Project is considered unlikely to interfere with any of the recovery actions listed above. While the Project may be a potential point source of ignition for fires (a potential threat to the species habitat) this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. Should Swift parrot be identified during Project activities this will contribute to current information on the species distribution in the region.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, it is considered likely that there will be a 'significant residual impact' on Swift parrot as a result of the Project through clearing of 243.54ha of Habitat critical to the survival of the species.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.1.6 Australian painted snipe (*Rostratula australis*) – endangered

Ecology and distribution

The Australian painted snipe generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. The species has also been observed to use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. The Australian painted snipe has been recorded nesting in and near swamps, canegrass swamps, flooded areas, including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch, saltbush (*Halosarcia* sp.) and grass, in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush (DAWE 2020).

Australian painted snipe is a very cryptic species that generally occurs in low numbers and has been recorded at wetlands in all states and territories of Australia but is more common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia. It is a highly nomadic species dependent on wetland conditions throughout its range. There is evidence that part of the population may migrate from south-eastern Australia to central and northern Queensland during autumn and winter. It's known distribution has likely declined by approximately 50 per cent in Australia since European settlement (Garnett et al 2011).

Breeding has been recorded at all times of the year and is likely a response to wetland conditions. Nesting habitat appears quite specific requiring shallow wetlands, exposed mud and nearby vegetative cover. Nests are often located on or near islands within the wetland (DAWE 2020).

Distribution in context to the Project

Australian painted snipe was not identified during any Project-associated field surveys within the impact assessment area, although conditions were dry at the time of surveys and not conducive to the species being present. The closest database record (2017) to the Project is from the north-east of Inglewood at a small farm dam located 6.5 km east of the footprint. There are several records in the wider area surrounding Toowoomba and the Lockyer Valley. The nearest recent records are from Cooby Creek Dam (1995) and several records from the Helidon area (1982 and 2013) located approximately 14 km north-east and 25 km east of the northern extent of the Project respectively (AoLA 2020). Other records occur to the west including near Jondaryan (undated - 26 km north-west) and several records in Dalby (1965) and to the south at Lake Broadwater (four records from 1983 – 2013) which are over 50 km west of the Project footprint (refer Figure 7.4 in Appendix B. There are no nearby records to the west of the majority of the Project footprint.

Wetland habitats within the impact assessment area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (palustrine). Dams and reservoirs are generally unlikely to provide suitable dense aquatic vegetation for the species. Riverine wetlands through much of the Project footprint are highly degraded with little aquatic vegetation present suitable for Australian painted snipe.

Areas of mapped palustrine wetland within the impact assessment area are considered the most likely wetland habitat present with potentially suitable values for Australian painted snipe although these areas are highly ephemeral in nature. Mapping indicates this represents a very small portion within the Project footprint (0.97 ha) (refer Section 4.3.4.10). Wetlands considered to be of 'high ecological significance under State mapping are restricted to two discrete wetlands located at western extent of the impact assessment area (near Kurumbul) but are not intersected by the Project footprint (refer EIS Appendix J: Terrestrial Ecology Technical Report and EIS Appendix K: Aquatic Ecology Technical Report for further detail regarding wetland values).

Recovery plans/threat abatement plans

There is currently a draft *National recovery plan for the Australian painted snipe (Rostratula australis)* (DotEE 2019b) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Reduced wetland availability due to draining, fragmentation and changed hydrology
- Habitat degradation such as reduced water quality
- Low genetic diversity
- Invasive species including herbivores impacting habitat (horses, pigs, goats and deer) and predators (red fox and cats)
- Wetland vegetation structure change caused by native plants (e.g. *Typha* spp.) and non-native plants ((e.g. *Lippia* (*Phyla canescens*))
- Climate variability and change.

There are no Commonwealth adopted threat abatement plans considered relevant to this species.

Important populations and Habitat critical to the survival of the habitat

The Australian population is thought to range between 1,000 to 1,500 mature individuals (Garnett et al 2011). The draft *National recovery plan for the Australian painted snipe (Rostratula australis)* (DotEEb 2019) identifies the population as a single homogenous breeding population spread thinly across much of Australia. The species is widespread with an extent of occurrence estimated at 7,100,000 km² (Garnett et al 2011). As such there is no population relevant to individual locations. Habitat 'critical to the survival of the species' is described as:

- Any wetland habitat where the species is known or likely to occur (especially with suitable breeding habitat) within the indicative distribution map
- Any location with suitable habitat outside the above area that may be periodically occupied by Australian Painted snipe when conditions are favourable.

The Project footprint is located within the 'known or likely to occur' habitat mapped within the distribution map from the draft recovery plan. As such, the predictive habitat modelling for the species estimates that 44.98 ha of Habitat critical to the survival of the species may be impacted under the current Project footprint (refer Table 7.1 and habitat figure in Appendix I). However, the predictive habitat mapping has been approached in a conservative manner and is largely modelled on available vegetation and corresponding wetland communities mapping provided by DES (refer Appendix A for methodology). This includes creek lines, associated riparian habitat and farm dams which are less likely to provide habitat for Australian painted snipe (large shallow wetlands with dense vegetative cover). The predictive habitat figure is likely to be an overestimation of the available habitat suitable for this species within the Project footprint. Impacts and mitigation measures associated with this species are identified within Table 7.4. Assessment against the significant impact criteria for endangered species is shown in Table 8.25.

Table 8.25 Assessment against the significant impact criteria: Australian painted snipe

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population	Australian painted snipe occurs as a single homogenous breeding population dispersed thinly across much of Australia. As such, no resident population can be attributed to the impact assessment area or immediate surrounds. There are a few records in the wider surrounds, largely around the northern end of the alignment, and the species is known to occur sporadically in the region. It is unknown to what extent the species may utilise wetland habitats associated with the Project footprint, or if it occurs at all. The species is highly nomadic and unlikely to use these areas in more than a transient manner as a response to local conditions. Predictive habitat mapping indicates the Project has the potential to impact 44.98 ha of critical habitat, although this is likely to be an overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the Project footprint comprises values suitable for the presence of Australian painted snipe (i.e. wetlands in the area were dry during the field surveys and habitat values could not be confirmed). Under the Project Biodiversity Management Sub-plan pre-construction surveys will be carried out following optimal (wet) conditions (where possible) to assess whether wetland habitat values are suitable for the species, and if so, if the species actually occurs. Surveys will follow Commonwealth survey guidelines for the species (e.g. DEWHA 2010b). If the species or habitat is identified during pre-construction surveys, further pre-clearance surveys will be carried out to assess whether the species is present with mitigation measures in place should this be the case (refer Table 7.4). Should the species be found individuals would be expected to disperse from the construction area. The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of the population.
Reduce the area of occupancy of the species	Predictive habitat mapping indicates the Project has the potential to impact 44.98 ha of habitat critical to the survival of the species, although this is likely to be a substantial overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the Project footprint comprises values suitable for the presence of Australian painted snipe. No database records of the species occur within the impact assessment area, although there are many records in the wider surrounds. It is unknown to what extent the species may utilise wetland habitats associated with the Project footprint, or if it occurs at all. The species is highly nomadic and unlikely to use these areas in more than a transient manner dependent on local conditions, while the Project is linear in nature and will not result in the substantial loss of wetland habitats (i.e. palustrine, lacustrine and riverine). The impacts of the Project are considered unlikely to reduce the area of occupancy of the species.

Criterion	Assessment against significance criteria ¹
Fragment an existing population into two or more populations	The species is highly mobile. The Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	Predictive habitat mapping indicates the Project has the potential to impact 44.98 ha of Habitat critical to the survival of the species, although this is likely to be a substantial overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the Project footprint comprises values suitable for the presence of Australian painted snipe. Pre-construction surveys will be carried out to assess whether wetland habitat values are suitable for the species, and where suitable habitat is identified whether the species actually occurs. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 7.4). Despite the conservative habitat mapping results, given the lack of records of the species close to the Project and the lack of records in the wider area it is considered unlikely the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	Australian painted snipe occurs as a single homogenous breeding population dispersed thinly across much of Australia. As such, no resident population can be attributed to the Project footprint. Predictive habitat mapping indicates the Project has the potential to impact 44.98 ha of Habitat critical to the survival of the species habitat, although this is likely to be a substantial overestimate. Breeding habitat for the species appears specific and it is unknown to what extent breeding habitat may actually occur within or near the Project footprint. The species may breed at any time of year dependent on local wetland conditions. Pre-construction surveys will be carried out to assess whether wetland habitat values are suitable for the species, and where suitable habitat is identified whether the species actually occurs. Should the species be observed as nesting measures will be in place within the Project's Biodiversity Management Sub-plan to allow nesting to occur undisturbed (refer Table 7.4). It is possible that Australian painted snipe individuals will be disrupted during breeding, but it is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No database records of the species occur within or near the impact assessment area. The species is widespread with an extent of occurrence estimated at 7,100,000 km ² (Garnett et al 2011). Predictive habitat mapping indicates the Project has the potential to impact 44.98 ha of critical habitat, although this is likely to be a substantial overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the Project footprint comprises values suitable for the presence of Australian painted snipe. Potential impacts to wetland habitat from localised changes to flood regimes or impacts to water quality are considered unlikely to be of a scale that will impact habitat for Australian painted snipe (refer Section 5.2.1.13). Given the very minor extent of habitat within the Project footprint the potential impacts of the Project are considered unlikely to be of the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Aquatic weed species have been identified as a potential threat to Australian painted snipe habitat (DotEE 2019b). No aquatic weed species were recorded during Project aquatic ecology surveys (refer EIS Appendix K: Aquatic Ecology Technical Report for further information). Project surveys have recorded pest fauna thought to be a threat to the species including feral cat and dog, red fox and feral pigs. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Project is not expected to lead to increased abundances of introduced predator species. Nevertheless, measures will be incorporated to monitor pest species observations associated with Project activities, and pest control actions where considered necessary. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and pest proliferation and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral species (i.e. wild dogs/dingo, Red fox and pigs) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.

Criterion	Assessment against significance criteria ¹
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The draft recovery Plan for the species identifies the following recovery objectives for Australian painted snipe: ■ Manage and protect known Australian Painted Snipe breeding habitats at the landscape scale ■ Develop and apply techniques to measure changes in population trajectory in order to measure the success of recovery actions ■ Reduce, or eliminate threats at breeding and non-breeding habitats ■ Improve knowledge of the habitat requirements, biology and behaviour of Australian Painted Snipe ■ Engage community stakeholders to improve awareness of the conservation of Australian Painted Snipe ■ Coordinate, review and report on recovery process (DotEEb 2019). At this stage it is uncertain the Project footprint comprises habitat likely to support breeding. The Project is considered unlikely to interfere with any of the recovery actions listed above to the extent it will interfere with the recovery of the species. Should Australian painted snipe be identified during Project activities this will contribute to current information on the species in the region. Weed and pest mitigation measures applied within the Project's Biosecurity Management Sub-plan will contribute to eliminating threats to the species across the wider area.
Assessment of potential for significant residual impacts	Although the Project has been estimated as impacting Habitat critical to the survival of the species as based on the known/likely to occur habitat mapping within the draft recovery plan for the species there is little evidence the Project footprint would provide habitat values supporting the species. Under the nine-part test detailed above, there is currently considered to be no 'significant residual impact' on Australian painted snipe as a result of the Project.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.1.7 Spotted-tail quoll (mainland) (*Dasyurus maculatus maculatus*) – endangered

Ecology and distribution

Spotted-tail quolls have been recorded from a wide range of habitats, including temperate and subtropical rainforests in mountain areas, wet sclerophyll forest, lowland forests, open and closed eucalypt woodlands, inland riparian and River red gum (*Eucalyptus camaldulensis*) forests, dry 'rainshadow' woodland, sub-alpine woodlands, coastal heathlands and occasionally in open country/other treeless areas. Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves (DAWE 2020). The species requires large home ranges of several hundred hectares (Victorian Department of Environment, Land, Water and Planning (DELWP) 2016).

In Queensland, the Spotted-tail quoll occurs in the southeast, coastally from Bundaberg to the NSW border, and inland to Monto and Stanthorpe. Spotted-tail quolls are known from five broad geographic regions: four from coastal ranges and the Great Dividing Range from the NSW border to Gladstone. The fifth is centred on the eastern Darling Downs-Inglewood Sandstone provinces of the Brigalow Belt South Bioregion. Unconfirmed reports suggest the subspecies may also occur in the Clarke and Conway Range areas, along the central Queensland coast.

Distribution in context to the Project

There are a number of database records in the region surrounding the eastern portion of the impact assessment area. There is a single 1980 record from the Pittsworth area located just outside of the impact assessment area (1.2 km from the Project footprint). There are a number of records to the east and south-east of Pittsworth all of which are relatively old (<1990). The most recent records in the vicinity of the impact assessment area are from the Day Range located 38 km east of the Project (from 1993). There are also several records in the south around the Texas area including from Wilga Park Nature Refuge (2002) (47 km south-east of Project footprint) and a museum record from Yelarbon State Forest (20 km south-east of the Project footprint) although with no associated collection year. There are only two records located west of the Project footprint: one in the Biddeston region near Toowoomba (5.5 west of the Project footprint) in what is now cleared agricultural lands; and a record west of Dalby from 1980 (over 60 km north-west of the Project) (AoLA 2020) (refer Figure 6.18 in Appendix B).

Woodland habitats within much of the impact assessment area are small and heavily fragmented and are very unlikely to support the species. The Project passes through an area of extensive tracts of woodland north of Inglewood associated with several protected areas (National Park and State Forests). This is the only habitat within the Project footprint that has some potential to support the species. Nevertheless, it is noted there is only one (undated) record of the species within this area in Yelarbon State Forest to the south of the footprint, and no records at all to the west.

Recovery plan/threat abatement plans

The *National recovery plan for the Spotted-tail quoll (Dasyurus maculatus)* (DEWLP 2016) identifies the following threatening processes as applicable to the species:

- Habitat loss and fragmentation
- Targeted killing and poison baiting (directed at introduced predators)
- Ingestion of Cane toads (*Rhinella marina*)
- Invasive predators (red fox, cats and wild dogs)
- Road mortality
- Climate change and increased fire frequency/intensity.

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015d)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008q).

Important populations and Habitat critical to the survival of the habitat

The overall Australian population (including all subspecies) is not reliably known but is estimated to be 20,000 mature individuals (Woinarski et al 2014). Important populations in southern Queensland include the Granite belt region around Stanthorpe, the Cherrabah area, the ranges extending from Main Range to Lamington National Parks, the Burnett Range and the Dalby region (DEWLP 2016). The nearest of these to the Project are Dalby and the Cherrabah area located over 60 km north-west and south-west (respectively) from the impact assessment area.

The recovery plan describes habitat critical to the survival of Spotted-tail quoll as 'large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey' (DEWLP 2016). The recovery plan also notes given the difficulty defining the threshold habitat requirements of these resources it currently impossible to map critical habitat. This assessment has taken a conservative approach and included all areas of 'potential habitat' that intersect with remnant vegetation that are greater than 200 ha in size (given the species extensive home range) as Habitat critical to the survival of the species (refer Appendix A for further information).

Predictive habitat mapping indicates that the Project may impact 65.93 ha of potential habitat and 15.49 ha of Habitat critical to the survival of the species for the species under the approach used for this assessment (refer Table 7.1 and habitat figure in Appendix I). This assessment has taken a conservative approach and the identified habitat is likely to comprise foraging habitat rather than denning/breeding sites. The mapped habitat is largely associated with the substantial and contiguous tracts of vegetation within the State Forest areas to the north of Inglewood.

Impacts and mitigation measures associated with this species are identified within Table 7.4. The following significant impact assessment (refer Table 8.26) under the MNES guidelines (DoE 2013) has been informed by the information detailed above.

Table 8.26 Assessment against the significant impact criteria: Spotted-tail quoll

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population of a species	It is uncertain if the species occurs at all. It is noted there are no recent database records close to the Project, only two older records located to the north-west, and only one record from the 2000's located over 40 km from the Project footprint near Texas. Nevertheless, predictive habitat modelling indicated that the project may impact 81.42 ha of suitable habitat (65.93 ha of potential habitat and 15.49 ha of critical habitat) for the species. This habitat is associated with the State Forest area near Inglewood although there are no database records of the species occurring. Preferred rocky shelter sites for the species were not observed during Project surveys. Under the Project Biodiversity Management Sub-plan targeted pre-construction surveys will be carried out if suitable denning habitat for this species is identified within or adjacent to the final construction footprint to identify whether the species actually occurs or not (refer Table 7.4). Should the species be found individuals are expected to be moved away from the area of disturbance prior to construction activities. The species requires large home ranges. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. The Project is considered unlikely to lead to a long-term decrease in a population.
Reduce the area of occupancy for a population	There is no evidence the species occurs, or has occurred, in the impact assessment area or surrounds. There are no records of this species within or close to the impact assessment area. The nearest recent (post 2000) record is located over 40 km south-east of the Project. There are no records to the west of the Project footprint where there is extensive tracts of potential habitat in the south of the alignment. Predictive habitat modelling indicated that the project may impact 65.93 ha of potential habitat and 15.49 ha of Habitat critical to the survival of the species for the species. Preferred rocky shelter sites do not occur within the Project footprint which preferentially traverses the flatter plains country. Given the general lack of records (recent or older) across the Project footprint the Project is considered unlikely to reduce the area of occupancy of a population.
Fragment an existing population into two or more populations	There is no evidence the species occurs, or has occurred, in the impact assessment area or surrounds. There are no records of this species within or close to the impact assessment area. The nearest recent (post 2000) record is located over 40 km south-east of the Project. There are no records to the west of the Project footprint where there is extensive tracts of potential habitat in the south of the alignment. The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. Nevertheless, the Project will fragment habitat patches in two State Forests (Bringalily and Whetstone). The final Project design will incorporate fauna crossing structures to allow fauna movement north and south of the alignment within the State Forests area north of Inglewood (refer Figure 6.1). The Project is considered unlikely to fragment an existing population.
Adversely affect habitat critical to the survival of the species	There are no records of this species within or close to the impact assessment area. Predictive mapping indicates 15.49 ha of habitat considered as 'critical' to the species (for the purposes of this assessment) occurs within the Project disturbance area as well as a further 65.93 ha of 'potential' habitat. The Project footprint largely intersects already disturbed (cleared) habitat through much of the alignment. Nevertheless, the Project has a minor potential to adversely affect habitat critical to the survival of the species, should the species be found to occur.

Criterion	Assessment against significance criteria ¹
Disrupt the breeding cycle of a population	There are no records of this species within or close to the impact assessment area. Predictive habitat modelling indicated the project may impact 81.42 ha of suitable habitat including 15.49 ha of habitat considered critical for the species. Preferred rocky shelter sites do not occur within the Project footprint which preferentially traverses the flatter plains country. Pre-clearance surveys will be carried out if suitable den habitat for this species is identified within or adjacent to the construction footprint. The species breeds in the winter months (June to August). Where possible the Project will avoid clearing/construction activities in sensitive habitat (should such habitat be identified) during the breeding season. Given the lack of observed suitable den habitat in the area the Project is not considered likely to disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subspecies occurs from central coastal Queensland, south to south-west Victoria. Predictive habitat mapping indicates that the Project may impact 65.93 ha of potential habitat and 15.49 ha of Habitat critical to the survival of the species although it's uncertain whether the species occurs within the Project footprint or surrounds. Given the extent of occurrence of Spotted-tail quoll the Project is considered unlikely to decrease the availability of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Relevant threat abatement/recovery plans for Spotted-tail quoll include management measures to address the impact of feral cats and European red fox. Feral cat was identified as present during Project-associated surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo and cat) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	Recovery strategies listed in the <i>National Recovery Plan for the Spotted-tailed quoll <i>Dasyurus maculata</i></i> (DEWLP 2016) include: ■ Determine population trends for the species including distribution and abundance ■ Investigate key aspects of the species biology/ecology to improve management ■ Reduce the rate of habitat loss and fragmentation ■ Determine and manage threats from introduced predators and uncontrolled fires ■ Assess and minimise sources of mortality including road deaths, deliberate killings and the threat of cane toads. If the species does occur on and around the Project footprint there is some potential for the Project to interfere with the recovery objectives outlined in the Plan through potential habitat loss. While the Project may be a potential point source of ignition for fires (a potential threat to the species) this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. The Impact assessment area is already subject to high levels of fragmentation. The Project's Biosecurity Management Sub-plan will control introduced predators associated with Project infrastructure. Nevertheless, any impact on the species will be minor, and is considered unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Predictive habitat mapping indicates that the Project will result in the clearance of 65.93 ha of potential habitat and 15.49 ha of Habitat critical to the survival of the species that potentially supports a population. Although it remains highly uncertain if the species occurs the assessment has been carried out in a conservative manner and the Project has a minor potential to have significant residual impacts on Spotted-tail quoll.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.1.8 Condamine earless dragon (*Tympanocryptis condaminensis*) – endangered

Ecology and distribution

The Condamine earless dragon (*Tympanocryptis condaminensis*) is a small, plump, spiny earless dragon lizard that grows to an average size of 12 cm. This species has only recently been taxonomically split from the Grassland earless dragon (*Tympanocryptis pinguicolla*). This dragon species appears to survive in areas that are intensely cropped and previously occupied as naturally treeless grassland. The dragon uses surface debris, including train ballast, surface rocks and rocky outcrops as shelter, while cracks in the black clays of the Condamine River floodplain provide holes to seek alternate shelter when disturbed. Knowledge of the diet is still limited; however, it is thought the species feeds on small invertebrates with anecdotal evidence suggesting ants are a popular source of food (DES 2017b).

Limited information is also known about the reproductive behaviour and biology of the Condamine earless dragon, but it has been observed males will take on their breeding colours, which are canary yellow at the throat and chin, during December and a gravid female was recorded in November (Melville et al. 2007).

The known distribution of the Condamine earless dragon is within the eastern Darling Downs region in south-east Queensland. Condamine earless dragons are often found in the Condamine River floodplains surrounded by Jimbour in the northeast, Millmerran in the southwest, Clifton in the southeast and Toowoomba in the northeast with records from Oakey, Bongeen, Bowenville, Brookstead and Mt Tyson (TSSC 2016c).

Distribution in context to the Project

Condamine earless dragon was recorded during Project-associated surveys in an existing rail line easement located within the Project footprint approximately 13 km north-east of Millmerran (refer Figure 4.3 and Section 4.3.2.2). There are a number of database records north-west of this area, located largely to the north of the Project footprint. The nearest record (2009) is located 1.5 km south of the Project footprint near Brookstead. There are several records (2003 to 2014) variously between 3 km to 4 km to the north of the Project footprint between Brookstead and Pittsworth, with many records located further north (refer Figure 5.6 in Appendix B). The only other records located south of the Project are from agricultural lands located north of the Pittsworth-Felton Road (15 km south-west of Pittsworth)

Recovery plan/threat abatement plans

The *National recovery plan for the Grassland earless dragon Tympanocryptis pinguicolla* (Robertson and Evans 2009) is the adopted plan as it comprised populations of the Condamine earless dragon at the time of writing. The plan identifies the following threatening processes as applicable to the species:

- Further habitat loss and fragmentation from urban and agricultural development
- Degradation of habitat by introduced livestock and agricultural practices (such as ploughing)
- Predation by introduced species including red fox (*Vulpes vulpes*)
- Inappropriate fire regimes
- Climate change and increased fire frequency/intensity

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015d).

Important populations and Habitat critical to the survival of the species

The *National recovery plan for the Grassland earless dragon Tympanocryptis pinguicolla* (Robertson and Evans 2009) observes that given the extent of decline of the species habitat all extant populations are considered extremely important and any habitat in which the species is known to occur may be considered critical to the survival of the species.

As such, this assessment has defined 'critical habitat' by applying a 1 km buffer on known records that intersect 'potential habitat' for the species (refer Appendix A for methodology). Predictive habitat mapping indicates that the Project may impact 227.66 ha of potential habitat and 17.93 ha of Habitat critical to the survival of the species for the species. The predictive habitat mapping has taken a conservative approach and includes pre-clearance mapping of suitable REs in which the species is thought to occur. This is not likely to reflect the actual occurrence of the species within the Project footprint. Impacts and mitigation measures associated with this species are identified within Table 7.4. The following significant impact assessment (refer Table 8.27) under the MNES guidelines (DoE 2013) has been informed by the information detailed above.

Table 8.27 Assessment against the significant impact criteria: Condamine earless dragon

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population of a species	The species was recorded within the Project footprint between Millmerran and Brookstead during Project-associated surveys. There are numerous records between Pittsworth and Brookstead. Predictive habitat mapping indicates that the Project may impact 245.59 ha of habitat considered as suitable (227.66 ha of potential habitat and 17.93 ha of critical habitat) for the species. The species is found in a relatively restricted area and may occur in heavily modified habitats such as croplands. The species is cryptic and occurs patchily within apparently suitable habitat. It is uncertain to what extent it may occur within the suitable habitat identified within the Project footprint. It is unknown if the species occurs as sub-populations or as a continuous single population (TSSC 2016c). Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify to what extent the species actually occurs as part of the Project Biodiversity Management Sub-plan. Survey methods will follow the relevant Commonwealth survey guidelines (detailed within Appendix 2 of the Recovery plan for the species). Should the species be found individuals will be relocated from the area of disturbance prior to construction/disturbance activities (refer Table 5.7). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the east and west of the Project footprint. The Project is considered unlikely to lead to a long-term decrease in an important population (or analogous important habitat).
Reduce the area of occupancy for a population	The species was recorded within the Project footprint between Millmerran and Brookstead during Project-associated surveys. There are numerous records between Pittsworth and Brookstead. Predictive habitat mapping indicates that the Project may impact 227.66 ha of habitat considered as suitable (245.59 ha of potential habitat and 17.93 ha of critical habitat) for the species. The species has a restricted range. The Project has potential to reduce the occupancy of a population of the species.
Fragment an existing population into two or more populations	The species was recorded within the Project footprint between Millmerran and Brookstead during Project-associated surveys. There are numerous records between Pittsworth and Brookstead. The species is found in a relatively restricted area and it is unknown if the species occurs as sub-populations or as a continuous single population (TSSC 2016c). The Project is linear and intersects suitable habitat for the species. At this stage the rail alignment is expected to utilise a viaduct or numerous culverts where it crosses the Condamine River floodplain and therefore, potential habitat for this species, potentially allowing movement opportunities for the species. Nevertheless, it is uncertain if the species would use these structures. The Project has potential to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	The species is known to occur within the Project footprint. The <i>National recovery plan for the Grassland earless dragon Tympanocryptis pinguicolla</i> (Robertson and Evans 2009) observes any habitat in which the species is known to occur may be considered critical to the survival of the species. Predictive habitat mapping indicates that the Project may impact 17.93 ha of Habitat critical to the survival of the species for the species (as well as a further 227.66 ha of potential habitat for the species). As such, the Project may be considered as adversely affecting habitat critical to the survival of the species.

Criterion	Assessment against significance criteria ¹
Disrupt the breeding cycle of a population	The species was recorded within the Project footprint between Millmerran and Brookstead during Project-associated surveys. There are numerous records between Pittsworth and Brookstead. Predictive habitat mapping indicates that the Project may impact 245.59 ha of habitat considered as suitable (227.66 ha of potential habitat and 17.93 ha of critical habitat) for the species. It is uncertain to what extent it may occur within the suitable habitat identified within the Project footprint. Information regarding the species breeding biology is scant. Breeding behaviour has been observed in November/December (TSSC 2015c). The Project has potential to disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species has a restricted range occurring from Millmerran and Clifton north to Toowoomba and Jimbour. Predictive habitat mapping indicates that the Project may impact 329.34 ha of habitat considered as suitable for the species. The Project impact footprint is linear and relatively narrow and as such is considered unlikely to decrease the availability of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	The relevant threat abatement and recovery plans for Condamine earless dragon include management measures to address the impact of feral cats and red fox. Both of these species were observed as widespread through the impact assessment area during Project surveys. Weeds are not identified as a threat to the species. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. red fox and cat) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	The <i>National recovery plan for the Grassland earless dragon Tympanocryptis pinguicolla</i> (Robertson and Evans 2009) includes the following recovery actions: ■ Determine the current distribution and abundance of the species, and potential available habitat ■ Determine key biological data and life history characteristics of the species ■ Determine the effects of land management activities on the species (such as fire and grazing) ■ Identify threats to the species ■ Secure the species in conservation reserves and establish management agreements with landholders where the species occurs on private lands. There is no reason the Project will substantially interfere with the management actions outlined above. The Project will necessarily reduce known threats to potential habitat such as grazing by livestock (on land within the Project footprint). While the Project may be a potential point source of ignition for fires (a potential threat to the species) this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. The Project may increase the knowledge of the species distribution in the region.
Assessment of potential for significant residual impacts	Predictive habitat mapping indicates that the Project may result in the clearance of up to 245.59 ha of habitat that likely supports a population and can be considered as critical to the survival of the species. Under the nine-part test detailed above, there is likely to be a 'significant residual impact' on Condamine earless dragon as a result of the Project.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.2 Vulnerable fauna species populations

The assessments commence with an evaluation of the likely importance of the population of vulnerable fauna species associated with the impact assessment area. Under the Guidelines vulnerable species are considered as subject to significant impacts when an 'important population' is impacted. Therefore, those species that are not considered to have an important population present are not considered further in the assessment.

An 'important population' as defined within the Guideline significant impact criteria for vulnerable species is as follows:

'An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal;
- Populations that are necessary for maintaining genetic diversity; and/or
- Populations that are near the limit of the species range.

Given the specificity of the above definition and the scarcity of information and records available for most listed species and populations in the region (and Australia), it is difficult to determine: 1) attributes such as breeding and dispersal behaviour and whether the population is a 'key source' and 2) the genetic diversity of individuals inhabiting a population or sub-population. It is noted the Project is linear and is not expected to impact the potential distribution of local pollinators for most (if not all) plant species and as such is not considered likely to impact dispersal or genetic exchange within a plant population.

Given the paucity of information available, significance of impacts to threatened species has been based on experience of the assessment team and the latest available information.

Table 8.28 provides an evaluation of the populations of vulnerable fauna species associated with the impact assessment area.

Table 8.28 Assessment of status of vulnerable fauna species population against Guideline criteria

Species name	Common name	Project footprint population evaluation ¹
<i>Anomalopus mackayi</i>	Five-clawed worm-skink	Predictive habitat mapping indicates that the Project may impact 178.26 ha of habitat in which <i>Anomalopus mackayi</i> may occur (refer Table 7.1). Database records indicate this species occurs within the impact assessment area to the east of the Project footprint near Pittsworth. Two records from this location are from 2002 and 2009 near the junction of Toowoomba Road and the Gore Highway east of Pittsworth. Another record exists for this species to the east of the northern section of the alignment near Toowoomba dated 1983 from within approx. 5 km from the Project footprint (AoLA 2020). There are a number of records within 50 km to the north of the impact assessment area in the Cecil Plains area, and from Oakey to Dalby. No recovery plan exists for this species. A review of the available literature has not revealed any important populations when referring to DOEE's SPRAT database the Department of the Environment (2020). The <i>Draft referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPac 2011e) identifies 'important habitat' as a surrogate for important populations given the difficulty of detecting many of the species. As per mapping within the Guidelines the Project footprint passes through habitat between Millmerran and Toowoomba considered 'known/likely to occur' for the species and is therefore considered 'important habitat'. As such the Project has the potential to significantly impact this species and is assessed as per the Guidelines in Table 8.39.

Species name	Common name	Project footprint population evaluation ¹
<i>Chalinolobus dwyeri</i>	Large-eared pied bat	There are only two database records of this species within 50 km of the Project footprint (AoLA 2020). One record is from 2011 and located in Toowoomba (approximately 14 south-east km of the Project). Consultation with the source of the record indicates this is erroneous and should be a different species (<i>Chalinolobus picatus</i>) (pers. Comm R. Hobson). Another database record (1997) exists 40 km west of the Project footprint from Western Creek State Forest located west of Millmerran. All other records exist well outside a 50 km radius around the Project footprint to the north-west in Carnarvon and Expedition National Parks and to the south-east in Main Range and Lamington National Parks (refer Figure 6.10 in Appendix B). The species occurs from the Rockhampton region, inland to the Canarvon Range, and potentially as far south as the Wollongong area. The Project footprint is not located near the limit of the species range (AoLA 2020). The <i>National recovery plan for the Large-eared pied bat Chalinolobus dwyeri</i> (DERM 2011) identifies important populations as the largest known populations occurring in areas dominated by sandstone escarpments in Carnarvon National Park, Blackdown Tableland National Park, Expedition National Park and Isla Gorge National Park. The Shoalwater Bay population occurs at the northern limit for the species and has been identified as an important population when referring to DAWE's SPRAT database (2020). None of these areas are relevant to the impact assessment area. The recovery plan identifies 'sandstone cliffs and fertile wooded valley habitat within close proximity' as habitat critical to the survival of the species. While the plan also notes that in SEQ the species uses volcanic substrates. The Project passes at least 8 km to the east of Wondul Range which does not comprises potential sandstone habitat. It comprises lands classed as 'ironstone jump-ups' (REs on land zones 7). Cliff/rocky escarpments may occur in the range, but not in the vicinity of the Project alignment which preferentially passes through low elevation lands along the alignment. The Project will not impact sandstone cliffs or similar habitat and there is no such habitat located close to the impact assessment area or surrounds. Therefore, the Project will not impact a potential roost site (should the species occur at all). Predictive habitat mapping indicates the Project has the potential to impact 54.85 ha of potential habitat and this is likely to be restricted to foraging habitat only (refer Table 7.1 and habitat figure in Appendix I). There is one record of the species ever occurring within 40 km to the west of the Project. No important populations or Habitat critical to the survival of the species have been identified that are relevant to the Project. It is not conceivable the Project will affect the recovery of the species or impact habitat such that the species may decline. The Project is currently considered unlikely to significantly impact this species and it is not considered further.
<i>Delma torquata</i>	Collared delma	The nearest database record is from 1993 taken from within 23 km east of the Project in Ballard, north of Toowoomba. The Project footprint is located near the southern limit of the species range. There is no recovery plan for this species. Given the difficulty in detecting this species the <i>Draft referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPaC 2011e) considers the presence of suitable and important habitat for this species a surrogate for an important population of the species. Predictive habitat mapping indicates that the Project may impact 295.76 ha of habitat in which this species is predicted to occur (refer Table 7.1). Therefore, important habitat for this species may be impacted and may result in a significant impact to the species. As such the Project has the potential to significantly impact this species and is assessed as per the Guidelines in Table 8.29.
<i>Egernia rugosa</i>	Yakka skink	Predictive habitat mapping indicates that the Project may impact 347.89 ha of habitat in which <i>Egernia rugosa</i> may occur (refer Table 7.1). Database records indicate this species has not been recorded within 50 km of the Project footprint (AoLA 2020). The nearest specimen backed record exists 65 km north-west of the Project footprint (north of Goondiwindi). This record is not dated and has been generalised to protect the exact location of the record. Another record exists from 1994 at the Bunya Mountains National Park located over 70 km north of the Project footprint. This record also has unreliable spatial accuracy. All other occurrence records exist to the north-west of the Project (refer Figure 5.12 in Appendix B). There are no records south or east of the Project.

Species name	Common name	Project footprint population evaluation ¹
		There is no recovery plan for this species. A review of the available literature has not revealed any important populations when referring to DOEE's SPRAT database the Department of the Environment (2020). The <i>Draft referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPaC 2011e) identifies 'important habitat' as a surrogate for important populations given the difficulty of detecting many of the species. This includes continuous patches of remnant vegetation where a colony is known, microhabitat where colonies could be found, and where the species is mapped as 'likely to occur' within the Guidelines. Mapping within the guidelines shows the species as 'may occur' only with the nearest 'likely to occur' habitat in the Miles area over 100 km north-west of the Project. Predictive habitat mapping indicates that the Project is expected to 364.47 ha of potential habitat in which <i>Egernia rugosa</i> may occur (refer Table 7.1 and habitat figure in Appendix I). Although the species is not known to occur within or near the Project, there is substantial suitable and contiguous habitat available within the State Forest areas located north of Inglewood. Should the species be found to occur the area is located on the south-eastern edge of its distribution and may be considered as an important population. Therefore, further consideration as to whether there will be a significant impact on this species is assessed in Table 8.30.
<i>Erythroriorchis radiatus</i>	Red goshawk	The species was not recorded during Project surveys. There are a number of database records (AoLA 2020) clustered around the Toowoomba area. It is noted available records have all been generalised in order to protect the species. The nearest recent database record from 2012 is located 17 km south-east of the northern extent of the Project footprint (south-east of Toowoomba). Further records (all from the early 1990s or older) occur to the north and east of Toowoomba. More recent records are associated with the Lockyer Valley to the east of the Toowoomba Range. The only records from west of the Project are near Kumbarella State Forest (55 km west) and the Chinchilla area (over 120 km west) and are from the early 1980s or older (refer Figure 7.12 in Appendix B). There are no records within 50 km of the alignment outside of the Toowoomba area. It is uncertain if the species still occurs in northern NSW. The <i>National recovery plan for the red goshawk Erythroriorchis radiatus</i> (DERM 2012) does not identify important populations. Specific important populations have not been identified for this species due to the sparse distribution of the species. Habitat 'critical to the species survival' is considered those areas which supports nesting and associated habitat factors to support nesting. Nests occupy an exposed fork in the upper quarter of a tree between 10 m to 20 m above ground and are often used each year. They are usually located on an emergent tree within 1 km of permanent water. Delineating an important population for this species is complicated by the ecology of the species. The species occupies large home ranges estimated to be up to 120 km² (females) and 200 km² (males). Preferred habitat requirements are extensive tracts or remnant woodlands/forests on fertile soils with a mosaic of vegetation types, access to permanent water, and large populations of birds (DERM 2012). It is estimated that in south-east Queensland only 10-30 pairs of the species remain (DAWE 2020). Predictive habitat mapping indicates that the Project is expected to 224.63 ha of potential habitat and 114.71 ha of Habitat critical to the survival of the species (as defined for this assessment – refer Appendix A for methodology) in which this species is predicted to occur (refer Table 7.1 and habitat figure in Appendix I). Nevertheless, given the species has never been known to occur in much of the alignment and habitat values in the north of the Project footprint do not constitute suitable habitat for the species (heavily cleared lands) the Project is considered unlikely to significantly impact habitat for the species. With the exclusion of clearing an actual nest site, it is inconceivable that any potential impact will be to the extent it will adversely impact the species or affect the species recovery. Therefore, the Project is currently considered unlikely to significantly impact this species and it is not considered further.

Species name	Common name	Project footprint population evaluation ¹
<i>Falco hypoleucos</i>	Grey falcon	Grey falcon was not recorded during Project surveys. There are four database records (AoLA 2020) within a 50 km radius of the Project, all in the Toowoomba region. It is noted available records have all been generalised in order to protect the species and have a wide location error attached. These records do not overlap with the Project footprint. The nearest record (2008) is located 5.5 km east of the Project footprint. Two of the records are recent (2008 and 2013) while the other two records are older (<1987). The vast majority of records across the wider region surrounding the Project are older records with recent records generally occurring much further inland. Recent records (post 2000) are located 100 km south-west of the southern extent of the Project footprint in New South Wales in the Moree and Mungindi areas. In Queensland the nearest recent record (apart from those identified above) is from 2013 and located west of Bollon (over 340 km west of the Project). Grey falcon is considered to occupy the arid and semi-arid zone of Australia where annual rainfall is <500 mm. Younger individuals may disperse outside of this habitat in drought years that follow wet years in inland Australia. The total population size is now generally accepted to be <1,000 mature individuals (Schoenjahn 2018, DAWE 2020). The breeding range has contracted to the arid parts of its range since the 1950s (OEHL 2020). Known breeding sites in Queensland are all in the arid zone well west of the Project (refer Schoenjahn 2018). The species appears to be partially nomadic, responding to local drought conditions. The species likely occupies large home ranges with preferred habitat including sparsely timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter (DAWE 2020). It is noted average annual rainfall in the region in which the Project footprint occurs is 600 mm to 1,000 mm (BoM 2020) which is outside the generally accepted range of the species as identified above. Given the sparse distribution of the overall population, specific important populations have not been identified. Habitat 'critical to the species survival' is considered those areas which supports nesting and associated habitat factors to support nesting. Delineating an important population for this species is complicated by the ecology of the species. Predictive habitat mapping indicates that the Project is expected to impact 838.71 ha of potential habitat and with none of this constituting Habitat critical to the survival of the species (as defined for this assessment – refer Appendix A for methodology) in which this species is predicted to occur (refer Table 7.1 and habitat figure in Appendix I). Nevertheless, given the species core range is in the arid zone to the west of the Project and it is not known to occur more than sporadically in the wider region surrounding the alignment, the Project is considered unlikely to significantly impact habitat for the species. It is inconceivable that any potential impact will be to the extent it will adversely impact the species or affect the species recovery. Therefore, the Project is currently considered unlikely to significantly impact this species and it is not considered further.
<i>Furina dunmali</i>	Dunmall's snake	Predictive habitat mapping indicates that the Project may impact 298.85 ha of habitat in which this species is predicted to occur. The nearest database record is from 2011 and occurs within the impact assessment area where the Project footprint intersects Brungalily State Forest north of Inglewood (refer Figure 4.2). Other records exist for the species within approx. 15 km north-west of the Project footprint in Oakey and approximately 25 km south-east of the Project between Yelarbon State Forest and Texas State Forest 2 however no dates are available for these records. There are no other occurrence records within 50 km of the Project footprint. Other records in Queensland exist to the north and north-west of the Project footprint (AoLA 2020). There is no recovery plan for this species. Given the difficulty in detecting this species the <i>Draft referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPac 2011e) considers the presence of suitable and important habitat for this species a surrogate for an important population of the species. Important habitat is identified as suitable habitat (i.e. Forests to woodlands within the range of the species) within the known/likely to occur distribution of this species along with any habitat corridors in between, particularly areas that maintain habitat connectivity. Habitat mapping in the guidelines identified the Project as being located adjacent to the north of 'likely or known' habitat to the south of Yelarbon (along the NSW border). The Project itself is located within suitable habitat mapped as 'may occur'. Given there is a known record within Brungalily State Forest the habitat in the area can be considered as maintaining habitat connectivity with 'likely habitat' located to the south. Therefore, under the MNES guidelines the Project has the potential to significantly impact this species and is assessed in Table 8.31.

Species name	Common name	Project footprint population evaluation ¹
<i>Geophaps scripta scripta</i>	Squatter pigeon (southern subspecies)	The species was not recorded during Project surveys. There are a number of database records (AoLA 2020) surrounding the impact assessment area in the Inglewood area and further east towards Durikai State Forest. The nearest of these is 1.2 km west of the Project footprint in Bringalilly State Forest refer Figure 7.16 in Appendix B). No recovery plan exists for this species. The southern extent of the species known distribution is contracting towards the north. A review of DAWE's SPRAT database (2020) notes an important population is known to occur in the Warwick-Inglewood-Texas region of southern Queensland. The Project intersects this area. Predictive habitat mapping indicates that the Project may impact 339.34 ha of potential habitat in which this species may occur (refer Table 7.1). Given that an important population has been identified for this species in relation to the Project, there is potential to have a significant impact on the species. Under the MNES Guidelines this species is assessed further in Table 8.32.
<i>Grantiella picta</i>	Painted honeyeater	Database records indicate that this species has not been recorded within the impact assessment area however has occurred within from within 50 km of the Project footprint (AoLA 2020). The nearest database record is from 2007 and approximately 2 km south of the Project in Pittsworth. A second record is located approximately 3 km north of the Project footprint from McEwan State Forest (2013) (near Pittsworth). There is a 2006 record located 2.5 km east of the northern extent of the Project (north of Toowoomba). There are two records further south along the alignment in the Inglewood area, one from close to Coolmunda Dam (1995) and another from Whetstone State Forest (1996). Both of these are more than 10 km from the Project footprint. Other database records are scattered in the wider area, largely to the north-west and south of the Project (refer Figure 7.10 in Appendix B). indicate occurrences of this species in all directions around the Project footprint except for the east where few records exist. The species population is sparsely dispersed across south-east Australia to north-west Queensland and eastern Northern Territory. The Project footprint is not located near the limit of the species' range. There is no Commonwealth adopted recovery plan for this species. A review of the available literature including the approved conservation advice for the species has not revealed any important populations (DotE 2015f). The species is considered to occur as a single wide-ranging population (Garnett et al 2011). As such no important populations have been identified that are key to the long-term survival and recovery of this species. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). As such, there is no 'critical habitat' identified within or close to the Project footprint. Predictive habitat mapping indicates that the Project has the potential to impact 432.99 ha of potential habitat in which this species may occur (refer Table 7.1 and habitat figure in Appendix I). No important populations or Habitat critical to the survival of the species have been identified to-date for this species within the Project footprint. However, given the Project may impact 432.99 ha of potential habitat for the species the assessment has taken a conservative approach for this species and it is considered further in the following section (refer Table 8.33).
<i>Maccullochella peelii</i>	Murray cod	This species was recorded within the Macintyre River and Macintyre Brook during targeted Project surveys for fish species (refer Section 4.3.2.3). Database records from 1998 indicate that this species has occurred within approx. 5 km west of the Project footprint near Millmerran. Another record from more recently (2011) occurs to the east of the Project footprint near the NSW border. The <i>Draft referral guidelines for the vulnerable Murray cod (Maccullochella peelii)</i> (DotE 2016c) identified important populations of Murray cod as occurring in both the Macintyre River and Macintyre Brook. Predictive habitat mapping indicates that the Project is expected to impact 12.82 ha of suitable habitat in which this species may occur (refer Table 7.1). Given the Project may impact habitat associated with both the Macintyre River and Macintyre Brook in which important populations have been identified as occurring. As such the Project has potential to cause significant impacts on the species and it is assessed in Table 8.34.

Species name	Common name	Project footprint population evaluation ¹
<i>Nyctophilus corbeni</i>	South-eastern long-eared bat	Echolocation calls potentially of this species were recorded at two locations during Project surveys (refer Figure 4.3). There are a number of database records of this species in the Inglewood area associated with the adjacent protected areas (National Park and State Forests). These are located variously between 3 km and 12 km east and west of the Project footprint including records from 1996 to 2006. There is also a single 1927 record from the Millmerran area located just outside of the impact assessment area (2 km from the Project footprint). In Queensland, South-eastern long-eared bat is noted as occurring on the western slopes of the Great Dividing Range from southern central Queensland (Churchill 2008) in the Brigalow Belt South Bioregion. There is no recovery plan for the species. The Pilliga Scrub region is noted as a stronghold for the species (OEH 2012) but there are no nominated important populations or Habitat critical to the survival of the species for the species. Predictive habitat mapping indicates that the Project is expected to impact 344.1 ha of potential habitat considered as suitable for the species. The Project passes through an extensive area of potential habitat north of Inglewood associated with several protected areas (National Park and State Forests). The Project is located on the eastern edge of the species range and is therefore considered as an important population for the purposes of this assessment. Project impacts on this species are assessed in Table 8.35.
<i>Petauroides volans volans</i>	Greater glider	The species was not recorded during Project surveys. Database records indicate the nearest occurrence of this species (from 1999) is from approximately 17 km south-east of the Project footprint in Yelarbon State Forest (south of Inglewood). A second more recent record (2011) from further south of the same area exists 27 km south-east of the Project from Texas State Forest. A number of records occur within 50 km of the Project footprint to the north of the alignment near Toowoomba and Crows Nest ranging in age from 1974 to 2003 (AoLA 2020). The nearest of these are from the Highfield area (2010 and 2016) and are located approximately 10 km north-east of the Project footprint (refer Figure 6.4 in Appendix B). In Queensland this species occurs from Windsor Tablelands in the north to the south-east of the state. Its range extends south to Victoria (DAWE 2020). The Project is not located near the limit of the species' range. No recovery plan exists for this species. A review of the available literature including the approved conservation advice for the species (TSSC 2016d) has not identified any important populations. No populations have been identified that are key to the long-term survival and recovery of this species. There is no habitat critical to the survival of the species defined for the species in approved conservation advice for the species (TSSC 2016d). In the absence of a definition Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). The predictive habitat mapping indicates there is 198.42 ha of potential habitat within the Project footprint for the species (refer Table 7.1 and habitat figure in Appendix I). No important populations or Habitat critical to the survival of the species have been identified for this species in relation to the Project. However, given the Project may impact 198.42 ha of potential habitat for the species the assessment has taken a conservative approach for this species and it is considered further in the following section (refer Table 8.36).
<i>Petrogale penicillata</i>	Brush-tailed rock-wallaby	Database records indicate this species has been recently recorded (2018) from within approximately 2 km of the Project footprint at Gowrie Mountain to the east of the northern section of the Project south of the intersection with the Warrego Highway. Other records occur to the east and north-east of the Project in the Toowoomba and Crows Nest areas, although none within 10 km of the Project footprint. Another record from 1992 exists approximately 12 km west of the Project footprint in Bulli State Forest (south-west of Millmerran) (AoLA 2020) (refer Figure 6.2 in Appendix B). The <i>National Recovery Plan for the Brush-tailed Rock-wallaby Petrogale penicillata</i> (Menkhorst and Hines 2010) identifies important populations in Victoria and NSW and outlines important populations as being at the limit of the species' range, outlying populations, stronghold populations, research populations and other where recovery actions are being implemented. Whilst the Project footprint is not located at the limit of the species range it may be adjacent to a stronghold population that occurs near Toowoomba; however, this population is located at least 10 km east of the Project.

Species name	Common name	Project footprint population evaluation ¹
		Predictive habitat mapping indicates that the Project is not expected to impact potential habitat in which this species may occur (refer Table 7.1 and Appendix A for habitat mapping methodology). The Project impacts unsuitable habitat that has been heavily modified by agricultural/grazing practices where the species has potential to occur in the northern section of the alignment. As such the Project is currently considered unlikely to significantly impact this species and it is not considered further.
<i>Phascolarctos cinereus</i>	Koala - combined populations of QLD, NSW and the ACT)	Signs of Koala presence were identified within the riparian corridor along the Condamine River during Project surveys. Database records indicate this species occurs from 2009 and 2011 within the impact assessment area to the south of the Project footprint near Pittsworth. There are multiple other records (approximately 30) outside of the impact assessment area from between 2009-2019 surrounding Pittsworth. Two records from within the impact assessment area occur at the south of the Project footprint at Yelarbon from 1965 and 1987. Other records from within 5 km of the Project footprint occur at Millmerran (1987) and Bringalilly State Forest (2006). Predictive habitat mapping indicates that the Project may impact 493.06 ha of habitat in which this species is predicted to occur (refer Table 7.1). Habitat critical to the survival of the species for Koala is used as a 'surrogate' for important populations as per the <i>EPBC Act referral guideline for the vulnerable Koala</i> (DoE 2014). An assessment has been carried out based on the available habitat within the impact assessment area. Based on this assessment there is 'critical habitat' for Koala within the Project footprint. The potential for significant impacts are assessed further in Table 8.38.
<i>Pteropus poliocephalus</i>	Grey-headed flying-fox	This species (between 200 – 300 individuals present) was observed at a known flying-fox roost site in Inglewood (approximately 3 km south of the Project footprint) during surveys for the Inland Rail Project. Examination of State (DES 2020) flying-fox monitoring data which includes this roost site (data ranging from 2008 – 2019) observes this species as never having been recorded at the site. The site is evidently not a regular roost site for the species. Database records indicate this species does not occur within the impact assessment area however has occurred within 50 km of the Project (AoLA 2020). The nearest database record is from 1960 taken from Inglewood. Database searches indicate more recent records to the east of the Project in the Toowoomba area (refer Figure 6.6 in Appendix B). The species distribution extends from Rockhampton south to Victoria and South Australia. The Project footprint is not at the limit of the species range. Several Flying-fox camps have been identified with 20 km of the Project including Goondiwindi, north of Millmerran, Pittsworth and around Toowoomba (DAWE 2020b). Flying-fox monitoring data has only recorded the species occurring at roost sites in the Toowoomba and Oakey areas. The draft <i>National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus)</i> (DotEE 2017c) does not identify important populations for the species. The <i>Referral guideline for management actions in grey-headed and spectacled flying-fox camps</i> (DotE 2015c) identifies 'nationally important' camps for Grey-headed flying-fox as: ■ Camps that have contained ≥ 10,000 grey-headed flying-foxes in more than one year in the last 10 years, or ■ Have been occupied by more than 2,500 grey-headed flying-foxes permanently or seasonally every year for the last 10 years None of the identified camps have sustained numbers of Grey-headed flying-fox analogous to the definition of a 'nationally important' camp based on the available data. The draft recovery plan does not specifically identify habitat critical to the survival of the species but does recommend management of habitat associated with winter flowering tree species located largely in the coastal lowlands of northern NSW and SEQ (i.e. outside the impact assessment area). This is a highly mobile species and the linear nature of the Project will not impact dispersal or breeding capacity. The species travels to foraging areas usually located within 15 km of the roost site (Tidemann 1998). As such, predictive habitat mapping has taken a conservative approach for this species and included all habitat within a 50 km radius of known regular roost sites for the species that are local to the impact assessment area (refer Appendix A for methodology). Analysis of flying-fox monitoring data shows two roost sites as regularly used by the species in the Toowoomba area (refer Appendix A for locations). The predictive assessment estimates that 110.38 ha of potential habitat and 0.01 ha of Habitat critical to the survival of the species (refer Table 7.1) may be impacted under the current Project footprint.

Species name	Common name	Project footprint population evaluation ¹
		No important populations have been identified to-date and there is a very minor extent of Habitat critical to the species survival associated with the Project (as defined under this assessment). In general, the species is known to occur regularly through much of the Project footprint. Habitat in the north of the Project footprint in the vicinity of known camps for the species is largely cleared for agriculture or grazing. While the Project may remove a minor area of potential foraging habitat for the species it is inconceivable this will be to the extent it will adversely impact the species or affect the species recovery. Therefore, the Project is currently considered unlikely to significantly impact this species and it is not considered further.
<i>Turnix melanogaster</i>	Black-breasted button-quail	The species has not been detected within the impact assessment area. There are several database records close to the northern extent of the Project footprint around Toowoomba. These records range from 1889 – 2018 with the nearest records from 1999 located 1.5 km north of the footprint from the Kingsthorpe area (AoLA 2020) (refer Figure 7.6 in Appendix B). The species occurs from Byfield in the north south to the Dorriggo area (Mathieson and Smith 2009). The Project footprint is not located near the limit of the species range. This <i>National recovery plan for the black-breasted button-quail Turnix melanogaster</i> (Mathieson and Smith 2009) identifies important populations from the Yarraman-Nanango, the Jimna-Conondale Range and Great Sandy Regions. These are not relevant to the Project footprint. Habitat critical to the survival of the species includes vine thickets, dense acacia thickets and woodland with dense shrub understorey. Predictive habitat mapping indicates that the Project is not expected to impact any potential habitat or Habitat critical to the survival of the species (refer Table 7.1 and Appendix A for habitat mapping methodology). The Project impacts unsuitable habitat that has been heavily modified by agricultural/grazing practices where the species has potential to occur in the northern section of the alignment. As such the Project is currently considered unlikely to significantly impact this species and it is not considered further.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3 Significant impact assessment - Vulnerable fauna species

8.3.3.1 Collared delma (*Delma torquata*) - vulnerable

Ecology and distribution

The Collared delma typically inhabits eucalypt-dominated woodlands and open-forests in Queensland on RE land zones 3, 9 and 10 (Brigalow Belt Reptiles Workshop 2010). Recent studies in the Toowoomba Range associated with the species indicated the species was frequently associated with open *Eucalyptus crebra* woodland located on northwest facing slopes on land zone 9 (Schell and Stark pers. obs. 2017).

The Collared delma has been recorded from rocky areas associated with dry open forests. This species occurs in open eucalypt and *Acacia* woodland with an understorey of native grasses and loose rocks. The Collared delma has also been recorded from Eucalypt woodland adjacent to semi-evergreen vine thicket. This species shelters under rocks, fallen timber, leaf litter and in soil cracks (Richardson 2006). The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of the Collared delma microhabitat and is always present where the species occurs (Brigalow Belt Reptiles Workshop 2010; Davidson 1993; Schell and Stark pers. obs. 2017).

The Collared delma is endemic to the SEQ and Southern Brigalow Belt Bioregions. The known distribution of the species includes Western Creek near Millmerran, the Toowoomba Range, and the Lockyer Forest Reserves north of Helidon, eastward to Moggill on the western outskirts of Brisbane. The largest known occurrence of this species occurs on the Toowoomba Range where large numbers of this species were subject to translocation activities associated with the Toowoomba second range crossing project (DAWE 2020; Schell and Stark pers. obs. 2017).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys (Eco Logical Australia 2016; Aurecon 2018). The Collared delma has not been recorded within or adjacent to the Project footprint. The nearest database records (AoLA 2020) are two from 2003 taken from the east of Toowoomba at Jones Road, Withcott approximately 12 km east of the northern section of the Project. Another nearby record with no date occurs approximately 17 km from the Project at Tabletop Drive, Toowoomba. Recent records associated with the Toowoomba second range crossing are located approximately 12 km west of the Project (Schell and Stark pers. obs. 2017). Towards the south of the Project a record occurs approximately 29 km north of the alignment at the southern boundary of Western Creek State Forest dated 1998 (refer Figure 5.4 of Appendix B). Further north and west the species occurs in Bunya Mountains National park and Yarraman State Forest and surrounds (AoLA 2020). The Project footprint is located near the southern limit of the species range.

Project associated surveys noted potential habitat for the species (woodlands with loose surface rocks) as occurring where the Project footprint passes between the township of Pampas and the Condamine River (north branch) (refer assessment proformas in Appendix H).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species. However, the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles is applicable to this species and outlines primary threats, impacts and mitigations to this species and other Brigalow Belt reptiles.

The DAWE Approved Conservation Advice (DEWHA 2008r) notes the following potentially threatening processes identified for Australian habitat as relevant to Collared delma:

- Loss and modification of habitat due to urban and agricultural development
- Landscaping activities removing surface rocks
- Fire and invasive weed species, particularly Dwarf lantana (*Lantana montevidensis*).

Important populations and Habitat critical to the survival of the species

There are no identified important populations or definitions of habitat critical to the survival of the species. The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) considers the presence of suitable and important habitat for this species a surrogate for an important population of the species. This includes known/likely habitat for the species as mapped within the guidelines. The Project lies to the south of known/likely habitat and is mapped as may occur only. Other important habitat factors include habitat near the limit of the species known range; and large patches of contiguous, suitable habitat and viable landscape corridors. Habitat within the State forest reserves near Inglewood, particularly where the Project footprint passes through Bringalily State Forest is extensive, acts as a wildlife corridors, and includes the following habitat types which the species is known to occur in:

- Open forest eucalypt woodland dominated by ironbarks
- Woodland adjacent to exposed rocky areas
- REs on land zones 3, 9 and 10 (DAWE 2020).

As such, the Project footprint includes habitat that may be considered as 'important habitat' for Collared delma.

Impacts and mitigation measures associated with this species are identified within Table 7.4. Predictive habitat mapping for this species estimates that 295.76 ha of important habitat may be impacted under the current Project footprint (refer Table 7.1 and habitat figure in Appendix I), although it is unknown if the species actually occurs. This habitat is associated predominantly with Bringalily State Forest and Whetstone State Forest (to the north and east of Yelarbon, Inglewood). Assessment against the significant impact criteria for vulnerable species is shown in Table 8.29.

Table 8.29 Assessment against the significant impact criteria: Collared delma

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population of a species	It is uncertain if the species actually occurs within the project area, although 'important habitat' is potentially present. The Project disturbance area has potential to impact 293.67 ha of important habitat for the species. There are no known records of this species within or adjacent to the Project footprint. The closest known records are located 12 km east of the Project in the Toowoomba Range area. Predictive mapping indicates 295.76 ha of important habitat may be impacted by the Project and is restricted to the southern portion of the Project footprint (within State Forest areas near Inglewood) although there are no records of the species in this area (southern-most record of the species is from Millmerran). The vast majority of the Project footprint impacts already cleared lands and avoids suitable rocky habitat where possible. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify whether the species actually occurs or not as part of the Project Biodiversity Management Sub-plan. Survey methods will follow the relevant MNES survey guidelines. Should the species be found individuals will be relocated from the area of disturbance prior to construction/disturbance activities (refer Table 6.2). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. The Project is considered unlikely to lead to a long-term decrease in an important population (or analogous important habitat).
Reduce the area of occupancy for an important population	It is uncertain if the species occurs although 'important habitat' is present. Predictive habitat mapping indicates the Project has the potential to impact 295.76 ha of 'important habitat' for the species. There is 4,700 ha of similar habitat located in the immediate surrounds within the impact assessment area. There are no known records of this species within or adjacent to the Project footprint although the species is known from the Toowoomba Range to the east. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify whether the species actually occurs or not. Should the species be found to occur in the State Forest reserves in the Inglewood area the Project may reduce the occupancy of an important population (or analogous important habitat) to a minor extent.
Fragment an existing important population into two or more populations	It is uncertain if the species occurs although 'important habitat' is considered present. The Project is linear but largely impacts areas which are already subject to extensive fragmentation. Should the species be found to occur in the State Forest areas around Inglewood the Project has some potential to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	It is uncertain if the species occurs although 'important habitat' is present. There are no database records within 23 km of the Project footprint. There is substantial habitat located north and south of the alignment where the species habitat is predicted to occur. It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	No historical records for the species exist within or close to the impact assessment area. Potential habitat will be inspected prior to clearing activity. Provisions to relocate individuals of Collared delma will be in place within the Project Biodiversity Management Sub-plan should any be recorded. While the Project may disrupt the breeding cycle of some individuals should they occur within the Project footprint it is considered unlikely this will disrupt the breeding cycle of an important population as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historical records of the species within or close to the impact assessment area. Predictive habitat mapping indicates the Project has the potential to impact 295.76 of 'important habitat' for the species located in the State Forest around Inglewood. Nevertheless, the Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. This impact is not considered to be of the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Project-associated surveys have recorded 16 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). Dwarf lantana has been identified as a particular threat to Collared delma habitat (DEWHA 2008r) but was not recorded during the surveys. Feral predators including cat, red fox and dog were observed as present during Project site surveys.

Criterion	Assessment against significance criteria ¹
	Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Plan will ensure pest predator species will be monitored with regard to utilising Project infrastructure as shelter. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The Approved conservation advice (DEWHA 2008r) notes the following priority actions applicable to the species: ■ Protect and monitor known populations and identify threats ■ Develop a fire management strategy for known populations and habitat ■ Minimise adverse impacts from land use including road widening and maintenance ■ Identify and control threatening weeds in Collared delma habitat. It is not known if the species occurs in the area. The Project is considered unlikely to interfere with any of the priority actions listed above such that it will substantially interfere with the recovery of the species. The Project's Biosecurity Management Sub-plan will help to control problem weed species and pests associated with Project infrastructure. Should Collared delma be identified during Project activities this will contribute to current information on the species wider distribution in the region.
Assessment of potential for significant residual impacts	The Project is currently considered to have a minor potential for a significant residual impact on Collared delma through a reduction in the occupancy and fragmentation of important habitat and therefore a population, although this is dependent on the species actually being found within the Project footprint.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.2 Yakka skink (*Egernia rugosa*) – vulnerable

Ecology and distribution

The Yakka skink (*Egernia rugosa*) is a large pale fawn lizard growing up to 40 cm long. It is known to occur in open dry sclerophyll forest, woodland and scrub. It occurs in several different vegetation types within a wide variety of Queensland RE Land Zones from alluvium (river and creek flats) to sandstone ranges. It utilises vegetation types such as Brigalow (*Acacia harpophylla*), Mulga (*A. aneura*), Bendee (*A. catenulate*), Lancewood (*A. shirleyi*), Belah (*Casuarina cristata*), Poplar Box (*Eucalyptus populnea*), ironbarks and White cypress Pine (*callitris glaucophylla*) (Brigalow Belt Reptiles Workshop 2010; QLD DERM 2010).

Yakka skinks are commonly found in cavities under and between partly buried rocks, hollow logs or tree stumps, root cavities and abandoned animal burrows. The species is known to excavate deep burrow systems, sometimes under dense ground vegetation (Brigalow Belt Reptiles Workshop 2010; DotEE 2018, TSN 2008). The species is omnivorous, consuming soft plant materials and fruits and a wide variety of invertebrates which they ambush from their burrows (TSN 2008).

Little is known of the breeding ecology of the species. The Yakka skink produces live young, with around six per litter. The breeding season for this species has not been recorded (QLD DERM 2010; TSN 2008). They are highly gregarious, with populations occurring primarily as colonies or aggregations. Colonies may use several sites over the course of a year. The species shows a very high site fidelity and has a limited capacity to disperse away from the colony area (Brigalow Belt Reptiles Workshop 2010).

The known distribution of the Yakka skink extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. Locations range from the Queensland/NSW border to the Brigalow Belt (North and South), Mulga Lands, Einasleigh Uplands and up to Cape York Peninsula (Brigalow Belt Reptiles Workshop 2010; DAWE 2020).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys (Eco Logical Australia 2016; Aurecon 2018). Database records indicate this species has not been recorded within 50 km of the Project footprint (AoLA 2020). The nearest specimen backed record exists 65 km north-west of the Project footprint (north of Goondiwindi). This record is not dated and has been generalised to protect the exact location of the record. Another record exists from 1994 at the Bunya Mountains National Park located over 70 km north of the Project footprint. This record also has unreliable spatial accuracy. All other occurrence records exist to the north-west of the Project (refer Figure 5.12 in Appendix B). There are no records south or east of the Project.

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species. However, the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles is applicable to this species and outlines primary threats, impacts and mitigations to this species and other Brigalow Belt reptiles.

The DAWE Approved Conservation Advice (DotE 2014b) notes the following potentially threatening processes identified for Australian habitat as relevant to Yakka skink:

- Previous broad-scale land clearing and associated habitat degradation in the Brigalow Belt
- Landscaping activities removing woody debris and surface rocks
- Inappropriate roadside management activities
- Predation by feral species

Important populations/ Habitat critical to the survival of the species

A review of the available literature has not revealed any important populations when referring to the approved conservation advice for the species (DotE 2014b). The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPac 2011e) identifies 'important habitat' as a surrogate for important populations given the difficulty of detecting many of the species. This includes continuous patches of remnant vegetation where a colony is known, microhabitat where colonies could be found, and where the species is mapped as 'likely to occur' within the Guidelines. Mapping within the guidelines shows the species as 'may occur' only with the nearest 'likely to occur' habitat in the Miles area over 100 km north-west of the Project. No important habitat has been identified that is relevant to the Project.

Predictive habitat mapping indicates that the Project may impact 364.47 ha of habitat in which Yakka skink may occur (refer Table 7.1 and habitat figure in Appendix I). Nevertheless, this is a highly conservative figure encompassing all potential woodland types the species may occur in and disregards the actual presence of the species in the area. The species is not known to occur within or near the Project, the nearest records are over 60 km north-west and the species has never been recorded east of the of the Project. There is substantial potential and contiguous habitat available within the State Forest areas located north of Inglewood, although it is noted these areas are subject to timber harvesting. Should the species be found to occur the area is located on the south-eastern edge of its distribution and may be considered as an important population.

Impacts and mitigation measures associated with this species are identified within Table 7.4. Assessment against the significant impact criteria for vulnerable species is shown in Table 5.37.

Table 8.30 Assessment against the significant impact criteria: Yakka skink

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population of a species	The species was not recorded within the Project footprint during Project-associated surveys. The nearest records of the species are over 65 km north-west and north of the Project footprint. There are no records south or east of the Project. The species may occur in most woodland types. Given the species has been recorded in similar habitat to the north the species has potential to occur within the Project footprint. If the species is found an 'important population' is likely to be identified as occurring within the Project footprint. Predictive mapping indicates there is 364.47 ha of potential habitat for the species within the Project footprint although this does not reflect the species known occurrence. The most likely habitat for the species may be in the large tracts of woodlands associated with the State Forests in the Inglewood area. This habitat is already subject to periodic disturbance from past and existing timber harvesting regimes. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify whether the species actually occurs or not as part of the Project Biodiversity Management Sub-plan. Survey methods will follow the relevant MNES survey guidelines. Should the species be found the individuals/colony will be relocated from the area of disturbance prior to construction/disturbance activities (in consultation with experts on the species/DES) (refer Table 7.4). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. The Project is considered unlikely to lead to a long-term decrease in an important population.
Reduce the area of occupancy for an important population	The species has not been recorded within or near the Project footprint, however there is potential for the species to occur. An 'important population' has not been identified as occurring within the Project footprint presently. There are no known records of this species within or close to the Project footprint. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify whether the species actually occurs or not. Predictive mapping indicates there is 364.47 ha of potential habitat for the species within the Project footprint although this does not reflect the species known occurrence. The most likely habitat for the species may be in the large tracts of woodlands associated with the State Forests in the Inglewood area. Should the species be found to occur in the State Forests, the Project may reduce the occupancy of an important population to a minor extent (should the species be identified as occurring within the Project footprint). However, there is substantial habitat located north and south of the alignment in these areas and the impact is not considered be significant.
Fragment an existing important population into two or more populations	The species has not been recorded within or near the Project footprint, however there is potential for the species to occur. An 'important population' has not been identified as occurring within the Project footprint presently. The Project is linear but largely impacts areas which are already subject to extensive fragmentation. Should the species be found to occur in the State Forest areas around Inglewood the Project has some potential to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	Predictive mapping indicates there is 364.47 ha of potential habitat for the species within the Project footprint although this does not reflect the species known occurrence. There are no database records within 65 km of the Project footprint. There is 7,071 ha of potential habitat located in the immediate surrounds within the impact assessment area to the north and south of the alignment where the species habitat is predicted to occur. It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	No historical records for the species exist within or close to the impact assessment area. Potential habitat will be inspected prior to clearing activity. Little is known of the breeding ecology of the species. Provisions to relocate individuals of Yakka skink will be in place within the Project Biodiversity Management Sub-plan should any be recorded. Given the species habits in the unlikely event a colony is located within the Project footprint the Project may disrupt the breeding cycle of an important population. However given the lack of records of this species, it is unlikely that this will occur as a result of the project activities
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historical records of the species within or close to the impact assessment area. Predictive habitat mapping indicates the Project has the potential to impact 364.47 ha of potential habitat for the species. The most likely habitat for the species may be in the large tracts of woodlands associated with the State Forests in the Inglewood area. This habitat is already subject to periodic disturbance from past and existing timber harvesting regimes. Nevertheless, the Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. This impact is not considered to be of the extent that the species is likely to decline.

Criterion	Assessment against significance criteria ¹
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weeds are not considered a threat to the species. Feral predators are identified as a threat (DotE 2014b). Project surveys identified red fox and feral cat and dog and all were observed as widespread during Project site surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Plan will ensure pest predator species will be monitored with regard to utilising Project infrastructure as shelter. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The Approved conservation advice (DotE 2014b) notes the following priority actions applicable to the species: ■ Protect and monitor known populations and identify threats ■ Encourage the retention of habitat structure elements (logs and surface rocks) in known and potential habitat ■ Develop a fire management strategy for known populations and habitat ■ Minimise adverse impacts from land use including road widening and maintenance ■ Develop and implement a feral predator management plan to control feral cat and red fox in the region. It is not known if the species occurs in the area. The Project is considered unlikely to interfere with any of the priority actions listed above such that it will substantially interfere with the recovery of the species. The Project's Biosecurity Management Sub-plan will help to control pests associated with Project infrastructure. Should Yakka skink be identified during Project activities this will contribute to current information on the species distribution.
Assessment of potential for significant residual impacts	The Project is currently considered unlikely to result in a "significant residual impact" on Yakka skink

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.3 Dunmall's snake (*Furina dunmalli*) – vulnerable

Ecology and distribution

The Dunmall's snake has been recorded from a broad range of habitats that include forests and woodlands associated with black alluvial cracking clay soils dominated by Brigalow (*Acacia harpophylla*) and other wattles, native Cypress or Bulloak as well as open eucalypt forests dominated by Spotted gum or Ironbark with Cypress and Bulloak on soils derived from sandstone (Brigalow Belt Reptiles Workshop 2010; Stephenson & Schmida 2008; Threatened Species Network 2008). Other environments that the species has been encountered in include the edge of dry vine scrub and hard ironstone country near Lake Broadwater. Whilst little is known about the ecological requirements of the species it has been discovered using microhabitat such as fallen timber, ground litter (Brigalow Belt Reptiles Workshop 2010; Cogger et al. 1993) and potentially uses cracks in alluvial clay soils in habitat ranging from 200 to 500 m above sea level (QLD DERM 2010; Richardson 2006).

Dunmall's snake has been found in a broad range of habitats, including:

- 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 Bulloak (*Allocasuarina luehmannii*)

- Various Spotted gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra* and *E. melanophloia*), White cypress pine (*Callitris glaucophylla*) and Bullock open forest and woodland associations on sandstone derived soils
- The edge of dry vine scrub near Tarong Power Station, Queensland, and hard ironstone country (Queensland RE Land Zone 7) at Lake Broadwater near Dalby, Queensland.

The Dunmall's snake occurs in Queensland and New South Wales where it has become highly fragmented across its range due to cropping and grazing, markedly in the Darling Downs region of Queensland. This has seen a sharp decline and the species is now of particular conservation significance (Covacevich 1995). Records for the species are very limited due to the cryptic nature of this species. It has been sighted at Archakoora, Oakey, Glenmorgan, Wallaville, Gladstone, Lake Broadwater, Mount Archer, Exhibition Range National Park, roadside reserves between Inglewood and Texas, Rosedale, Yeppoon and Lake Broadwater Conservation Park (Cogger et al. 1993; Covacevich et al. 1988; Covacevich et al. 1996; McDonald et al. 1991). Recent records exist only from a restricted area of inland south eastern Queensland between Chinchilla and Morven (Chapple et al. 2019).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys (Eco Logical Australia 2016; Aurecon 2018). The nearest database record is recent from 2011 and occurs within the impact assessment area on the Millmerran – Inglewood Road north of Inglewood where the Project footprint traverses Bringalily State Forest (refer Figure 4.2). This is the only specimen backed record within the impact assessment area or Project footprint. Other records within a 50 km radius of the Project occur at the southern end of Yelarbon State Forest although this is somewhat dated (1996) and located 22 km south-east of the southern end of the Project. The only other record within the context of the Project occurs at Oakey approximately 13 km from north-east of the northern section of the Project (refer Figure 5.8 Appendix B). This record is not dated. The Project is located at the southern end of the species distribution, particularly at the southern end of the alignment.

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species. However, the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles is applicable to this species and outlines primary threats, impacts and mitigations to this species and other Brigalow Belt reptiles.

The DAWE Approved Conservation Advice (DotE 2014c) notes the following potentially threatening processes identified for Australian habitat as relevant to Dunmall's snake:

- Habitat loss and fragmentation due to land clearing in core areas of the Darling Downs
- Predation by feral animals such as foxes, cats and pigs
- Inappropriate road side management (DES 2017c).

Important populations and Habitat critical to the survival of the species

There are no identified important populations or definitions of habitat critical to the survival of the species. The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPac 2011e) considers the presence of suitable and important habitat for this species a surrogate for an important population of the species. Given the rarity, and difficulty of detecting Dunmall's snake, all suitable habitats (remnant or non-remnant vegetation) that are coincident with the known locations of the species are considered important habitats.

Habitat mapping in the guidelines identified the Project as being located adjacent to the north of 'likely or known' habitat to the south of Yelarbon (along the NSW border). The Project itself is located within suitable habitat mapped as 'may occur'. Given there is a known record within Bringalily State Forest the habitat in the area can be considered as maintaining habitat connectivity with 'likely habitat' located to the south and therefore considered as 'important habitat'.

Impacts and mitigation measures associated with this species are identified within Table 7.4. Predictive habitat mapping for this species estimates that 298.85 ha of important habitat may be impacted under the current Project footprint (refer Table 7.1 and habitat figure in Appendix I). This habitat is associated predominantly with Bringalily State Forest (to the north-east of Yelarbon, north of Inglewood and south of Bringalily). Assessment against the significant impact criteria for vulnerable species is shown in Table 8.31.

Table 8.31 Assessment against the significant impact criteria: Dunmall's snake

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population of a species	The species has been recorded relatively recently (2011) adjacent to the Project footprint in Bringalily State Forest. There are few other records of the species in the wider area although the species is known to be difficult to detect. Predictive mapping indicates 298.85 ha of suitable (or important) habitat may be impacted by the Project and is restricted to the southern portion of the Project footprint (within State Forest areas near Inglewood). The vast majority of the Project footprint impacts already cleared lands. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify whether the species actually occurs or not as part of the Project Biodiversity Management Sub-plan. Survey methods will follow the relevant MNES survey guidelines. Should the species be found individuals will be relocated from the area of disturbance prior to construction/disturbance activities (refer Table 7.4). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. The Project is considered unlikely to lead to a long-term decrease in an important population (or analogous important habitat).
Reduce the area of occupancy for an important population	Predictive habitat mapping indicates the Project has the potential to impact 298.85 ha of 'important habitat' for the species. There is a known record of this species adjacent to the Project footprint in Bringalily State Forest. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify where the species may occur, although it is acknowledged the species is difficult to locate and is likely naturally rare within its range. Given the species has been recorded in the Inglewood area the Project has potential to reduce the occupancy of an important population (or analogous important habitat).
Fragment an existing important population into two or more populations	It is uncertain if the species occurs throughout the Project footprint although there is potential for an important population to be present in the State Forests in the Inglewood area. The Project is linear. Crossing structures will include culverts and bridges. A viaduct is expected to be used where the alignment crosses the Condamine River floodplain thereby allowing dispersal. Should the species be present within the Project footprint there is some potential to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	It is uncertain if the species occurs throughout the Project footprint although there is potential for an important population to be present in the State Forests in the Inglewood area. There is a known record of this species adjacent to the Project footprint in Bringalily State Forest. Nevertheless, there is substantial habitat located north and south of the alignment where the species habitat is predicted to occur. It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	There is a single database record within the impact assessment area and the species has also been recorded in the wider area. Potential habitat will be inspected prior to clearing activity. Provisions to relocate individuals of Dunmall's snake will be in place within the Project Biodiversity Management Sub-plan should any be recorded. The species appears naturally uncommon. While the Project may disrupt the breeding cycle of some individuals should they occur within the Project footprint it is considered unlikely this will disrupt the breeding cycle of an important population as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is a single database record within the impact assessment area and the species has also been recorded in the wider area. The Project disturbance area has potential to impact 298.85 ha of 'important habitat' for the species. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. The Project is not considered likely to impact suitable habitat for the species to the extent the species is likely to decline.

Criterion	Assessment against significance criteria ¹
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weeds are not considered as a threat to the species. Feral predators are considered a threat to the species (DotE 2014c). Feral cat, red fox and dog were observed as present within the impact assessment area during Project site surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Plan will ensure pest predator species will be monitored with regard to utilising Project infrastructure as shelter. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The approved conservation advice for <i>Furina dunmali</i> (TSSC 2014) notes the following priority actions applicable to the species: Protect and monitor known populations and identify threats Develop a fire management strategy for known populations and habitat Minimise adverse impacts from land use including road widening and maintenance Identify and control threatening weeds in Dunmall's snake habitat. The Project will contribute to impacts from land use with regard to the alignment. Nevertheless, this impact is considered unlikely to substantially interfere with the recovery of the species. Should Dunmall's snake be identified during Project activities this will contribute to current information on the species in the south-east Queensland region.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, it is currently considered likely the Project will cause 'significant residual impacts' on an <i>important population</i> of Dunmall's snake through reduction in occupancy of the species and fragmentation of important habitat.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.4 Squatter pigeon (southern) (*Geophaps scripta scripta*) - vulnerable

Ecology and distribution

The Squatter pigeon (southern sub-species) forages on the ground for grass seeds, herbs, shrubs and insects. The Squatter pigeon is typically seen in pairs, or in small groups of up to 20 or more individuals and breed throughout the year. Breeding however is influenced by heavy rainfall which most commonly occurs during the dry season between May and June (Pizzey and Knight 2007; OEH 2017d; DAW 2020).

Squatter pigeon nests are depressions scraped into the ground beneath a tussock of grass, bush, fallen tree or log and sparsely lined with grass. The female lays two eggs which are smooth, lustrous, pale cream and oval with an incubation period of approximately 17 days by both parents. Southern Squatter pigeon chicks will remain in the nest for a further 2 to 3 weeks after hatching (Australian Bush Birds 2018; AWC 2017; DAW 2020).

The Squatter pigeon (southern sub-species) is known to inhabit grassy understorey of open eucalypt woodlands and plains featuring sandy areas within close proximity to water. Areas of semi-arid or arid landscape with sandy, open and short grass cover dissected by gravel ridges is the preferred habitat for the species. The ground cover in foraging and breeding habitat is typically patchy, consisting of native, perennial tussock grasses or a mix of perennial tussock grasses and low shrubs or forbs. This vegetated ground layer rarely exceeds 33 per cent of the ground area. The remaining ground surface typically consists of bare patches of gravelly or dusty soil, and areas lightly covered in leaf litter and coarse, woody debris (e.g. fallen trees, logs and smaller debris). The species is also often found alongside tracks and roadsides (OEH 2017d; DAW 2020).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys (Eco Logical Australia 2016; Aurecon 2018). There are a number of database records around the Inglewood area and further north-east in Durikai State Forest. The nearest of these is from 2017 and located 1.2 km west of the Project footprint in Bringalily State Forest. A second record (2014) is located 5 km east of the alignment in the same area located on the edge of Devine State Forest. The majority of records are to the south and east of the alignment and are generally more than 10 km away from the Project footprint (refer Figure 7.16 in Appendix B). These records occur predominantly within forest reserves around the Inglewood area. Records are mostly scattered occurring from Dhinna Dhinawan National Park over the border in northern New South Wales, at Yelarbon State Forest to Texas to the south-east of the Project to Talgai and Bringalily State Forest. Records throughout this region include many that are from within the last 20 years. There are scattered records to the east of the northern extent of the Project, however these are largely older and located more than 15 km away from the Project footprint.

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved Conservation Advice (TSSC 2015b) notes the following potentially threatening processes identified for Australian habitat as relevant to Squatter pigeon:

- Overgrazing by livestock and exotic herbivores, particularly during periods of drought
- Habitat loss and land clearing
- Replacement of natural habitat with grazing pasture decreasing availability of natural food sources
- Encroachment from invasive weeds
- Inappropriate fire regimes
- Changes to micro-habitat through the thickening of understorey vegetation (Higgins & Davies, 1996; Garnett et al 2011).

Important populations and Habitat critical to the survival of the species

The subspecies range occurs north to Townsville and west to Charleville. Important populations of the Squatter pigeon have been identified as those isolated and sparsely distributed sub-populations that occur south of the Carnarvon Ranges in central and southern Queensland, including:

Populations occurring in the Condamine River catchment and Darling Downs of southern Queensland

Populations occurring in the Warwick-Inglewood-Texas region of southern Queensland

Any population that may potentially occur in NSW (Squatter Pigeon Workshop 2011)

The Project will impact habitat in the Inglewood area and therefore has potential to impact an important population. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). It is estimated that the project is likely to impact 339.34 ha of potential habitat in which this species is predicted to occur (refer Table 7.1 and habitat figure in Appendix G), although the predictive habitat modelling is conservative and this is likely a substantial overestimation. Given the known records of the species this population is very likely to be restricted to the woodlands in the Inglewood region (with regard to the Project footprint).

Impacts and mitigation measures associated with this species are identified within Table 7.4. The following significant impact assessment (refer Table 8.32) under the MNES guidelines (DoE 2013) has been informed by the information detailed above.

Table 8.32 Assessment against the significant impact criteria: Squatter pigeon (southern)

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population of a species	The species was not recorded during Project surveys but there are recent database records located close to the Project footprint. There is considered an important population existing within the impact assessment area and surrounds, likely restricted to the wider Inglewood area. The Project footprint largely intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. It is considered very unlikely the Project will result in direct mortality of individuals of the species. Pre-clearance surveys will be carried out as part of the Biodiversity Management Sub-plan. Any individuals occurring within the Project footprint are expected to move away from the area naturally. Predictive habitat mapping indicates that the Project may impact 339.34 ha of potential habitat for the species, although this may be a substantial overestimate. The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. The Project is considered unlikely to result in a long-term decrease in the size of a population.
Reduce the area of occupancy for an important population	There is considered an important population existing within the impact assessment area and surrounds, likely restricted to the Inglewood area. Predictive habitat mapping indicates that the Project may impact 339.34 ha of habitat considered as suitable for the species, although this is likely a substantial overestimate. The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. Nevertheless, the species can utilise cleared habitat for feeding. The Project has potential to reduce the occupancy of an important population across the local region. However, given the absence of recent records for this species within the Project footprint, reductions in the area of occupancy are unlikely to be significant.
Fragment an existing important population into two or more populations	There is considered an important population existing within the impact assessment area and surrounds, likely restricted to the Inglewood area. The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. Nevertheless, the Project will fragment habitat patches in two State Forests (Bringalily and Whetstone). Nevertheless, this is a mobile species and the Project is considered unlikely to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	Predictive habitat mapping indicates that the Project may impact 339.34 ha of potential habitat for the species, although this is likely a substantial overestimate. No habitat considered critical to the survival of Squatter pigeon will be impacted (as defined under the method used for this assessment). The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. There is abundant similar habitat to the north and south of the alignment that will not be impacted by the Project. The Project will not impact Habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	There is considered an important population existing within the impact assessment area and surrounds, likely restricted to the Inglewood area. The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. Breeding habitat is identified as stony rises with sandy or gravel soils and within 1 km of permanent water (Squatter Pigeon Workshop 2011). The Project preferentially traverses low-lying lands and is unlikely to impact breeding habitat. The Project is considered unlikely to disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subspecies occurs across a wide area from northern central Queensland, south to the Warwick/Inglewood area and west to Charleville. Given the extent of occurrence of the species the Project is considered unlikely to decrease the availability of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Encroachment by invasive weed species is considered a potential threatening process to this species (TSSC 2015b). Project-associated surveys have recorded 16 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). Grasslands in the area are already subject to significant invasion by introduced pastoral grass species. Invasive introduced pasture species such as Buffel grass (<i>Cenchrus ciliaris</i>) was noted as present on the sandy soils in the south of the alignment.

Criterion	Assessment against significance criteria ¹
	Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The approved conservation advice (TSSC 2015b) includes the following conservation/management actions: - Identify high priority sub-populations (particularly in southern areas) and establish conservation protections, habitat rehabilitation and management plans for threats including stock and feral herbivore management - Monitor sub-populations throughout the distribution of the species - Further research on the species ecology including preferred food plants, movement/dispersal patterns and reproductive factors. There is no reason the Project will substantially interfere with the management actions outlined above. The Project will necessarily reduce known threats such as grazing by livestock (on land within the Project footprint) and through weed controls under the Project's Biosecurity Management Sub-plan. While the Project may be a potential point source of ignition for fires (a potential threat to the species) this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. Any impact on the species will be minor and is considered unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Mapping indicates that the Project may result in the clearance of up to 339.34 ha of potential habitat for this species. However, there are no recent records associated with this species in the Project footprint to validate the species occurrence. Therefore, under the nine-part test detailed above, the Project is currently considered unlikely to have a 'significant residual impact' on Squatter pigeon.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.5 Painted honeyeater (*Grantiella picta*)

Ecology and distribution

The Painted honeyeater is predominantly found in open forest, box-open woodland, eucalypt forest/woodlands, riparian woodlands, box-ironbark-yellow gum woodland, and acacia woodlands. The species is often associated with Brigalow (*Acacia harpophylla*) and Buloke (*Allocasuarina luehmannii*). Habitats with a prevalence of mature trees are preferred as they host more mistletoe. It is generally more common in larger tracts of habitat, but is known to breed in smaller areas where abundant mistletoe occurs. The Painted honeyeater inhabits environments with a high prevalence of mistletoe which provides nesting and foraging resources, particularly mistletoe fruits. The species may also consume nectar and insects. Favoured species include Needle-leaved mistletoe (*Amyema cambagei*) and Grey mistletoe (*A. quandang*). Mistletoe foliage helps with concealment of the nest to protect from predation (Garnett et al. 2011; DotE 2015f).

Breeding generally occurs between October through to March and can be influenced by environmental conditions and the availability of food resources (again particularly mistletoes). Generally, the male will arrive at a nesting site several weeks before the female. The Painted honeyeater is known to use the same nest sites each season and are generally seen in pairs or singles, rarely in small flocks of up to six birds (DotE 2015f; DES 2018).

The species distribution in summer and spring is closely aligned with mistletoe fruiting and extends from inland central Victoria through scattered parts of NSW, the ACT and southern Queensland. In winter (following the breeding season) the species migrates to semi-arid areas such as central and north-west Queensland, around Cape York Peninsula, and eastern areas of the Northern Territory. Opportunistic sightings have also been recorded in far eastern parts of South Australia (DotE 2015f). The majority of records occur on the inland slopes of the Great Dividing Range. The Project footprint is not located near the limit of the species' range.

Distribution in context to the Project

The species was not recorded during Project-associated surveys. Database records indicate the species has not been recorded within the Impact assessment area but has occurred at scattered locations within the wider area (AoLA 2020). There are a number of records in the Pittsworth area including a 2007 record located approximately 2 km south of the Project footprint in Pittsworth itself. A second record is located approximately 3 km north of the Project footprint from McEwan State Forest (2013). There are two nearby older records (1970's) (12 km north-west of Pittsworth). At the northern extent of the alignment there is a 2006 record located 2.5 km east of the northern extent of the Project (Gowrie area), 2019 records from Highfields (10 km east of the Project) and a 2013 record from Toowoomba (15 km south-east of the Project). To the west there is a 2000 record from Oakey (12 km north-west) and a large number of records around Jondaryan where there is a known regular nesting area for the species (26 km north-west). In the south of the alignment there are two records in the Inglewood area, one from close to Coolmunda Dam (1995) and another from Whetstone State Forest (1996). Both of these are more than 10 km from the Project footprint. There are records (2015 and 2017) between Yelarbon and Goondiwindi (12 km north of the Project). Other database records are scattered in the wider area, largely to the south of the Project in NSW (refer Figure 7.10 in Appendix B).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved Conservation Advice (DotE 2015f) notes the following potentially threatening processes identified as relevant to Painted honeyeater:

- The main threat to the species is ongoing habitat loss (tree clearing) and degradation (tree thinning), largely for agriculture
- Habitat degradation due to ongoing grazing pressure from introduced and native herbivores resulting in structural changes to natural habitat and mistletoe occurrence
- Competition with the native Noisy miner (*Manorina melanocephala*)
- Predation from introduced predators [e.g. black rat (*Rattus rattus*)]
- Nest predation from native bird species

Important populations and Habitat critical to the survival of the species

The species is considered to occur as a single, sparsely distributed breeding population (Garnett et al. 2011). A review of the available literature including the approved conservation advice for the species has not revealed any identified important populations (DotE 2015f). The species is considered to occur as a single, sparsely distributed breeding population (Garnett et al. 2011). As such no important populations have been identified that are key to the long-term survival and recovery of this species. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). As such, there is no 'critical habitat' identified within or close to the Project footprint. Predictive habitat mapping indicates that the Project has the potential to impact 432.99 ha of potential habitat in which this species may occur (refer Table 7.1 and habitat figure in Appendix I). There is widespread identical habitat surrounding the Project footprint that will remain unimpacted.

Impacts and mitigation measures associated with this species are identified within Table 7.4. The following significant impact assessment (refer Table 8.33) under the MNES guidelines (DoE 2013) has been informed by the information detailed above.

In regard to the Painted honeyeater, the draft *Guide to nationally protected species significantly impacted by paddock tree removal* (DoEE 2020) notes that significant impacts may arise due to the removal of old growth eucalyptus paddock trees containing mistletoe, within known breeding areas. Whilst there are scattered records of this species occurring in the region, there is no evidence that there are any known breeding areas (i.e. areas where the species is known to occur repeatedly). The nearest such area is at Jondaryan, located over 25 km west of the Project footprint.

Table 8.33 Assessment against the significant impact criteria: Painted honeyeater

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population of a species	The species occurs as a sparsely and widely distributed single interbreeding population dispersed across inland eastern Australia as far north as north-west Queensland in the winter months. As such, no 'important population' can be considered as occurring in the Project footprint or impact assessment area. Scattered small numbers of individuals occur sporadically within the wider area surrounding the Project in a variety of habitats where it is associated with habitats containing a high abundance of mistletoes. There are scattered records in the wider area surrounding the Project largely in the northern and southern regions. The nearest database records of Painted honeyeater are located in the Pittsworth area and north of Toowoomba with the closest records located 2 km and 2.5 km from the Project footprint. There is no evidence the species occurs regularly (inferring a known breeding location) within the Impact assessment area. The northern section of the alignment passes through cleared lands and open woodlands for the most part and appears generally unsuitable for the species. There is no evidence the impact assessment area provides habitat considered to be of importance or regularly used by the species. It is considered very unlikely the Project will result in direct mortality of individuals of the species. Predictive habitat modelling indicates the project may impact 432.99 ha of potential habitat for the species, although it is uncertain to what extent the species occurs along much of the alignment given the distribution of known records. Pre-clearance surveys will determine the extent of potentially suitable habitat actually occurring within the Project footprint (i.e. habitat comprising mature trees with abundant mistletoes). The Project alignment is linear and there is extensive identical habitat (including 7,236 ha in the immediate surrounds of the Impact assessment area) and throughout the wider region that will not be impacted. The Project is considered unlikely to result in a long-term decrease in the size of an important population.
Reduce the area of occupancy for an important population	The species occurs as a sparsely and widely distributed single interbreeding population dispersed across inland eastern Australia as far north as north-west Queensland in the winter months. There are scattered records in the wider area surrounding the Project largely in the northern and southern regions. The nearest database records of Painted honeyeater are located in the Pittsworth area and north of Toowoomba with the closest records located 2 km and 2.5 km from the Project footprint. There is no evidence the species occurs regularly (inferring a known breeding location) within the Impact assessment area. The Project has been predicted to impact 432.99 ha of potential habitat for the species, although it is uncertain to what extent the species occurs along much of the alignment given the distribution of known records. The Project alignment is linear and there is extensive identical habitat (including 7,236 ha in the immediate surrounds of the Impact assessment area) and throughout the wider region that will not be impacted. The Project will not reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	This is a highly mobile species. The Project is not considered to represent a barrier to movement for the species. It is considered unlikely the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	There are scattered records in the wider area surrounding the Project largely in the northern and southern regions. The nearest database records of Painted honeyeater are located in the Pittsworth area and north of Toowoomba with the closest records located 2 km and 2.5 km from the Project footprint. There is no evidence the species occurs regularly (inferring a known breeding location) within the Impact assessment area. Predictive habitat mapping indicates that the Project may impact 432.99 ha of potential habitat for the species, although this is likely a substantial overestimate. No habitat considered critical to the survival of Painted honeyeater will be impacted (as defined under the method used for this assessment). It is considered unlikely the Project will adversely affect habitat critical to the survival of the species.

Criterion	Assessment against significance criteria ¹
Disrupt the breeding cycle of an important population	The species occurs as a sparsely and widely distributed single interbreeding population. As such, no 'important population' can be considered as occurring in the Project footprint or impact assessment area. There are scattered records in the wider area surrounding the Project largely in the northern and southern regions. The nearest database records of Painted honeyeater are located in the Pittsworth area and north of Toowoomba with the closest records located 2 km and 2.5 km from the Project footprint. There is no evidence the species occurs regularly (inferring a known breeding location) within the Impact assessment area. The Project is considered unlikely to disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The population of Painted honeyeater is sparsely dispersed across eastern Australia as far as north-west Queensland in the winter months. The nearest database records of Painted honeyeater are located in the Pittsworth area and north of Toowoomba with the closest records located 2 km and 2.5 km from the Project footprint. There is no evidence the species occurs regularly (inferring a known breeding location) within the Impact assessment area. The Project will not impact 'critical habitat' for the species. The Project has been predicted to impact 432.99 ha of potential foraging habitat for the species, although it is uncertain to what extent the species occurs along much of the alignment given the distribution of known records. The Project alignment is linear and there is extensive identical habitat (including 7,236 ha in the immediate surrounds of the Impact assessment area) and throughout the wider region that will not be impacted. The Project is considered unlikely to impact habitat suitable for Painted honeyeater to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	There are no weed species considered as relevant to the species. Feral cat was observed as widespread through the impact assessment area during Project-associated surveys, although it is uncertain whether this species presents a threat to Painted honeyeater. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral species (such as Black rat) are controlled in infrastructure associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The approved conservation advice (TSSC 2015f) includes the following conservation/management actions: - Protect woodland in which the species has been regularly recorded from clearing - Place public lands in which the species occurs under conservation management including timber reserves - Promote management of woodlands containing mature trees that host preferred mistletoe species - Manage land use activities that impact habitat in which Painted honeyeater occurs including firewood collection and grazing pressure - Further research on the species ecology including preferred foraging resources in the non-breeding season in the northern parts of its' distribution, reproductive success factors and improving estimates of population size and distribution. There is no reason the Project will substantially interfere with the management actions outlined above. Any impact on the species will be minor and is considered unlikely to interfere substantially with the recovery of the species.
Assessment of potential for significant residual impacts	Although mapping indicates that the Project may result in the clearance of up to 432.99 ha of habitat for the species there is no evidence the species utilises the impact assessment area regularly (if at all) and there is abundant identical habitat in the immediate surrounds and wider area that will remain undisturbed. Under the nine-part test detailed above it is currently considered unlikely there will be a 'significant residual impact' on Painted honeyeater as a result of the Project.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.6 Murray cod (*Maccullochella peelii*) – vulnerable

Ecology and distribution

The Murray cod (*Maccullochella peelii*) is the largest freshwater species of fish in Australia, measuring up to 1.8 m in length and weighing about 10 kg although some records indicate the species may reach over 100 kg in weight. The habitat of the species is diverse, ranging from clear rocky streams to slow-flowing, turbid lowland rivers or billabongs where the fish is found frequently in the main channel. Due to the species preferred breeding environment, it is often found in streams containing large rock, snags, overhanging vegetation, stumps or other woody structures. Due to the size of the Murray cod, it is considered the apex predator of the Murray-Darling river system and known to ambush its prey. The demersal species is known to hunt from sunset to sunrise, feeding on spiny crayfish and shrimp as well as reptiles and other fish species including cod (DAWE 2020).

The species is known to take long distance journeys prior to spawning travelling up to several hundred kilometres upstream despite their naturally sedentary nature (Koehn et al. 2009). The Murray cod has relatively low fertility compared to many other freshwater fish with the species generally reaching sexual maturity, which is heavily dependent on size, at 5 years of age. Male Murray cod, who are known to guard and fan the eggs during incubation, mature at a larger size than females with the species breeding as a pair. A female cod weighing 3 kg can produce up to 10,000 eggs often laid in logs or snags after developing them through winter until spawning, which is triggered by an increase in temperature and day length (DAWE 2020).

The Murray cod was once a widespread species and abundant in the lower and mid reaches of the Murray-Darling Basin between Queensland and South Australia (refer Appendix B). However, the distribution of the species has now reduced to several bioregions between Queensland and Victoria, including the Brigalow Belt South Bioregion (National Murray Cod Recovery Team 2010).

Distribution in context to the Project

This species was recorded within the Macintyre River and Macintyre Brook during targeted Project surveys for fish species (refer Section 4.3.2.3 and Figure 4.3). Database records (i.e. AoLA) indicate the species is known from within 10 km of the Project footprint. Records indicate the species has been found as recently as 2011 on the Macintyre River on the NSW border, approximately 4km to the south of the project between Yelarbon and Goondiwindi. There are several other records upstream and downstream of the Project crossing on the Macintyre River. Another record of this species occurs within 5 km west of the Project footprint from 1998 in the Millmerran area. Two recent records (2015) are located upstream of the Project from Kings Creek (tributary feeding into the Condamine River) located nearly 50 km west in the Clifton area. Other records exist between Dalby and Oakey along Oakey Creek downstream of the northern extent of the Project footprint.

As noted above, the species was recorded during Project surveys in the Macintyre River and Macintyre Brook. The species was not recorded elsewhere along the alignment and aquatic habitat assessments indicated waterways associated with the Project footprint on the Condamine River floodplain and Oakey Creek were not suitable for the permanent presence of the species. These areas, particularly on the Condamine River floodplain, are only likely to be used by the species during and following large flooding events (refer Section 4.3.4.10 and EIS Appendix K: Aquatic Ecology Technical Report).

Recovery plans/threat abatement plans

The *National Recovery Plan for the Murray Cod Maccullochella peelii peelii* (NMCRT 2010) identifies the following threatening processes as applicable to the species:

- River regulation of flows and instream impoundments impact spawning movements and recruitment processes and impact water quality in rivers

- Habitat degradation caused by the removal of habitat elements (large woody debris), sedimentation and siltation events from broad-scale land clearing and following large fires
- Competition/predation from introduced fish species including European carp (*Cyprinus carpio*), Redfin perch (*Perca fluviatilis*), Goldfish (*Carassius auratus*) and Mosquitofish (*Gambusia holbrooki*)
- Commercial and recreational fishing
- Stocking and translocation of the species impacting the genetic integrity of populations.

There are no threat abatement plans considered applicable to this species.

Important populations and Habitat critical to the survival of the species

The *Draft referral guidelines for the vulnerable Murray cod (Maccullochella peelii)* (DoE 2016c) identifies the following important populations for Murray cod in Queensland:

- Condamine River upstream of Warwick
- Border rivers (see also populations listed for NSW):
 - the Macintyre-Dumaresq Rivers to approximately 50 km downstream of Goondiwindi
 - Weir River
 - Macintyre Brook downstream of Inglewood
 - Severn River, and
 - Pike Creek downstream of Glenlyon Dam
- Warrego River between Charleville and Cunnamulla.

As such, the populations within the Macintyre River and Macintyre Brook are considered to be important populations that are relevant to the Project footprint. The Project intersects the Condamine River substantially downstream of Warwick. Habitat critical to the survival of the species has not been defined for the species in either the Recovery plan or the Referral guidelines. The predictive habitat mapping has taken a conservative approach and included habitat within the Condamine River, Macintyre River and Macintyre Brook as critical habitat for the species (refer Appendix A for mapping methodology), although as noted above, the waterways on the Condamine River floodplain intersected by the Project are unlikely to provide permanent habitat for the species. Predictive habitat mapping indicates that the Project may impact 7.76 ha of potential habitat and 5.06 ha of Habitat critical to the survival of the species for Murray cod (refer Table 8.34 and habitat figure in Appendix I).

Impacts and mitigation measures associated with this species are identified within Table 7.4. The following significant impact assessment (refer Table 8.34) under the MNES guidelines (DoE 2013) has been informed by the information detailed above.

Table 8.34 Assessment against the significant impact criteria: Murray cod

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population	Murray cod was recorded in the Macintyre River and Macintyre Brook during Project surveys. These waterways are considered as supporting an 'important population' under the draft referral guidelines for the species. Waterways elsewhere along the alignment generally did not provide suitable habitat to support the species outside of flood events (including within the Condamine River floodplain). Predictive habitat mapping indicates that the Project may impact 5.06 ha of Habitat critical to the survival of the species (as defined for this species) and 7.76 ha of potential habitat for the species. The Project design incorporates culverts, bridges and viaducts to allow fish passage, including crossings at the Macintyre River and floodplain, Macintyre Brook, and Condamine River channels (refer Section 6.1). Flood modelling indicates that stream flows (e.g. flood heights and flow velocities) will not be adversely impacted as a result of the Project (refer EIS Appendix P: Surface Water Quality Technical Report).

Criterion	Assessment against significance criteria ¹
	The Project's construction phase may require temporary stream impoundments at waterway crossing points, along with the removal of instream habitat. These works will be temporary and localised. Dewatering activities of impounded areas will be carried out with consideration of the Department of Agriculture and Fisheries Guidelines for fish salvage in impounded areas under the Project Flora and Fauna Management Plan (refer Table 7.4). The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of the species	The species was recorded in the Macintyre River and Macintyre Brook during Project surveys and these waterways are considered to support important populations. Predictive habitat mapping indicates that the Project may impact 5.06 ha of Habitat critical to the survival of the species (as defined for this species) and 7.76 ha of potential habitat. The Project design incorporates culverts, bridges and viaducts to allow fish passage, including crossings at the Macintyre River and floodplain, Macintyre Brook, and Condamine River channels. Stream impoundments may be required temporarily only during the construction phase. The impacts of the Project are temporary and considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	The Project is not considered to represent a barrier to movement for the species. The Project design incorporates culverts, bridges and viaducts to allow fish passage, including crossings at the Macintyre River and floodplain, Macintyre Brook, and Condamine River channels. Stream impoundments may be required temporarily only during the construction phase. These structures and construction measures will avoid fragmentation of an existing population. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	The Project will intersect 'critical habitat' as defined under this assessment on the Macintyre River, Macintyre Brook and Condamine River floodplain. However, onsite assessments indicate the Condamine River floodplain provides poor habitat values for Murray cod. Murray cod was recorded in the Macintyre River and Macintyre Brook during Project surveys. Project disturbance to these areas will be temporary being restricted to the construction period. Following construction, no impact to flows will occur as a result of the Project. It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	Murray cod is restricted to areas of permanent water and is known to complete their lifecycle entirely within freshwater habitats (i.e. potamodromous). Breeding occurs in Spring as associated with warmer temperatures and increased day length. The species is known to make significant upstream migrations prior to spawning. The temporary impoundment of the Macintyre River and Macintyre Brook may pose a risk to the species given they are potamodromous. The Project design incorporates culverts, bridges and viaducts to allow fish passage, including crossings at the Macintyre River and floodplain, Macintyre Brook, and Condamine River channels. Stream impoundments may be required temporarily only during the construction phase. Where possible construction will be timed to occur outside of the potential spawning season. Project disturbance to waterways will be temporary being restricted the construction period. It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Aquatic habitat degradation is a contributing factor to the decline in Murray cod populations. The degradation generally occurs at a catchment scale such as land clearing, broad-scale fires and river regulation which influence water quality. The Project will require works within instream habitats, which may result in the localised removal of important habitat features such as woody debris and changes to the local geomorphology. The majority of the water crossing points along the alignment are ephemeral and instream habitat complexity is limited. Project disturbance to waterways will be localised and temporary being restricted the construction period. Changes to water quality may also occur if not appropriately managed during construction (e.g. erosion and sediment controls) or operations (accidental spills and maintenance of waterway barriers). However, the risk of impact is likely to be low and localised. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 7.4). The impacts of the Project are considered unlikely to be of the extent that the species is likely to decline.

Criterion	Assessment against significance criteria ¹
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Introduced fish species are identified as a potential threat to the species. Targeted fish assessments identified three introduced species in Macintyre Brook including European carp, Goldfish and Mosquito fish. Goldfish and Mosquito fish were also recorded in the Macintyre River (Eco Logical Australia 2020). As such, there is potentially already elevated competition levels from these species with Murray cod within these waterways. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction of novel weeds and spread of existing weed species across the Project footprint. This will include measures to ensure aquatic weeds and pest species are not introduced as a result of the Project. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The <i>National Recovery Plan for the Murray Cod Maccullochella peelii peelii</i> (NMCRT 2010) includes the following recovery objectives: ■ Determine the distribution, structure and dynamics of Murray cod populations across the Murray-Darling Basin ■ Manage river flows to enhance recruitment to Murray cod populations ■ Evaluate the risks of threats and benefits of recovery options on Murray Cod populations for each management unit ■ Determine the habitat requirements of Murray cod life stages and populations ■ Manage the recreational fishery for Murray Cod in a sustainable manner while recognising the social, economic and recreational value of the fishery ■ Encourage community ownership for Murray Cod conservation With mitigation measures in place, particularly for the construction phase, the Project is considered unlikely to interfere with any of the recovery actions listed above and will not interfere with the recovery of the species.
Assessment of potential for significant residual impacts	The Project is currently considered unlikely to have a significant impact on Murray cod

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.7 South-eastern long-eared bat (*Nyctophilus corbeni*) – vulnerable

Ecology and distribution

South-eastern long-eared bat occurs in a variety of dry forest habitats including River Red Gum (*Eucalyptus camaldulensis*), open woodland, mallee vegetation, Brigalow (*Acacia harpophylla*) and other arid and semi-arid habitats. It roosts in tree hollows or under bark (NSW NPWS 2003). Surveys suggest the species requires large tracts of forest to occur (Turbill et al. 2008). It occurs in a range of woodlands but the preferred habitat is mallee and *Callitris* woodlands and habitats that have a distinct canopy with a dense, cluttered understorey (Pennay et al 2011; Turbill and Ellis 2006).

In Queensland, the species is noted as occurring on the western slopes of the GDR from southern central Queensland (Churchill 2008) in the Brigalow Belt South Bioregion. There is no recovery plan for the species. The Pilliga Scrub region is noted as a stronghold for the species (OEH 2012) but there are no nominated important populations or Habitat critical to the survival of the species.

Distribution in context to the Project

Microbat echolocation calls of the Genus *Nyctophilus* were recorded during the Project surveys in the south of the alignment including from the Canning Creek area (Eco Logical Australia 2016) and near Whetstone State Forest (Aurecon 2018) (refer Figure 4.3 for locations). Three *Nyctophilus* species have potential to occur in the area and cannot be reliably distinguished from each other by call. South-eastern long-eared bat is well known to occur in the State Forests in the Inglewood area. As such, this assessment has taken a conservative approach and assumed the species as present and detected during Project surveys.

There are a number of database records in the region to the west and south of the central and southern sections of the Project. The nearest record occurs less than 3 km to the west of the Project at Millmerran however this is a very old record from 1927. Several records occur to the west of the Project footprint within Bringalily State Forest, Whetstone State Forest, Bulli State Forest and Wondul Range National Park. The nearest of these are two 2006 records occurring approximately 3 km west of the Project. The remaining records are located between 10 km and 20 km west with dates ranging from 1996 to 2006. Four records from 1999 occur within Yelarbon State Forest approximately 15.5 km south of the southern section of the Project (refer Figure 6.16 in Appendix B). The only other records within a 50 km radius of the Project occur south of the Queensland/New South Wales border at Dhinna Dhinawan National Park. Database records for this species are largely confined to remnant vegetation in State Forests and National Parks.

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved Conservation Advice (TSSC 2015c) notes the following potentially threatening processes identified for Australian habitat as relevant to South-eastern long-eared bat:

- Loss and fragmentation of woodland and mallee habitat
- Fire impacting foraging and roosting habitat
- Agrichemicals impacting the species insect prey
- Grazing resulting in structural changes to natural habitat
- Predation from introduced predators (i.e. cats and foxes).

Important populations and Habitat critical to the survival of the species

The approved conservation advice does not identify important populations or Habitat critical to the survival of the species. Most records for the species occur inland of the Great Dividing Range where the species is largely uncommon, except for Nandewar and Brigalow Belt South bioregions in New South Wales and Queensland. The Project passes through an extensive area of potential habitat north of Inglewood associated with several protected areas (National Park and State Forests). The Project is located on the eastern edge of the species range and is therefore considered as an important population for the purposes of this assessment. Given the habitat needs of the species (i.e. large tracts of woodland and habitat with a suitable canopy layer) this population is very likely to be restricted to the extensive contiguous woodlands in the Inglewood region.

In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). It is estimated that the Project is likely to impact 344.10 ha of potential habitat in which this species is predicted to occur (refer Table 7.1 and habitat figure in Appendix G). The predictive habitat mapping has taken a conservative approach and includes all REs in which the species may occur including smaller isolated fragments to the north of the State Forests in the Inglewood area. Given the species prefers large areas of contiguous forest it is much less likely to occur in these fragments. As such, the mapping is likely to be overestimation of the likely extent of the species occurrence within the Project footprint.

Impacts and mitigation measures associated with this species are identified within Table 7.4. The following significant impact assessment (refer Table 8.35) under the MNES guidelines (DotE 2013) has been informed by the information detailed above.

Table 8.35 Assessment against the significant impact criteria: South-eastern long-eared bat

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population of a species	There is considered an important population existing within the impact assessment area and surrounds, likely restricted to the State Forests of the Inglewood area. The species was potentially recorded during Project surveys via echolocation call. Database records indicate the species is known from the State Forests in the Inglewood area. Pre-construction surveys (as per DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the construction footprint. Provisions to protect the species will be in place within the Project Biodiversity Management Sub-plan should individuals be located within the Project footprint (refer Table 7.4). Should the species be found during pre-clearance surveys individuals will be relocated from the area of disturbance by qualified fauna spotter-catchers. Predictive habitat mapping indicates that the Project may impact 344.10 ha of potential habitat for the species, although this may be a substantial overestimate. This habitat is largely located within the State Forests in the Inglewood area. The species is much less likely to occur in smaller isolated fragments. The Project is linear and relatively narrow. There is abundant similar habitat in the region surrounding the Project footprint to the north and south where the species is known to occur. It is considered unlikely the Project will lead to a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy for an important population	It is considered that an important population occurs within the impact assessment area and surrounds, this is likely to be restricted to the State Forests in the Inglewood area. Predictive habitat mapping indicates that the Project may impact 344.10 ha of potential habitat for the species, although this is likely a substantial overestimate and includes areas that are not considered habitat critical to the survival of the species. The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. Nevertheless, the Project will impact remnant habitat patches within two State Forests (Bringalily and Whetstone). The Project has a minor potential to reduce the occupancy of an important population across the local region, although the extent of this is not considered to be significant in the local context given the species highly mobile nature.
Fragment an existing important population into two or more populations	There is considered an important population existing within the impact assessment area and surrounds, likely restricted to the State Forests around the Inglewood area. The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. The Project will fragment habitat patches in two State Forests (Bringalily and Whetstone). Nevertheless, this is a highly mobile species and the Project is considered unlikely to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	Predictive habitat mapping indicates that the Project may impact 344.10 ha of potential habitat considered as suitable for the species, although this is likely a substantial overestimate. No Habitat critical to the survival of the species (as defined under this assessment) will be impacted. The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. The Project is not considered as adversely affecting habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	There is considered an important population existing within the impact assessment area and surrounds, likely restricted to the State Forests around the Inglewood area. The Project footprint generally intersects already disturbed (cleared) habitat where the Project footprint passes through the extensive forests near Inglewood. Pre-clearance surveys will be carried out where suitable roost habitat for this species is identified as a part of the Project Flora and Fauna Management Sub-plan. Information regarding the species breeding biology is scant. In Queensland pregnant females have been recorded in November and maternity roosts of 10 to 20 individuals are known from tree hollows in New South Wales (TSSC 2015c). The Project has some minor potential to disrupt the breeding cycle of an important population, but this is not considered significant given the quality of habitat contained within the Project disturbance footprint.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subspecies occurs from southern central Queensland, western New South Wales, south to north-west Victoria. Given the extent of occurrence of South-eastern long-eared bat the Project is considered unlikely to decrease the availability of habitat to the extent that the species is likely to decline.

Criterion	Assessment against significance criteria ¹
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	Weeds are not considered as a threat to the species. Feral predators including cat and red fox are considered a potential threat to the species (TSSC 2015c) and were observed as present within the impact assessment area during Project site surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Plan will ensure pest predator species will be monitored with regard to utilising Project infrastructure as shelter. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The approved conservation advice (TSSC 2015c) includes the following conservation/management actions: ■ Protect known and potential habitat of key populations, including within conservation reserves, from habitat loss and fragmentation ■ Retain hollow-bearing trees and provide for hollow tree recruitment where possible ■ Incorporate key population locations into the planning and decision-making process for major infrastructure projects, such as the development of new roads and pipeline routes, and extractive industries ■ Where feasible, undertake habitat renewal actions to link habitat supporting known populations or potential habitat. It is noted there are no identified 'key populations'. There is no reason the Project will substantially interfere with the management actions outlined above. While the Project may be a potential point source of ignition for fires (a potential threat to the species habitat) this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. Any impact on the species will be minor and is considered unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, it is currently considered unlikely that the Project will result in a 'significant residual impact' on South-eastern long-eared bat as a result of the Project.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.8 Greater glider (*Petauroides Volans*)

Ecology and distribution

The Greater glider (*Petauroides volans*) is the largest species of gliding possum. It has large ears fringed with thick fur and a gliding membrane which attaches to the elbows and ankles. Greater gliders are typically found in mature eucalypt forests and woodlands with a variety of eucalypt species and a high density of large tree hollows (van der Ree et al. 2004). The diet is largely composed of eucalypt leaves and sometimes flowers. Large hollows in old trees are favoured as shelter sites during the daytime (Goldingay 2012). Sites with a high abundance of suitable hollows appear to support higher populations. The species uses relatively small home ranges of 1 ha to 4 ha in more productive forests (Gibbons and Lindenmayer 2002), but up to 16 ha in more open and dry habitats (Smith et al. 2007).

Females breed in their second year giving birth to a single young each year (March to June). Their low birth rate may cause isolated populations in small forest fragments to be vulnerable to extinction (van der Ree et al. 2004).

The Greater glider occurs in eucalypt forests along the ranges and coastal plains of eastern Australia from central Victoria near Daylesford to the Windsor Tablelands in far northern Queensland. It has an elevational range from sea level to 1,200 m above sea level (TSSC 2016b; OEH 2018a).

Distribution in context to the Project

The species was not recorded during Project surveys. Database records indicate the nearest occurrence of this species (from 1999) is from approximately 17 km south-east of the Project footprint in Yelarbon State Forest (south of Inglewood). A second more recent record (2011) from further south of the same area exists 27 km south-east of the Project from Texas State Forest. A number of records occur within 50 km of the Project footprint to the north of the alignment near Toowoomba and Crows Nest ranging in age from 1974 to 2003 (AoLA 2020). The nearest of these are from the Highfield area (2010 and 2016) and are located approximately 10 km north-east of the Project footprint (refer Figure 6.4 in Appendix B). There are no database records to the west of the majority of the alignment. The nearest record to the west is on the Condamine River near Tipton (2009) and located 57 km west of the northern extent of the Project.

In general, the Project surveys observed that habitat containing large tree hollows was patchy throughout the alignment. Habitat within the State Forest Reserves north of Inglewood have been subject to periodic timber harvesting in the past limiting the extent of large hollows available in this area (refer Appendix H).

Recovery plan/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved Conservation Advice (TSSC 2016b) notes the following potentially threatening processes identified for Australian habitat as relevant to Collared delma:

- Habitat loss and fragmentation through tree clearing and logging (including for timber production) and loss of dead stag trees (with hollows) due to prescribed burning
- Changed fire regimes (including from climate change) leading too intense and/or frequent fires
- Entanglement in barbed wire is a minor threat
- Impacts from native bird species including hyper-predation by owls and competition with cockatoos for tree hollows
- Impact to habitat from *Phytophthora cinnamomi*.

Important populations and Habitat critical to the survival of the species

There are no important populations or definition of habitat critical to the survival of the species in any available literature for the species. The species occurs across eastern Australia and the Project footprint is not located on the edge of the species range and there is no evidence to suggest the area supports a key source population. In the absence of any other habitat definition for the species this assessment has defined 'critical habitat' by applying a 1 km buffer on known records that intersect 'potential habitat' for the species (refer Appendix A for methodology). As such, the Project disturbance footprint is not considered to comprise habitat 'critical to the survival of the species'. Predictive habitat mapping indicate the Project may impact 198.42 ha of potential habitat in which this species may occur (refer Table 7.1 and habitat figure in Appendix G). The predictive habitat modelling has been approached in a conservative manner and includes patchy smaller remnants which are less likely to be suitable. Given the species has never been recorded through much of the wider area the modelled habitat is likely a substantial overestimate of the species occupancy, if the species occurs at all.

Impacts and mitigation measures associated with this species are identified within Table 7.4. Assessment against the significant impact criteria for vulnerable species is shown in Table 8.36.

Table 8.36 Assessment against the significant impact criteria: Greater glider

Criteria	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population of the species	The species has never been recorded within or near the Project footprint during Project surveys and there is no evidence an 'important population' occurs in the area. The species is not known to occur within or near the Project footprint or much of the wider surrounds. There are no database records within 10 km of the Project footprint with the nearest records located in the Toowoomba Range area and south of Inglewood. There are no other records in the vicinity of, or west of the majority of the alignment. It is uncertain to what extent the habitat within the Project footprint retains suitable large tree hollows within contiguous woodlands that may support the species. Pre-construction surveys (as per DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint. Provisions to protect the species will be in place within the Project Flora and Fauna Management Sub-plan should individuals be located within the disturbance footprint (refer Table 7.4). Should the species be found individuals will be relocated from the area of disturbance by qualified fauna spotter-catchers. Predictive habitat mapping indicates that the Project may impact 198.42 ha of potential habitat for the species, although this is likely a substantial overestimate. Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint including 2,680 ha within the Impact assessment area. It is considered unlikely the Project will lead to a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population	The species has never been recorded within or near the Project footprint during Project surveys and there is no evidence an 'important population' occurs in the area. The species is not known to occur within or near the Project footprint or much of the wider surrounds. It is uncertain to what extent the habitat within the Project footprint retains suitable large tree hollows within contiguous woodlands that may support the species. Pre-construction surveys (as per DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint. Predictive habitat mapping indicates that the Project may impact 198.42 ha of potential habitat for the species, although this is likely a substantial overestimate. Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint including 2,680 ha within the impact assessment area. The Project is considered unlikely to reduce the area of occupancy of an important population of the species.
Fragment an existing important population into two or more populations	The species has never been recorded within or near the Project footprint and there is no evidence an 'important population' occurs in the area. Lands surrounding much of the Project footprint (excluding sections within the State Forest areas around Inglewood) have been substantially cleared. The Project is linear but generally impacts areas which are already subject to extensive fragmentation. Much of the Project largely lies adjacent to the existing rail line (South Western System) and passes through heavily disturbed agricultural and urban lands. Nevertheless, the Project will bisect remnant habitat within Bringalily and Whetstone State Forests. The Project will apply design mitigations with the incorporation of fauna crossing structures at targeted areas as part of the final Project design (refer Section 6.1 and Figure 6.1). The Project is considered unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	It is uncertain if the species occurs within the Project disturbance footprint or surrounds at all. Predictive habitat mapping indicates that the Project may impact 198.42 ha of potential habitat for the species, although this is likely a substantial overestimate. There is abundant similar habitat in the region surrounding the Project disturbance footprint including 2,680 ha within the impact assessment area. The majority of the alignment passes through heavily cleared lands. The State Forest areas have largely been subject to periodic timber harvesting limiting the extent of large tree hollows available through this area. There is no 'critical habitat' for the species (as defined for this assessment). The Project is largely located within lands already subject to substantial disturbance. As such The Project is considered unlikely to adversely affect habitat critical to the survival of Greater glider.
Disrupt the breeding cycle of an important population	The species has never been recorded within or near the Project footprint and there is no evidence an 'important population' occurs in the area. It is uncertain to what extent the habitat within the Project footprint retains suitable large tree hollows within contiguous woodlands that may support the species. The species is known to breed from March to June. It is uncertain if the species occurs in the Project disturbance footprint. Pre-clearance surveys (as per DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the final construction footprint. It is considered unlikely the Project will disrupt the breeding cycle of an important population.

Criteria	Assessment against significance criteria ¹
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	It is uncertain if the species occurs within or near the Project disturbance footprint at all. The species has never been recorded in the wider area through much of the alignment. Predictive habitat mapping indicates that the Project may impact 198.42 ha of potential habitat for the species, although this is likely a substantial overestimate. There is abundant similar habitat in the region surrounding the Project disturbance footprint including 2,680 ha within the impact assessment area. The majority of the alignment passes through heavily cleared lands. The State Forest areas have largely been subject to periodic timber harvesting limiting the extent of large tree hollows available through this area. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed or pest species identified as relevant to Greater glider. <i>Phytophthora cinnamomi</i> is considered a potential threat to the species habitat. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction, <i>Phytophthora cinnamomi</i> outbreaks and associated diseases resulting from Project activities (refer Table 7.4). This will be particularly important during any revegetation activities in the vicinity of potential Greater glider habitat. Revegetation plant species will be obtained from a reliable source that is certified free of the pathogen. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for New Holland mouse. The Approved conservation advice (TSSC 2016b) notes the following priority management actions applicable to the species: - Active threat mitigation in Greater glider habitat including managing fire regimes, constraining timber harvesting activity and clearing in forests with significant subpopulations - Avoid fragmentation and habitat loss from developments and upgrades of transport corridors - High priority monitoring actions include designing an integrated monitoring program across major subpopulations and monitor the abundance/size structure of critical tree species and their responses to management actions - Assess the impacts of fire management strategies on habitat values and Greater glider populations - Assess the abundance, density and types of hollow-bearing trees required to support viable populations It is not known if the species occurs within the Project disturbance footprint. While the Project may be a potential point source of ignition for fires (a potential threat to the species habitat) this is considered likely to be a rare event and the provision of adjacent access roads for the Project will enhance access for bushfire control in the wider landscape. The Project's Biosecurity Management Sub-plan will control introduced predators and weeds associated with Project infrastructure, and ensure <i>Phytophthora cinnamomi</i> is not introduced to the area as a result of Project activities. Should the species occur any impact will be minor, and is considered unlikely to interfere substantially with the management actions identified above or the recovery of the species.
Assessment of potential for significant residual impacts	It is uncertain if the species actually occurs in the Project footprint. Mapping indicates that the current Project footprint would result in the clearance of up to 198.42 ha of potential habitat for the species, although this is likely a substantial overestimate. There is extensive identical habitat remaining in the immediate surrounds. Based on the nine-part test above the Project is currently considered unlikely to have a significant residual impact on Greater glider.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.9 Koala (*Phascolarctos cinereus*) - vulnerable

Ecology and distribution

The Koala is a leaf-eating specialist feeding primarily during dawn, dusk or during the night. Its diet is restricted mainly to foliage of *Eucalyptus* spp.; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. Koala habitat can be broadly defined as any environment containing Koala food tree species or shelter trees. Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands dominated by *Eucalyptus* species. Koalas are also known to occur in highly modified (e.g. urbanised) or regenerating native vegetation communities. Home range size is dependent on the quality of habitat. In central Queensland home ranges may be as large as 135 ha (Ellis et al. 2002) and as little as 37 ha in northern New South Wales (Goldingay and Dobner 2014). Koalas are generally sedentary with longer movements largely restricted to dispersing males which may extend several kilometres through lands cleared of vegetation (DAWE 2020).

Female Koalas generally produce one offspring each year with births occurring between October and May (DAWE 2020). Males are not involved with parental care. Mothers engage in increased feeding and related movements while lactating (Logan and Sanson 2003). The young vacate the pouch permanently at 7 months and then travels with the mother (generally carried on her back) becoming fully weaned at 12 months (van Dyck and Strahan 2009). The Koala is distributed along the east coast of Australia extending from Queensland to NSW (refer Figure 5.7). In Queensland, the Koala's distribution extends across several bioregions, encompassing a great diversity of habitats with the greatest concentration in SEQ. In NSW, the species occurs mostly in the central and north coasts with populations known to inhabit the area west of the Great Dividing Range (DES 2017d; OEH 2018c).

Distribution in context to the Project

Signs of scat and scratch marks on large Red river gums *Eucalypts camaldulensis* were discovered during Eco Logical Project-associated field surveys where the Project footprint intersects the Condamine River in 2016. Koala food tree were also records along the proposed Project footprint during surveys with primary food tree species including *E. camaldulensis*, *E. tereticornis* and *E. chloroclada* along with other food trees including *E. microcarpa/pilligensis*, *E. populnea* and *E. orgadophila* (Eco Logical Australia 2016).

There are numerous database records (i.e. AoLA and Wildlife Online) indicating Koala occurring within the impact assessment area and surrounds although these are largely concentrated north of Millmerran. Two records occur within the impact assessment area to the north of Yelarbon however one of these is very old (dated 1965) and the other is from 1987. Two recent records (2011) occur within the impact assessment area at Pittsworth and there a number of other nearby records in the surrounding area. A further two records occur within the impact assessment area to the north of Southbrook with one of these occurring in 2018 and the other in 2009 (refer Figure 4.2). The 2018 record occurs along bushy Lane between Linthorpe Valley Road and the Gore Highway. Records for this species outside of the Project footprint and impact assessment area occur predominantly at the northern section of the alignment at Cecil Plains, Jondaryan, the area surrounding Pittsworth, Oakey, the Great Dividing Range from Crows Nest to West Haldon and the Lockyer Valley. At the southern end of the Project isolated records occur at Millmerran (1987), east towards Durakai State Forest, Bringalily State Forest (2006 and 3 km west of the Project footprint) and Texas State Forest (over 30 km south of the Project) (refer figure 6.8 Appendix B).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plan applicable to Koala. The National Koala Conservation and Management Strategy 2009-2014 (NRMMC 2009) expired in 2014. The DAWE Approved Conservation Advice (DSEWPaC 2012) notes the following potentially threatening processes identified for Koala:

- Habitat loss, modification or fragmentation as a result of urbanisation

- Secondary threats such as predation by domestic dogs, vehicle strikes and stress
- Extreme heat events and drought
- Chlamydia and other diseases (such as Koala retrovirus) which reduces the life expectancy of the species (DAWE 2020).

Important populations and Habitat critical to the survival of the species

There are no 'important populations' identified for Koala in the Approved Conservation Advice (DSEWPac 2012) or the (lapsed) National Koala Conservation and Management Strategy 2009 – 2014 (NRMMC 2009). The species occurs from north Queensland south to Victoria and west to central Queensland. The area is not on the edge of the species distribution and there is no evidence to suggest Koalas in the area are a source for breeding or dispersal or for maintaining genetic diversity. Population modelling based on field survey data carried out in SEQ shows the species occurs in low-medium densities in areas encompassed by the Project (Rhodes et al 2015).

The 'EPBC Act referral guidelines for the vulnerable Koala' (DoE 2014a) does not refer to any 'important populations' but provides a 'koala habitat assessment tool' to assist in the determining the sensitivity, value and quality of lands potentially impacted under development proposals. The assessment tool is used to determine whether lands may be considered as 'critical to the survival of the Koala' and therefore critical to the long-term survival and recovery of the species. The results of the assessment are to aid the decision-making process and determine whether a Project may need to be referred to DAWE based on potential significant impacts to Koalas and/or habitat critical to the survival of the species. The identification of habitat 'critical to the survival of the Koala' may be used as a surrogate for 'important populations' when assessing a Project's impacts under the Guidelines. The assessment summarised in Table 8.37 is preliminary only as it is based largely on desktop information with limited site observation obtained during opportunistic surveys within the impact assessment area.

Table 8.37 Koala habitat assessment tool (DoE 2014) - Project footprint

Attribute	Score	Details
Koala occurrence	2	There is at least one 2018 database record of the species within the impact assessment area to the north-west of Pittsworth.
Vegetation composition	2	The vegetation communities contain woodlands/open forest with two or more koala food trees.
Habitat connectivity	2	Based on koala habitat extent, the woodland areas north of Inglewood which are intersected by the Project footprint (Bringalily and Whetstone State Forests) are a part of a contiguous landscape that is greater than 1,000 ha.
Key existing threats	1	There are populations of feral dogs/dingoes throughout the impact assessment area, that would result in koala mortality. Sections of the Project footprint lie close to highways where car mortality may be an issue including the Gore Highway, Cunningham Highway and Warrego Highway.
Recovery value	1	It is uncertain whether the habitat is important for achieving interim recovery, as: ■ Much of the vegetation within the Project footprint is identified as non-remnant under the State vegetation framework and is at risk of being thinned for timber and livestock purposes. State Forest areas have potential to be subject to logging. ■ Continued mortality due to vehicle strikes and dog attacks
Koala habitat score	8	Habitat is 'critical to the survival of Koala' where Koala habitat score is ≥ 5

Habitat within the Project footprint is considered 'critical to the survival of Koala' based on the Koala habitat score (8) for the Project footprint. For the significant impact assessment this habitat is considered a surrogate for an 'important population'.

The main impacts predicted from the Project include habitat removal, injury/mortality to individuals during clearing and vehicle/train collision, and habitat fragmentation/barrier effect. The predictive habitat modelling indicates a potential area of 481.15 ha of Habitat critical to the survival of the species and an additional 11.91 ha of potential habitat for Koala occurs within the Project footprint (refer Table 7.1 and habitat figure in Appendix G, and Appendix A for habitat mapping methodology). Potential habitat is based on a 1 km buffer placed on recent species records (refer Figure 4.2) located outside of mapped vegetation communities (remnant or regrowth). This encompasses habitat comprising scattered trees in grazing paddocks and cropped areas which do not feature trees at all. As such, this is likely a significant over-estimate of available habitat for the species and will be subject to further refinement during the final design stage of the Project.

The draft *Guide to nationally protected species significantly impacted by paddock tree removal* (DoEE 2020) notes for Koala that an impact requiring approval (under the EPBC Act) may be required when '*removing paddock trees where they are habitat critical to the species survival or provide the only movement opportunity/refuge to or between areas of habitat critical to the species survival*'. This will not occur as a result of the Project given it is linear and there will be trees located adjacent to the Project footprint.

Impacts and mitigation measures associated with this species are identified within Table 7.4. The following significant impact assessment (refer Table 8.38) under the MNES guidelines (DotE 2013a) has been informed by the information detailed above.

Table 8.38 Assessment against the significant impact criteria: Koala

Criteria	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of an important population of the species	There is no evidence the impact assessment area comprises habitat supporting an 'important population' of Koala. The species was identified as present in eucalypt habitat on the Condamine River floodplain within the impact assessment area. Pre-clearance surveys will be carried out where suitable habitat for this species is identified within the final construction footprint. Provisions to protect Koalas will be in place within the Project Biodiversity Management Sub-plan should individuals be located within the Project footprint (refer Table 6.1 and Table 7.4). Should the species be found individuals will remain undisturbed and allowed to leave the construction area of their own volition or be relocated from the area of disturbance by qualified fauna spotter-catchers. There is some potential for ongoing Koala mortality during the Project's operational phase through collisions with trains. This will be mitigated with the incorporation of fauna crossing structures as part of the final Project design (refer Section 5.2.1). Koala-proof fencing will be used to guide Koalas through crossing structures. The extent of Koala proof fencing will be dependent on surrounding Koala habitat availability. The Project is predicted to require clearing up to 481.15 ha of Habitat critical to the survival of the species and 11.91 ha of potential habitat for the species. Although it is uncertain to what extent the species occurs throughout the Project footprint, particularly in the southern half of the alignment where previous records of the species are sparse. This is scattered throughout the Project footprint but includes substantial tracts of vegetation in the State Forests around Inglewood. The Project is linear and there is abundant similar habitat in the region surrounding the Project alignment including over 8,091 ha within the immediate surrounds of the impact assessment area. It is considered unlikely the Project will lead to a long-term decrease in the size of an important population of Koala.
Reduce the area of occupancy of an important population	There is no evidence the impact assessment area supports an important population of Koala. The Project is predicted to require clearing up to 481.15 ha of Habitat critical to the survival of the species and 11.91 ha of potential habitat for the species. Although it is uncertain to what extent the species occurs throughout the Project footprint, particularly in the southern half of the alignment where previous records of the species are sparse. The Project is considered unlikely reduce the potential area of occupancy of an important population.
Fragment an existing important population into two or more populations	There is no evidence the impact assessment area supports an important population of Koala. Lands surrounding much of the Project footprint (excluding sections within the State Forest areas around Inglewood) have been substantially cleared. Nevertheless, the species is known to traverse cleared lands when foraging. The Project is linear but generally impacts areas which are already subject to extensive fragmentation. Much of the Project largely lies adjacent to the existing rail line (South Western System) and passes through heavily disturbed agricultural and urban lands.

Criteria	Assessment against significance criteria ¹
	Nevertheless, the Project will bisect remnant habitat within Bringalily and Whetstone State Forests. The Project will apply design mitigations with the incorporation of fauna crossing structures (including Koala-proof fencing) at targeted areas as part of the final Project design (refer Section 6.1 and Figure 6.1). The Project is considered unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	Habitat critical to the survival of the species for Koala has been assessed as occurring on the site as defined under the Koala referral guidelines (refer Table 8.37). The Project is predicted to require clearing of up to 481.15 ha of this habitat. As such the Project will adversely affect habitat critical to the survival of the Koala.
Disrupt the breeding cycle of an important population	Where possible, clearing activities will take place outside the breeding season for Koala (October-May). Provisions to protect Koalas will be in place within the Project Biodiversity Management Sub-plan should individuals be located within the Project footprint (refer Table 6.1 and Table 7.4). Should the species be found individuals will remain undisturbed and allowed to leave the construction area of their own volition or be relocated from the area of disturbance by qualified fauna spotter-catchers. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is suitable woodland habitat for the species in the Project footprint. However; there is abundant suitable habitat for the species in the area surrounding the Project and the wider region. The species occurs across a wide area from northern central Queensland south to Victoria. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed species identified as relevant to Koala. Project-associated surveys have recorded 16 weed species listed under the Biosecurity Act and/or as WoNS (Eco Logical Australia 2016/2017 and Aurecon 2018). Feral predators are identified as a threat to the species (DSEWPac 2012). Feral dog and cat, and red fox were recorded as present in the area during Project-associated surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be a part of the overall Project CEMP. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The EMP will be in place for the life of the Project and will minimise the potential for weed invasion or spread. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction, <i>Phytophthora cinnamomi</i>, Myrtle rust outbreaks and associated diseases (such as Chlamydia) resulting from Project activities (refer Table 7.4). The Plan will consider relevant guidelines to control <i>Phytophthora cinnamomi</i> and Myrtle rust (e.g. DotE 2015b) associated with Project activities. This will include at a minimum vehicle washdown procedures and contractor education (including procedures regarding cleaning clothing). This will be particularly important during any revegetation activities in the vicinity of Koala habitat. Revegetation plant species will be obtained from a reliable source that is certified free of these pathogens. Vegetation clearing within the Project footprint in Koala habitat will be carried out in a manner to minimise stress on potential individuals as much as is practicably possible (e.g. sequential clearing and minimising time of disturbance to animals) as stressed animals are more susceptible to Chlamydia infection. Where individuals are required to be handled during vegetation clearing they will be examined by experienced personnel. If the individual is suspected of Chlamydia infection it will be taken to a veterinarian/wildlife care facility for treatment prior to release. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criteria	Assessment against significance criteria ¹
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for Koala. The <i>EPBC Act referral guidelines for the vulnerable Koala</i> (DotE 2014a) notes the following actions that may substantially interfere with the recovery of the Koala in areas associated with critical habitat: - Increasing koala fatalities due to dog attacks to a level that is likely to result in multiple, ongoing mortalities - Increasing koala fatalities due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities. - Facilitating the introduction or spread of disease or pathogens for example <i>Chlamydia</i> or <i>Phytophthora cinnamomi</i>, to habitat critical to the survival of the koala - Creating a barrier to movement that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala - Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term The Project will employ a range of mitigation measures (refer Table 7.4) to minimise these impacts including measures identified in Section 8 of the referral guidelines (DotE 2014a). Of the identified actions the Project may increase mortality due to ongoing vehicle (rail line) strikes in the long-term. With mitigation of potential Project impacts through measures incorporated within the Project CEMP, any potential impact on Koala will be minor and is considered unlikely to interfere substantially with the recovery of the species.
Assessment of potential for significant residual impacts	Mapping indicates that the Project will result in the clearance of up to 481.15 ha of Habitat critical to the survival of the species and may fragment populations in the State Forests in the Inglewood area. Based on the nine-part test for significance the Project is currently considered likely to have a significant residual impact on Koala.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

8.3.3.10 Five-clawed worm-skink (*Anomalopus mackayi*) - vulnerable

Ecology and distribution

The Five-clawed worm-skink, also called the Long-legged worm-skink (*Anomalopus mackayi*), is a burrowing skink, which is characterised by three fingers and two toes. Very little is known about the Five-clawed worm-skink's reproduction and diet. However, it is believed to feed on arthropods, such as white ants and captive specimens have been recorded eating mealworms. Five-clawed worm-skinks lay up to three eggs per clutch during Spring (DAWE 2020).

Within the Darling Downs region, the species is known to occur in grassy woodlands and grasslands on cracking dark clay soils. Habitat for this species in Queensland includes:

- Bluegrass and/or Mitchell grass dominated grasslands
- Grassy woodland dominated by Coolibah (*Eucalyptus coolibah*)
- Poplar box (*Eucalyptus populnea*), Weeping myall (*Acacia pendula*) or White box (*Eucalyptus albens*)
- Brigalow (*Acacia harpophylla*) forests and woodlands on cracking clay soils (DAWE 2020).

The known distribution of the Five-clawed worm-skink is patchy in north-eastern NSW and south-eastern Queensland. In south-eastern Queensland, the species' known distribution is on the upper Condamine River floodplain, from Warwick in the south, to the Jimbour region in the north, and bordered by the western edge of the granite belt (Brigalow Belt Reptiles Workshop 2010).

Distribution in context to the Project

This species was not identified during any Project-associated field surveys (Eco Logical Australia 2016; Aurecon 2018). There are no known records of this species within the Project footprint however three specimen backed records occurs within the impact assessment area to the north-east of Pittsworth (refer Figure 4.2). These records are recent (2002 and 2009) and occur at the Broxburn railway siding where it meets Broxburn Road located 300 m east of the Project footprint. There are other records in the wider the Pittsworth area to the north-west (1985 and 2009 – 20 km from the Project footprint) and south-east (2008 - 14 km from the Project footprint). Another record exists for this species to the east of the northern section of the alignment near Toowoomba dated 1983 located approximately 4 km from the Project footprint (AoLA 2020). There are a number of records within 50 km to the north of the impact assessment area at Allora and Felton East to the south of the northern section of the Project. To the north of the Project records occur at Bongeene and within native grasslands associated with the Warrego Highway between Oakey and Bowenville (refer Figure 5.10 in Appendix B).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species. However, the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles is applicable to this species and outlines primary threats, impacts and mitigations to this species and other Brigalow Belt reptiles.

The DAWE Approved Conservation Advice (DEWHA 2008s) notes the following potentially threatening processes identified for Australian habitat as relevant to Five-clawed worm-skink:

- Loss and fragmentation of habitat for agriculture and development
- Grazing reducing the quality of suitable habitat for the species through the loss of ground litter and refugia
- Predation by introduced predators (i.e. cats and foxes)
- Pollution of soil and water.

Important populations and Habitat critical to the survival of the species

There are no identified important populations or definitions of habitat critical to the survival of the species. The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) considers the presence of suitable and important habitat for this species a surrogate for an important population of the species. This includes known/likely habitat for the species as mapped within the guidelines. The Project intersects areas that have been mapped as 'species is known/likely to occur' and 'species may occur'. The areas of mapped habitat occur at Yelarbon at the southern end of the Project and from Millmerran to Toowoomba at the northern section of the Project. The area between Millmerran and Toowoomba includes areas mapped as 'species known/likely to occur'. As such, the Project footprint includes habitat in the area north of Millmerran that may be considered as 'important habitat' for Five-clawed worm-skink. Habitat to the south of this area, particularly in the State Forests around Inglewood, is composed of communities which are on soils that are largely unsuitable for the species presence (sandy soils).

Impacts and mitigation measures associated with this species are identified within Table 7.4. Predictive habitat mapping for this species estimates that 16.68 ha of important habitat and 161.58 ha of potential habitat may be impacted under the current Project footprint (refer Table 4.4 and habitat figure in Appendix I). Assessment against the significant impact criteria for vulnerable species is shown in Table 8.39.

Table 8.39 Assessment against the significant impact criteria: Five-clawed worm-skink

Criterion	Assessment against significance criteria ¹
Lead to a long-term decrease in the size of a population of a species	The species has been recorded relatively recently (2009) adjacent to the Project footprint in the Pittsworth area. There are a number of other records of the species in the wider area around Pittsworth as well as further north. Predictive mapping indicates 16.68 ha of important habitat and 161.58 ha of potential habitat may be impacted by the Project. This is restricted to the northern portion of the Project footprint where dark clay soils dominate the Condamine River floodplain (north of Millmerran). The vast majority of the Project footprint impacts already cleared lands in this area. The species is unlikely to occur in cultivated areas but may occur on grazing lands. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify whether the species actually occurs or not as part of the Project Biodiversity Management Sub-plan. Survey methods will follow the relevant MNES survey guidelines. Should the species be found individuals will be relocated from the area of disturbance prior to construction/disturbance activities (refer Table 7.4). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project footprint. The Project is considered unlikely to lead to a long-term decrease in an important population (or analogous important habitat).
Reduce the area of occupancy for a population	The species has been recorded relatively recently (2009) adjacent to the Project footprint in the Pittsworth area. Predictive habitat mapping indicates that the Project may impact 16.68 ha of important habitat and 161.58 ha of potential habitat for the species in the north of the Project footprint. The species has a restricted range in Queensland. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final construction footprint to identify where the species may occur, although it is acknowledged the species is difficult to locate. The <i>Draft Referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPac 2011e) lists the clearing of four or more hectares of important habitat as a high-risk significant impact. The Project has potential to reduce the occupancy of the population.
Fragment an existing population into two or more populations	The species has been recorded relatively recently (2009) adjacent to the Project footprint in the Pittsworth area. Predictive habitat mapping indicates that the Project may impact 16.68 ha of important habitat and 161.58 ha of potential habitat for the species. The Project is linear and there are database records located to the north and south of the Project footprint. The Project footprint may present a barrier to the species. The Project design incorporates culverts, viaducts and bridges across the Condamine River floodplain which may mitigate this impact. Nevertheless, the Project has potential to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	The species is known to occur within the Project footprint. Predictive habitat mapping indicates that the Project may impact 16.68 ha of important habitat and 161.58 ha of potential habitat for the species. The Project is linear and there are database records located to the north and south of the Project footprint., there is substantial suitable habitat located east and west of the alignment where the species habitat is predicted to occur. It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	The species is known to occur within the Project footprint. Information regarding the species breeding biology is scant. Breeding behaviour has been observed in Spring (DAWE 2020). Provisions to relocate individuals of Five-clawed worm-skink will be in place within the Project Biodiversity Management Sub-plan should any be recorded. While the Project may disrupt the breeding cycle of some individuals should they occur within the Project footprint it is considered unlikely this will disrupt the breeding cycle of an important population as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Predictive habitat mapping indicates that the Project may impact 16.68 ha of important habitat and 161.58 ha of potential habitat for the species. The Project is linear and there are database records located to the north and south of the Project footprint., there is substantial suitable habitat located east and west of the alignment where the species habitat is predicted to occur. It is considered unlikely that the Project will decrease habitat availability to the extent the species is likely to decline.

Criterion	Assessment against significance criteria ¹
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	Weeds are not considered as a threat to the species. Feral predators are considered a threat to the species (DotE 2014). Feral cats, red foxes and wild dogs were observed within the impact assessment area during Project site surveys. Weed and pest control measures will be incorporated into the Project's Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Plan will ensure pest predator species will be monitored with regard to utilising Project infrastructure as shelter. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project's Biosecurity Management Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The Approved conservation advice (DEWHA 2008s) notes the following priority actions applicable to the species: ■ Protect and monitor known populations and identify threats ■ Develop a stock management plan for known populations and habitat including private lands, roadside verges and stock routes ■ Develop and implement pest management plans for the control of red fox and feral cats in the region There is no reason the Project will substantially interfere with the management actions outlined above. The Project will necessarily reduce known threats such as grazing impacts on habitat by livestock (on land within the Project footprint). Should it be found to occur the Project may increase the knowledge of the species distribution in the region.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is potential for the Project to cause 'significant residual impacts' on an <i>important population</i> (or analogous important habitat) of Five-clawed worm-skink.

Table note:

1 Conclusions will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint

9 Biodiversity offsets

Impacts to MNES will be avoided where possible and then minimised and mitigated to the greatest extent practicable (refer Sections 6.1 and 6.2). Residual impacts are those impacts that remain after the implementation of an avoidance hierarchy and mitigation measures. In some instances, the magnitude and significance of potential impacts will remain unchanged following the implementation of the mitigation measures. The significance of residual impacts, as shown in Section 7.2, reflects the effectiveness of the proposed mitigation measures but also allows for the identification of areas where further management measures may be required.

A Draft Environmental Offset Delivery Strategy - QLD has been developed for the Project and is provided as EIS Appendix N: Draft offset strategy.

The EPBC Act Offsets Policy states: *"Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures. These remaining, unavoidable impacts are termed 'residual impacts'. For assessments under the EPBC Act, offsets are only required if residual impacts are significant."*

A 'significant impact' is defined as *"an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts"* (DotE 2013a).

Residual impact significance is reflective of the potential for some Project activities to have a cumulative, irreversible and/or permanent impact upon some terrestrial MNES TEC and species, even after the implementation of all mitigation measures, including rehabilitation. In these cases, the residual impact will require offset should the residual impact be considered significant in accordance with the EPBC Act Matters of National Environmental Significance Significant Impact Assessment 1.1 (DotE 2013a).

Offsets will be required to compensate for the significant residual impacts on MNES to *Habitat critical to the survival of the species* or *Important habitat* as a result of the Project. Post EIS and during the detailed design stage of the Project, offsets will be delivered to offset significant residual impacts to MNES *Habitat critical to the survival of the species* and *Important habitat* that are significant in accordance with the relevant Commonwealth guidelines/policies

An assessment of the relevant MNES to the Project has been undertaken in accordance with the MNES significant impact criteria within the MNES Guidelines (refer Section 8). Analysis, based on predictive habitat modelling and mapping, indicates that significant residual impacts for the following sensitive environmental values have potential to occur:

- **TECs:**
 - Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (refer Section 8)
 - Weeping Myall Woodlands TEC (refer Section 8)
 - Poplar Box Grassy Woodland on Alluvial Plains TEC (refer Section 8)
- **Threatened flora:**
 - King bluegrass (*Dichanthium queenslandicum*) (refer Section 8.2.1)
 - Winged peppercress (*Lepidium monoplacoides*) (refer Section 8.2.1)
 - Belson's panic (*Homopholis belsonii*) (refer Section 8.2.3)
 - Austral cornflower (*Rhaponticum australe*) (refer Section 8.2.3)
- **Threatened fauna:**
 - Spotted-tail quoll (mainland) (*Dasyurus maculatus maculatus*) (refer Section 8.3.1)
 - Condamine earless dragon (*Tympanocryptis condaminensis*) (refer Section 8.3.1)
 - Collared delma (*Delma torquata*) (refer Section 8.3.3)

- Dunmall's snake (*Furina dunmalli*) (refer Section 8.3.3)
- Swift parrot (*Lathamus discolor*) (refer Section 8.3.1)
- Koala (*Phascolarctos cinereus*) (refer Section 8.3.3).

An initial quantification of anticipated significant residual impacts to MNES is presented in Table 9.1. The initial significant residual impacts presented here are conservative values, based on the Project footprint at reference design. It is anticipated that the actual footprint of disturbance for the Project will be greatly reduced through the detail design process and in response to further ecological confirmatory surveys.

Table 9.1 Quantification of anticipated significant residual impacts to matters of national environmental significance

Sensitive environmental receptor (MNES)	Identified significant residual impact ¹
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) TEC	62.89 ha – potential extent
Weeping Myall Woodlands TEC	81.92 ha – potential extent
Poplar Box Grassy Woodland on Alluvial Plains TEC	81.92 ha – potential extent
King blue-grass (<i>Dichanthium queenslandicum</i>)	5.29 ha
Winged peppercress (<i>Lepidium monoplacoides</i>)	40.91 ha
Belson's panic (<i>Homopholis belsonii</i>)	3.19 ha
Hawkweed (<i>Picris evae</i>)	18.68 ha
Austral cornflower (<i>Rhaponticum australe</i>)	2.29 ha
Spotted-tail quoll (mainland) (<i>Dasyurus maculatus maculatus</i>)	15.49 ha
Condamine earless dragon (<i>Tympanocryptis condaminensis</i>)	17.93 ha
Five-clawed worm-skink (<i>Anomalopus mackayi</i>)	16.68 ha
Collared delma (<i>Delma torquata</i>)	295.76 ha
Dunmall's snake (<i>Furina dunmalli</i>)	298.85 ha
Swift parrot (<i>Lathamus discolor</i>)	243.54 ha
Koala (<i>Phascolarctos cinereus</i>)	481.15 ha

Table note:

1 The significant residual impact assessment for MNES will be updated, as necessary, following the completion of detailed ecological surveys of the Project footprint. Conclusions from the updated significant residual impact assessments will be used to refine the quantification of significant residual impacts and confirm the biodiversity offset requirements for the Project.

ARTC's Environmental Offset Delivery Strategy – Qld (Strategy) is contained in Appendix N of the EIS. This Strategy informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans. A Detailed Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction commencement subject to the approval under the EPBC Act.

The Environmental Offset Delivery Plan will:

- Quantify the significant residual impact of the Project on MNES
- Detail offsets to address significant residual impacts for MNES
- Include:
 - Details of milestones to establish the offset
 - Evidence that significant residual impacts can be offset
 - The offset delivery mechanisms, comprising one or more of: land-based offsets, direct benefit management plans, offset transfers or offset payments
 - Identification of land required to provide the offset
 - A legally binding mechanism that ensures protection and management of land-based offset areas.

10 Commitments

The approach outlined in this report is considered to be adequate to address the controlling provisions relevant to the Project. The report describes the particular aspects of the environment relevant to these matters and addresses the relevant sections of the EIS ToR.

As the Project moves into the detailed design and construction phases, more focused and comprehensive ecological surveys in accordance with the Commonwealth's survey guidelines will be undertaken under the Project's Flora and Fauna Sub-plan. Targeted surveys are to commence in October 2020 and will identify the actual occurrence/extent of TECs within and adjacent to the Project footprint and the presence of threatened species and/or habitat suitable to supporting the presence of threatened species. Surveys will be carried out as per diagnostic criteria and condition thresholds outlined in community-specific Approved conservation advice (for TECs) and relevant survey guidelines (for threatened fauna). The surveys aim to address any changes to the Project design and footprint, along with informing the design and construction, including specific measures to avoid, mitigate, minimise impacts on a particular species or TECs, along with ongoing monitoring activities.

The surveys will also have the added benefit in addressing some of the recommendations in conservation advices, recovery plans and threat abatement plans including:

- Surveys may identify extent and quality of TECs
- Surveys may identify extent and quality of habitat for threatened species
- Identify new populations and knowledge of the species ecology
- Surveys may be designed to monitor known populations for certain species
- The Project is also a mechanism to engage the public about a species.

As part of these surveys, ARTC will look to collaborate and supplement existing studies being undertaken by local councils, environmental groups and government agencies.

During detailed design ARTC will also finalise the location and design of fauna movement structures across Project alignment, targeting key locations. ARTC will work with the relevant stakeholders including DTMR, local councils, DES and where applicable local environmental groups to finalise the location and design of any crossing structures. This will be especially important in areas of future development or complementary to any ecological corridor strategies within the impact assessment area.

An Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction subject to approval under the EPBC Act. The Environmental Offset Delivery Plan will quantify the significant residual impacts of the Project and detail offsets to address these significant residual impacts.

ARTC is committed to implementing ongoing monitoring of the effectiveness of the measures with contingency (under an adaptive management framework) to change/improve management strategies where deleterious impacts to the identified environmental values are observed, or are not minimised, as per the objectives of the proposed mitigation measures.

11 Cumulative impact assessment

Cumulative impacts were assessed using the methodology identified in Section 3.5, incorporating the projects identified in Table 3.11 and depicted in Figure 3.4. The assessment has been based on MNES occurring within the Project footprint (refer Table 11.1) and uses a conservative approach to assessment of habitat lost (i.e. combines the habitat categories as identified in Table 4.4 to identify the maximum potential habitat loss).

The cumulative impacts of multiple projects occurring in the vicinity of the Project will likely include the continued loss of biodiversity in the South East Queensland and Brigalow Belt bioregions. Twenty of the 23 initially identified projects are within close enough proximity (50 km) to the Project that potential cumulative impacts to ecological values may occur due to one or more of the following processes:

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction, contamination and bioaccumulation
- Displacement of flora and fauna species from invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light
- Increase in litter (waste)
- Aquatic habitat degradation
- Erosion and sedimentation
- Flooding.

Cumulative impacts are most appropriately considered at a biologically relevant spatial scale. A distance of 50 km from the Project was selected as many of the MNES of relevance to the Project do not occur beyond this area, and if they do occur, any cumulative impacts associated with the Project are not considered to be relevant beyond this extent.

The total impact area of MNES habitat contained within the combined footprint of the 20 projects occurring within the cumulative impact assessment area has been quantified and is provided in Table 11.1. It must be noted that the areas of assessment varied between MSES and MNES. For MNES, assessment included areas contained within NSW as well as Queensland, considering projects within both states. However, for MSES, the cumulative impact assessment only considered projects and areas within Queensland as MSES are bound by State borders. The results of the significance assessment of these cumulative impacts are summarised as follows:

- TECs:
 - Weeping Myall woodlands TEC (6.49 per cent of available habitat to be removed of which the Project contributes up to 3.15 per cent of the extent to be cleared)
 - Poplar box woodlands TEC (5.17 per cent of available habitat to be removed of which the Project contributes up to 3.01 per cent of the extent to be cleared)
- Flora species habitat
 - *Bertya opposens* (6.8per cent of available habitat to be removed of which the Project contributes up to 0.21 per cent of the extent to be cleared)

- Belson's panic (8.02 per cent of available habitat to be removed of which the Project contributes up to 3.12 per cent of the extent to be cleared)
- Wandering peppercreep (5.4 per cent of available habitat to be removed of which the Project contributes up to 1.62 per cent of the extent to be cleared)
- Coolmunda Leucopogon (10.51 per cent of available habitat to be removed of which the Project contributes up to 1.34 per cent of the extent to be cleared)
- Fauna species habitat
 - Painted honeyeater (3.27 per cent of available habitat to be removed of which the Project contributes up to 3.19 per cent of the extent to be cleared)
 - Squatter pigeon (3.46 per cent of available habitat to be removed of which the Project contributes up to 3.19 per cent of the extent to be cleared)
 - South-eastern long-eared bat (3.30 per cent of available habitat to be removed of which the Project contributes up to 2.57 per cent of the extent to be cleared)
 - Greater glider (5.55 per cent of available habitat to be removed of which the Project contributes up to 1.89 per cent of the extent to be cleared)
 - Five-clawed worm-skink (4.64 per cent of available habitat to be removed of which the Project contributes up to 4.47 per cent of the extent to be cleared)
 - Dunmall's snake (3.32 per cent of available habitat to be removed of which the Project contributes up to 3.05 per cent of the extent to be cleared)
 - Yakka skink (3.43 per cent of available habitat to be removed of which the Project contributes up to 2.63 per cent of the extent to be cleared)
 - Swift Parrot (3.12 per cent of available habitat to be removed of which the Project contributes up to 1.99 per cent of the extent to be cleared)
 - Condamine earless dragon (3.69 per cent of available habitat to be removed of which the Project contributes up to 31.2 per cent of the extent to be cleared).

The quantitative method of assessment that has been applied establishes a percentage of impact to each significant Sensitive environmental receptor as a combined consequence of all projects identified for the cumulative impact assessment. The results of the significance assessment of these cumulative impacts are presented in aggregated form in Table 11.2 (i.e. a level of cumulative impact significance is not attributed for each project).

Unmitigated, the cumulative impacts resulting from existing and proposed developments within the cumulative impact assessment area include some that can be considered irreversible and permanent. Without targeted mitigation measures, the potential cumulative impacts upon Sensitive environmental receptors within cumulative impact assessment area have been assessed to be low to moderate significance.

The potential for cumulative impacts to ecological features will be managed through:

- Implementation of mitigation measures specified in Sections 6.1 and 6.2
- Development and implementation of the following, as components of the CEMP:
 - Biodiversity Management Sub-plan
 - Biosecurity Management Sub-plan
 - Soil Management Sub-plan
 - Waste Management Sub-plan
 - Rehabilitation and Landscaping Management Sub-plan

- Consultation with owners/operators of adjoining projects regarding the compatibility/comprehensiveness of management measures for the Border to Gowrie Project with their developments to achieve positive ecological outcomes
- Refinement of the Project footprint through detail design to limit the extent of disturbance to sensitive environmental receptors to that required to enable safe and efficient construction, operation and maintenance of the Project.
- Pre-construction surveys will be carried out to confirm to what extent the identified MNES and MSES (or their habitat) occur within, or adjacent to the Project footprint. Where MNES or MSES are found to occur, condition assessment will be undertaken (using BioCondition assessment)
- Annual monitoring of MNES and MSES (or their habitat) retained within the Project footprint against the initial BioCondition assessment. Corrective actions to be implemented where Project-associated impacts are identified.
- Delivery of offsets for residual impacts to MNES and MSES due to the Project in accordance with the EPBC Act and EO Act.

Table 11.1 Cumulative impact assessment of magnitude for matters of national environmental significance cumulative impact assessment area

Sensitive environmental receptor	Occurrence in the cumulative impact assessment area (ha) ¹	Occurrence in the cumulative impact project area (excluding Project footprint) ²	Occurrence in the footprint of all projects, including the Project	% disturbance in cumulative impact assessment area of all projects including the Project	% disturbance in cumulative impact assessment area as a result of the Project	Magnitude of disturbance ³
Commonwealth significant ecological constraints						
TECs (EPBC Act)						
Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	29,809.15	159.77	222.66	0.75	28.24	Low
Natural grassland on basalt and fine-textured alluvial plains of northern NSW and southern Queensland	2,278.37	60.44	60.44	2.65	0.00	Low
Weeping Myall Woodlands	40,077.38	2,518.31	2,600.23	6.49	3.15	Low
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	140,376.00	23.80	23.80	0.02	0.00	Low
Poplar Box Grassy Woodland on Alluvial Plains	52,611.28	2,639.67	2,721.59	5.17	3.01	Low
Threatened flora habitat (EPBC Act)						
Tara wattle (<i>Acacia lauta</i>)	270,012.58	8,995.49	9,294.34	3.44	3.22	Low
Hairy-joint grass (<i>Arthraxon hispidus</i>)	104,535.28	4,112.49	4,145.58	3.96	0.80	Low
<i>Bertya opposens</i>	74,060.99	5,026.90	5,037.50	6.80	0.21	Low
Ooline (<i>Cadellia pentastylis</i>)	9,967.50	241.49	246.05	2.47	1.85	Low
Stream clematis (<i>Clematis fawcettii</i>)	747.67	0.00	0.00	0.00	0.00	None
King blue- grass (<i>Dichanthium queenslandicum</i>)	46,727.72	1,009.51	1,131.44	2.42	10.78	Low
Bluegrass (<i>Dichanthium setosum</i>)	46,819.62	1,009.51	1,070.00	2.29	5.65	Low
Shiny-leaved ironbark (<i>Eucalyptus virens</i>)	248,597.94	8,665.68	8,958.24	3.60	3.273	Low
Belson's panic (<i>Homopholis belsonii</i>)	116,142.08	9,022.55	9,313.44	8.02	3.12	Low
Winged peppercress (<i>Lepidium monoplacoides</i>)	312,467.35	11,745.18	12,115.70	3.88	3.06	Low
Wandering pepper-cress (<i>Lepidium peregrinum</i>)	57,727.63	3,065.91	3,116.30	5.40	1.62	Low
Coolmunda leucopogon (<i>Leucopogon</i> sp. Coolmunda (D. Halford Q 1635))	34,296.05	3,561.43	3,609.62	10.52	1.34	Low
<i>Macrozamia machinii</i>	104,937.28	3,062.88	3,140.59	2.99	2.47	Low
Hawkweed (<i>Picris evae</i>)	160,083.62	4,726.26	5,320.24	3.32	11.16	Low

Sensitive environmental receptor	Occurrence in the cumulative impact assessment area (ha) ¹	Occurrence in the cumulative impact project area (excluding Project footprint) ²	Occurrence in the footprint of all projects, including the Project	% disturbance in cumulative impact assessment area of all projects including the Project	% disturbance in cumulative impact assessment area as a result of the Project	Magnitude of disturbance ³
Dunmore Prostanthera (<i>Prostanthera</i> sp. Dunmore)	100,230.59	3,460.92	3,566.77	3.56	2.97	Low
Austral cornflower (<i>Rhaponticum australe</i>)	70,967.63	2,601.69	2,824.22	3.98	7.88	Low
Brush Sophora (<i>Sophora fraseri</i>)	22,960.66	327.93	327.93	1.43	0	Low
Austral toadflax (<i>Thesium australe</i>)	72,373.58	1,869.06	2,071.66	2.86	9.78	Low
Slender Tylophora (<i>Tylophora linearis</i>)	220,874.12	5,238.38	5,467.79	2.48	4.20	Low
<i>Xerothamnella herbacea</i>	21,833.42	250.50	317.47	1.45	21.10	Low
<i>Westringia parvifolia</i>	14,556.51	0.00	0.00	0.00	0.00	Absent – not applicable
Threatened fauna habitat (EPBC Act)						
Birds						
Regent honeyeater (<i>Anthochaera phrygia</i>)	176,116.89	6,573.48	6,730.87	3.82	2.33	Low
Australasian bittern (<i>Botaurus poiciloptilus</i>)	47,137.39	442.96	487.94	1.04	9.22	Low
Curlew sandpiper (<i>Calidris ferruginea</i>)	21,214.89	251.52	265.32	1.25	5.20	Low
Red goshawk (<i>Erythrotriorchis radiatus</i>)	339,517.32	12,015.86	12,355.20	3.64	2.74	Low
Grey falcon (<i>Falco hypoleucos</i>)	645,134.52	13,485.73	14,324.44	2.22	5.86	Low
Squatter pigeon - southern subspecies (<i>Geophaps scripta scripta</i>)	307,545.26	10,311.00	10,650.34	3.46	3.19	Low
Painted honeyeater (<i>Grantiella picta</i>)	414,530.36	13,134.37	13,567.36	3.27	3.19	Low
Swift parrot (<i>Lathamus discolor</i>)	424007.53	12979.59	13243.25	3.12	1.99	Low
Australian painted snipe (<i>Rostratula australis</i>)	47,451.51	442.96	487.94	1.03	9.22	Low
Black-breasted button-quail (<i>Turnix melanogaster</i>)	43,303.76	164.02	164.02	0.38	0	Low
Fish						
<i>Maccullochella peelii</i> (Murray cod)	20,899.39	101.47	114.29	0.55	11.22	Low
Mammals						
Large-eared pied bat (<i>Chalinolobus dwyeri</i>)	103,741.82	3,307.17	3,362.11	3.24	1.63	Low

Sensitive environmental receptor	Occurrence in the cumulative impact assessment area (ha) ¹	Occurrence in the cumulative impact project area (excluding Project footprint) ²	Occurrence in the footprint of all projects, including the Project	% disturbance in cumulative impact assessment area of all projects including the Project	% disturbance in cumulative impact assessment area as a result of the Project	Magnitude of disturbance ³
Spotted-tailed quoll (<i>Dasyurus maculatus maculatus</i>)	146,145.71	4,177.76	4,259.19	2.91	1.91	Low
South-eastern long-eared bat (<i>Nyctophilus corbeni</i>)	405,983.87	13,065.54	13,409.64	3.30	2.57	Low
Greater glider (<i>Petauroides volans volans</i>)	188,901.99	10,286.82	10,485.24	5.55	1.89	Low
Brush-tailed rock-wallaby (<i>Petrogale penicillata</i>)	6,239.60	0.54	0.54	0.01	0	Low
Koala (<i>Phascolarctos cinereus</i>)	521,674.94	16,881.67	17,374.73	3.33	2.84	Low
Grey-headed flying-fox (<i>Pteropus poliocephalus</i>)	202,963.26	1,820.14	1,930.63	0.95	5.72	Low
Reptiles						
Five-clawed worm-skink (<i>Anomalopus mackayi</i>)	89,794.23	3,984.09	4,162.35	4.64	4.47	Low
Collared delma (<i>Delma torquata</i>)	273,942.02	8,243.10	8,538.86	3.12	3.46	Low
Yakka skink (<i>Egernia rugosa</i>)	414,435.87	13,492.26	13,856.73	3.43	2.63	Low
Dunmall's snake (<i>Furina dunmali</i>)	295,290.03	9,509.38	9,808.23	3.32	3.05	Low
Condamine earless dragon (<i>Tympanocryptis condaminensis</i>)	21,307.47	541.62	787.21	3.69	31.20	Low
Invertebrates						
Brigalow woodland snail (<i>Adclarkia cameroni</i>)	150,415.22	2,218.55	2,350.01	1.56	5.59	Low

Table notes:

1 Area = 2,367,317.00 ha

2 Area = 48,648.44 ha

3 Low magnitude = project contribution of less than two per cent OR an overall cumulative impact of <10 per cent. For example, the Project's contribution to cumulative impacts to the brigalow TEC is 28.24% of 0.75%, which equates to 0.21%

Table 11.2 Significance assessment of cumulative impacts within the cumulative impact assessment area

Sensitive environmental receptor(s)	Potential cumulative impact	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
MNES							
Commonwealth significant ecological constraint (community listed under the EPBC Act) ■ Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) ■ Natural grassland on basalt and fine- textured alluvial plains of northern NSW and southern Queensland ■ Weeping Myall Woodlands ■ White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ■ Poplar Box Grassy Woodland on Alluvial Plains	■ Habitat loss from vegetation clearing/removal	1	3	1	3	8	Medium
	■ Edge effects	1	2	1	3	7	Medium
	■ Habitat fragmentation						
	■ Barrier effects						
	■ Reduction in connectivity of biodiversity corridors						
	■ Fauna species injury or mortality	1	1	1	3	6	Low
	■ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	■ Increase in litter (waste)	1	1	1	3	6	Low
	■ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
■ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low	
Commonwealth significant ecological constraint (species listed under the EPBC Act): Flora ■ Tara wattle (<i>Acacia lauta</i>) ■ Hairy-joint grass (<i>Arthraxon hispidus</i>) ■ <i>Bertya opposens</i> ■ Ooline (<i>Cadellia pentastylis</i>) ■ Stream clematis (<i>Clematis fawcettii</i>) ■ King blue- grass (<i>Dichanthium queenslandicum</i>) ■ Bluegrass (<i>Dichanthium setosum</i>) ■ Shiny-leaved ironbark (<i>Eucalyptus virens</i>) ■ Belson's panic (<i>Homopholis belsonii</i>) ■ Winged peppercress (<i>Lepidium monoplocoides</i>)	■ Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	■ Edge effects	2	2	1	3	8	Medium
	■ Habitat fragmentation						
	■ Barrier effects						
	■ Reduction in connectivity of biodiversity corridors						
	■ Fauna species injury or mortality	1	1	1	3	6	Low
	■ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	■ Increase in litter (waste)	1	1	1	3	6	Low
	■ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	■ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

Sensitive environmental receptor(s)	Potential cumulative impact	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
- Wandering pepper-cress (<i>Lepidium peregrinum</i>) - Coolmunda Leucopogon (<i>Leucopogon</i> sp. Coolmunda (D. Halford Q 1635)) <i>Macrozamia machinii</i> - Hawkweed (<i>Picris evae</i>) - Dunmore Prostanthera (<i>Prostanthera</i> sp. Dunmore) - Austral cornflower (<i>Rhaponticum australe</i>) - Brush Sophora (<i>Sophora fraseri</i>) - Austral toadflax (<i>Thesium australe</i>) - Slender Tylophora (<i>Tylophora linearis</i>) <i>Xerothamnella herbacea</i> Fauna - Regent honeyeater (<i>Anthochaera phrygia</i>) - Australasian bittern (<i>Botaurus poiciloptilus</i>) - Curlew sandpiper (<i>Calidris ferruginea</i>) - Red goshawk (<i>Erythrorhynchus radiatus</i>) - Grey falcon (<i>Falco hypoleucos</i>) - Squatter pigeon - southern subspecies (<i>Geophaps scripta scripta</i>) - Painted honeyeater (<i>Grantiella picta</i>) - Swift parrot (<i>Lathamus discolor</i>) - Australian painted snipe (<i>Rostratula australis</i>) - Black-breasted button-quail (<i>Turnix melanogaster</i>) - Maccullochella peelii (<i>Murray cod</i>) - Large-eared pied bat (<i>Chalinolobus dwyeri</i>) - Spotted-tailed quoll (<i>Dasyurus maculatus maculatus</i>) - South-eastern long-eared bat (<i>Nyctophilus corbeni</i>) - Greater glider (<i>Petauroides volans volans</i>)							

Sensitive environmental receptor(s)	Potential cumulative impact	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
- Brush-tailed rock-wallaby (<i>Petrogale penicillata</i>) - Koala (<i>Phascolarctos cinereus</i>) - Grey-headed flying-fox (<i>Pteropus poliocephalus</i>) - Five-clawed worm-skink (<i>Anomalopus mackayi</i>) - Collared delma (<i>Delma torquata</i>) - Yakka skink (<i>Egernia rugosa</i>) - Dunmall's snake (<i>Furina dunmalli</i>) - Condamine earless dragon (<i>Tympanocryptis condaminensis</i>) - Brigalow woodland snail (<i>Adclarkia cameroni</i>)							

Table notes:

- Table 3.12 defines the consequences of the impact significance ratings, as follows:

Low (sum of relevance factors = 1 to 5): Negative impacts need to be managed by standard environmental management practices. Special approval conditions unlikely to be necessary. Monitoring to be part of general Project monitoring program.

Medium (sum of relevance factors = 6 to 9): Mitigation measure likely to be necessary and specific management practices to be applied. Specific approval conditions are likely. Targeted monitoring program required.

High (sum of relevance factors = 10 to 12): Alternative actions would be considered and/or mitigation measures applied to demonstrate improvement. Specific approval conditions required. Targeted monitoring program necessary.

12 Conclusion

In February 2018, the Project was submitted as an EPBC Act referral to the DotEE (now called the DAWE). (EPBC 2018/8165). On 9 April 2018, the Minister for the Environment declared the Project a 'controlled action' requiring the preparation of an EIS. The controlling provision for the Project is listed threatened species and communities.

This Technical Report has been prepared in accordance with Sections 11.1 – 11.35 of the *Terms of Reference for an environmental impact statement: Inland Rail - Border to Gowrie project* issued in November 2018 by the Queensland Coordinator-General. It has been prepared as a "stand-alone" document that assesses potential impacts on listed threatened species and communities under the EPBC Act during construction, operation and decommissioning of the Project.

The impact assessment area contains one confirmed TEC, two other potential TECs may occur, and suitable habitat for threatened fauna and flora species as listed under the provisions of the EPBC Act.

Forty-seven MNES were identified as potentially present within the impact assessment area for the purposes of this assessment. These consisted of five TECs and 19 threatened flora and 24 threatened fauna species. These MNES were grouped into high, moderate and low sensitivity categories based on factors including conservation status, exposure to threatening processes, resilience and representation in the broader landscape.

The construction, operation and decommissioning of the Project has the potential to impact on MNES due to the following activities and processes:

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species from invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light
- Increase in litter (waste)
- Aquatic habitat degradation
- Erosion and sedimentation
- Flooding.

In order to determine the significance of potential impacts of the Project upon the identified MNES, sensitivity categories were applied to each of the MNES. The sensitivity of the MNES was grouped into three distinct categories: high, moderate and low. These groupings were based on factors including, but not limited to, legislative status, resilience and representation in the broader landscape. In addition to sensitivity, the magnitude of each potential impact was assigned based on the extent, duration and resultant change to the MNES. The magnitude of impact was grouped into five categories: major, high, moderate, low and negligible. Both the sensitivity of a MNES and the magnitude of the potential impact were used to determine the significance of a potential impact.

The proposed mitigation measures for the Project were considered in order to reduce the initial magnitude and ultimately the significance of the potential impacts upon the listed threatened species and communities. Project mitigation measures included (but were not limited to):

- Reducing the Project footprint as far as reasonably practical
- Development and implementation of a Biodiversity Management Sub-plan as a component of the CEMP
- Development and implementation of a Soil Management Sub-plan, including erosion and sedimentation controls, as a component of the CEMP
- Identification and implementation of fauna movement features to reduce barrier effects associated with the Project and enable fauna passage
- Development and implementation of a Rehabilitation and Landscaping Management Sub-plan
- Development and implementation of the whole-of-Project Outline EMP.

Following the implementation of a range of mitigation measures and management plans including, but not limited to, avoidance, minimisation and mitigation, the magnitude of residual impacts to the listed threatened species and communities were predicted to be generally reduced, followed by a subsequent reduction in the significance of the impact. However, one potential impact (i.e. habitat loss from vegetation clearing/removal upon most of the terrestrial MNES) was not predicted to significantly reduce in magnitude of impact following the implementation of Project mitigation measures, resulting in a residual impact to each of the MNES.

As a result of the modelling approach, it is predicted that the significant residual impacts are likely to occur to the following listed threatened species and communities:

- TECs
 - Brigalow (*Acacia harpophylla* dominant and codominant) – total potential impact of up to 62.89 ha
 - Weeping Myall Woodlands TEC - total potential impact of up to 81.92 ha
 - Poplar Box Grassy Woodland on Alluvial Plains TEC - total potential impact of up to 81.92 ha
- Flora
 - King blue-grass (*Dichanthium queenslandicum*) – total potential impact of up to 5.29 ha to *Habitat critical to the survival of the species*
 - Belson's panic (*Homopholis belsonii*) – total potential impact of up to 3.19 ha to *Habitat critical to the survival of the species*
 - Winged peppergrass (*Lepidium monoplacoides*) – total potential impact of up to 40.91 ha to *Habitat critical to the survival of the species*
 - Hawkweed (*Picris euae*) – total potential impact of 18.68 ha to *Habitat critical to the survival of the species*
 - Austral cornflower (*Rhaponticum australe*) – total potential impact of up to 2.29 ha to *Habitat critical to the survival of the species*
- Fauna
 - Condamine earless dragon (*Tympanocryptis condaminensis*) - total potential impact of up to 17.93 ha to *Important habitat*
 - Five-clawed worm-skink (*Anomalopus mackayi*) – total potential impact of up to 16.68 ha to *Important habitat*
 - Collared delma (*Delma torquata*) - total potential impact of up to 295.76 ha to *Important habitat*
 - Dunmall's snake (*Furina dunmali*) – total potential impact of up to 298.85 ha to *Important habitat*

- Swift parrot (*Lathamus discolor*) - total potential impact of up to 243.54 ha to *Habitat critical to the survival of the species*
- Spotted-tail quoll (*Dasyurus maculatus maculatus*) - total potential impact of up to 15.49 ha to *Habitat critical to the survival of the species*
- Koala (*Phascolarctos cinereus*) - total potential impact of up to 481.15 ha to *Habitat critical to the survival of the species*

This list is reflective of the significant residual impacts that are anticipated based on the predictive habitat assessment conducted to-date. Detailed ecological surveys of the Project footprint will be undertaken in parallel to the development of the detail design. Data obtained from these detailed surveys will be used to refine the quantification of ecological impacts, revise the analysis of significant residual impacts and re-calculate offset requirements for the Project. Additional species or TECs may be identified through this process.

The primary reason for these significant residual impacts is the potential loss of habitat as a result of the Project, along with barrier effects and habitat fragmentation. The Project footprint will be refined during the detail design phase of the Project to reflect the final Project design and the land required to accommodate the Principal Contractor's adopted construction methodology. This process is expected to result in a reduction in the total Project footprint area and subsequent impacts to ecological receptors (including MNES). Additionally, design solutions to mitigate barrier effects will be incorporated into the detail design, as appropriate (e.g. fauna fencing and fauna passage ways which will facilitate the movement of wildlife across the alignment).

Predicted cumulative impacts within 50 km of the Project may potentially include habitat loss from vegetation clearing/removal, fauna species injury or mortality, reduction in biological viability of soil to support growth due to soil compaction, displacement of flora and fauna species due to invasion of weeds and pest species, reduction in connectivity of biodiversity corridors, edge effects, habitat fragmentation, barrier effects, noise, dust, and light impacts and increase in litter (waste) and aquatic habitat degradation. However, the significance of the predicted cumulative impact as a result of the Project and other similar projects that occur within 50 km of the Project boundary are likely to be higher on the following ecological MNES TECs and fauna and flora species:

- Weeping Myall woodlands TEC
- Poplar box grassy woodlands TEC
- Belson's panic (*Homopholis belsonii*)
- Wandering pepper-cress (*Lepidium peregrinum*)
- Coolmunda Leucopogon (*Leucopogon* sp. Coolmunda)
- Painted honeyeater (*Grantiella picta*)
- South-eastern long-eared bat (*Nyctophilus corbeni*)
- Greater glider (*Petauroides volans*)
- Five-clawed worm-skink (*Anomalopus mackayi*)
- Swift parrot (*Lathamus discolor*)
- Yakka skink (*Egernia rugosa*)
- Condamine earless dragon (*Tympanocryptis condaminensis*)

The MNES identified through the draft EIS will be subject to further investigations and surveys during the detail design phase to more accurately determine the magnitude of the significant residual impacts upon the listed threatened species and communities. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as is reasonably practicable.

The Project will result in significant residual adverse impact on MNES, even after the implementation of all mitigation measures, including rehabilitation. Therefore, it is expected that environmental offsets will be required for the Project. Offsets will need to be provided in accordance with requirements of the EPBC Act, *Environmental Offsets Act 2014* and relevant policies.

A Project Environmental Offset Delivery Plan will be developed to provide for the staged delivery of offsets, where appropriate, ahead of relevant clearing works being undertaken and finalised in consultation with relevant Australian Government and State regulatory agencies.

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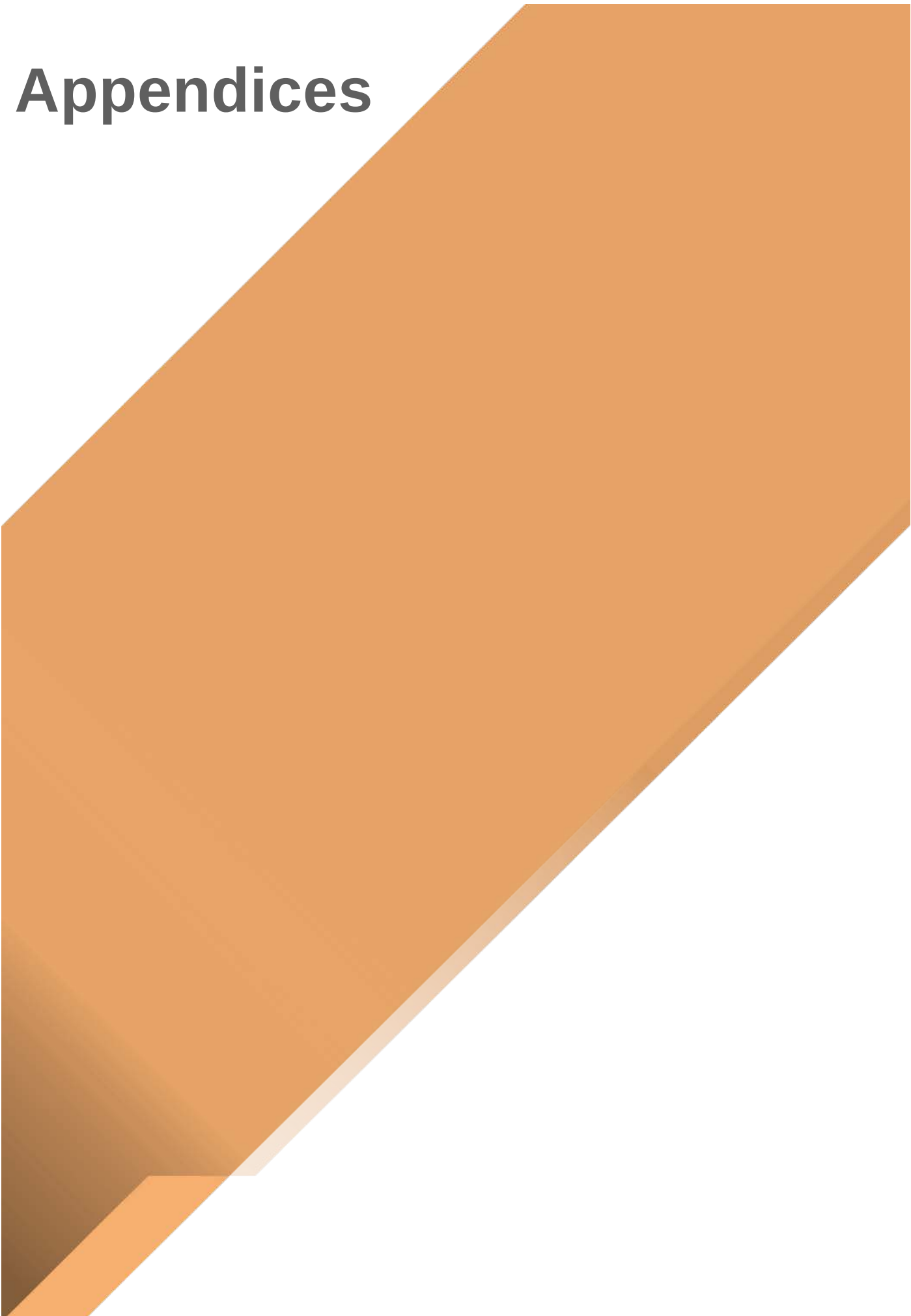
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Appendices



APPENDIX

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Matters of National Environmental Significance Technical Report

Appendix A Predictive Habitat Modelling Methodology

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Appendix A

Predictive habitat modelling methodology

Inland Rail Border to Gowrie EIS

Appendix A – Predictive habitat
modelling methodology

**Australian Rail Track
Corporation**

Reference: 3100

Contents

1	Introduction	1
1.1	Background.....	1
1.2	Context	1
1.3	Review of existing databases and literature	1
2	Species and communities included within the predictive habitat mapping model	5
3	Predictive habitat modelling input datasets	10
4	Predictive habitat modelling categories.....	11
4.1	Flora and fauna species	11
4.1.1	General context	11
4.1.2	Unlikely habitat	11
4.1.3	Potential habitat.....	11
4.1.4	Important habitat.....	12
4.1.5	Habitat critical to the survival of the species	12
5	Predictive habitat models and general assumptions associated with their development	13
6	Bibliography	67
6.1	Flora species	67
6.2	Fauna species – conservation significant species	77

Tables

Table 1.1	Database and document review summary
Table 1.2	Document review summary
Table 2.1	Conservation significant flora species identified from database searches
Table 2.2	Conservation significant and migratory fauna species identified from database searches
Table 5.1	Listed conservation significant flora species habitat assumptions used to map areas of occurrence within the impact assessment area
Table 5.2	Listed conservation significant fauna species habitat assumptions used to map areas of occurrence within the Impact assessment area

1 Introduction

1.1 Background

For the purposes of the Border to Gowrie Project (the Project) predictive habitat models for threatened flora and fauna have been developed. These models have been designed to map the potential areas that are likely to be analogous to habitat associated with *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth (Cth) (EPBC Act) and/or the *Nature Conservation Act 1992* (Queensland (Qld) (NC Act) conservation significant species. This mapping has the following objective:

- To provide predictive habitat modelling for EPBC Act listed flora and/or fauna species to:
 - Identify areas of potential habitat for EPBC Act and *Nature Conservation Act 1992* (Qld) (NC Act) listed species
 - Facilitate the calculation of potential disturbance areas associated with the Project and to subsequently inform the assessment of significant residual impacts for matters of national environmental significance (MNES).

This document outlines the methodology used for the development of the predictive habitat models and provides the species/community specific assumptions and mapping requirements used to reproduce the predictive habitat models for each MNES. The models have been used to prepare maps indicating the potential extent of each MNES associated with the Project as identified in the Inland Rail Border to Gowrie Environmental Impact Statement (EIS) Terms of Reference (ToR). In addition, those species identified from the desktop review phase of the Project EIS were subject to modelling when they were deemed to have potential to occur within the impact assessment area.

1.2 Context

For context with respect to the methodology's compliance with EPBC Act Survey Guidelines for threatened species, the more conservative approach of this methodology surpasses the guidelines expectations. The "How to use these guidelines" statement includes:

"... Alternatives to a dedicated survey may also be appropriate. For example, a desktop analysis of historic data may indicate that a significant impact is not likely. Similarly, a regional habitat analysis may be used to determine the importance of a site to the listed birds. Proponents should also consider the proposals impact in the context of the species' national, regional, district and site importance to establish the most effective survey technique(s)..."

This methodology includes analysis of historic and current data gained from a range of sources (as listed in Table 1.1 (Section 1.3) with direct and current survey efforts including dedicated ground truthing surveys of the database mapping and follow-up ecological assessments within the project area as part of the projects geotechnical drilling survey program.

1.3 Review of existing databases and literature

Each predictive fauna habitat model has been developed to deliver a process that is robust, transparent and repeatable. The first stage in developing each of the models involved determining the extent of species occurrence and the availability of information pertaining to available species habitat.

Eleven data sources were accessed to identify MNES species that have potential to occur within the Impact assessment area. These data sources are listed in Table 1.1.

In addition, a total of two ecological assessments were identified to present the MNES values (including species protected under the EPBC Act) within the Impact assessment area (refer Table 1.2).

Table 1.1 Database and document review summary

Database/data source name	Database search date	Database search areas	Data type
Atlas of Living Australia	25/02/2020	Project footprint with 50 km buffer applied	Ongoing inspection of records of flora and fauna, including threatened species listed under the EPBC Act.
Flying Fox Monitoring Program: https://data.qld.gov.au/dataset/flying-fox-monitoring-program	26/02/2020	Project footprint within 15 km buffer applied	Show the general location of flying-fox roosts in Queensland recorded by the DES and includes camp survey data for continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Flying-fox roost monitoring and locations: https://www.ehp.qld.gov.au/wildlife/livingwith/flyingfoxes/roost-locations.html#flying_fox_roost_locations	26/02/2020	Impact assessment area	Show the general location of flying-fox roosts in Queensland recorded by the department and include continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Birds Australia	29/03/2019	Impact assessment area	Records of avian fauna, including threatened species listed under the EPBC Act.
EPBC Act Protected Matters Search Tool (Australian Government)	26/02/2020	Impact assessment area	Provides a “predictive” account of MNES identified within a specific area. Includes MNES such as world heritage properties, national heritage places or wetlands of international importance and threatened species.
Regulated Vegetation Management Map (Queensland Government 2019)	26/02/2020	Impact assessment area	Mapping of REs and High Value Regrowth that provide habitat for TECs and threatened species under the EPBC Act.
Wetland Info database (DES 2019)	26/02/2020	Impact assessment area	Provides interactive maps, species records, case studies and legislation associated with Queensland wetlands.
Wildlife Habitat Map, version (Queensland Government 2019)	26/02/2020	Impact assessment area	Modelled habitat for threatened species listed under the EPBC Act.
Wildlife Online database (Queensland Government) incorporating WildNet and HerbreCs datasets	26/02/2020	Impact assessment area	Records of flora and vertebrate fauna including threatened species listed under the EPBC Act.
Queensland Springs Database (Queensland Government 2018)	26/02/2020	Regional extent	The dataset provides a comprehensive catalogue of permanently saturated springs that have fixed locations and any associated surface expression GDEs.
Matters of national environmental significance (Department of Environment and Energy 2018)	26/02/2020	Impact assessment area	Location of MNES, including: - Threatened species as listed under the EPBC Act - Migratory species listed under the EPBC Act - TECs listed under the EPBC Act - Critical habitats - World Heritage Properties - National Heritage Places - Wetlands of International Importance (i.e. Ramsar) - Great Barrier Reef Marine Park - Commonwealth Marine Area - Nuclear Areas.

Table 1.2 Document review summary

Document title	Reference	Summary of significant findings related to MNES
Australian Rail Track Corporation Limited/Transport - Land/Multiple lots/Queensland/Inland Rail Border to Gowrie project, QLD (EPBC referral 2018/8165)	Aecom (2018)	- Confirmation of Brigalow (<i>Acacia harpophylla</i> dominant and codominant) TEC - Confirmation of Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions TEC - South-eastern long-eared bat (<i>Nyctophilus corbeni</i>) considered potentially present based on call and location (Canning Creek)
Inland Rail (Border to Gowrie) Aquatic Ecology Technical Report)	Eco Logical (2020)	Confirmation of Murray cod (<i>Maccullochella peelii</i>) in the Macintyre River and Macintyre Brook

In addition to the assessment of pre-existing datasets and reports identified above, the Project EIS field team has deployed a total survey effort of approximately 360 person hours (i.e. 36 field days) between April and October 2018 assessing environmental attributes associated with the impact assessment area. Data associated with this field analysis aided in the validation and iteration of the predictive habitat mapping. However, it must be noted that field investigations were subject to voluntary land access agreements which place heavy restrictions upon areas that were accessible.

In addition to previous surveys and site based investigations, recovery programs were assessed in order to identify areas of high conservation significance or of recognised conservation value for each of the MNES subject to predictive habitat modelling.

Of the species identified as potentially occurring in the Impact assessment area and impacted by the Project activities, 12 have a Commonwealth approved recovery program. These species consist of the following:

- Murray cod (*Maccullochella peelii*)
- Mary River cod (*Maccullochella mariensis*)
- Condamine earless dragon (*Tympanocryptis condaminensis*)
- Brush-tailed rock-wallaby (*Petrogale penicillata*)
- Large-eared pied bat (*Chalinolobus dwyeri*)
- Northern quoll (*Dasyurus hallucatus*)
- Spotted-tail quoll (*Dasyurus maculatus maculatus*)
- Black-breasted button-quail (*Turnix melanogaster*)
- Black-throated finch (*Poephila cincta cincta*)
- Red goshawk (*Erythrotriorchis radiatus*)
- Regent honeyeater (*Anthochaera phrygia*)
- Swift parrot (*Lathamus discolor*)

Three species relevant to this assessment are subject to a Draft recovery plan. These species consist of the following:

- Grey-headed flying-fox (*Pteropus poliocephalus*)
- Australasian bittern (*Botaurus poiciloptilus*)
- Australian painted snipe (*Rostratula australis*)

In addition to the Recovery and Draft Recovery Programs identified above, EPBC Act Referral guidelines (including drafts) are applicable to the following species:

- Collared delma (*Delma torquata*)
- Dunmall's snake (*Furina dunmalli*)

- Long-legged worm-skink (*Anomalopus mackayi*)
- Yakka skink (*Egernia rugosa*)
- White-throated needletail (*Hirundapus caudacutus*)

Information derived from the Recovery Plans, Draft Recovery Plans and Referral Guidelines were used to derive specific habitat characterisation criteria to inform the predictive habitat modelling process.

2 Species and communities included within the predictive habitat mapping model

A total of 31 conservation significant flora species and 34 conservation significant fauna species listed under the provisions of the EPBC Act and/or NC Act were identified as occurring or potentially occurring within the Impact assessment area (refer Table 2.1 and Table 2.2). Of these, 21 flora and 25 fauna species are considered to potentially occur within the Impact assessment area.

Table 2.1 Conservation significant flora species identified from database searches

Family	Species name	Common name	EPBC Act Status	Data source			Likelihood of occurrence
				Wildlife online	PMST	Atlas	
Acanthaceae	<i>Xerothamnella herbacea</i>	A herb	E	-	✓	-	Possible
Apocynaceae	<i>Tylophora linearis</i>	Slender tylophora	E	-	✓	-	Possible
Asteraceae	<i>Picris evae</i>	A hawkweed	V	✓	✓	-	Likely
Asteraceae	<i>Rhaponticum australe</i>	Austral cornflower	V	✓	✓	✓	Likely
Brassicaceae	<i>Lepidium monoplacoides</i>	Winged peppergrass	E	✓	-	-	Likely
Brassicaceae	<i>Lepidium peregrinum</i>	Wandering pepper-grass	E	-	✓	-	Possible
Ericaceae	<i>Leucopogon</i> sp. <i>Coolmunda</i> (D. Halford Q 1635)	Coolmunda leucopogon	E	-	-	-	Possible
Euphorbiaceae	<i>Bertya oppositifolia</i>	A shrub	V	-	-	-	Possible
Fabaceae	<i>Acacia laeta</i>	Tara wattle	V	-	✓	-	Possible
Fabaceae	<i>Sophora fraseri</i>	Brush sophora	V	✓	✓	-	Possible
Lamiaceae	<i>Prostanthera</i> (sp. <i>Dunmore</i>)	Dunmore prostanthera	V	✓	-	-	Possible
Lamiaceae	<i>Westringia parvifolia</i>	Small-flowered westringia	V	-	✓	✓	Possible
Malvaceae	<i>Androcalva procumbens</i>	A shrub	V	-	✓	-	Unlikely, impact assessment area outside of recorded distribution - endemic to NSW
Myrtaceae	<i>Eucalyptus infera</i>	Durikai mallee	V	-	-	-	Unlikely, outside recorded distribution of SF444 near Warwick
Myrtaceae	<i>Eucalyptus virens</i>	Shiny-leaved ironbark	V	-	✓	-	Possible
Orchidaceae	<i>Bulbophyllum globuliforme</i>	Miniature moss-orchid	V	-	-	-	Unlikely, outside of the species known distribution and lack of naturally occurring host species (i.e. Hoop pine)
Orchidaceae	<i>Sarcophilus hartmanii</i>	Waxy sarcophilus	V	-	-	-	Unlikely, impact assessment area located to the west of known distribution
Orchidaceae	<i>Sarcophilus weinthalii</i>	Blotched sarcophilus	V	-	✓	-	Unlikely, impact assessment area located to the west of known distribution and suitable habitat unlikely to occur
Poaceae	<i>Arthraxon hispidus</i>	Hairy-joint grass	V	-	-	-	Possible

Family	Species name	Common name	EPBC Act Status	Data source			Likelihood of occurrence
				Wildlife online	PMST	Atlas	
Poaceae	<i>Bothriochloa bunyensis</i>	Bunya Mountains bluegrass	V	-	-	-	Unlikely, impact assessment area west of Toowoomba Range is highly modified and very unlikely to be suitable for the species
Poaceae	<i>Dichanthium queenslandicum</i>	King blue- grass	E	✓	✓	✓	Likely
Poaceae	<i>Dichanthium setosum</i>	Bluegrass	V	-	✓	-	Possible
Poaceae	<i>Homopholis belsonii</i>	Belson's panic	V	✓	✓	✓	Likely
Proteaceae	<i>Macadamia integrifolia</i>	Macadamia nut	V	-	-	-	Unlikely, outside of known coastal distribution
Ranunculaceae	<i>Clematis fawcettii</i>	Stream clematis	V	-	✓	-	Possible
Rutaceae	<i>Phebalium distans</i>	Mt Berryman phebalium	CE	-	-	-	Unlikely, outside of the species known distribution
Santalaceae	<i>Thesium australe</i>	Austral toadflax	V	-	✓	-	Possible
Scrophulariaceae	<i>Microcarpaea agonis</i>	A herb	E	-	-	-	Unlikely, species known from a single location over 50 km west of Project
Surianaceae	<i>Cadellia pentastylis</i>	Ooline	V	-	-	-	Possible
Zamiaceae	<i>Macrozamia conferta</i>	A cycad	V	-	-	-	Unlikely, only known from very restricted small populations located outside the range of the Project
Zamiaceae	<i>Macrozamia machinii</i>	A cycad	V	-	✓	-	Possible

Table notes:

- = Species not listed or no common name EX = Extinct E = Endangered V = Vulnerable NT = Near threatened C = Least concern PMST = Protected Matters Search Tool
 ✓ = species present within database record within the Project Impact assessment area

Table 2.2 Conservation significant and migratory fauna species identified from database searches

Family	Species name	Common name	EPBC Act	Data source			Likelihood of occurrence
				Wildlife online	PMST	Atlas	
Birds							
Accipitridae	<i>Erythrotriorchis radiatus</i>	Red goshawk	V	-	✓	-	Possible
Apodidae	<i>Hirundapus caudacutus</i>	White-throated needletail	V, M	-	✓	-	Likely
Ardeidae	<i>Botaurus poiciloptilus</i>	Australasian bittern	E	-	✓	-	Likely
Columbidae	<i>Geophaps scripta scripta</i>	Squatter pigeon (southern subspecies)	V	✓	✓	-	Possible
Falconidae	<i>Falco hypoleucos</i>	Grey falcon	V	-	-	✓	Possible
Meliphagidae	<i>Anthochaera phrygia</i>	Regent honeyeater	CE	-	✓	-	Possible
Meliphagidae	<i>Grantiella picta</i>	Painted honeyeater	V	✓	-	-	Possible
Passeridae	<i>Poephila cincta cincta</i>	Southern black-throated finch	E	-	✓	-	Unlikely – considered to be locally extinct
Psittacidae	<i>Lathamus discolor</i>	Swift parrot	CE	-	✓	-	Possible
Rostratulidae	<i>Rostratula australis</i>	Australian painted snipe	E	-	✓	-	Possible
Scolopacidae	<i>Calidris ferruginea</i>	Curlew sandpiper	CE, M	-	✓	-	Possible
Turnicidae	<i>Turnix melanogaster</i>	Black-breasted button-quail	V	✓	✓	-	Possible
Fish [#]							
Perichthyidae	<i>Maccullochella mariensis</i>	Mary river cod	E	-	-	-	Unlikely – incorrect drainage system (outside natural distribution)
Perichthyidae	<i>Maccullochella peelii</i>	Murray cod	V	-	✓	-	Likely
Terapontidae	<i>Bidyanus bidyanus</i>	Silver perch	CE	-	-	-	Unlikely – no suitable habitat present. Local Toowoomba records likely a result of fish stocking.
Mammals							
Dasyuridae	<i>Dasyurus hallucatus</i>	Northern quoll	E	-	✓	-	Unlikely – outside current distribution
Dasyuridae	<i>Dasyurus maculatus maculatus</i>	Spotted-tailed quoll	E	✓	-	-	Possible
Macropodidae	<i>Petrogale penicillata</i>	Brush-tailed rock-wallaby	V	-	✓	-	Possible
Muridae	<i>Pseudomys novaehollandiae</i>	New Holland mouse	V	-	✓	-	Unlikely – west of current distribution

Family	Species name	Common name	EPBC Act	Data source			Likelihood of occurrence
				Wildlife online	PMST	Atlas	
Petauridae	<i>Petauroides volans volans</i>	Greater glider	V	-	✓	-	Possible
Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala	V	✓	✓	✓	Likely
Potoroidae	<i>Potorous tridactylus tridactylus</i>	Long-nosed potoroo	V	-	-	-	Unlikely – impact assessment area is located west of known distribution and suitable habitat is unlikely to be present
Pteropodidae	<i>Pteropus poliocephalus</i>	Grey-headed flying-fox	V	-	-	-	Likely
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared pied bat	V	-	✓	-	Possible
Vespertilionidae	<i>Nyctophilus corbeni</i>	South-eastern long-eared bat	V	✓	✓	-	Possible
Reptiles							
Agamidae	<i>Tympanocryptis condaminensis</i>	Condamine earless dragon	E	✓	✓	-	Likely
Chelidae	<i>Wollumbinia belli</i>	Bell's turtle	V	-	-	-	Unlikely – outside known distribution
Elapidae	<i>Furina dunmalli</i>	Dunmall's snake	V	✓	-	-	Likely
Gekkonidae	<i>Uvidocolus sphryurus</i>	Border thick-tailed gecko	V	-	✓	-	Unlikely – outside known distribution
Pygopodidae	<i>Delma torquata</i>	Collared delma	V	-	-	-	Possible
Scincidae	<i>Anomalopus mackayi</i>	Five-clawed worm-skink	V	✓	✓	✓	Likely
Scincidae	<i>Egernia rugosa</i>	Yakka skink	V	-	✓	-	Possible
Invertebrates							
Camaenidae	<i>Adclarkia cameroni</i>	Brigalow woodland snail	E	-	✓	-	Possible
Camaenidae	<i>Adclarkia dulacca</i>	Dulacca woodland snail	E	-	✓	-	Unlikely – outside of known distribution

Table notes:

- = Species not listed or no common name EX = Extinct E = Endangered V = Vulnerable NT = Near threatened C = Least concern
 ✓ = species present within database record within the Impact assessment area
 PMST = Protected Matters Search Tool

3 Predictive habitat modelling input datasets

Predictive habitat modelling was undertaken to identify and map areas that are considered to have the potential to provide habitat for the conservation significant species and communities listed in Table 2.1 and Table 2.2 which have potential to occur within the Impact assessment area. This modelling provides an additional tool to assess the likely occurrence of species of interest and facilitates impact assessment by allowing for the quantification of areas of habitat using GIS.

In addition to specimen and community specific RE associations that are identified within Table 5.1 and Table 5.2, additional GIS layers and field derived information have been utilised to identify areas of habitat within the Impact assessment area where applicable to a species. These layers include:

- RE datasets (Version 11) and pre-clearing regional ecosystem layers
- High resolution aerial photography with site derived datasets (i.e. utilisation of condition data, species records and general observational data pertaining to species habitat)
- Historic records of conservation significant species (derived from government databases and previous ecological investigations)
- Field derived datasets related to species sightings/records and habitat suitability, the presence of micro-habitat features
- Topographic and geological information
- Government derived cadastral datasets
- Watercourses and wetlands datasets (Waterway barrier works mapping).

4 Predictive habitat modelling categories

4.1 Flora and fauna species

4.1.1 General context

Each predictive habitat model allowed partitioning of habitat for flora and fauna species using current scientific knowledge and pre-existing data derived from historic surveys and State based mapping identified above. The specific habitat assumptions for each species that were subject to predictive mapping are provided in Table 5.1 and Table 5.2. The species-specific assumptions allowed the following areas to be identified for each conservation significant species:

- Unlikely habitat
- Potential habitat
- Important habitat
- Habitat critical to the survival of the species.

The use of these habitat categories aligns with the Commonwealth Department of Agriculture, Water and Environment's (DAWE's) habitat definitions for species protected under the *Environment Protection and Biodiversity Conservation Act 1999*.

An overview of each of these categories is provided in the sections below.

4.1.2 Unlikely habitat

Unlikely habitat consists of areas that do not contain specimen backed records of the particular species (i.e. no point data derived from the positive identification/confirmation of a species in the field) and contain no evidence of habitat values to support the presence or existence of resident individuals or populations of the species. However, it is acknowledged that these areas may provide temporary habitat for species during exceptional circumstances. It is considered that occurrences of the subject species within these areas is an anomaly as these areas are not likely to support the species in the long term.

4.1.3 Potential habitat

Potential habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as Important habitat or Habitat critical to the survival of the species (i.e. records of the species are considered anomalies as general microhabitat features are not considered to be present from a desktop perspective). Potential habitat also includes suitable habitat that is available to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records, where these areas are not considered to fulfil the criteria of "*Habitat Critical to the survival of the species*". Potential habitat may include areas of suboptimal habitat for species. Species specific assumptions that define the Potential habitat category are identified in Table 5.1 and Table 5.2. Impacts to *Potential habitat* are not considered to contribute to significant impact to an MNES

4.1.4 Important habitat

In line with DAWE's guidelines, areas of Important habitat are regarded as a surrogate for important populations of Brigalow belt reptiles. Relevant to the current investigations, the following species are classified as Brigalow Belt reptiles and where relevant, Important habitat for these species has been mapped as defined in Section 5 of the *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011):

- Dunmall's snake (*Furina dunmalli*)
- Collared delma (*Delma torquata*)
- Five-clawed worm-skink (*Anomalopus mackayi*)

Important habitat has been identified for migratory species under the *Draft Referral guideline for 14 birds listed as migratory species under the EPBC Act* (DotE 2015).

Relevant to the current investigations, the following species is classified as migratory species in the Draft Referral guidelines:

- White-throated needletail (*Hirundapus caudacutus*)

In addition to the species identified above, the Important habitat has been used to capture "Priority habitat areas" for the Swift parrot (*Lathamus discolor*) as identified in the *National Recovery Plan for the Swift Parrot* (*Lathamus discolor*) (Saunders and Tzaros 2011).

Species specific assumptions that define the Important habitat category for the above mentioned species is provided in Table 5.2. Impacts to *Important habitat* are considered to contribute to significant impact to an MNES.

4.1.5 Habitat critical to the survival of the species

Habitat critical to the survival of the species represent habitat with the greatest value for the particular MNES. This habitat category identifies areas that align with "habitat critical to the survival" of a listed threatened species is identified in an approved Recovery Plan for the relevant MNES. However, in instances where there are no Recovery Plans for a specific species, the presence of a specimen backed record (i.e. derived from either desktop assessments or field investigations) is considered to align with this category where breeding and foraging habitat is potentially present. For these species, elevation of habitat to this level adequately accounts for the significance of such areas regardless of the absence of a Recovery Plan. Species specific assumptions associated with the mapping of Habitat critical to the survival of the species are detailed in Table 5.1 and Table 5.2. Impacts to *Habitat critical to the survival of the species* are considered to contribute to significant impact to an MNES.

5 Predictive habitat models and general assumptions associated with their development

The predictive habitat models for each of the relevant flora and fauna species was designed to provide a dynamic, robust and predictive GIS layer that could incorporate data from scientific literature and DAWE conservation listing advice/recovery programs, verified government datasets, specimen backed datasets (i.e. data derived from a known/confirmed location of an observed specimen) and field identified records into a single layer that could be used to identify areas that are known, or considered to have the potential to support specific threatened MNES. Development of these layers had the ultimate objective to:

- Predict areas that have the potential to support EPBC Act significant flora and fauna species
- Facilitate the quantification of impacts to inform later stages of the EIS process (e.g. Offset liabilities)
- Facilitate the assessment of assessment of significant residual impacts in accordance with the *Matters of National Environmental Significance: Significant impact guidelines 1.1* (DotE 2015).

The habitat modelling was created using ESRI ArcGIS, specifically the ESRI ArcGIS Model Builder which facilitated the development of scripts that allowed for the species-specific development of queries that utilised a range of GIS input datasets (e.g. vegetation communities containing site derived and filed verified information).

The models also incorporated the use of selecting relevant components and performing functions such as buffers and intersects that reflected the preferred habitat of a particular species. As a result of this process output habitat layers were generated for each species according to their individual requirements. The species-specific requirements that were used to generate the species-specific queries used to map potential habitat are identified in Table 5.1 and Table 5.2. Once produced model outputs were reviewed internally by suitably qualified and experience ecologists to assess that they accurately reflected/identified habitat suitable for supporting the relevant species. If anomalies were identified, GIS iterations were undertaken to produce outputs of greater accuracy. However, it is noted that whilst species that were identified to have potential to occur within the broader region underwent habitat modelling, the results of the modelling did not necessarily identify habitat within the Impact assessment area for all of the species modelled. Where this occurred, these species (i.e. without identified habitat within the Impact assessment area) did not undergo impact assessment as part of the Project EIS.

As with any modelling, assumptions have had to be made in determining the inputs to the assessment. These assumptions are outlined below.

- Heterogeneous RE polygons – Mapping has been designed to identify maximum areas of disturbance based on a precautionary approach. In the case of heterogeneous polygons, if the RE code is contained within the heterogeneous polygon, and if the relevant community/communities constitute 50% or more of the heterogeneous polygon, then the entire polygon was selected and included as part of the habitat mapping. This represents a highly conservative approach to habitat modelling as it has potential to significantly over-estimate habitat in the absence of ground-truthing. This is of importance to species such as those that rely on limited areas of habitat, which would otherwise be missed by the model. Areas of predicted habitat may be removed from mapping if field survey indicates that habitat is not available.
- Buffers – Buffers have been used when integrating a specimen backed record into the predicted mapping. Generally, a 1 km buffer from the species data point is used (in line with the methodology adopted by the Queensland *Vegetation Management 1999* when identifying 'critical habitat' derived from a specimen backed record under state based legislation). Deviations from this methodology (where they occur), are identified in Table 5.1 and Table 5.2.

- Habitat critical to the survival of the species – The predictive flora and fauna habitat mapping outlined in this document primarily proposes potential habitat as the preferred habitat requirements for many of the species mapped. This is as a result of their habitat not being fully understood or cannot be easily extrapolated from available datasets or species information (such as applicable species recovery plans or approved conservation advice). In those cases, site derived species records were used to extrapolate preferred habitat by correlating with the underlying GIS layer. For these species, where a species point record and associated 1 km buffer intersect with areas of predicted potential habitat, the area of overlap has been elevated to the Habitat critical to the survival of the species category. The relationship between potential habitat, important habitat, species records and habitat critical to the survival of the species outlined in Table 5.1 (flora) and Table 5.2 (fauna).
- Use of existing specimen backed records to identify habitat associations – In instances where there was insufficient literature to confidently identify areas of potential habitat, specimen backed records were used to identify the associated vegetation association (e.g. RE type). These point-selected datasets were then assessed to determine that they were consistent with the species habitat requirements. When identified as valid, the point selected data points were incorporated into the predictive mapping “recipe” for the particular species (refer Table 5.1 and Table 5.2). Point selected datasets that were not identified as being able to support the species were rejected from use in further analysis.
- Minimum areas of habitat – Mapping has been designed to identify maximum areas of disturbance and therefore no minimum area of habitat has been identified. The methodology was developed to predict areas of potential habitat. However, the resolution of the mapping is constrained by the data inputs (e.g. vegetation community mapping) and therefore areas that may potentially be identified as habitat will always be contiguous to areas of similar habitat that reflect the minimum resolution for the input dataset (e.g. minimum vegetation community polygon size, etc.).
- Levels of habitat mapping – Potential habitat has primarily been indicated on the predictive mapping. However, where areas identified in relevant recovery programs or referral guidelines have been identified and these areas overlap with areas of predicted Potential habitat category, these areas have been elevated to Habitat critical to the survival of the species or Important habitat (e.g. for Brigalow belt reptiles) in line with the information contained within the relevant species advice/guideline or policy.

Table 5.1 Listed conservation significant flora species habitat assumptions used to map areas of occurrence within the impact assessment area

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Asclepiadaceae	<i>Tylophora linearis</i>		E	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco logical 2016; Aurecon 2018). There are no database records of <i>Tylophora linearis</i> (i.e. AoLA, Wildlife Online) within or close to the impact assessment area. The nearest record (2001) occurs in New South Wales near Dthinna Dthinnawan National Park approximately 42 km south of the Project. <i>Tylophora linearis</i> grows in dry scrub, open forest and woodlands associated with <i>Melaleuca uncinata</i>, <i>Eucalyptus fibrosa</i>, <i>E. sideroxylon</i>, <i>Eucalyptus albens</i>, <i>Callitris endlicheri</i>, <i>C. glaucophylla</i>, <i>Allocasuarina luehmannii</i>, <i>Acacia hakeoides</i>, <i>A. lineata</i>, <i>Myoporum</i> spp., and <i>Casuarina</i> spp.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as dry scrub, open forest or woodland communities that contain one or more of the following species <i>Melaleuca uncinata</i>, <i>Eucalyptus fibrosa</i>, <i>E. sideroxylon</i>, <i>Eucalyptus albens</i>, <i>Callitris endlicheri</i>, <i>C. glaucophylla</i>, <i>Allocasuarina luehmannii</i>, <i>Acacia hakeoides</i>, <i>A. lineata</i>, <i>Myoporum</i> spp., and <i>Casuarina</i> spp: 11.3.18, 11.3.38, 11.5.4, 11.7.7, 11.8.8, 11.9.9a, 11.10.1, 11.10.4, 11.11.1 and 11.11.7. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute General habitat.</i>	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).
Asteraceae	<i>Picris evae</i>	Hawkweed	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco logical 2016; Aurecon 2018). Database records indicate that <i>Picris evae</i> has been identified as potentially occurring within the Project footprint. Two records	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as <i>Eucalyptus</i> dominated woodland communities that contain one or more of the following species <i>Dicanthium</i> spp., <i>Eucalyptus melliodora</i>, <i>Eucalyptus crebra</i>, <i>Eucalyptus populnea</i>, <i>Eucalyptus albens</i>, <i>Angophora subvelutina</i>,	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas</i>

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				from 2002 are present within the Project footprint approximately 2 km southwest of Brookstead dated 2002. They were recorded in <i>Dicanthium sericeum</i> grassland adjacent to cultivated land growing on black clay soil. Another seven records are located within the impact assessment area, one approximately 3 km northeast of Pittsworth and another six in the surrounds of Southbrook dated from 1983 to 2016. Several of these records (including the 2016 record) are associated with road reserves adjacent to the Gore Highway. Hawkweed occurs in <i>Eucalyptus</i> open woodland with a grassy understorey composed of <i>Dichanthium</i> spp. Upper stratum species include <i>Eucalyptus melliodora</i>, <i>Eucalyptus crebra</i>, <i>Eucalyptus populnea</i>, <i>Eucalyptus albens</i>, <i>Angophora subvelutina</i>, <i>Allocasuarina torulosa</i>, and <i>Casuarina cunninghamiana</i>. Collections have been made along roadsides and in cultivated areas, such as paddocks, on black, dark grey or red-brown soils (i.e. Landzone 8), reddish clay-loam or medium clay soils.	<i>Allocasuarina torulosa</i>, and <i>Casuarina cunninghamiana</i>: 11.3.2, 11.3.2c, 11.3.10, 11.3.17, 11.3.18, 11.3.21, 11.3.30, 11.3.36, 11.5.1, 11.5.13, 11.8.5, 11.8.5a, 11.8.8, 11.9.9, 11.9.9a, 11.9.9b, 11.10.12, 11.11.1, 11.12.1c, 11.12.2c. In addition, the following pre-clearance REs are considered to constitute potential habitat: 11.8.8, 11.8.5 (when it is located along a road reserves <u>on basalt derived soils</u>). <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		that fall outside of identified vegetation communities).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Asteraceae	<i>Rhaponticum australe</i>	Austral cornflower	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint however there are several nearby records within the impact assessment area. A 2003 record exists to the west of Pittsworth at the Gore Highway and Tip Road junction and is located adjacent to the Project footprint. There are several other records in the Pittsworth area located between 2 km to 4 km from the Project footprint to the north and south. Another 2016 record occurs adjacent to the north of the Project footprint 4 km west of Gowrie township (northern extent of the Project). Austral cornflower grows in eucalypt open forest with grassy understory on roadsides and on road reserves with <i>Chloris gayana</i>, <i>Cirsium vulgare</i>, <i>Eucalyptus tereticornis</i> and <i>Angophora floribunda</i> on black clay soil.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as potentially including eucalypt open forest with grassy understory on black clay soils that contain one or more of the following species <i>Chloris gayana</i>, <i>Cirsium vulgare</i>, <i>Eucalyptus tereticornis</i> and <i>Angophora floribunda</i>: 11.3.4, 11.3.23, 11.3.38, 11.8.5, 11.8.8. In addition, the following pre-clearance REs (non-remnant) are considered to constitute potential habitat when they are contained within a road reserve: 11.3.4, 11.3.23, 11.3.38, 11.8.5, 11.8.8. <i>Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Brassicaceae	<i>Lepidium monoplocoides</i>	Winged peppergrass	E	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016/2017; Aurecon 2018). Only six records for this species occur in Queensland, all of which have been identified within the impact assessment area around Yelarbon township. Three of these records are older (dated 1919 to 1935). The three recent records are from 2005 and 2011 occurring almost on the southern edge of the Project footprint (two records from 2005) and 1 km north of the footprint (2011). Occurs predominantly in mallee scrub in semi-arid areas. Sites are seasonally moist to waterlogged with heavy, fertile soils and a mean annual rainfall of around 300 to 500 mm. The species is typically associated with <i>Allocasuarina leuhmannii</i> and/or eucalypts, particularly <i>Eucalyptus largiflorens</i> (Black box) or <i>Eucalyptus populnea</i> (Poplar box). Other species within the ground stratum may include <i>Danthonia</i> spp. and <i>Stipa</i> spp., but seasonally waterlogged areas include moisture dependent herbs, such as <i>Marsilea</i> spp.	The following REs (remnant) are considered to be potential habitat for this species as they are identified as woodland communities that contain <i>Allocasuarina leuhmannii</i>, <i>Eucalyptus largiflorens</i>, or <i>Eucalyptus populnea</i>: 11.3.14, 11.3.16, 11.3.18, 11.3.32, 11.5.1, 11.5.1a, 11.5.2, 11.5.4, 11.5.14, 11.5.21, 11.10.11. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside areas specified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Brassicaceae	<i>Lepidium peregrinum</i>	Wandering Pepper-cress	E	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). Wandering pepper-cress has not been identified within or near the Project footprint or the impact assessment area. The nearest database record is from Highfield Falls north of Toowoomba (2007) approximately 10 km east of the north-eastern extent of the Project footprint. <i>Lepidium peregrinum</i> grows in riparian open forest dominated by <i>Eucalyptus camaldulensis</i> and <i>Casuarina cunninghamiana</i> with a variably dense shrubby understorey of <i>Hymenanthera dentata</i>, <i>Bursaria spinosa</i>, <i>Acacia fimbriata</i>, <i>Acacia floribunda</i>, <i>Callistemon viminalis</i> and <i>Leptospermum brachyandrum</i>. This species is often most abundant in tussock grassland fringing riparian open forest (<i>Poa</i> sp. - <i>Lomandra longifolia</i> - <i>Paspalum dilatatum</i>), with some plants scrambling to a height of 2 m in thickets of <i>Hymenanthera</i>. It also occurs in shade under shrubs close to the creek bank, where most plants were small, about 30 cm in height.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as <i>Eucalyptus camaldulensis</i> dominated forest associated with drainage lines or depressions: 11.3.2b, 11.3.25, 11.3.25c, 11.3.25e, 11.3.27. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Cycadaceae	<i>Macrozamia machinii</i>		V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). Database records indicate that the nearest record (i.e. AoLA) is from 1922 and is located approximately 2.5 km south of the Project footprint near Inglewood. Occur in deep sandy soils in flat areas of open forest dominated by <i>Angophora leiocarpa</i>, <i>Allocasuarina inophloia</i>, <i>Callitris glaucophylla</i>, <i>Lysicarpus angustifolius</i> and <i>Acacia conferta</i>. The species is found at 320-460 m ASL.	The following REs are considered to constitute potential habitat for the species when they are located between 320-460 m ASL as they are identified as open forest communities dominated by <i>Angophora leiocarpa</i>, <i>Allocasuarina inophloia</i>, <i>Callitris glaucophylla</i>, <i>Lysicarpus angustifolius</i> and <i>Acacia conferta</i> on deep sandy soils: 11.5.4, 11.5.5a, 11.5.12, 11.5.21, 11.7.4, 11.10.4, 11.10.6, 11.10.6a, 11.10.9 <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).
Fabaceae	<i>Sophora fraseri</i>	Brush sophora	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. The nearest records in relation to the Project occur approximately 1.3 km north of the eastern end of the Project footprint at Mount Kingsthorpe Reserve east of Kingsthorpe.	The following REs (remnant) are considered to constitute potential habitat for the species when they are located within an altitude of 60-660 m ASL as they are identified as vine forest or semi-evergreen vine-thicket communities: 11.3.11, 11.3.40, 11.8.13, 11.10.8, 11.11.5.	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				<i>Sophora fraseri</i> grows in moist habitats, often in hilly terrain at altitudes from 60–660 m on shallow soils along rainforest margins in eucalypt forests or in large canopy gaps in closed forest communities.	In addition to the above REs, where the following REs (remnant) occur within an altitude of 60-660 m ASL, a 200 m buffer is to be placed around their perimeter where it intersects with any other RE type in order to include vine forest or semi-evergreen vine-thicket margins and transitional zones into the potential habitat category: 11.3.11, 11.3.40, 11.8.13, 11.10.8, 11.11.5. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		
Lamiaceae	<i>Westringia parvifolia</i>	-	V	This species was not identified during Project-associated field investigations. Database records (i.e. AoLA) indicate that two records from 1919 and 1948 are present within the impact assessment area at Yelarbon. Additional older records are located southeast of the Project footprint near Inglewood (1910 - 4 km south of the Project footprint) and Yelarbon State Forest (1974 – 8 km south). Another record (1977) is also located approximately 23 km to the west near Goondiwindi. More recent records (2007 and 2014) are also located approximately 25 km south across the border in	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as woodland communities containing <i>Eucalyptus bakeri</i> or <i>Eucalyptus viridis</i> : 11.9.13, 11.10.4. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				New South Wales near Dhinna Dhinawan National Park. There are no other records of the species. This species grows with <i>Eucalyptus bakeri</i> and <i>Eucalyptus viridis</i> and between clumps of Spinifex (<i>Triodia</i> sp.) on sandy and stony soils.			
Lamiaceae	<i>Prostanthera</i> sp. (Dunmore D.M.Gordon 8A)	Prostanthera	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area or within a 50 km radius of the Project. The only database record that is available is located within state forest between Boondandilla and Western Creek State Forest at the southern end of the reserve along Boondandilla Road approximately 50 km west of the Project. Occurs in <i>Eucalyptus</i> and <i>Callitris</i> woodland on shallow sandy soil or <i>Eucalyptus</i> woodland on hard sandstone ridge tops.	The following Res (remnant) are considered to constitute potential habitat for the species as they are identified as <i>Eucalyptus</i> and <i>Callitris</i> dominated woodland on shallow sandy soil or <i>Eucalyptus</i> dominated woodland on hard sandstone ridge tops: 11.7.7, 11.10.6, 11.10.7, 11.10.7a, 11.10.9, 11.12.6. Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the REs identified above are considered to constitute potential habitat.	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Mimosaceae	<i>Acacia lauta</i>	Tara wattle	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment (Eco logical 2016; Aurecon 2018). Database records (i.e. AoLA) indicate the species has been recorded in the wider region surrounding the Project. The nearest database record is located approximately 16 km south of the Project footprint at the south-eastern section of Coolmunda Conservation Park. This record is over 30 years old (1989) and the only one within a 50 km radius of the Project. Grows on soils which are moderately deep and hard setting with a weakly acidic to neutral sandy loam surface grading into neutral to alkaline sandy clay subsoil. Associated vegetation communities vary from open forest to low woodland with a dense or moderately dense shrub layer. Associated canopy tree species include <i>Callitris glaucophylla</i> and <i>Allocasuarina luehmannii</i> whilst understorey species typically consist of <i>Melaleuca nodosa</i>, <i>Melaleuca uncinata</i>, <i>Acacia caroleae</i>, <i>Westringia cheelii</i>, <i>Ozothamnus diotophyllus</i>, <i>Melaleuca diosmatifolia</i>, <i>Kunzea opposita</i> and <i>Hakea purpurea</i>. Grasses such as <i>Aristida caput-medusae</i>, <i>Aristida jerichoensis</i>, <i>Triodia</i>	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as woodland communities containing <i>Callitris glaucophylla</i> or <i>Allocasuarina luehmannii</i> on sandy soils: 11.5.1, 11.5.2, 11.5.3, 11.5.4, 11.5.5, 11.5.14, 11.5.20, 11.5.21, 11.10.9, 11.10.11. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>). It is noted that the species has a very limited distribution and is located outside of the impact assessment area. Therefore, it is not envisaged that habitat critical to the survival of this species occurs within the Project footprint.

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				<i>scariosa</i> and <i>Cymbopogon refractus</i> dominate the ground stratum.			
Myrtaceae	<i>Eucalyptus virens</i>	Shiny-leaved ironbark	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur approximately 11 km north of the Project in Bringalily State Forest and approximately 15 km to the south at Coolmunda and have been recorded between the early 1980s to early 1990s. Inhabits plateaux, sandstone escarpments or sandy soils on low rises. Most populations occur in areas of remnant vegetation. The species grows in woodland communities and is commonly associated with <i>Angophora leiocarpa</i>, <i>Corymbia trachyphloia</i>, <i>Eucalyptus exserta</i>, <i>Allocasuarina inophloia</i> and <i>Lysicarpus angustifolius</i>.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as woodland communities on sandy soil that contain one or more of the following species <i>Angophora leiocarpa</i>, <i>Corymbia trachyphloia</i>, <i>Eucalyptus exserta</i>, <i>Allocasuarina inophloia</i> or <i>Lysicarpus angustifolius</i>: 11.5.1, 11.5.4, 11.5.21, 11.10.4, 11.10.6, 11.10.9, <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).
Poaceae	<i>Homopholis belsonii</i>	Belson's panic	E	This species was identified during Project-associated field investigations in 2018 between Bringalily State Forest and Millmerran in habitats not previously known to support the	The following REs (remnant) are considered to be potential habitat for this species when they occur at an elevation of between 342–500 m ASL as they are identified as woodland communities	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				species. One was located along a section of Millmerran-Inglewood Road between Paton and Nicol Creek Road. More than 100 individuals were found growing in a non-remnant road reserve on poor dark brown soils in large clumps at this location. The second record is located to the south-east of Millmerran at the junction of Owens Scrub Road and Lovell Road. There are a number of historical records for this species near Millmerran with occurrences from between 2002 and 2016. Three of these records lie within 1.5 km of the Project footprint, from 5 km east and extending as far as 23 km south of Millmerran. Other records for this species occur within the impact assessment area to the north of the Project footprint between Brookstead and Pittsworth from 2016. Belson's Panic is found on poor soils in dry woodlands at elevations ranging from 342–500 m. Three general types of habitat which support Belson's Panic include: Rocky, basaltic hills supporting <i>Eucalyptus albens</i> (White box)/<i>Geijera parviflora</i> (Wilga) woodland with assorted shrubs and a number of grass species	containing <i>Eucalyptus albens</i> or <i>Geijera parviflora</i> on rocky basalt derived soils, forest communities containing <i>Acacia harpophylla</i>, <i>Casuarina cristata</i>, or <i>Geijera parviflora</i> on alluvial soils, or forest communities containing <i>Callitris glaucophylla</i>, <i>Corymbia</i> spp. or <i>Eucalyptus melanophloia</i> on sand plains: 11.3.1, 11.3.1b, 11.3.2, 11.3.17, 11.3.18, 11.3.28, 11.5.12, 11.5.13, 11.5.21, 11.8.5, 11.8.5a, 11.8.6, 11.8.8. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside areas specified above are considered to constitute potential habitat. Potential habitat identified by specimen backed records made during Project-associated field investigations account for the knowledge gap regarding previously known habitat for the species and include areas of non-remnant habitat.</i>		potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				- Flat to gently undulating alluvial areas supporting <i>Casuarina cristata</i> (Belah) forest and sometimes <i>Acacia harpophylla</i> (Brigalow) or <i>G.parviflora</i> (Wilga) - Drainage lines supporting <i>C. cristata</i> and sandy country dominated by Cypress Pine-Bloodwood-Ironbark-She-Oak Forest (DAWE, 2020).			
Poaceae	<i>Dichanthium queenslandicum</i>	King blue-grass	E	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). Two recent records (2015 and 2016) occur on the southern edge of the Project footprint north-east of the township of Pittsworth. These records occur near the junction of the Gore Highway and Toowoomba Road. King blue-grass is endemic to central and southern Queensland. This species occurs on black cracking clay in tussock grasslands mainly in association with other species of Bluegrass (<i>Dichanthium</i> spp. and <i>Bothriochloa</i> spp.) but also with other grasses restricted to this soil type.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as grasslands dominated by <i>Dichanthium</i> spp. or <i>Bothriochloa</i> spp., or grasslands on basalt derived soils: 11.3.21, 11.3.24, 11.4.4, 11.4.11, 11.8.5, 11.8.5a, 11.8.11, 11.8.11a, 11.9.3, 11.9.11a, 11.9.12, 11.11.17. In addition, RE 11.8.5 was included as it supports specimens recently identified in the Pittsworth area. RE 11.9.11a was included as it occurs on heavy clay soils and includes <i>Bothriochloa decipiens</i>, a sympatric species to <i>Dichanthium queenslandicum</i>. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Poaceae	<i>Dichanthium setosum</i>	A Bluegrass	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur approximately 10 km south of the southern end of the Project in New South Wales. This is a recent record from 2018 and is located to the south and between North Star Road and the Bruxner Highway along an existing rail corridor. To the north and north-east of the northern end of the Project three records occur at the Toowoomba Range approximately 15 km from the Project footprint. <i>Dichanthium setosum</i> is associated with heavy basaltic black soils and stony red-brown hard-setting loam with clay subsoil and is found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The extent to which this species tolerates disturbance is unknown.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as grasslands dominated by <i>Dichanthium</i> spp. or <i>Bothriochloa</i> spp., or grasslands and grassy woodlands on basalt derived soils: 11.3.21, 11.3.24, 11.4.4, 11.4.11, 11.8.5, 11.8.5a, 11.8.11, 11.8.11a, 11.9.3, 11.9.11a, 11.9.12, 11.11.17. RE 11.9.11a was included as it occurs on heavy clay soils and includes <i>Bothriochloa decipiens</i>, a sympatric species to <i>Dichanthium setosum</i>. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Santalaceae	<i>Thesium australe</i>	Austral toadflax	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any records within the Project footprint or impact assessment area. The nearest record in relation to the Project is from 2000 and occurs approximately 12 km east of the eastern end of the Project footprint in the Toowoomba area. The record at this location is recent from 2000. Other records from within a 50 km radius of the Project are sparsely scattered from Bowenville, to Grapetree to the north, to Gatton east of the Project, Allora south of the Project and west to Ellangowan. Austral toadflax is semi-parasitic on roots of a range of grass species, notably <i>Themeda triandra</i> and <i>Dichanthium</i> spp. It occurs in shrubland, grassland or woodland, often on damp sites. Vegetation types include open grassy heath dominated by <i>Leptospermum myrtifolium</i>, <i>Hakea microcarpa</i>, <i>Callistemon sieberi</i>, <i>Grevillea lanigera</i>, <i>Epacris microphylla</i> and <i>Poa</i> spp.; <i>Themeda triandra</i> grassland surrounded by <i>Eucalyptus</i> woodland; and	The following REs (remnant) are considered to constitute potential habitat for the species when they occur on basalt derived soils as they are identified as eucalypt woodlands that include <i>Themeda triandra</i>, <i>Cymbopogon refractus</i> or <i>Dichanthium</i> spp., or grasslands dominated by <i>Themeda triandra</i> or <i>Dichanthium</i> spp.: 11.3.4, 11.3.12, 11.3.24, 11.3.30, 11.3.31, 11.3.38, 11.4.13, 11.8.5, 11.8.8, 11.8.10, 11.8.11, 11.9.3. In addition, the following pre-clearance REs (non-remnant) are considered to constitute habitat when they are contained within a road reserve <u>on basalt derived soils</u>: 11.3.4, 11.3.12, 11.3.24, 11.3.30, 11.3.31, 11.3.38, 11.4.13, 11.8.5, 11.8.8, 11.8.10, 11.8.11, 11.9.3. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				grassland dominated by <i>Cymbopogon refractus</i> . The species is also known to occur within highly disturbed road reserves within the Toowoomba region which are maintained to control woody weed species.			
Poaceae	<i>Arthraxon hispidus</i>	Hairy-joint grass		This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment (Eco logical 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur at Toowoomba approximately 13 km from the Project. Most of these records are recent from within the last 15 years. Outside of a 50 km radius records occur throughout south-east Queensland and north-east New South Wales from Port Macquarie to Cooloolo. Hairy-joint grass is found in or on the edge of rainforest, wet eucalypt forest and woodland where it occurs near creeks, swamps, freshwater springs, coastal foreshore dunes, shaded gullies and creek beds.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as eucalypt woodland on alluvial plains, semi-evergreen vine thicket, microphyll vine forest or microphyll rainforest: 11.3.11, 11.3.11x1, 11.3.14, 11.4.1, 11.5.15, 11.7.1x1, 11.8.3, 11.3.13, 11.9.4, 11.9.4a, 11.9.4c, 11.10.8, 11.11.5, 11.11.5a, 11.11.18, 11.11.21, 11.12.4, 11.12.4a. In addition, the following REs (remnant) are considered to constitute potential habitat for the species when they are located <u>within 100 m</u> (i.e. create a buffer, which will be used to “cleave” larger REs to create new polygons) of a watercourse (stream order 3 and above) as they are identified as eucalypt or <i>Acacia</i> woodland which potentially provide habitat when adjacent to a creek or river: 11.2.1, 11.3.2, 11.3.3, 11.3.4a, 11.3.6, 11.3.7, 11.3.8, 11.3.9, 11.3.10, 11.3.13, 11.3.14, 11.3.15, 11.3.16, 11.3.17, 11.3.18, 11.3.23, 11.3.27,	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
					11.3.28, 11.3.29, 11.3.35, 11.3.36, 11.3.37, 11.3.39. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		
Euphorbiaceae	<i>Bertya opposens</i>	A shrub	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment (Ecological 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur at Devine State Forest approximately 13 km east of the Project. Most of these records are recent from within the last 14 to 26 years. <i>Bertya opposens</i> grows in a variety of community types including mixed shrubland, lancewood woodland, mallee woodland, eucalypt/<i>Acacia</i> open forest with shrubby understorey, Eucalypt/<i>Callitris</i> open woodland and semi-evergreen vine-thicket. The soils are recorded as generally shallow sandy loams or red earths associated mostly with sandstone, but also with rhyolite, shale and metasediments.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as <i>Acacia shirleyi</i> woodland on duricrust, shrubland on natural scalds associated with duricrusts and sandstone derived soils, eucalypt woodland on duricrusts, <i>Eucalyptus crebra</i> woodland on deep red earths, or eucalypt open forest/woodland with a tall shrub layer: 11.5.9, 11.7.2, 11.7.5, 11.7.7, 11.11.1, 11.11.3, 11.12.5, 11.12.6, 11.12.19. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				Associated species include: woodland with <i>Corymbia citriodora</i> and <i>Alyxia spicata</i> ; <i>Corymbia leichhardtii</i> woodland with some <i>Acacia harpophylla</i> on sandstone; sheltered sandstone gully with <i>Acacia shirleyi</i> , <i>Corymbia citriodora</i> , <i>C. trachyphloia</i> , <i>Gahnia aspera</i> ; woodland of <i>E. cloeziana</i> with <i>E. suffulgens</i> and <i>Callitris endlicheri</i> ; <i>E. crebra</i> / <i>C. trachyphloia</i> tall woodland; and in open woodland of <i>E. exserta</i> , <i>E. panda</i> , <i>C. trachyphloia</i> on lateritic sandstone (Halford and Henderson, 2002; Queensland Herbarium, 2012).			

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Surianaceae	<i>Cadellia pentastylis</i>	Ooline	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Records within a 50 km radius of the Project occur at Bendidee State Forest and Kindon Station approximately 42 km east of the Project. Ooline (<i>Cadellia pentastylis</i>) grows in dry rainforest, semi-evergreen vine thickets and sclerophyll ecological communities, often locally dominant or as an emergent.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as semi-evergreen vine thicket, microphyll vine forest, semi-deciduous notophyll to mesophyll vine forest, microphyll rainforest, mixed <i>Acacia/Casuarina/Eucalyptus</i> woodland on duricrust, <i>Acacia harpophylla</i> open forest with a semi-evergreen vine thicket understorey, and <i>Eucalyptus crebra</i> woodland with patches of semi-evergreen vine thicket: 11.2.3, 11.3.11, 11.3.11x1, 11.3.40, 11.4.1, 11.5.15, 11.7.1, 11.7.1x1, 11.8.3, 11.8.13, 11.9.4, 11.9.4a, 11.9.4c, 11.9.5, 11.10.8, 11.11.5, 11.11.14, 11.11.18, 11.11.21, 11.12.4, 11.12.7. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Ranunculaceae	Clematis fawcettii	Stream clematis	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment (Eco logical; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project footprint or impact assessment area. Database records across the wider area are few. The nearest records were identified approximately 7 km north of the Project footprint in 2011 from a patch of semi-evergreen vine thicket in the Mount Tyson area (north of Pittsworth). Other records are located approximately 20 km north of the northern extent of the Project footprint at Goombungee, and 20 km south-east in the foothills of the Toowoomba Range. The Stream Clematis occurs most commonly in the canopy gaps of drier rainforests near streams. It has been recorded in: ■ Semi-evergreen vine thicket ■ Araucarian microphyll vine forest ■ Complex notophyll vine forest ■ Eucalypt woodland communities that are close to vine thicket or rainforest.	The following REs (remnant) are considered to constitute potential habitat for the species when they are located <u>within 200 m</u> (i.e. create a buffer, which will be used to "cleave" larger REs to create new polygons) of a watercourse (stream order 3 and above) as they are identified as semi-evergreen vine thicket, microphyll vine forest, semi-deciduous notophyll to mesophyll vine forest, and microphyll rainforest: 11.2.3, 11.3.11, 11.3.11x1, 11.3.40, 11.4.1, 11.5.15, 11.7.1x1, 11.8.3, 11.8.13, 11.9.4, 11.9.4a, 11.9.4c, 11.10.8, 11.11.5, 11.11.5a, 11.11.18, 11.11.21, 11.12.4, 11.12.4a. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Ericaceae	<i>Leucopogon</i> sp. Coolmunda (D. Halford Q 1635)	Coolmunda leucopogon	V	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). <i>Leucopogon</i> sp. Coolmunda has not been identified within or near the impact assessment area. The nearest database record (i.e. AoLA, Wildlife Online) is from 1993 occurring near Inglewood approximately 10 km south-east of the southern section of the Project footprint. <i>Leucopogon</i> sp. Coolmunda (D. Halford Q 1635) occurs in undulating terrain between 300 and 340 metres above sea level (Halford, 1993). The area is subtropical with hot, moist summers and mild dry winters and an annual rainfall of 640 mm, predominantly in summer. The soils are shallow to 1 m in depth, light coloured sandy loams with mottled orange clayey subsoils (Halford, 1993). The vegetation is predominantly open forest to woodland with a dense lower stratum of heath to 1.5 m high. <i>Eucalyptus terrica</i>, <i>Corymbia trachyphloia</i>, <i>E. virens</i> and <i>Callitris endlicheri</i> co-dominate the upper storey, while the lower stratum is very diverse with common species being <i>Calytrix tetragona</i>, <i>Triodia</i> sp., <i>Grevillea floribunda</i>, <i>Boronia glabra</i>,	The following REs (remnant) are considered to constitute potential habitat for the species when they occur between 300-340 m ASL as they have been identified as eucalypt woodland on duricrust, <i>Corymbia citriodora</i> woodland on sandy soil, eucalypt woodland on medium to coarse grained sediments, <i>Corymbia</i> spp. mixed shrubby open woodlands: 11.7.4, 11.7.7, 11.10.1, 11.10.4, 11.12.5. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Family	Scientific name	Common name	EPBC Act status	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				<i>Xanthorrhoea johnsonii</i> , <i>Brachyloma daphnoides</i> , <i>Ricinocarpos linearifolius</i> and <i>Melichrus urceolatus</i> .			
Acanthaceae	Xerothamnella herbacea	A herb	E	This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco logical 2016; Aurecon 2018). There are no database records (i.e. AoLA, Wildlife Online) that occur for <i>Xerothamnella herbacea</i> within the Project footprint or within the impact assessment area. A 2006 record occurs approximately 5 km from the Project north of Yelarbon. The record details the occurrence as 5.59 km along Merton Road, in a shallow gilgai depression with occasional plants scattered amongst Brigalow along the road reserve. A second recent record occurs approximately 40 km from the Project within a road reserve along the Gore Highway located at the southern end of the Western Creek State Forest. Occurs in Brigalow (<i>Acacia harpophylla</i>) dominated communities in shaded situations, often in leaf litter and is associated with gilgais (shallow ground depressions). Soils are heavy, grey to dark brown clays.	The following REs (remnant) are considered to constitute potential habitat for the species as they are identified as <i>Acacia harpophylla</i>-<i>Casuarina cristata</i> open forest on deep cracking clays with gilgais, mixed <i>Eucalyptus populnea</i>-<i>Acacia harpophylla</i>-<i>Casuarina cristata</i> woodlands on deep cracking clay with gilgais, <i>Acacia harpophylla</i>/<i>Casuarina cristata</i> open forest on sand plains with gilgais, semi-evergreen vine thickets-<i>Acacia harpophylla</i> woodland on heavy clay, or <i>Dicanthium sericeum</i> grassland with clumps of <i>Acacia harpophylla</i> on deep cracking clays with linear gilgais: 11.3.1, 11.4.3, 11.4.7, 11.5.16, 11.9.5, 11.9.12. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Table notes:

CE = Critically endangered E = Endangered V = Vulnerable C = Least concern

Table 5.2 Listed conservation significant fauna species habitat assumptions used to map areas of occurrence within the Impact assessment area

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Birds/ Accipitridae	<i>Erythroriorchis radiatus</i>	Red goshawk	V	The species was not recorded during Project surveys. There are a number of database records (AoLA 2020) clustered around the Toowoomba area. It is noted available records have all been generalised in order to protect the species. The nearest recent database record from 2012 is located 17 km south-east of the northern extent of the Project footprint (south-east of Toowoomba). Further records (all from the early 1990s or older) occur to the north and east of Toowoomba. More recent records are associated with the Lockyer Valley to the east of the Toowoomba Range. The only records from west of the Project are near Kumberilla State Forest (55 km west) and the Chinchilla area (over 120 km west) and are from the early 1980s or older. The Red goshawk prefers large tracts of forest and woodlands with a mosaic of vegetation types, large prey populations (birds), and permanent water. Habitat must be open enough for fast attack and manoeuvring in flight but provide cover for ambushing of prey. They avoid very dense and very open habitats.	The following REs (remnant) are considered to be potential habitat for the species in the State Forest area near Inglewood (i.e. isolated fragments are unlikely to represent habitat) as they are identified as lagoons fringed with <i>Melaleuca</i> spp., <i>Eucalyptus</i> woodland fringing drainage lines, <i>Eucalyptus coolabah</i> woodland/open woodland in back swamps and old channels, <i>Eucalyptus tereticornis</i> woodland-open forest on deep cracking clays, <i>Eucalyptus</i> spp. shrubby woodland, <i>Eucalyptus</i> spp. open forest-woodland on the margins of alluvial plains, <i>Corymbia</i> spp. tall open woodland, <i>Eucalyptus crebra</i> woodland, mixed eucalypt woodland-open forest on sandy soil, mixed eucalypt woodland on duricrust, mixed eucalypt/<i>Callitris</i> woodland on sand plains, semi-deciduous notophyll-mesophyll vine forest fringing watercourses, microphyll-notophyll rainforest, or semi-evergreen vine thicket: 11.2.4, 11.3.2b, 11.3.3c, 11.3.4, 11.3.11, 11.3.14, 11.3.18, 11.3.25, 11.3.26, 11.3.40, 11.5.1, 11.5.4, 11.7.4, 11.5.20, 11.8.5, 11.8.13, 11.8.15, 11.10.8, 11.9.7, 11.10.5, 11.11.5, 11.11.6, 11.11.7x1, 11.11.15, 11.11.15c, 11.12.1, 11.12.1a, 11.12.5.	Not applicable	The <i>National recovery plan for the Red goshawk (Erythroriorchis radiatus)</i> (DERM 2012) describes habitat critical to the survival of this species comprises all required habitat elements including 'sites for nesting, food resources, water, shelter, essential travel routes, dispersal, buffer areas, and sites needed for the future recovery'. As such, for the purposes of this assessment any potential habitat when it is contained within 1 km of a stream order 3 watercourse (or above) or a lacustrine or palustrine RE or Water body is considered habitat critical to the survival of the species.

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				The vegetation types utilised by this species include eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins. Nests are in tall trees within one km of and often beside permanent water (river, swamp, pool), usually in fairly open, biologically rich forest or woodland. These habitats provide appropriate foraging conditions for the large Red goshawk, and a diversity and abundance of the medium to large birds taken as food.	<i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		
Birds/ Ardeidae	<i>Botaurus poiciloptilus</i>	Australasian bittern	E	Australasian bittern was not identified during any Project-associated field surveys within the impact assessment area, although conditions were dry at the time of surveys and not conducive to the species being present. There are few database records within 50 km of the Project. There are records in the wider area surrounding Toowoomba with two records of indeterminate location (some records have been generalised to protect the species) located 24 km east of the northern extent of the Project, a record from Jondaryan (25 km north-west) and a record near Bowenville (37 km north-west). There is also	The following REs (remnant) and habitat types are considered to constitute potential habitat for the species as they have been identified as lakes, swamps, rivers, estuaries and marine areas and associated vegetation: Lacustrine REs, lacustrine water bodies, palustrine REs, palustrine water bodies, riverine REs, riverine water bodies, estuarine REs, estuarine water bodies, marine REs and marine water bodies. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	Under the draft <i>National recovery plan for the Australasian bittern (Botaurus poiciloptilus)</i> (DoEE 2019) habitat critical to the survival of this species includes: Any wetland habitat where the species is 'known or likely to occur' (breeding or foraging habitat) within the indicative distribution map within the Draft recovery plan; and

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				a record east of Inglewood (40 km east of the Project). The Australasian Bittern occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats. It favours wetlands with tall, dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. The species favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. <i>Phragmites</i>, <i>Cyperus</i>, <i>Eleocharis</i>, <i>Juncus</i>, <i>Typha</i>, <i>Baumea</i>, <i>Bolboschoenus</i>) or cutting grass (<i>Gahnia</i>) growing over muddy or peaty substrate.			Any location with suitable habitat outside the above area that may be periodically occupied by Australasian bittern. The MNES study area is currently outside of areas mapped within the recovery plan for this species. However, any wetland containing a specimen backed record is considered to constitute habitat critical to the survival of the species.
Birds/ Columbidae	<i>Geophaps scripta scripta</i>	Squatter pigeon (southern subspecies)	V	This species was not identified during any Project-associated field surveys (Eco logical 2016; Aurecon 2018). There are a number of database records around the Inglewood area and further north-east in Durikai State Forest. The nearest of these is from 2017 and located 1.2. km west of the Project footprint in Bringalily State Forest. A second record (2014) is located 5 km east of the alignment in the same area located on the edge of Devine State Forest. The majority of records are to the south and east of the alignment and are generally more than 10 km away from the Project footprint. These	The REs (remnant) are considered to be potential habitat for the species <u>when it occurs south of Millmerran and within 3 km of a Stream Order 3 or greater Watercourse, or within 3 km of a Lacustrine Wetland or Water body</u> as they have been identified as eucalypt open woodland-woodland on sandy soil, <i>Eucalyptus camaldulensis</i>/<i>Eucalyptus tereticornis</i> woodland fringing drainage lines, <i>Eucalyptus tereticornis</i> woodland-open forest on clay soils, mixed eucalypt woodland on duricrust, <i>Eucalyptus crebra</i> woodland, or <i>Corymbia citriodora</i> open forest:	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				records occur predominantly within forest reserves around the Inglewood area. The Squatter pigeon (southern) habitat is generally defined as open-forests to sparse, open-woodlands and scrub that are mostly dominated in the over storey by <i>Eucalyptus</i>, <i>Corymbia</i>, <i>Acacia</i> or <i>Callitris</i> species; remnant, regrowth or partly modified vegetation communities, and within 3 km of water bodies or water courses. Typically, the ground covering vegetation layer in foraging and breeding habitat is considerably patchy consisting of native, perennial tussock grasses or a mix of perennial tussock grasses and low shrubs or forbs. This patchy, ground layer of vegetation rarely exceeds 33% of the ground area.	11.3.39, 11.3.14, 11.3.18, 11.3.25, 11.3.26, 11.3.4, 11.3.4a, 11.5.1, 11.5.4, 11.5.20, 11.7.4, 11.7.7, 11.11.15, 11.11.15a, 11.11.15b, 11.11.15c, 11.11.15d, 11.3.17, 11.12.1, 11.12.1a, 11.12.1b, 11.12.1c, 11.12.6, 11.12.6a, 11.12.6b, 11.11.4, 11.11.4a, 11.11.4b, 11.11.4c, 11.11.4d. <i>Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		
Birds / Falconidae	<i>Falco hypoleucos</i>	Grey falcon	V	The Grey falcon prefers timbered habitat in the arid to semi-arid zone. However, during drought younger individuals are believed to disperse towards the east coast (Marchant and Higgins 1993). Preferred habitats include open woodland, shrubland, grassland, and pastoral land on alluvial floodplains and flats, clay plains, sandy plains, dunefields and wetlands.	The following REs (remnant and regrowth) are considered to be potential habitat: 11.3.2, 11.3.3, 11.3.4, 11.3.5, 11.3.6, 11.3.7, 11.3.9, 11.3.10, 11.3.12, 11.3.13, 11.3.15, 11.3.16, 11.3.20, 11.3.21, 11.3.23, 11.3.24, 11.3.25, 11.3.27, 11.3.28, 11.3.30, 11.3.31, 11.3.32, 11.3.33, 11.3.34, 11.3.36, 11.3.38, 11.3.39, 11.4.2, 11.4.4, 11.4.5, 11.4.6, 11.4.10, 11.4.11, 11.4.12, 11.4.13, 11.5.2, 11.5.6, 11.5.8, 11.5.9, 11.5.10, 11.5.11, 11.5.12,	No applicable	Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				Grey falcons hunt from large standing trees in the landscape, with prey species primarily consisting of flocking, ground-feeding granivores (NSW Scientific Committee 2009). Nests of other falcons and corvids are renovated. Suitable nest trees are live and usually adjacent to watercourses or waterholes.	11.5.13, 11.5.14, 11.5.17, 11.5.18, 12.3.3, 12.3.4, 12.3.5, 12.3.6, 12.3.7, 12.3.10, 12.3.11, 12.3.19, 12.5.2, 12.5.4, 12.5.8 and 12.5.10. In addition to the communities identified above, all non-remnant areas that are located within 1km of a Stream Order 3 or greater Watercourse are potential habitat for this species. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute general habitat</i>		
Birds/ Meliphagidae	<i>Anthochaera phrygia</i>	Regent honeyeater	CE	This species was not identified during any Project-associated field surveys within the impact assessment area. The Regent honeyeater is not known from within or near the impact assessment area. It is noted AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. The nearest records to the Project footprint are two records east of Toowoomba from the 1980s (24 km and 27 km away from the Project footprint). There is also a number of records (including recent sightings) from the Durikai area which is located approximately 35 km east of the Project footprint (AoLA 2020).	The following REs (remnant) are potential habitat for the species as they are identified as riparian woodland with <i>Casuarina</i>, or eucalypt woodland with <i>Corymbia citriodora</i>, <i>Eucalyptus melliodora</i> or <i>Eucalyptus albens</i>: 11.3.25, 11.5.9d, 11.7.6, 11.7.7, 11.8.2, 11.8.2a, 11.8.4a, 11.8.8, 11.10.1, 11.11.1, 11.11.3, 11.12.6. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				The Regent honeyeater primarily inhabits inland slopes of the Great Dividing Range, in areas of low to moderate relief with moist, fertile soils. It is most commonly associated with box-ironbark eucalypt woodland and dry sclerophyll forest, but also inhabits riparian vegetation such as she oak (<i>Casuarina</i> spp.) where it feeds on needle-leaved mistletoe and occasionally breeds. It may occasionally utilise lowland coastal forest, which may act as a refuge when its usual habitat is affected by drought. Tree species with which the Regent honeyeater is most often associated include <i>Eucalyptus melliodora</i> , <i>Eucalyptus albens</i> , <i>Eucalyptus sideroxylon</i> away from the coast, and <i>Eucalyptus robusta</i> , <i>Corymbia citriodora/maculata</i> in coastal areas.			
Birds/ Meliphagidae	<i>Grantiella picta</i>	Painted honeyeater	V	The species was not recorded during Project-associated surveys. Database records indicate the species has not been recorded within the impact assessment area but has occurred at scattered locations within the wider area (AoLA 2020). There are a number of records in the Pittsworth area including a 2007 record located approximately 2 km south of the Project footprint in Pittsworth itself. A second record is located approximately 3 km north of the	The following REs (remnant) are potential habitat for the species as they have been identified as <i>Acacia harpophylla/Casuarina cristata</i> open forest, <i>Eucalyptus camaldulensis</i> woodland in drainage depressions, <i>Eucalyptus tereticornis</i> woodland-open forest on clay soils, <i>Acacia cambagei</i> woodland, eucalypt shrubby woodland, <i>Eucalyptus tereticornis/Eucalyptus camaldulensis</i> fringing drainage lines, eucalypt woodland on sand plains, <i>Eucalyptus/Callitris</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				Project footprint from McEwan State Forest (2013). There are two nearby older records (1970's) (12 km north-west of Pittsworth). At the northern extent of the alignment there is a 2006 record located 2.5 km east of the northern extent of the Project (Gowrie area), 2019 records from Highfields (10 km east of the Project) and a 2013 record from Toowoomba (15 km south-east of the Project). To the west there is a 2000 record from Oakey (12 km north-west) and a large number of records around Jondaryan where there is a known regular nesting area for the species (26 km north-west). In the south of the alignment there are two records in the Inglewood area, one from close to Coolmunda Dam (1995) and another from Whetstone State Forest (1996). Both of these are more than 10 km from the Project footprint. There are records (2015 and 2017) between Yelarbon and Goondiwindi (12 km north of the Project). The Painted honeyeater inhabits mistletoes in eucalypt forests/ woodlands, riparian woodlands of black box and River red gum, box-ironbark-Yellow gum woodlands, Acacia dominated woodlands, paperbarks, <i>Casuarinas</i>, <i>Callitris</i>, and trees on farmland or gardens.	woodland on sand plains, eucalypt woodland on duricrust, or <i>Acacia harpophylla</i> woodland with a semi-evergreen vine thicket understorey: 11.3.1, 11.3.1b, 11.3.2b, 11.3.4, 11.3.5, 11.3.18, 11.3.25, 11.3.25b, 11.3.25c, 11.3.25e, 11.3.27i, 11.4.3, 11.5.1, 11.5.4, 11.5.20, 11.7.7, 11.9.5. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				The species is often associated with following tree species in particular: <i>Acacia harpophylla</i>, <i>Acacia homalophylla</i>, <i>Acacia pendula</i>, <i>Allocasuarina luehmannii</i>, <i>Eucalyptus largiflorens</i> and <i>Eucalyptus camaldulensis</i>. The Painted honeyeater prefers woodlands which contain a higher number of mature trees, as these host more mistletoes. It is more common in wider blocks of remnant woodland than in narrower strips, although it has been observed to breed in relatively narrow roadside strips when ample mistletoe fruit is available.			
Birds/ Psittacidae	<i>Lathamus discolor</i>	Swift parrot	E	This species was not identified during any Project-associated field surveys within the impact assessment area. There are several records from the Toowoomba area, the closest of which is 4.5 km east of the northern extent of the Project footprint (no location or date data attached). It is noted most AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. The Swift parrot inhabits dry eucalypt forests and woodlands. It occasionally occurs in wet sclerophyll forests. Breeding occurs in Tasmania. The Swift parrot predominantly forages within habitats that have been so	The following REs (<u>remnant and regrowth areas</u>) are considered to be potential habitat as they may provide cover for the species but do not provide tree species that are identified as providing feeding resources: 11.2.5a, 11.3.14, 11.3.27d, 11.3.27f, 11.4.3a, 11.5.9 (except 11.5.9.c), 11.8.2 (except 11.8.2a), 11.8.4a. It is acknowledged that mature food trees are preferred foraging habitat, however to capture non-mature foraging habitat, the following <u>regrowth REs</u> containing the food trees (i.e. <i>Eucalyptus tereticornis</i>, <i>Eucalyptus melliodora</i>,	Important habitat is defined as "priority habitat" for this species in the species recovery plan. This includes the following: ■ Brisbane - Bowman Park, Bardonia; Rafting Creek Reserve Kenmore/Fig Tree Pocket. Toowoomba - Glen Lomond Park	The recovery plan does not define 'critical habitat' for this species. Therefore, for this assessment the following REs which contain food trees (i.e. <i>Eucalyptus tereticornis</i>, <i>Eucalyptus melliodora</i>, <i>Eucalyptus microcarpa</i>, <i>Eucalyptus moluccana</i>, <i>Eucalyptus sideroxylon</i>, <i>Eucalyptus albens</i>) have been considered as 'foraging habitat critical to the survival of the species' where they occur in <u>remnant</u> (mature) patches:

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				significantly cleared that they are classified as <u>endangered</u> ecological communities. This species primarily feeds on nectar and lerp in the canopy. The species is observed to prefer foraging in large mature trees (Saunders and Tzaros 2011). West of the Great Dividing Range the species is known to forage in Queensland blue gum (<i>Eucalyptus tereticornis</i>), Gum-topped box (<i>Eucalyptus moluccana</i>), Yellow box (<i>Eucalyptus melliodora</i>), Grey box (<i>Eucalyptus microcarpa</i>), Mugga ironbark (<i>Eucalyptus sideroxylon</i>), and White box (<i>Eucalyptus albens</i>) (Saunders and Heinsohn 2008).	<i>Eucalyptus microcarpa</i>, <i>Eucalyptus moluccana</i>, <i>Eucalyptus sideroxylon</i>, <i>Eucalyptus albens</i>) are considered to provide potential habitat: 11.2.3, 11.3.2, 11.3.3, 11.3.4, 11.3.9, 11.3.11, 11.3.23, 11.3.25, 11.3.25, 11.3.26, 11.3.27a, 11.3.27b, 11.3.27f, 11.3.29, 11.3.36, 11.3.38, 11.5.1, 11.5.2, 11.5.9c, 11.5.13, 11.5.17, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.5, 11.7.6, 11.8.2a, 11.8.5, 11.8.8, 11.9.2, 11.9.5, 11.9.9, 11.9.13, 11.10.1, 11.10.2, 11.10.11a, 11.11.1, 11.11.3, 11.11.4, 11.11.10, 11.11.15a, 11.12.1, 11.12.3, 11.12.6, 11.12.15, 11.12.26. <i>Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		11.2.3, 11.3.2, 11.3.3, 11.3.4, 11.3.9, 11.3.11, 11.3.23, 11.3.25, 11.3.25, 11.3.26, 11.3.27a, 11.3.27b, 11.3.27f, 11.3.29, 11.3.36, 11.3.38, 11.5.1, 11.5.2, 11.5.9c, 11.5.13, 11.5.17, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.5, 11.7.6, 11.8.2a, 11.8.5, 11.8.8, 11.9.2, 11.9.5, 11.9.9, 11.9.13, 11.10.1, 11.10.2, 11.10.11a, 11.11.1, 11.11.3, 11.11.4, 11.11.10, 11.11.15a, 11.12.1, 11.12.3, 11.12.6, 11.12.15, 11.12.26.
Birds/ Rostratulidae	<i>Rostratula australis</i>	Australian painted snipe	E	Australian painted snipe was not identified during any Project-associated field surveys within the impact assessment area, although conditions were dry at the time of surveys and not conducive to the species being present. The closest database record (2017) to the Project is from the north-east of Inglewood at a small farm dam located 6.5 km east of the footprint. There are several records in the wider area surrounding Toowoomba	The following REs (remnant) and habitat types are considered to constitute potential habitat for the species as they have been identified as lakes, swamps, rivers, estuaries and marine areas and associated vegetation: Lacustrine REs, lacustrine water bodies, palustrine REs, palustrine water bodies, riverine REs, riverine water bodies, estuarine REs, estuarine water bodies,	Not applicable	Under the draft <i>National recovery plan for the Australian painted snipe (Rostratula australis)</i> (DotEE 2019) habitat critical to the survival of the species includes: Any habitat where the species is known or likely to occur (from map within the Plan).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				and the Lockyer Valley. The nearest recent records are from Cooby Creek Dam (1995) and several records from the Helidon area (1982 and 2013) located approximately 14 km north-east and 25 km east of the northern extent of the Project respectively (AoLA 2020). The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and clay pans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum <i>Muehlenbeckia</i> spp. or cane grass or sometimes <i>Melaleuca</i> spp. The Australian painted snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up.	marine REs and marine water bodies. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		Any location outside the above area that may be periodically occupied by Australian Painted Snipe when conditions are favourable. The MNES study area occurs within areas mapped as known or likely to support the species as indicated by the Draft Recovery Plan. Therefore, all wetland areas identified as potential habitat within the MNES study area constitute critical habitat for this species.

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Birds/ Scolioacidae	<i>Calidris ferruginea</i>	Curlew sandpiper	CE	Curlew sandpiper was not identified during any Project-associated field surveys within the impact assessment area. There are few within 50 km of the Project footprint. The closest database record occurs from at Lake Coolmunda to the east of Inglewood (12 km east of the Project footprint), however this record is not dated. There is a recent record (2018) from Lake Cooby located 14 km north of the northern extent of the Project. Other records occur near Oakey (1980 - 15 km north-west), south of Dalby at dam sites (2007 and 1985 – over 50 km west). The Curlew Sandpiper primarily occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. Occasionally they are recorded around floodwaters.	The following REs (remnant) and habitat types are considered to constitute potential habitat for the species as they have been identified as lakes, swamps, rivers, estuaries and marine areas and associated vegetation: Lacustrine REs, lacustrine water bodies, palustrine REs, palustrine water bodies, riverine REs, riverine water bodies, estuarine REs, estuarine water bodies, marine REs and marine water bodies. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	Species does not breed in the southern hemisphere. There is no definition of critical habitat available for the species. Therefore, for the purposes of this assessment, wetlands containing a specimen backed record are considered to constitute Critical habitat for this species.

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Birds/ Turnicidae	<i>Turnix melanogaster</i>	Black-breasted button-quail	V	The species has not been detected within the impact assessment area. The are several database records close to the northern extent of the Project footprint around Toowoomba. These records range from 1889 – 2018 with the nearest records from 1999 located 1.5 km north of the footprint from the Kingsthorpe area (AoLA 2020). The species occurs from Byfield in the north south to the Dorriggo area (Mathieson and Smith 2009). The Black-breasted button-quail primarily occurs in drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest. They may also be found in low, dense acacia thickets and, in littoral area, in vegetation behind sand dunes. This species is also known to utilise Lantana thickets as habitat.	The following is considered to be potential habitat: Any specimen backed records (buffered to a 1 km radius) that fall outside of areas identified as Critical habitat.	Not applicable	The recovery plan identifies habitat considered critical to the survival of the species as those communities described under the species habitat requirements: ■ Vine thickets and rainforest vegetation types that are periodically water-stressed. These include: semi-evergreen vine thicket, low microphyll vine forest, <i>Araucarian</i> microphyll vine forest, <i>Araucarian</i> notophyll vine forest and <i>Brachychiton</i> scrubs that may incorporate bottle trees (<i>Brachychiton</i> sp.), Brigalow (<i>Acacia harpophylla</i>) and Belah (<i>Casuarina cristata</i>) ■ Low thickets or woodlands with a dense understorey but little ground cover, typically dominated by <i>Acacia</i> spp. ■ In littoral situations, dry vine scrubs,

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					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
							<i>Acacia</i> thickets and areas densely covered in shrubs, particularly Midgen berry <i>Austromyrtus dulcis</i>. As such the following REs are Critical habitat: 11.2.3, 11.3.11, 11.3.11x1, 11.4.1, 11.5.15, 11.7.1x1, 11.8.3, 11.8.6, 11.8.13, 11.9.4, 11.9.4a, 11.9.4c, 11.9.8, 11.9.11, 11.10.2a, 11.10.8, 11.11.5, 11.11.14, 11.11.18, 11.11.21, 11.12.4 and 11.12.21.
Mammals/ Dasyuridae	<i>Dasyurus maculatus maculatus</i>	Spotted-tailed quoll (southern subspecies)	E	There are a number of database records in the region surrounding the eastern portion of the impact assessment area. There is a single 1980 record from the Pittsworth area located just outside of the impact assessment area (1.2 km from the Project footprint). There are a number of records to the east and south-east of Pittsworth all of which are relatively old (<1990). The most recent records in the vicinity of the impact assessment area are from the Day Range located 38 km east of the Project (from 1993). There are also several records in the south around the Texas area including from Wilga Park Nature Refuge (2002)	The following REs (remnant) constitute potential habitat for the species where they occur in areas that <u>receive at least 600 mm of rainfall annually</u> as they have been identified as <i>Eucalyptus tereticornis/Eucalyptus camaldulensis</i> woodland-open forest on alluvium, <i>Eucalyptus tereticornis/Eucalyptus camaldulensis</i> woodland-fringing drainage lines, semi-evergreen vine thicket, semi-deciduous notophyll-mesophyll vine forest fringing watercourses, microphyll rainforest, or microphyll vine forest:	Not applicable	The <i>National recovery plan for the Spotted-tail quoll (Dasyurus maculatus)</i> (DEWLP 2016) identifies habitat critical to the survival of the species as including: large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey. As such, for the purposes of this assessment potential

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				(47 km south-east of Project footprint) and a museum record from Yelarbon State Forest (20 km south-east of the Project footprint) although with no associated collection year. There are only two records located west of the Project footprint: one in the Biddeston region near Toowoomba (5.5 west of the Project footprint) in what is now cleared agricultural lands; and a record west of Dalby from 1980 (over 60 km north-west of the Project) (AoLA 2020). In South-east Queensland, the Spotted-tailed Quoll occurs coastally from Bundaberg to the border and inland to Monto and Stanthorpe. The Spotted-tailed Quoll prefers mature wet forest habitat, especially in areas with rainfall in excess of 600 mm/year. Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable. This subspecies has been recorded from a wide range of habitats, including large tracts of vine forest, wet and dry sclerophyll forest and woodland, and is often associated with <i>Eucalyptus camaldulensis</i> within the west of its range. This species uses boulder piles, fallen logs and standing tree hollows as shelter sites.	11.3.4, 11.3.11, 11.3.11x1, 11.3.25, 11.3.25e, 11.3.40, 11.4.1, 11.5.15, 11.7.1x1, 11.8.3, 11.8.13, 11.9.4, 11.9.4a, 11.9.4c, 11.10.8, 11.11.5, 11.11.5a, 11.11.18, 11.11.21, 11.12.4, 11.12.4a. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		habitat that intersects with remnant vegetation patches that are equal to or greater than 200 ha in size are considered critical habitat for this species ((taking into account the species extensive home range requirements).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
Mammals/ Macropodidae	<i>Petrogale penicillata</i>	Brush-tailed rock-wallaby	V	Database records indicate this species has been recently recorded (2018) from within approximately 2 km of the Project footprint at Gowrie Mountain to the east of the northern section of the Project south of the intersection with the Warrego Highway. Other records occur to the east and north-east of the Project in the Toowoomba and Crows Nest areas, although none within 10 km of the Project footprint. This Brush-tailed rock-wallaby prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks. Rocky outcrops appear crucial to current habitat selection by rock-wallabies, however, vegetation structure and composition is also considered to be an important factor. In many parts of their range, rock-wallabies are closely associated with dense arboreal cover, especially fig trees. The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases, may provide some protection from predation. A range of vegetation types are associated with Brush-tailed Rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry	The following REs (remnant) constitute potential habitat for the species where they occur on <u>very steep terrain</u> (i.e. terrain with <u>a 50% grade</u>) as they have identified as eucalypt open forest to forest, semi-evergreen vine thicket, semi-deciduous notophyll-mesophyll vine forest fringing watercourses, microphyll rainforest, or microphyll vine forest: 11.7.1, 11.7.2, 11.7.3, 11.7.4, 11.7.6, 11.8.1, 11.8.2, 11.8.4, 11.8.5, 11.8.8, 11.8.9, 11.8.11, 11.8.12, 11.8.13, 11.8.14, 11.8.15, 11.9.1, 11.9.2, 11.9.3, 11.9.4, 11.9.5, 11.9.6, 11.9.7, 11.9.9, 11.9.10, 11.9.13, 11.9.14, 11.10.1, 11.10.2, 11.10.4, 11.10.5, 11.10.6, 11.10.7, 11.10.8, 11.10.9, 11.10.11, 11.10.12, 11.10.13, 11.11.1, 11.11.2, 11.11.3, 11.11.4, 11.11.5, 11.11.6, 11.11.7, 11.11.8, 11.11.9, 11.11.10, 11.11.11, 11.11.12, 11.11.13, 11.11.14, 11.11.15, 11.11.16, 11.11.17, 11.11.18, 11.11.19, 11.11.20, 11.12.1, 11.12.2, 11.12.3, 11.12.4, 11.12.5, 11.12.6, 11.12.7, 11.12.8, 11.12.9, 11.12.10, 11.12.11, 11.12.12, 11.12.13, 11.12.14, 11.12.17, 11.12.19, 11.12.20, 11.12.21. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are</i>	Not applicable	The <i>National Recovery Plan for the Brush-tailed Rock-wallaby (Petrogale penicillata)</i> (Menkhorst and Hynes 2010) describes habitat critical to survival of the species as: rocky refuge habitat, foraging habitat and commuting routes between the two. Therefore, all areas mapped as potential habitat that intersect with remnant vegetation are considered to constitute critical habitat for the species.

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					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				sclerophyll forest, and open forest.	<i>considered to constitute General habitat.</i>		
Mammals/ Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala	V	Signs of Koala presence were identified within the riparian corridor along the Condamine River during Project surveys. Database records indicate this species occurs from 2009 and 2011 within the impact assessment area to the south of the Project footprint near Pittsworth. There are multiple other records (approximately 30) outside of the impact assessment area from between 2009-2019 surrounding Pittsworth. Two records from within the impact assessment area occur at the south of the Project footprint at Yelarbon from 1965 and 1987. Other records from within 5 km of the Project footprint occur at Millmerran (1987) and Bringalily State Forest (2006). Koalas naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by <i>Eucalyptus</i> species which can be broadly defined as any forest or woodland containing species that are known Koala food trees, or shrubland with emergent food trees. Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands mostly dominated by <i>Eucalyptus</i> species.	The following is considered to be potential habitat: Any specimen backed records (buffered to a 1 km radius) that fall outside of areas identified as Critical habitat (regardless of the level of clearing or development within the area).	Not applicable	Under the <i>EPBC Act referral guidelines for the vulnerable Koala</i> (DotE 2014) critical habitat for Koala in inland areas (< 800 mm per annum rainfall isohyet) can be characterised by areas including: - Woodlands and forests (where Koala food trees have reliable access to soil moisture) - Box gum or red gum woodlands on heavier soils in remnant or regrowth vegetation patches particularly riparian zones - Small, patchy and sparsely distributed woodlands, shrublands and forest in highly modified, agricultural-grazing landscapes or in and around rural towns. For the purposes of this assessment all areas of the above-mentioned habitat

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					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				Feed trees including <i>Eucalyptus tereticornis</i> and <i>Eucalyptus camaldulensis</i> occur within the impact assessment area.			types are considered to constitute Critical habitat for this species. Such habitats have been identified through field surveys, interrogation of aerial imagery and from datasets that establish State mapped remnant vegetation, high-value regrowth vegetation and unmapped riparian conduits. It is acknowledged that, given the scale of datasets adopted for the assessment, this approach may not recognise every small, patchy and sparsely distributed stand of vegetation that occurs within the Project footprint, particularly those that are less than 1 ha in size (refer Sections 3 and 5). It is anticipated that any such isolated vegetation that has been omitted from mapping for the EIS will be identified as a component of detailed ecological surveys of the entire Project footprint which will be conducted in parallel with development of

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							the detail design. The results from the detailed ecological surveys will be used to further refine the quantifiable impacts of the offset obligations for the Project.
Mammals/ Pseudocheiridae	<i>Petauroides volans</i>	Southern greater glider	V	The species was not recorded during Project surveys. Database records indicate the nearest occurrence of this species (from 1999) is from approximately 17 km south-east of the Project footprint in Yelarbon State Forest (south of Inglewood). A second more recent record (2011) from further south of the same area exists 27 km south-east of the Project from Texas State Forest. A number of records occur within 50 km of the Project footprint to the north of the alignment near Toowoomba and Crows Nest ranging in age from 1974 to 2003 (AoLA 2020). The nearest of these are from the Highfield area (2010 and 2016) and are located approximately 10 km north-east of the Project footprint. The greater glider is an arboreal nocturnal marsupial, largely restricted to <u>eucalypt forests and woodlands</u>. It is primarily folivorous, with a diet mostly comprising eucalypt leaves, and occasionally flowers. It is typically found in highest abundance in <u>taller, montane, moist eucalypt forests with relatively old trees</u>	The species main habitat requirement is tall eucalypt woodland/open forests with large tree hollows for shelter. The following vegetation communities (REs) are considered to constitute potential habitat in remnant habitat only (i.e. where large hollows are much more likely to occur) as they have been identified as <i>Eucalyptus tereticornis</i> open forest, <i>Eucalyptus tereticornis/Eucalyptus camaldulensis</i> woodland-open forest along drainage lines, or eucalypt woodland-open forest including <i>Corymbia intermedia</i>, <i>Eucalyptus drepanophylla</i>, <i>Eucalyptus latisinensis</i>, or <i>Corymbia trachyphloia</i>: 11.3.4, 11.3.25, 11.3.29, 11.3.30b, 11.5.8, 11.7.4, 11.7.7, 11.10.2, 11.10.13, 11.11.4b, 11.11.15b, 11.11.20, 11.12.5, 11.12.5a, 11.12.8b, 11.12.9, 11.12.9a, 11.12.13a, 11.12.13b and 11.12.20. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are</i>	Not applicable	There is no recognised definition of habitat critical to the survival of the species. For the purpose of this assessment critical habitat is considered to include: Any breeding or foraging habitat in areas where the species occurs. Therefore, any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				and abundant hollows. The distribution may be patchy even in suitable habitat. The greater glider favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species. During the day Greater gliders shelter in tree hollows, with a selection for large hollows in large, old trees. Home ranges are relatively small (1–4 ha). Within south-east Queensland, the Greater Glider has been reported to feed upon the following species: <i>Eucalyptus latisinensis</i> , <i>Corymbia intermedia</i> , <i>Eucalyptus drepanophylla</i> , <i>Corymbia trachyphloia</i> with lesser amounts of <i>Melaleuca quinquenervia</i> .	considered to constitute potential habitat.		
Mammals/ Pteropodidae	<i>Pteropus poliocephalus</i>	Grey-headed flying-fox	V	This species (between 200 – 300 individuals present) was observed at a known flying-fox roost site in Inglewood (approximately 3 km south of the Project footprint) during surveys for the Inland Rail Project. Examination of State (DES 2020) flying-fox monitoring data which includes this roost site (data ranging from 2008 – 2019) observes this species as never having been recorded at the site. The site is evidently not a regular roost site for the species. Database records indicate this species does not occur within the impact assessment area however has occurred within 50 km of the Project (AoLA 2020). The nearest	Any REs (remnant) located within a 50 km radius of a flying fox camp known to regularly support Grey-headed flying-foxes. Two camps that fit this criterion are known to occur at the following locations: ■ Toowoomba, Spring Street (-27.601, 151.943) ■ Highfields, Jackson Close (-27.4605, 151.9283).	Not applicable	The draft <i>National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus)</i> (DoEE 2017) does not define habitat critical to the survival of the species but recommends management of habitat associated with a number of tree species that occur in the area including <i>Eucalyptus tereticornis</i> , <i>E. crebra</i> , <i>E. siderophloia</i> , <i>Corymbia citriodora citriodora</i> , and <i>Grevillea robusta</i> . For the purpose of this

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					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				database record is from 1960 taken from Inglewood. Database searches indicate more recent records to the east of the Project in the Toowoomba area. The Grey-headed Flying-fox requires foraging resources and roosting sites. It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, <i>Melaleuca</i> swamps and <i>Banksia</i> woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas. The primary food source is blossom from <i>Eucalyptus</i> and related genera but in some areas it also utilises a wide range of rainforest fruits. None of the vegetation communities used by the Grey-headed Flying-fox produce continuous foraging resources throughout the year. As a result, the species has adopted complex migration traits in response to ephemeral and patchy food resources. The Grey-headed Flying-fox roosts in aggregations of various sizes on exposed branches. Roost sites are typically located near water, such as lakes, rivers or the coast. Roost vegetation includes rainforest patches, stands of <i>Melaleuca</i>, mangroves and riparian vegetation.			assessment critical habitat is considered to include a 100 m buffer surrounding the following: ■ Toowoomba, Spring Street (-27.601, 151.943) ■ Highfields, Jackson Close (-27.4605, 151.9283). In addition, the species travels to foraging areas usually located within 15 km of a roost site (Tidemann 1998). Therefore all mature vegetation (which includes winter and spring key foraging species) within 15 km from a flying fox camp known to regularly support the species also constitutes habitat critical to the survival of the species Individuals may occasionally utilise foraging trees beyond a 15 km radius. The foraging tree species for the Grey-headed Flying-fox are analogous with tree species utilised by Koala. Therefore, any habitat critical to the survival of the species outside of the 15 km

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					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				Grey-headed Flying-foxes commute daily to foraging areas, usually within 15 km of the day roost site. Grey-headed Flying-foxes are capable of nightly flights of up to 50 km from their roost to different feeding areas as food resources change. At most times of the year there is a complete exodus from the colony site at dusk.			radius is included in the critical habitat mapping for the Koala, which in turn will contribute to the quantified impacts of the Project.
Mammals/ Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared pied bat	V	A database record (1997) exists 40 km west of the Project footprint from Western Creek State Forest located west of Millmerran. All other records exist well outside a 50 km radius around the Project footprint to the north-west in Carnarvon and Expedition National Parks and to the south-east in Main Range and Lamington National Park. This species has been recorded from a large range of vegetation types including: dry and <u>wet sclerophyll</u> forest; <i>Callitris glauca</i> dominated forest; <u>tall open eucalypt</u> forest. Roosting has also been observed in disused mine shafts, caves, overhangs and disused Fairy Martin nests. Foraging habitat is usually within several kilometres of escarpments that provide roosting sites. Although preferred escarpment country is not known to the impact assessment area, many culverts with disused Fairy martin nests have been observed	The following REs (remnant) are considered to constitute potential habitat for the species as they have been identified as <i>Eucalyptus tereticornis</i> / <i>Eucalyptus camaldulensis</i> woodland-open forest along drainage lines, eucalypt woodland-tall open forest, <i>Acacia harpophylla</i> open forest, <i>Acacia harpophylla</i> / <i>Eucalyptus</i> woodland-open forest on rocky scarps, Eucalyptus open forest in sheltered gorges, semi-evergreen vine thicket, or <i>Araucaria cunninghamii</i> woodland/open forest on boulder strewn slopes: 11.3.25, 11.3.26, 11.8.1, 11.11.3, 11.11.14, 11.12.6, 11.12.12, 11.12.13, 11.9.1, 11.9.5, 11.9.10, 11.10.2 and 11.10.5. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	Habitat critical to the survival of the species includes: Sandstone cliffs and fertile wooded valley habitat within close proximity of each other should be considered habitat critical to the survival of the large-eared pied bat. Where site investigations identify sandstone cliffs, these are to be mapped as Habitat Critical to the species.

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				and may provide suitable roosting habitat.			
Mammals/ Vespertilionidae	<i>Nyctophilus corbeni</i>	South-eastern long-eared bat	V	Microbat echolocation calls of the Genus <i>Nyctophilus</i> were recorded during the Project surveys in the south of the alignment including from the Canning Creek area (Eco logical 2016) and near Whetstone State Forest (Aurecon 2018). Three <i>Nyctophilus</i> species have potential to occur in the area and cannot be reliably distinguished from each other by call. South-eastern long-eared bat is well known to occur in the State Forests in the Inglewood area. As such, this assessment has taken a conservative approach and assumed the species as present and detected during Project surveys. Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands as well as Bull oak woodland, <i>Acacia harpophylla</i> woodland, <i>Casuarina cristata</i> woodland, <i>Angophora leiocarpa</i>, woodland; <i>Eucalyptus camaldulensis</i> forests lining watercourses and lakes <i>Eucalyptus largiflorens</i>, woodland and dry sclerophyll forest. This species roosts in hollows in dead and living trees. Surveys suggest the species requires large tracts of forest to occur (Turbill et al. 2008).	The following REs (remnant) are potential habitat for the species where they occur within the large tracts of woodlands in the Inglewood area south of Millmerran (isolated polygons are unlikely to provide habitat) as they have been identified as eucalypt/<i>Acacia</i>/<i>Callitris</i>/<i>Casuarina</i> woodlands and forests: 11.10.11, 11.10.11a, 11.10.12, 11.10.4, 11.10.4a, 11.10.4b, 11.10.4c, 11.10.4d, 11.10.6, 11.10.6a, 11.10.7, 11.10.7a, 11.10.9, 11.11.1, 11.11.10, 11.11.10a, 11.11.13, 11.11.14, 11.11.15, 11.11.15a, 11.11.15b, 11.11.15c, 11.11.15d, 11.11.19, 11.11.4, 11.11.4a, 11.11.4b, 11.11.4c, 11.11.4d, 11.11.7, 11.11.7a, 11.11.7x1, 11.11.9, 11.12.1, 11.12.13, 11.12.13a, 11.12.13b, 11.12.17, 11.12.1a, 11.12.1b, 11.12.1c, 11.12.2, 11.12.21, 11.12.2a, 11.12.2b, 11.12.2c, 11.12.3, 11.12.6, 11.12.6a, 11.12.6b, 11.12.7, 11.3.1, 11.3.14, 11.3.16, 11.3.17, 11.3.18, 11.3.19, 11.3.1a, 11.3.1b, 11.3.1d, 11.3.2, 11.3.25, 11.3.25a, 11.3.25b, 11.3.25c, 11.3.25d, 11.3.25e, 11.3.25f, 11.3.25g, 11.3.25h, 11.3.2a, 11.3.2b, 11.3.2c, 11.3.36, 11.3.37, 11.3.39, 11.3.4, 11.3.4a, 11.3.6, 11.4.10, 11.4.12, 11.4.12a, 11.4.3, 11.4.3a, 11.4.3b, 11.4.4, 11.4.7, 11.4.8,	No applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (<i>excluding areas that fall outside of identified vegetation communities</i>).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
					11.4.8a, 11.4.9, 11.4.9a, 11.4.9b, 11.5.1, 11.5.13, 11.5.16, 11.5.16a, 11.5.1a, 11.5.2, 11.5.2a, 11.5.3, 11.5.3a, 11.5.3b, 11.5.4, 11.5.5, 11.5.5a, 11.5.5c, 11.5.7, 11.5.9, 11.5.9a, 11.5.9b, 11.5.9c, 11.5.9d, 11.7.4, 11.7.4c, 11.7.6, 11.7.7, 11.8.14, 11.8.15, 11.8.4, 11.8.4a, 11.8.8, 11.8.9, 11.9.1, 11.9.10, 11.9.11, 11.9.2, 11.9.2a, 11.9.5, 11.9.5a, 11.9.6, 11.9.6a, 11.9.7, 11.9.7a, 11.9.9, 11.9.9a, 11.9.9b. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>		
Ray-finned fishes/ Percichthyidae	<i>Maccullochella peelii</i>	Murray cod	E	This species was recorded within the Macintyre River and Macintyre Brook during targeted Project surveys for fish species. Database records (i.e. AoLA) indicate the species is known from within 10 km of the Project footprint. Records indicate the species has been found as recently as 2011 on the Macintyre River on the NSW border, approximately 4 km to the south of the project between Yelarbon and Goondiwindi. There are several other records upstream and downstream of the Project crossing on the Macintyre River. The Murray cod inhabits from high gradient, rocky, upland streams, to large, slow-flowing pools in lowland areas. Anecdotal	The following areas are considered to constitute potential habitat for the species as they are identified as larger, more permanent waterways: All areas mapped as Water courses with a Stream order rating of 5 and above. <u>Areas identified as Estuarine REs, Estuarine Waterbodies, Marine REs or Marine Waterbodies are to be excluded from the habitat mapping.</u> <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute General habitat.</i>	Not applicable	Habitat critical to the survival of the species includes: ■ The border rivers (Barwon and McIntyre, including their major tributaries) ■ Up-land reaches of the Condamine River Therefore, both the Condamine River and Macintyre River (buffered by a 50m buffer from the river centreline) are considered to constitute Habitat

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				accounts by anglers and landowners often describe the ideal cod habitat as comprising deep, shaded, slow flowing pools with plenty of snags and log-piles.			critical to the survival of this species.
Reptiles/ Agamidae	<i>Tympanocryptis condaminensis</i>	Condamine earless dragon	E	Condamine earless dragon was recorded during Project-associated surveys in an existing rail line easement located within the Project footprint approximately 13 km north-east of Millmerran. There are a number of database records north-west of this area, located largely to the north of the Project footprint. The nearest record (2009) is located 1.5 km south of the Project footprint near Brookstead. There are several records (2003 to 2014) variously between 3 km to 4 km to the north of the Project footprint between Brookstead and Pittsworth, with many records located further north. The only other records located south of the Project are from agricultural lands located north of the Pittsworth-Felton Road (15 km south-west of Pittsworth). The Condamine earless dragon occurs in the Condamine River floodplain on black-cracking clay soil that is intensively cropped. Almost all records of the species have been made on one private property, along narrow road reserves or in headlands (thin, less than 10 m wide strips of grassland on paddock verges).	The following REs (remnant) are considered to constitute potential habitat for the species where they occur within the Condamine River catchment (extends approx. 20 km south of Millmerran within Project footprint) as they have been identified as <i>Eucalyptus tereticornis</i>/<i>Eucalyptus coolabah</i>/<i>Eucalyptus populnea</i> woodland on deep cracking clay soils, or <i>Dichanthium</i> spp. grassland on cracking clay soils: 11.3.4, 11.3.15, 11.3.21, 11.4.4, 11.8.11, 11.8.15, 11.9.12. In addition, the <u>following pre-clearance REs (non-remnant)</u> are considered to constitute potential habitat when they are contained within <u>a road reserve or within agricultural cropping (as per habitat type mapping)</u>: 11.3.4, 11.3.15, 11.3.21, 11.4.4, 11.8.11, 11.8.15, 11.9.12.	Not applicable	Because the species is known from few sites and former habitat has been reduced all known occurrences are considered critical: any specimen backed records (buffered to a 1 km radius) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities)

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				Vegetation where this species has been observed is cropland (on private property), and remnant native grassland and exotic grassland (on private property, headlands and road verges). Prior to European settlement, the area where the Condamine earless dragon occurs was on natural grassland. This grassland has been extensively cleared or modified and less than one percent of its pre-European extent remains and is evidence of continuing decline of species extent and quality of habitat. There are no large, non-linear areas of remnant grassland remaining.			
Reptiles/Elapidae	<i>Furina dunmalli</i>	Dunmall's snake	V	This species was not identified during any Project-associated field surveys (Eco logical 2016; Aurecon 2018). The nearest database record is recent from 2011 and occurs within the impact assessment area on the Millmerran – Inglewood Road north of Inglewood where the Project footprint traverses Bringalily State Forest. This is the only specimen backed record within the impact assessment area or Project footprint. Other records within a 50 km radius of the Project occur at the southern end of Yelarbon State Forest although this is somewhat dated (1996) and located 22 km south-east of the southern end of the	The following REs (remnant) are considered to constitute potential habitat for the species as they have been identified as forests or woodland containing <i>Acacia harpophylla</i>, <i>Callitris glaucophylla</i>, <i>Allocasuarina luehmannii</i> and <i>Casuarina cristata</i> on black alluvial cracking clay and clay loams or sandstone derived soils: 11.3.1, 11.3.17, 11.3.18, 11.3.32, 11.4.7, 11.4.9, 11.4.11, 11.5.1, 11.5.2a, 11.5.4, 11.5.16, 11.5.20, 11.8.9, 11.9.1, 11.9.5, 11.9.5a, 11.9.10, 11.9.11, 11.9.12, 11.10.9, 11.10.11. <i>Note: Any specimen backed records (buffered to a 1 km</i>	The <i>Draft Referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPaC 2011) describe 'important habitat' under Section 5 of the guidelines. The entire impact assessment area has been identified as important habitat for this species as defined in Section 5 of the Draft Referral guidelines for the	Not applicable

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				Project. The only other record within the context of the Project occurs at Oakey approximately 13 km from north-east of the northern section of the Project. Dunmall's snake has been found in a broad range of habitats, and is most often associated with forests and woodlands containing the following species: <i>Acacia harpophylla</i>, <i>Callitris glaucophylla</i>, <i>Allocasuarina luehmannii</i> and <i>Casuarina cristata</i> on black alluvial cracking clay and clay loams or sandstone derived soils.	<i>radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	nationally listed Brigalow Belt reptiles. Therefore, all areas of potential habitat constitute important habitat.	
Reptiles/ Pygopodidae	<i>Delma torquata</i>	Collared delma	V	This species was not identified during any Project-associated field surveys (Eco logical 2016; Aurecon 2018). The Collared delma has not been recorded within or adjacent to the Project footprint. The nearest database records (AoLA 2020) are two from 2003 taken from the east of Toowoomba at Jones Road, Withcott approximately 12 km east of the northern section of the Project. Another nearby record with no date occurs approximately 17 km from the Project at Table Top Drive, Toowoomba. Towards the south of the Project a record occurs approximately 29 km north of the alignment at the southern boundary of Western Creek State Forest dated 1998.	The following REs (remnant) are considered to constitute potential habitat for the species as they have been identified as <i>Eucalyptus crebra</i> dominated woodlands or <i>Acacia harpophylla</i> open forest with emergent <i>Eucalyptus crebra</i>: 11.3.29, 11.3.30, 11.3.36, 11.5.1, 11.5.9, 11.5.9c, 11.8.4, 11.8.8, 11.8.14, 11.9.9, 11.9.9b, 11.10.1d, 11.10.7, 11.11.1, 11.11.14, 11.11.15, 11.12.1, 11.12.1a, 11.12.7. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	The <i>Draft Referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPac 2011) describe 'important habitat' under Section 5 of the guidelines. The entire impact assessment area has been identified as important habitat for this species as defined in Section 5 of the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles.	Not applicable

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				The <u>presence of rocks, logs, bark and other coarse woody debris</u>, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of the Collared Delma microhabitat and is always present where the species occurs. Whilst Collared Delmas are often found associated with small rocks, the presence of small rocks is not an Essential habitat characteristic. On the Toowoomba range, the species is most often found in association with <u>Eucalyptus crebra open forest or woodland</u> with a grassy understorey containing <i>Lantana montevidensis</i>. An essential habitat component is the <u>penetration of sunlight to the ground</u>. Dense thickets of <i>Lantana camara</i> (i.e. reduces light penetration to the ground) has been identified as a threatening process to this species.		Therefore, all areas of Potential habitat constitute important habitat.	
Reptiles/ Scincidae	<i>Anomalopus mackayi</i>	Five-clawed worm-skink	V	This species was not identified during any Project-associated field surveys (Eco logical 2016; Aurecon 2018). There are no known records of this species within the Project footprint however three specimen backed records occurs within the impact assessment area to the north-east of Pittsworth. These records are recent (2002 and 2009) and occur at the Broxburn railway	The following REs (remnant) are considered to constitute potential habitat for the species as they have been identified as <i>Eucalyptus populnea/Eucalyptus tereticornis/Eucalyptus coolabah</i> woodlands and forests on cracking clays, or <i>Dichanthium sericeum/Astrebla</i> spp. grasslands on crack clays:	The <i>Draft Referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPac 2011) describe 'important habitat' under Section 5 of the guidelines.	Not applicable

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				siding where it meets Broxburn Road located within 300 m east of the Project footprint. There are other records in the wider the Pittsworth area to the north-west (1985 and 2009 – 20 km from the Project footprint) and south-east (2008 - 14 km from the Project footprint). Another record exists for this species to the east of the northern section of the alignment near Toowoomba dated 1983 located approximately 4 km from the Project footprint (AOLA 2020). The species shelters at the soil surface where moisture is sufficiently retained under decaying leaf litter, coarse woody debris or artificial debris. The species also lives in cavities in rotting tree bases, logs and in tussock bases. It is known to dig permanent tunnel-like burrows in loose, friable, humic soils in woodlands on slight basalt rises. On the Darling Downs, the species occurs in Bluegrass (<i>Dichanthium sericeum</i>) and/or Mitchell Grass dominated grasslands or mixed grasslands dominated by other grass species. In south-east Queensland, the species may occur in <i>Eucalyptus tereticornis</i>/ <i>Eucalyptus camaldulensis</i>/ <i>Eucalyptus populnea</i> grassy woodland/ open forests. In addition, the species has been	11.3.2, 11.3.4, 11.3.15, 11.3.21, 11.3.25, 11.4.4, 11.4.7, 11.4.11, 11.5.17, 11.8.11, 11.9.12. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Portions of the impact assessment area has been identified as important habitat for this species as defined in Section 5 of the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles. Therefore, the following sections of the B2G alignment constitute important habitat: Areas between Toowoomba and Millmerran where they overlap with areas identified as potential habitat for the species.	

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				recorded in areas characterised by <i>Callitris</i> sp. woodland. The species <u>is not likely to be found in soils in which deep cracks do not form</u> , such as hard-setting brown clays or sandy soils types).			
Reptiles/ Scincidae	<i>Egernia rugosa</i>	Yakka skink	V	This species was not identified during any Project-associated field surveys (Eco logical 2016; Aurecon 2018). Database records indicate this species has not been recorded within 50 km of the Project footprint (AoLA 2020). The nearest specimen backed record exists 65 km north-west of the Project footprint (north of Goondiwindi). The Yakka skink is known to occur in open dry sclerophyll forest, woodland and scrub. It occurs in a wide variety of vegetation types within Queensland Regional Ecosystem Land Zones (LZ) including: ■ LZ 3 - Alluvium (river and creek flats) ■ LZ 4 - Clay plains not associated with current alluvium ■ LZ 5 - Old loamy and sandy plains ■ LZ 7 - Ironstone jump-ups ■ LZ 9 - Undulating country on fine-grained sedimentary rocks	The following REs (remnant) are considered to constitute potential habitat for the species as they have been identified as forests, woodlands or shrublands on LZ 3, 4, 5, 7, 9 or 10 that include one or more of the following species <i>Eucalyptus crebra</i>, <i>Eucalyptus fibrosa</i>, <i>Eucalyptus melanophloia</i>, <i>Eucalyptus populnea</i>, <i>Allocasuarina luehmannii</i>, <i>Casuarina cristata</i>, <i>Callitris glaucophylla</i>, <i>Acacia aneura</i>, <i>Acacia catenulata</i>, <i>Acacia shirleyi</i> and <i>Acacia harpophylla</i>: 11.3.1, 11.3.1b, 11.3.2, 11.3.4, 11.3.6, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.29, 11.3.30, 11.3.36, 11.3.39, 11.4.2, 11.4.7, 11.4.8, 11.4.9, 11.4.9a, 11.4.12, 11.5.1, 11.5.2, 11.5.3, 11.5.4, 11.5.5, 11.5.5a, 11.5.5b, 11.5.5c, 11.5.9, 11.5.9a, 11.5.9b, 11.5.9c, 11.5.13, 11.5.14a, 11.5.16, 11.5.20, 11.7.1, 11.7.4, 11.7.7, 11.9.1, 11.9.2, 11.9.7, 11.9.9, 11.9.10, 11.9.11, 11.9.12, 11.9.14, 11.10.1d, 11.10.4a, 11.10.4b, 11.10.4c, 11.10.6, 11.10.7, 11.10.7a, 11.10.9, 11.10.11.	The <i>Draft Referral guidelines for the nationally listed Brigalow Belt reptiles</i> (DSEWPac 2011) describe 'important habitat' under Section 5 of the guidelines. Portions of the impact assessment area has been identified as important habitat for this species as defined in Section 5 of the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles: ■ Any contiguous patch of suitable habitat, particularly remnant vegetation,	Not applicable

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				■ LZ 10 - Sandstone ranges. Tree species most commonly associated with the Yakka skink include: <i>Eucalyptus crebra</i>, <i>Eucalyptus fibrosa</i>, <i>Eucalyptus melanophloia</i>, <i>Eucalyptus populnea</i>, <i>Allocasuarina luehmannii</i>, <i>Casuarina cristata</i>, <i>Callitris glaucophylla</i>, <i>Acacia aneura</i>, <i>Acacia catenulate</i>, <i>Acacia shirleyi</i> and <i>Acacia harpophylla</i>. This species shelters at the base of stumps, piles of logs and fallen wood and under rocks.	<i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat</i>	where a colony is known or identified ■ Any microhabitat where colonies are likely to be found. Therefore, any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Important habitat (excluding areas that fall outside of identified vegetation communities).	
Invertebrates/ Camaenidae	<i>Adclarkia cameroni</i>	Brigalow woodland snail	E	DAWE habitat mapping for the species (2020) within the impact assessment area indicates the species as 'likely to occur' on the Condamine floodplain (south of Pittsworth), and as 'may occur' from Millmerran to approximately Southbrook (north of Pittsworth). However, there is only one current database record (i.e. AoLA, WildNet) (approximately 38 km north-west of Toowoomba) for this species within 50 km of the Project footprint.	All remnant forest/woodland habitat (Herbarium 10.1) on the black soils of the Condamine river floodplain are considered to be potential habitat for the species. <i>Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.</i>	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Class/Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions ¹	GIS habitat modelling instructions		
					Potential Habitat	Important Habitat	Habitat critical to the survival of the species
				The Brigalow woodland snail is restricted to the black soils of the Condamine river floodplain (TSSC 2016). Suitable habitat includes remnant Brigalow woodland and eucalypt woodlands. *Note: the similar <i>Adclarkia dulacca</i> is restricted to an area bound by Dulacca, Miles and Meandarra and therefore not modelled.			
Birds/ Apodidae	<i>Hirundapus caudacutus</i>	White-throated needletail	M, V	DAWE habitat mapping for the species (2020) within the impact assessment area indicates the species as 'likely to occur' east of Inglewood, and as 'may occur' further west. Database records (i.e. AoLA) occur within the impact assessment area between Yelarbon and Inglewood, and in the vicinity of Millmerran, Pittsworth and Gowrie. Aerial insectivore, ubiquitous. Breeds only in the northern hemisphere.	All areas located outside of mapped remnant vegetation communities are potential habitat, includes non-remnant vegetation and cleared areas.	All areas mapped as remnant vegetation (Category B regulated vegetation).	Not applicable

Table notes:

CE = Critically endangered E = Endangered V = Vulnerable NT = Near threatened C = Least concern

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6.2 Fauna species – conservation significant species

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APPENDIX

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Matters of National Environmental Significance Technical Report

Appendix B Species and Community Profiles

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

Appendix B

Species and Community Profiles

Inland Rail Border to Gowrie EIS

Appendix B - Species and
Community Profiles

**Australian Rail Track
Corporation**

Reference: 3100

Contents

1	Species and community profiles.....	1
2	Threatened ecological communities.....	2
2.1	Brigalow (<i>Acacia harpophylla</i> dominant and co dominant)	2
2.2	Coolibah – Black box woodlands of the Darling Riverine Plains and the Brigalow belt south bioregions	5
2.3	Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	8
2.4	Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar bioregions	11
2.5	Weeping Myall woodlands.....	15
2.6	White box-yellow box-Blakely's red gum grassy woodland and derived native grassland (also known as Box-gum grassy woodland and derived grassland)	18
3	Flora species	24
3.1	<i>Androcalva procumbens</i>	24
3.2	Austral cornflower (<i>Rhaponticum australe</i>)	26
3.3	Austral toadflax (<i>Thesium australe</i>).....	28
3.4	Belson's panic (<i>Homopholis belsonii</i>).....	31
3.5	<i>Bertya opposens</i>	35
3.6	Blotched sarcochilus (<i>Sarcochilus weinthalii</i>)	39
3.7	Bluegrass (<i>Dichanthium setosum</i>).....	43
3.8	Brush sophora (<i>Sophora fraseri</i>)	47
3.9	Hawkweed (<i>Picris evae</i>)	52
3.10	King blue-grass (<i>Dichanthium queenslandicum</i>)	56
3.11	Ooline (<i>Cadellia pentastylis</i>).....	60
3.12	<i>Prostanthera</i> sp. Dunmore (D.M. Gordon 8A)	64
3.13	Shiny-leaved ironbark (<i>Eucalyptus virens</i>)	66
3.14	Stream clematis (<i>Clematis fawcettii</i>)	68
3.15	Tara wattle (<i>Acacia lauta</i>).....	73
3.16	Slender tylophora (<i>Tylophora linearis</i>)	76
3.17	Wandering pepper-cress (<i>Lepidium peregrinum</i>).....	78
3.18	Westringia parvifolia	82
3.19	Winged pepper-cress (<i>Lepidium monoplacoides</i>)	85
3.20	Xerothamnella herbacea	88
3.21	Hairy-joint grass (<i>Arthraxon hispidus</i>)	91
3.22	Bunya Mountains bluegrass (<i>Bothriochloa bunyensis</i>)	94
3.23	Miniature moss-orchid (<i>Bulbophyllum globuliforme</i>)	97
3.24	Durikai mallee (<i>Eucalyptus infera</i>).....	100
3.25	Coolmunda leucopogon (<i>Leucopogon</i> sp. Coolmunda) (D. Halford Q 1635)	103
3.26	Queensland nut tree (<i>Macadamia integrifolia</i>)	105
3.27	Macrozamia conferta	109
3.28	Macrozamia machinii.....	111
3.29	Mt. Berryman phebalium (<i>Phebalium distans</i>)	113
3.30	<i>Microcarpaea agonis</i>	116
3.31	Kogan waxflower (<i>Philotheca sporadica</i>)	119
3.32	Waxy sarcochilus (<i>Sarcochilus hartmannii</i>).....	122
4	Fauna species – threatened species – invertebrates.....	126
4.1	Brigalow woodland snail (<i>Adclarkia cameroni</i>).....	126
4.2	Dulacca woodland snail (<i>Adclarkia dulacca</i>)	128

5	Fauna species – threatened species – fish	131
5.1	Murray cod (<i>Maccullochella peelii</i>)	131
5.2	Silver perch (<i>Bidyanus bidyanus</i>)	135
5.3	Mary River cod (<i>Maccullochella mariensis</i>)	139
6	Fauna species – threatened species – reptiles	142
6.1	Border thick-tailed gecko (<i>Uvidicolus sphyrurus</i>)	142
6.2	Collared delma (<i>Delma torquata</i>)	145
6.3	Condamine earless dragon (<i>Tympanocryptis condaminensis</i>)	149
6.4	Dunmall's snake (<i>Furina dunmali</i>)	153
6.5	Long-legged worm-skink (<i>Anomalopus mackayi</i>).....	155
6.6	Yakka skink (<i>Egernia rugosa</i>).....	159
6.7	Bell's turtle (<i>Wollumbinia belli</i>).....	162
7	Fauna species – threatened species – mammals.....	166
7.1	Brush-tailed rock-wallaby (<i>Petrogale penicillata</i>)	166
7.2	Greater glider (<i>Petauroides volans</i>).....	171
7.3	Grey-headed flying-fox (<i>Pteropus poliocephalus</i>)	174
7.4	Koala (<i>Phascolarctos cinereus</i>).....	177
7.5	Large-eared pied bat (<i>Chalinolobus dwyeri</i>)	181
7.6	New Holland mouse (<i>Pseudomys novaehollandiae</i>).....	185
7.7	Northern quoll (<i>Dasyurus hallucatus</i>)	189
7.8	South-eastern long-eared bat (<i>Nyctophilus corbeni</i>).....	193
7.9	Spotted-tail quoll (southeastern mainland population) (<i>Dasyurus maculatus maculatus</i>) ...	197
7.10	Long-nosed potoroo (SE mainland) (<i>Potorous tridactylus tridactylus</i>)	202
8	Fauna species – threatened species – birds	206
8.1	Australasian bittern (<i>Botaurus poiciloptilus</i>)	206
8.2	Australian painted snipe (<i>Rostratula australis</i>).....	210
8.3	Black-breasted button-quail (<i>Turnix melanogaster</i>)	214
8.4	Black-throated finch (<i>Poephila cincta cincta</i>)	219
8.5	Grey falcon (<i>Falco hypoleucos</i>).....	224
8.6	Painted honeyeater (<i>Grantiella picta</i>)	226
8.7	Red goshawk (<i>Erythrotriorchis radiatus</i>)	230
8.8	Regent honeyeater (<i>Anthochaera phrygia</i>)	234
8.9	Squatter pigeon (<i>Geophaps scripta scripta</i>).....	238
8.10	Swift parrot (<i>Lathamus discolor</i>).....	242
8.11	Curlew sandpiper (<i>Calidris ferruginea</i>)	246
8.12	White-throated needletail (<i>Hirundapus caudacutus</i>)	250

Figures

Figure 2.1	Distribution range of Brigalow TEC
Figure 2.2	Distribution range of Coolibah TEC
Figure 2.3	Distribution range of Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC
Figure 2.4	Distribution range of semi-evergreen vine thicket TEC
Figure 2.5	Distribution range of Weeping Myall woodland TEC
Figure 2.6	Distribution range of White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC
Figure 3.1	Distribution range of <i>A. procumbens</i>
Figure 3.2	Distribution range of <i>A. procumbens</i> in relation to the Project
Figure 3.3	Distribution range of the Austral cornflower
Figure 3.4	Distribution range of the Austral cornflower in relation to the Project
Figure 3.5	Distribution range of the Austral toadflax

Figure 3.6	Distribution range of the Austral toadflax in relation to the Project
Figure 3.7	Distribution range of Belson's panic
Figure 3.8	Distribution range of Belson's panic in relation to the Project
Figure 3.9	Distribution range of the <i>B. opponens</i>
Figure 3.10	Distribution range of the <i>B. opponens</i> in relation to the Project
Figure 3.11	Distribution range of Blotched sarcochilus
Figure 3.12	Distribution range of Blotched sarcochilus in relation to the Project
Figure 3.13	Distribution range of bluegrass
Figure 3.14	Distribution range of bluegrass in relation to the Project
Figure 3.15	Distribution range of the Brush sophora
Figure 3.16	Distribution range of the Brush sophora in relation to the Project
Figure 3.17	Distribution range of the Hawkweed
Figure 3.18	Distribution range of the Hawkweed in relation to the Project
Figure 3.19	Distribution range of King blue-grass
Figure 3.20	Distribution range of King blue-grass in relation to the Project
Figure 3.21	Distribution range of Ooline
Figure 3.22	Distribution range of Ooline in relation to the Project
Figure 3.23	Distribution range of the <i>Prostanthera</i> sp. Dunmore (D.M. Gordon 8A)
Figure 3.24	Distribution range of the <i>Prostanthera</i> sp. Dunmore (D.M. Gordon 8A) in relation to the Project
Figure 3.25	Distribution range of Shiny-leaved ironbark
Figure 3.26	Distribution range of Shiny-leaved ironbark in relation to the Project
Figure 3.27	Distribution range of Stream clematis
Figure 3.28	Distribution range of Stream clematis in relation to the Project
Figure 3.29	Distribution range of the Tara wattle
Figure 3.30	Distribution range of the Tara wattle in relation to the Project
Figure 3.31	Distribution range of <i>T. linearis</i>
Figure 3.32	Distribution range of <i>T. linearis</i> in relation to the Project
Figure 3.33	Wandering pepper-cress (<i>Lepidium peregrinum</i>)
Figure 3.34	Distribution range of the Wandering pepper-cress
Figure 3.35	Distribution range of the Wandering pepper-cress in relation to the Project
Figure 3.36	Distribution range of <i>Westringia parvifolia</i>
Figure 3.37	Distribution range of <i>Westringia parvifolia</i> in relation to the Project
Figure 3.38	Distribution range of the Winged pepper-cress
Figure 3.39	Distribution range of the Winged pepper-cress in relation to the Project
Figure 3.40	Distribution range of <i>Xerothamnella herbacea</i>
Figure 3.41	Distribution range of <i>Xerothamnella herbacea</i> in relation to the Project
Figure 3.42	Distribution range of Hairy-joint grass
Figure 3.43	Distribution range of Hairy-joint grass in relation to the Project
Figure 3.44	Bunya Mountains bluegrass (<i>Bothriochloa bunyensis</i>)
Figure 3.45	Distribution range of Bunya Mountains bluegrass
Figure 3.46	Distribution range of Bunya Mountains bluegrass in relation to the Project
Figure 3.47	Occurrence record of Miniature moss-orchid
Figure 3.48	Occurrence record of Miniature moss-orchid in relation to the Project
Figure 3.49	Distribution range of Durikai Mallee
Figure 3.50	Distribution range of Durikai Mallee in relation to the Project
Figure 3.51	Distribution range of Leucopogon sp. Coolmunda (D.A. Halford Q1635)
Figure 3.52	Distribution range of Leucopogon sp. Coolmunda (D.A. Halford Q1635) in relation to the Project
Figure 3.53	Distribution range of Queensland nut tree
Figure 3.54	Distribution range of Queensland nut tree in relation to the Project
Figure 3.55	Distribution range of <i>M. conferta</i>
Figure 3.56	Distribution range of <i>M. conferta</i> in relation to the Project
Figure 3.57	Distribution range of <i>M. machinii</i>
Figure 3.58	Distribution range of <i>M. machinii</i> in relation to the Project

Figure 3.59	Distribution range of Mt. Berryman phebalium
Figure 3.60	Distribution range of Mt. Berryman phebalium in relation to the Project
Figure 3.61	Occurrence record of <i>Microcarpaea agonis</i>
Figure 3.62	Occurrence record of <i>Microcarpaea agonis</i> in relation to the Project
Figure 3.63	Distribution range of the Kogan waxflower
Figure 3.64	Distribution range of the Kogan waxflower in relation to the Project
Figure 3.65	Distribution range of Waxy sarcochilus
Figure 3.66	Distribution range of Waxy sarcochilus in relation to the Project
Figure 4.1	Distribution range of Brigalow woodland snail
Figure 4.2	Distribution range of Brigalow woodland snail in relation to the Project
Figure 4.3	Distribution range of Dulacca woodland snail
Figure 4.4	Distribution range of Dulacca woodland snail in relation to the Project
Figure 5.1	Distribution range of Murray cod
Figure 5.2	Distribution range of Murray cod
Figure 5.3	Distribution range of Silver perch
Figure 5.4	Distribution range of Silver perch in relation to the Project
Figure 5.5	Distribution range of the Mary River cod
Figure 5.6	Distribution range of the Mary River cod in relation to the Project
Figure 6.1	Distribution range of Border thick-tailed gecko
Figure 6.2	Distribution range of Border thick-tailed gecko in relation to the Project
Figure 6.3	Distribution range of the Collared delma
Figure 6.4	Distribution range of the Collared delma in relation to the Project
Figure 6.5	Distribution range of the Condamine earless dragon
Figure 6.6	Distribution range of the Condamine earless dragon in relation to the Project
Figure 6.7	Distribution range of the Dunmall's snake
Figure 6.8	Distribution range of the Dunmall's snake in relation to the Project
Figure 6.9	Distribution range of the Long-legged worm-skink
Figure 6.10	Distribution range of the Long-legged worm-skink in relation to the Project
Figure 6.11	Distribution range of the Yakka skink
Figure 6.12	Distribution range of the Yakka skink in relation to the Project
Figure 6.13	Distribution range of the Bell's turtle
Figure 6.14	Distribution range of the Bell's Turtle in relation to the Project
Figure 7.1	Distribution range of the Brush-tailed rock-wallaby
Figure 7.2	Distribution range of the Brush-tailed rock-wallaby in relation to the Project
Figure 7.3	Distribution range of the Greater glider
Figure 7.4	Distribution range of the Greater glider in relation to the Project
Figure 7.5	Distribution range of the Grey-headed flying-fox
Figure 7.6	Distribution range of the Grey-headed flying-fox in relation to the Project
Figure 7.7	Distribution range of Koala
Figure 7.8	Distribution range of Koala in relation to the Project
Figure 7.9	Distribution range of the Large-eared pied bat
Figure 7.10	Distribution range of the Large-eared pied bat in relation to the Project
Figure 7.11	Distribution range of New Holland mouse
Figure 7.12	Distribution range of New Holland mouse
Figure 7.13	Distribution range of the Northern quoll
Figure 7.14	Distribution range of the Northern quoll in relation to the Project
Figure 7.15	Distribution range of the Southeastern long-eared bat
Figure 7.16	Distribution range of the Southeastern long-eared bat in relation to the Project
Figure 7.17	Distribution range of the Spotted-tail quoll (southern subspecies)
Figure 7.18	Distribution range of the Spotted-tail quoll (southern subspecies) in relation to the Project
Figure 7.19	Distribution range of the Long-nosed potoroo (SE Mainland)
Figure 7.20	Distribution range of the Long-nosed potoroo (SE Mainland) in relation to the Project
Figure 8.1	Distribution range of the Australasian bittern
Figure 8.2	Distribution range of the Australasian bittern in relation to the Project
Figure 8.3	Distribution range of the Australian painted snipe

Figure 8.4	Distribution range of the Australian painted snipe in relation to the Project
Figure 8.5	Distribution range of the Black-breasted button-quail
Figure 8.6	Distribution range of the Black-breasted button-quail in relation to the Project
Figure 8.7	Distribution range of the Black-throated finch
Figure 8.8	Distribution range of the Black-throated finch in relation to the Project
Figure 8.9	Distribution range of the Grey falcon
Figure 8.10	Distribution range of the Grey falcon in relation to the Project
Figure 8.11	Distribution range of the Painted honeyeater
Figure 8.12	Distribution range of the Painted honeyeater in relation to the Project
Figure 8.13	Distribution range of Red goshawk
Figure 8.14	Distribution range of Red goshawk in relation to the Project
Figure 8.15	Distribution range of the Regent honeyeater
Figure 8.16	Distribution range of the Regent honeyeater in relation to the Project
Figure 8.17	Distribution range of the southern Squatter pigeon
Figure 8.18	Distribution range of the southern Squatter pigeon in relation to the Project
Figure 8.19	Distribution range of Swift parrot
Figure 8.20	Distribution range of Swift parrot in relation to the Project
Figure 8.21	Distribution range of the Curlew sandpiper
Figure 8.22	Distribution range of the Curlew sandpiper in relation to the Project
Figure 8.23	Distribution range of the White-throated needletail
Figure 8.24	Distribution range of the White-throated needletail in relation to the Project

1 Species and community profiles

This document presents profiles for ecological communities and species that have been considered in the ecological assessment for the Border to Gowrie Project. Profiles are presented for the following:

- Threatened ecological communities
- Threatened flora
- Threatened fauna
 - Invertebrates
 - Fish
 - Reptiles
 - Mammals
 - Birds.

In each of the profiles, commentary is provided on the distribution of the community or species in relation to the Project. This commentary is based on the distribution for each community or species as indicated by the predictive habitat mapping that has been developed as part of the Border to Gowrie Project Environmental Impact Statement. This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design. The reported distribution of communities or species will be amended, as required, following the completion of the detailed ecological surveys.

2 Threatened ecological communities

2.1 Brigalow (*Acacia harpophylla* dominant and co dominant)

2.1.1 Status

EPBC Act – Endangered

2.1.2 Ecology

2.1.2.1 Characteristic and defining features

Brigalow Threatened Ecological Community (TEC) is a low woodlands or forest communities dominated by Brigalow (*Acacia harpophylla*), with pockets of Belah (*Casuarina cristata*) and Poplar Box (*Eucalyptus populnea* subsp. *bimbi*). The canopy tends to be quite dense and the understorey and ground cover are only sparse (refer Photograph 2.1). The height of the tree layer varies from about 9 m in low rainfall areas (averaging around 500 mm per annum) to around 25 m in higher rainfall areas (averaging around 750 mm per annum). This community has been extensively cleared for agriculture, with most surviving remnants along roadsides and paddock edges (Butler 2007; OEH 2017).



Photograph 2.1 Brigalow TEC

In Queensland, Brigalow TEC occur within the following 16 regional ecosystems REs:

- 6.4.2 *Casuarina cristata* +/- *Acacia harpophylla* open forest on clay plains
- 11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains
- 11.4.3 *Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains
- 11.4.7 Open forest of *Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* on Cainozoic clay plains
- 11.4.8 *Eucalyptus cambageana* open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
- 11.4.9 *Acacia harpophylla* shrubby open forest with *Terminalia oblongata* on Cainozoic clay plains
- 11.4.10 *Eucalyptus populnea* or *E. pilligaensis*, *Acacia harpophylla*, *Casuarina cristata* open forest on margins of Cainozoic clay plains

- 11.5.16 *Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces
- 11.9.1 *Acacia harpophylla*-*Eucalyptus cambageana* open forest on Cainozoic fine-grained sedimentary rocks
- 11.9.5 *Acacia harpophylla* and/or *Casuarina cristata* open forest on Cainozoic fine-grained sedimentary rocks
- 11.9.6 *Acacia melvillei* ± *A. harpophylla* open forest on Cainozoic fine-grained sedimentary rocks
- 11.11.14 *Acacia harpophylla* open forest on deformed and metamorphosed sediments and interbedded volcanics
- 11.12.21 *Acacia harpophylla* open forest on igneous rocks; colluvial lower slopes
- 12.8.23 *Acacia harpophylla* open forest on Cainozoic igneous rocks
- 12.9-10.6 *Acacia harpophylla* open forest on sedimentary rocks
- 12.12.26 *Acacia harpophylla* open forest on Mesozoic to Proterozoic igneous rocks (TSSC 2001).

2.1.2.2 Known distribution

Brigalow TEC extend from south of Charters Towers in Queensland, in a broad swathe east of Blackall, Charleville and Cunnamulla, south to northern NSW near Narrabri and Bourke (refer Figure 2.1). In Queensland, it occurs predominantly within the Brigalow Belt North, Brigalow Belt South, Darling Riverine Plains and Southeast Queensland bioregions. In NSW, remnants of Brigalow TEC mostly occur north of Burke, west of Narrabri and north of Moree (Butler 2007).

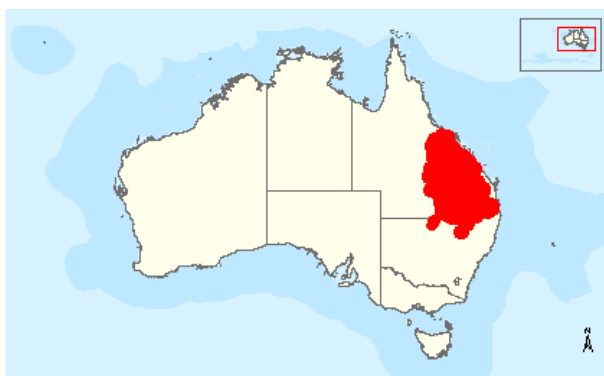


Figure 2.1 Distribution range of Brigalow TEC

Source: DotEE (2018)

2.1.2.3 Distribution in relation to the Project

The Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC has been identified as occurring within the impact assessment area. Approximately 503.65 ha of this TEC is estimated to occur within the impact assessment area and 62.86 ha is identified as potentially occurring within the Project footprint.

2.1.3 Threatening processes

The following have been identified as potentially threatening processes to Brigalow TEC:

- Land clearing and fragmentation
- Invasion and establishment of weed species
- Overgrazing by domestic stock
- Changes in hydrological regimes
- Spray drift of herbicides and pesticides

- Fragmentation resulting in edge effects and risk of loss of small, scattered remnants
- Clearing and damage from road and rail maintenance activities
- Lack of viability of seed set
- Lack of pollinators
- Logging for fence posts (OEH 2017).

2.1.4 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this community. The following approved conservation advice has been identified for this community:

- Department of the Environment (2013). Approved Conservation Advice for the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community. Canberra: Department of the Environment. Available from:
<http://www.environment.gov.au/biodiversity/threatened/communities/pubs/028-conservation-advice.pdf>. In effect under the EPBC Act from 17-Dec-2013.

2.1.5 Summary of threat abatement/recovery plans

The threats outlined in the conservation advice for Brigalow (*Acacia harpophylla* dominant and co dominant) include:

- Land clearing as most of the habitat occurs as fragments within substantially modified landscapes. Mining in the Bowen Basin and logging for fence posts in the Brigalow Belt South, Nandewar and Darling Riverine Plains bioregions of NSW continue to be major threats to this TEC
- Fire has become a risk for this TEC through the incursion of exotic pasture grasses. Fire has been historically rare in the type of vegetation. If climate change is to increase temperatures and create drier conditions this will increase the susceptibility of brigalow to the impacts of fire
- Weeds can adversely impact the structure and function of brigalow ecosystems making them less suitable for native species. Exotic grasses increase the fire load within brigalow drawing fire into the ecosystem during a fire event and increasing the fire severity
- Feral pigs are probably the most widespread and problematic pest animal within brigalow however goats, cane toads, cats and foxes also pose a serious threat. The Noisy miner (*Manorina melanoccephala*) have become a native pest excluding other native bird species where they share habitat
- Inappropriate grazing regimes altering soil structure, leaf litter and woody debris. Grazing also alters the vegetation structure of herbs and shrubs in the understorey and prevent new recruitment and growth of shrubs and trees
- Climate change will present conditions different to those which have historically been encountered within the range of this TEC. Species associated with this TEC will be vulnerable to the effects of hotter, drier conditions with fragments so isolated with such little connectivity that species will struggle to move further afield to find more resources. Flora may be subject to increased frequency and intensity of fire in hotter and drier conditions.

Objectives and actions outlined in the conservation advice for Brigalow (*Acacia harpophylla* dominant and co dominant) include:

- Prevent the clearing of this TEC where it occurs as fragments and regrowth. If clearing of brigalow is required mitigate impacts by avoiding high quality fragments and avoid dissection of fragments
- Manage both vertebrate pests and exotic flora incursion targeting high biomass of exotic grasses within brigalow ecological communities and surrounding areas avoiding the application of fertiliser, tree thinning and soil disturbance

- Manage grazing pressure to allow regeneration of microhabitat that is provided from shrubs and understorey vegetation to give other woodland bird species the opportunity to avoid aggression from Noisy miners
- Encourage land managers to conserve native flora and fauna within and close to this TEC by managing stock rates, leaving trees and regrowth in paddocks to provide connectivity between patches, connecting shade-lines keeping them as wide as possible and allowing standing dead trees, ground timber and leaf litter to rot where it falls
- Undertake regeneration of high value sites and revegetation of degraded sites increasing the size of community managed land for conservation through conservation agreements with landholders and establishing adequate buffer zones to protect remnants
- Devise and implement water management, sediment erosion and pollution control along with monitoring plans
- Develop and disseminate conservation information in conjunction with land managers, local/state authorities and indigenous groups to establish sustainable management guidelines and technical material to address fire management, plant pathogens, invasive animal management and weed management.

2.1.6 References

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2.2 Coolibah – Black box woodlands of the Darling Riverine Plains and the Brigalow belt south bioregions

2.2.1 Status

EPBC Act – Endangered

2.2.2 Ecology

2.2.2.1 Characteristic and defining features

Coolibah TEC is a semi-arid to humid subtropical woodlands dominated by *Eucalyptus coolabah* subsp. *coolabah* and/or *Eucalyptus largiflorens* (Black Box) with a grassy understorey. The mid or shrub layer may or may not be present. When present it is typically sparse or clumped and is of variable composition. The ground layer is of variable composition and cover ranging from sparse to dense (refer Photograph 2.2). It typically occurs on grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands and stream levees (DSEWPC 2011).



Photograph 2.2 Coolibah TEC

Source: Elliot (2015)

In Queensland, Coolibah TEC occur within the following REs:

- 11.3.3 - *Eucalyptus coolabah* woodland on alluvial plains
- 11.3.16 - *Eucalyptus largiflorens*, ± *Acacia cambagei* ± *A. harpophylla* woodland to low open woodland on alluvial plains
- 11.3.28 - *Eucalyptus coolabah* ± *Casuarina cristata* open woodland on alluvial plains
- 11.3.37 - *Eucalyptus coolabah* fringing woodland on alluvial plains (DSEWPC 2011).

2.2.2.2 Known distribution

Coolibah TEC are situated within the upper reaches of the Murray-Darling Basin and southern part of the Fitzroy River system and are limited to the Darling Riverine Plains and Brigalow Belt South bioregions, situated in northern NSW and southern Queensland (DSEWPC 2011) (refer Figure 2.2).



Figure 2.2 Distribution range of Coolibah TEC

Source: DotEE (2018)

2.2.2.1 Distribution in relation to the Project

Whilst the Coolibah – Black Box Woodland of the Darling Riverine Plains TEC has been predicted to occur within the region, however it has not been predicted to occur within the impact assessment area or within the Project footprint.

2.2.3 Threatening processes

The following have been identified as potentially threatening processes Coolibah TEC:

- Grazing, cropping and pasture improvement
- Weeds and pest animals
- Mining activities and construction of roads and other infrastructure
- Hydrological changes
- Changes in fire regime (DSEWPC 2011).

2.2.4 Threat abatement/recovery plans

No threat abatement/recovery plans have been identified as being relevant for this community.

The following threat abatement plan has been identified as being relevant for this community:

- Saving our species: Help save Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions.

2.2.5 Summary of threat abatement/recovery plans

Threats specific to Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions in the strategy include:

- Land clearing for infrastructure, rural and agricultural development and associated activities
- Lack of recruitment in some areas, particularly east of Walgett
- Herbicide and pesticide drift
- Overgrazing and trampling causing loss of flora species and structural diversity, particularly in the understorey and ground layer resulting in erosion and changes in soil structure
- Incursion by exotic flora including Lippia, African boxthorn and particularly Hudson's pear, which has the potential to severely degrade this TEC
- Changes to hydrological processes impacting flooding regimes as a result of drainage works resulting in less frequent flooding events which impacts recruitment.

Objectives and actions outlined in the threat abatement plan for Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions include:

- Where this TEC occurs on private properties provide residents with information about how to identify TEC plant species and inform them of the impacts through stakeholder engagement forums, information packages and other community engagement means
- Consult with landholders about adopting a Volunteer Conservation Agreement or similar form of long-term in perpetuity conservation/stewardship agreement to protect the TEC on their property
- Retain hollow trees, plant native hollow producing species ensuring they are left to grow to maturity, as a last resort install artificial hollows in areas where natural hollows are currently lacking
- Encourage landholders to retain standing dead trees, fallen trees, coarse woody debris and logs in remnant patches
- Protect cultural heritage scar trees within the TEC consulting with the Aboriginal community and NSW government
- Install exclusion fencing to protect areas from grazing and foster natural regeneration
- Encourage land managers to regenerate or revegetate cleared areas of the TEC to improve connectivity and overall condition encouraging natural revegetation where possible if groundcover and over-storey is still present. Planting in a continues, stepping stone or buffering approach
- Provide appropriate stakeholders information regarding pesticide choice and application methods encouraging the retention of buffers around the TEC to protect from spray drift along with encouraging early weed identification, intervention and prevention in line with best practice management strategies
- Provide advice to Water NSW on the importance in providing natural flow regimes for the TEC and reinstate appropriate hydrological regimes by infilling drains installing smart gates.

2.2.6 References

Department of Sustainability, Environment, Water, Population and Communities (2011). Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions in Community and Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra [Accessed 31 August 2018].

Department of the Environment and Energy (2018). Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: <http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=66> [Accessed 31 August 2018].

Elliot, D. (2015). Coolibah – Black box woodlands of the Darling Riverine Plains and the Brigalow belt south bioregions [image] [online] Available from: <https://www.flickr.com/photos/drelliott0net/20918518819/in/photolist-8Hc8kk-8Hfaqb-8Hfe4L-dhXpRE-8Hc4Dr-Nr4bvD-2KjDHT-8uYQhD-8v2SEu-8uYQca-NzJdL-xSuSRz/>. [18 September 2019].

2.3 Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland

2.3.1 Status

EPBC Act – Critically endangered

2.3.2 Ecology

2.3.2.1 Characteristic and defining features

The Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC occurs on basalt and fine-textured alluvial plains of northern NSW and southern Queensland. Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC change with seasonal conditions and are dominated by perennial tussock grasses such as Mitchell grasses (*Astrebla* spp.), Plains grass (*Austrostipa aristiglumis*), Queensland blue grass (*Dichanthium sericeum*), Kangaroo grass (*Themeda australis*), Yabbila (*Panicum queenslandicum*) or one of 13 other indicator grass species (refer Photograph 2.3). The composition of the grassland will change according to seasonal rainfall, temperature, fire and management. The TEC occurs on plains with a slope less than 5 degrees. The communities have very few trees or shrubs, but will have a diversity of herb species including legumes, orchids, daisies and lilies (OEH 2014).



Photograph 2.3 Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC

In Queensland, this TEC is considered to be analogous to the following regional ecosystems REs:

- 11.3.21 *Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains (cracking clay soils)
- 11.3.24 *Themeda avenacea* grassland on alluvial plains (basalt derived soils) (TSSC 2010).

2.3.2.2 Known distribution

The natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC can be found on the Liverpool Plains and the Moree Plains of NSW and the Darling Downs of Queensland (OEH 2014) (refer Figure 2.3).

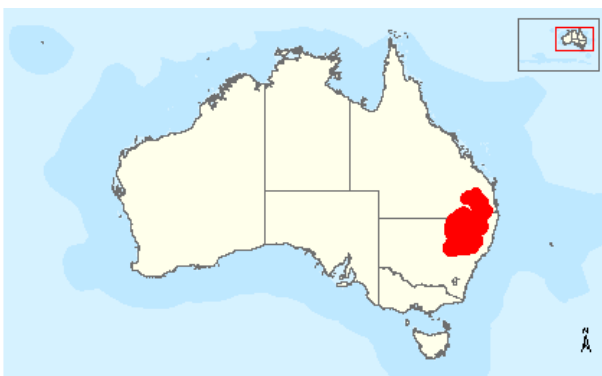


Figure 2.3 Distribution range of Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC

Source: DotEE (2018)

2.3.2.3 Distribution in relation to the Project

The natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC has been identified as occurring within the impact assessment area. Approximately 0.95 ha of this TEC is estimated to occur within the impact assessment area and has not been predicted to occur within the Project footprint

2.3.3 Threatening processes

The following have been identified as potentially threatening processes to Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC:

- Clearing for cropping and mining
- Grazing by introduced livestock
- Weed invasion
- Changed flood regimes
- Changed fire regimes
- Feral animals such as pigs (OEH 2014).

2.3.4 Threat abatement/recovery plans

No threat abatement/recovery plans have been identified as being relevant for this community.

The following threat abatement plan has been identified as being relevant for this community:

- Department of the Environment and Energy (2017). Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (2017). Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017>. In effect under the EPBC Act from 18-Mar-2017.

2.3.5 Summary of threat abatement/recovery plans

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pigs (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

2.3.6 References

Department of the Environment and Energy (2018). Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland, Department of the Environment and Energy, Canberra. Available from: <http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=88> [Accessed 3 September 2018].

Office of Environment and Heritage, NSW (2014). Natural Grasslands on Alluvial Plains. Available from: https://northerntablelands.ils.nsw.gov.au/__data/assets/pdf_file/0003/542559/TECfact-NaturalGrassland-LLS.pdf [Accessed 3 September 2018].

Threatened Species Scientific Committee (2010). Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on an Amendment to the list of Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* [Accessed 3 September 2018].

2.4 Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar bioregions

2.4.1 Status

EPBC Act – Endangered

2.4.2 Ecology

2.4.2.1 Characteristic and defining features

Semi-evergreen vine thicket TEC is considered an extreme form of dry seasonal subtropical rainforest. It is generally characterised by the prominence of trees with microphyll sized leaves and the presence of Bottle trees (*Brachychiton* spp.) as emergent. Semi-evergreen vine thicket TEC are generally less than 10 m high, made up of vines and rainforest trees as well as some shrubs (refer Photograph 2.4). The main canopy is dominated by rainforest species such as Red olive plum (*Cassine australis* var. *angustifolia*), Wilga (*Geijera parvifolia*), Native olive (*Notelaea microcarpa* var. *microcarpa*) and Peach bush (*Ehretia membranifolia*). Currant bush (*Carissa ovata*) is often present and typical vines include Gargaloo (*Parsonsia eucalytophylla*) and Wonga vine (*Pandorea pandorana*). The thickets occur in areas with a subtropical, seasonally dry climate on soils of high to medium fertility. It is common on undulating plains on fine grained sedimentary rocks (frequently shale) and on basalt hills and plains (DotEE 2018; OEH 2017; McDonald 1996).



Photograph 2.4 Semi-evergreen vine thicket TEC

In Queensland, Semi-evergreen vine thicket TEC occur within the following REs:

- 11.2.3-Microphyll vine forest ("beach scrub") on sandy beach ridges
- 11.3.11-Semi-evergreen vine thicket on alluvial plains
- 11.4.1-Semi-evergreen vine thicket ± *Casuarina cristata* on Cainozoic clay plains
- 11.5.15-Semi-evergreen vine thicket on Cainozoic sand plains/remnant surfaces
- 11.8.3-Semi-evergreen vine thicket on Cainozoic igneous rocks
- 11.8.6-*Macropteranthes leichhardtii* thicket on Cainozoic igneous rocks
- 11.8.13-Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks
- 11.9.4-Semi-evergreen vine thicket on Cainozoic fine-grained sedimentary rocks
- 11.9.8-*Macropteranthes leichhardtii* thicket on Cainozoic fine-grained sedimentary rocks
- 11.11.18-Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding (TSSC 2001).

2.4.2.2 Known distribution

Semi-evergreen vine thicket TEC extend from the Townsville area in Queensland to northern NSW. It is mostly located within the Brigalow Belt bioregion (refer Figure 2.4). In Queensland, the remnant patches are mostly scattered from coastal dunes and river deltas through the northern and central parts of the Brigalow Belt Bioregion to its southeastern parts between Jandowae and Killarney on the Queensland/NSW border (Queensland Herbarium 2002).

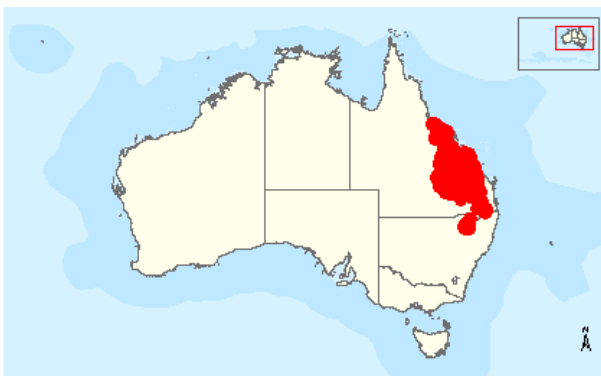


Figure 2.4 Distribution range of semi-evergreen vine thicket TEC

Source: DotEE (2018)

2.4.2.3 Distribution in relation to the Project

Whilst the Semi-evergreen vine thicket TEC has been predicted to occur within the region it has not been predicted to occur within the impact assessment area or within the Project footprint.

2.4.3 Threatening processes

The following have been identified as potentially threatening processes to semi-evergreen vine thicket TEC:

- Fragmentation
- Land clearing
- Inappropriate fire regimes
- Invasion by introduced pasture species and increased grazing (TSSC 2001).

2.4.4 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this community:

- McDonald, W.J.F (2010). National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community. Report to Department of the Environment, Water, Heritage and the Arts, Canberra. Queensland Department of Environment and Resource Management, Brisbane. Available from: <http://www.environment.gov.au/resource/national-recovery-plan-semi-evergreen-vine-thickets-brigalow-belt-north-and-south-and>. In effect under the EPBC Act from 12-Mar-2010.

The following threat abatement plans have been identified as being relevant for this community:

- Department of Sustainability, Environment, Water, Population and Communities (2011). Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/resource/threat-abatement-plan-biological-effects-including-lethal-toxic-ingestion-caused-cane-toads>. In effect under the EPBC Act from 06-Jul-2011.
- Department of the Environment and Energy (2017). Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (2017). Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017>. In effect under the EPBC Act from 18-Mar-2017.

2.4.5 Summary of threat abatement/recovery plans

The threats outlined in the National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community include:

- Broad-scale land clearing of remnant vegetation
- Fire where SEVT is not protected by topography or substrate and where fuel characteristics have been altered by the introduction of introduced pasture grasses
- Incursion by exotic flora including Buffel grass *Pennisetum ciliare*, Green panic *Megathyrsus maximus* var. *pubiglumis*, Parthenium weed *Parthenium hysterophorus*, Velvet tree pear *Opuntia tomentosa*, Lantana *Lantana camara*, Rubber vine *Cryptostegia grandiflora* and Brazilian nightshade *Solanum seaforthianum*. Of these *L. camara* and *C. grandiflora* pose the most serious threat to this TEC.
- Trampling from cattle grazing opening up the understorey of SEVT habitat facilitating the incursion of invasive flora
- Invertebrate pest species including feral pigs, foxes, rabbits and cane toads impacting the vegetation structure and associated native fauna
- Coastal development where remnant vine thicket occurs on coastal beach ridges.

Threat abatement actions outlined in the National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community include:

- Identify and evaluate the extent, biodiversity value and condition of remnant and regrowth areas of this TEC in the Brigalow Belt (North and South) and Nandewar Bioregions
- Complete mapping of this TEC in New South Wales and refine mapping of remnants in Queensland
- Establish a condition assessment methodology establishing benchmark sites for each component regional ecosystem
- Determine the extent and condition of SEVT areas that have been impacted by invasive flora, particularly weeds of national significance
- Survey data deficient species within SEVT communities
- Identify key ecosystem components and processes determining their response to management actions

- Monitor selected populations of EPBC-Act listed species that occur within SEVT communities including *Cadellia pentastylis*, *Cossinia australiana*, *Denhamia parvifolia*, *Macropus dorsalis*, *Paradelma orientalis*, *Turnix melanogaster* and *Zieria verrucosa*
- Establish a comprehensive, adequate and representative system of SEVT ecological community across the Brigalow Belt (North and South) and Nandewar Bioregions, protected by either reservations or conservation agreements (including MOU's)
- Ensure best practice management to sites containing SEVT
- Involve landholders and community members in the conservation and management of SEVT ecological communities
- Enhance the ability of government and non-government organisations at the national, regional and local level (including consent authorities) to recognise and incorporate SEVT ecological community conservation issues into all planning processes.

The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads include:

- Predation by cane toads
- Larval competition with frog tadpoles or mosquitoes
- Parasite transfer
- Competition for terrestrial food
- Competition for shelter sites.

Threat abatement actions for cane toads (*Rhinella marina*) include:

- \$11 million in funding from the Australian Government provided for the development of a broad-scale control method
- \$9 million in funding from the Australian Government for research and management activities
- Identification of native species, ecological communities and off-shore islands that are known to have a high to moderate risk
- Identify the impacts that toads have on listed native species and ecological communities
- Where the impact is expected to be high on native species and ecological communities establish support research techniques in aiding the recovery of priority native species and ecological communities
- Develop a prioritisation tool to aid in the direction of resources for the protection of native species and ecological communities.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pigs (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters

- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

2.4.6 References

Department of the Environment and Energy (2018). Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=24 [Accessed 31 August 2018].

Queensland Herbarium (2002). Environment Protection and Biodiversity Conservation Act Threatened ecological communities 1997 remnant. Unpublished map, Queensland Herbarium, Brisbane.

Threatened Species Scientific Committee (2001). Commonwealth Listing Advice on Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions. Available from: www.ea.gov.au/biodiversity/threatened/communities/sevt.html [Accessed 31 August 2018].

McDonald, W.J.F. (1996). *Spatial and temporal patterns in the dry season subtropical rainforests of eastern Australia, with particular reference to the vine thickets of central and southern Queensland*. PhD thesis, Botany Department, University of New England.

2.5 Weeping Myall woodlands

2.5.1 Status

EPBC Act – Endangered

2.5.2 Ecology

2.5.2.1 Characteristic and defining features

Weeping Myall woodland TEC are predominantly underlain by red-brown earths and heavy textured grey and brown alluvial soils in areas receiving 375 mm to 500 mm of mean annual rainfall. Weeping Myall (*Acacia pendula*) is the dominant overstorey flora species due to its ability to undergo regular cycles of senescence and regeneration, making it often the only tree species in a Weeping Myall woodland TEC (OEH 2017b; DEWHA 2009) (refer Photograph 2.5).

The structure of the community varies between low to open woodland and open shrubland. Understorey structure and composition is affected by latitude with areas south of the Lachlan River district featuring a dominant open layer of chenopod shrubs including saltbushes, native cotton bushes and bluebushes. More woody species and summer grasses including Mitchell grass (*Astrebla* spp.), Queensland blue grass (*Dichanthium sericeum*) as well as Wallaby grass (*Austrodanthonia*) species feature in the northern part of the TEC (DEWHA 2009).



Photograph 2.5 Weeping Myall woodland TEC

Weeping Myall Woodland TEC are typically restricted to small patches and occur within two REs in Queensland:

- 11.3.2 *Eucalyptus populnea* woodland on alluvial plains
- 11.3.28 *Casuarina cristata* ± *Eucalyptus coolabah* open woodland on alluvial plains (DEWHA 2009).

2.5.2.2 Known distribution

The TEC is found inland along alluvial plains west of the Great Dividing Range in NSW and Queensland. Weeping Myall Woodland is found in natural resource management and catchment management authority regions (refer Figure 2.5), including the:

- Border-Rivers-Gwydir catchment management authority region, NSW
- Border Rivers and Maranoa Balonne natural resource management region, QLD
- Condamine natural resource management region, QLD (DEWHA 2009).

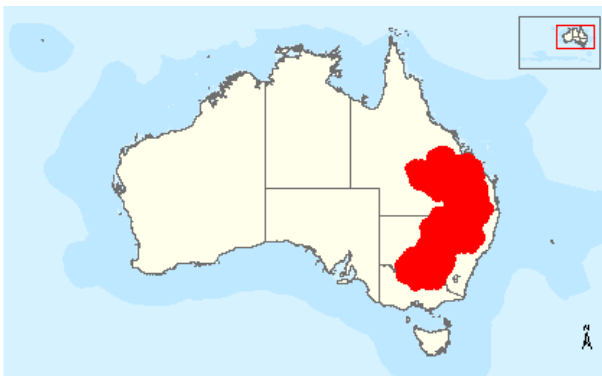


Figure 2.5 Distribution range of Weeping Myall woodland TEC

Source: DotEE (2018)

2.5.2.3 Distribution in relation to the Project

The Weeping Myall Woodland TEC has been identified as occurring within the impact assessment area. Approximately 1736.17 ha of this TEC is estimated to occur within the impact assessment area and 81 ha is identified as potentially occurring within the Project footprint.

2.5.3 Threatening processes

The following have been identified as potentially threatening processes to Weeping Myall woodland TEC:

- Land clearing due to cropping or agriculture
- Land degradation
- Weed invasion and herbivory by caterpillars (DotEE 2018).

2.5.4 Threat abatement/recovery plans

The following threat abatement plan has been identified for this community:

- Office of Environment and Heritage, National Recovery Plan Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley. NSW: Department of Premier and Cabinet. Available from: <https://www.environment.gov.au/system/files/resources/ac38dfdc-df4b-44ea-99b5-e99c016ca34d/files/weeping-myall-recovery-plan.pdf>. This plan has been prepared by the Office of Environment and Heritage, Department of Premier and Cabinet NSW (OEH) in consultation with the Hunter Valley Threatened Flora Recovery Team.

The following threat abatement plan has been identified as being relevant for this community:

- Department of Sustainability, Environment, Water, Population and Communities (2011). *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads*. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/resource/threat-abatement-plan-biological-effects-including-lethal-toxic-ingestion-caused-cane-toads>. In effect under the EPBC Act from 06-Jul-2011.

2.5.5 Summary of threat abatement/recovery plans

Threats identified in the National Recovery Plan Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley include:

- Habitat loss and fragmentation
- Habitat degradation from grazing, weeds, road maintenance and longwall mining
- Long-term consequences of small population size.

Threat abatement actions for Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley include:

- Establishment of a recovery team with various government, industry and research stakeholders
- Development of a status report to assist the drafting of the recovery report
- In-situ protection and habitat management to improve long-term security
- Community education, awareness and involvement
- Conducting surveys and ongoing monitoring
- Identify and minimise threats
- Gain greater insight into the taxonomy of Weeping Myall.

The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads include:

- Predation by cane toads
- Larval competition with frog tadpoles or mosquitoes
- Parasite transfer
- Competition for terrestrial food
- Competition for shelter sites.

Threat abatement actions for cane toads (*Rhinella marina*) include:

- \$11 million in funding from the Australian Government provided for the development of a broad-scale control method
- \$9 million in funding from the Australian Government for research and management activities
- Identification of native species, ecological communities and off-shore islands that are known to have a high to moderate risk
- Identify the impacts that toads have on listed native species and ecological communities
- Where the impact is expected to be high on native species and ecological communities establish support research techniques in aiding the recovery of priority native species and ecological communities
- Develop a prioritisation tool to aid in the direction of resources for the protection of native species and ecological communities.

2.5.6 Reference

Department of the Environment (2018). Weeping Myall Woodlands in Community and Species Profile and Threats Database. Department of the Environment. Canberra. Available from: <http://www.environment.gov.au/sprat> [Accessed 17 August 2018].

Department of the Environment, Water, Heritage and the Arts (2009). Weeping Myall Woodlands. Australian Government. Available from: <http://www.environment.gov.au/system/files/resources/a887e6ec-f4db-4476-8e72-977085028dbd/files/weeping-myall-woodlands.pdf> [Accessed 17 August 2018].

Office of Environment and Heritage (2017). Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Penplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions - profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10973> [Accessed 17 August 2018].

2.6 White box-yellow box-Blakely's red gum grassy woodland and derived native grassland (also known as Box-gum grassy woodland and derived grassland)

2.6.1 Status

EPBC Act – Critically endangered

2.6.2 Ecology

2.6.2.1 Characteristic and defining features

White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC is an open woodland communities, which have a tussock grass layer, patchy shrub layer and tree layer predominantly made up of *Eucalyptus albens*, *E. melliodora* and *E. blakelyi*. Intact sites contain a high diversity of trees, shrubs, climbing plants, grasses and especially herbs. Tree cover is generally discontinuous and consists of widely-spaced trees of medium height (refer Photograph 2.6). This ecological community occurs on moderate to highly fertile soils at altitudes of 170 m to 1,200 m (NSWSC 2002; OEH 2017; Yates and Hobbs 1997).



Photograph 2.6 White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC

In Queensland, White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC is considered to be analogous to the following regional ecosystems REs:

- 11.3.23 *Eucalyptus conica*, *E. tereticornis*, *Angophora floribunda* ± *E. melliodora* ± *E. nobilis* grassy woodland
- 11.8.2a *Eucalyptus tereticornis* and *E. melliodora* occurring on low hills
- 11.8.8 *Eucalyptus albens* ± *E. crebra* ± *E. tereticornis* ± *Callitris baileyi* grassy woodland
- 11.9.9a *Eucalyptus albens* ± *E. crebra* ± *E. tereticornis* ± *Callitris baileyi* woodland
- 12.8.16 *Eucalyptus crebra*, generally with *E. tereticornis* and *E. melliodora* ± *E. albens* grassy woodland (only at the far western edge of the bioregion)
- 13.3.4 *Eucalyptus conica*, *E. microcarpa* or *E. moluccana*, *E. melliodora* grassy woodland
- 13.3.1 *Eucalyptus blakelyi* grassy woodland or open forest +/- *E. bridgesiana* +/- *E. melliodora* on Cainozoic alluvial plains
- 13.11.3 *Eucalyptus crebra*, *E. dealbata*, *E. albens* grassy woodland
- 13.11.4 *Eucalyptus melanophloia*, *E. dealbata*, *E. albens* ± *Callitris glaucophylla* grassy woodland.
- 13.11.8 Woodland of *E. melliodora* and/or *E. microcarpa/moluccana* on rolling hills, depressions and lower slopes around drainage lines
- 13.12.8 Woodland of *E. melliodora* and/or *E. microcarpa/moluccana* +/- *conica*, on undulating plains and lower slopes in granite basins
- 13.12.9 Woodland to open forest of *E. blakelyi* and/or *E. calignosa* or *E. mckieana* on plains and rolling hills in granite basins (TSSC 2006).

2.6.2.2 Known distribution

White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC occur in an arc along the western slopes and tablelands of the Great Dividing Range from southern Queensland through NSW to central Victoria (Beadle 1981) (refer Figure 2.6).

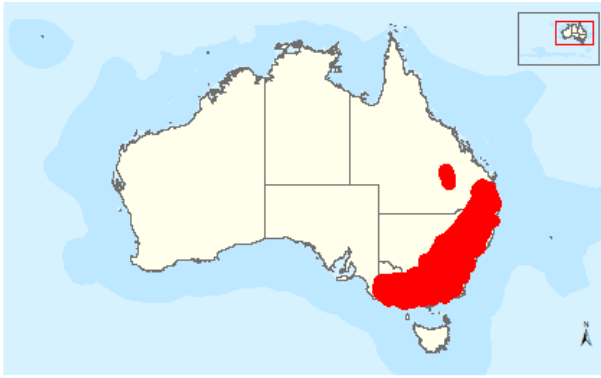


Figure 2.6 Distribution range of White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC

Source: DotEE (2018)

2.6.2.3 Distribution in relation to the Project

The White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC has been identified as occurring within the impact assessment area. Approximately 22.96 ha of this TEC is estimated to occur within the impact assessment area and has not been identified as potentially occurring within the Project footprint.

2.6.3 Threatening processes

The following have been identified as potentially threatening processes to White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC:

- Habitat loss, degradation and fragmentation from agricultural, forestry, mining, infrastructure and residential development
- Degradation by over grazing and trampling
- Degradation of remnants by non-native plant species
- Increased nutrient status due to application of fertilisers to native groundcover
- Altered fire regimes.
- Lack of community knowledge
- Human disturbance by off road vehicles, camping, other recreational activities (OEI 2017).

2.6.4 Threat abatement/recovery plans

The following recovery plan has been identified for this community:

- Department of Environment, Climate Change and Water NSW (2010). *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland*. Department of Environment, Climate Change and Water NSW, Sydney. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/white-box-yellow-box-blakelys-red-gum-grassy-woodland-and-derived-native-grassland-national>. In effect under the EPBC Act from 22-Mar-2013.

The following threat abatement plans has been identified as being relevant for this community:

- Department of Sustainability, Environment, Water, Population and Communities (2011). Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/resource/threat-abatement-plan-biological-effects-including-lethal-toxic-ingestion-caused-cane-toads>. In effect under the EPBC Act from 06-Jul-2011.

- Department of the Environment and Energy (2017). Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (2017). Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017>. In effect under the EPBC Act from 18-Mar-2017.
- Department of the Environment and Energy (2018). Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*. Canberra: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/threat-abatement-plan-disease-natural-ecosystems-caused-phytophthora-cinnamomi-2018>. In effect under the EPBC Act from 22-Feb-2019.

2.6.5 Summary of threat abatement/recovery plans

Threats identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Land use and management change
- Agricultural and horticultural development
- Public Infrastructure upgrades in travelling stock routes (TSRs)
- Firewood collection and 'tidying up'
- Changed fire regimes
- Increase in soil nutrients and use of chemicals
- Mowing and slashing regimes
- Revegetation management
- Weed invasion
- Climate change
- Salinity
- Acid soils
- Declining tree health and regeneration
- Increased grazing pressure from invasive herbivores
- Disease – *Phytophthora cinnamomi*
- Collection and removal of native flora.

Recovery actions identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Collect baseline data on the locations, quality and management regimes of remnant sites
- Extent and condition mapping
- Component species surveys
- Protection of existing habitat in priority areas including on private land
- Engagement with the community, particularly where remnants occur on private land to provide information on appropriate management and with Aboriginal communities.

Summary of baseline information actions undertaken to date:

- The establishment of databases comprising of information on CMN members (land managers with Box-Gum Grassy Woodland remnants), remnant locations, composition of flora and fauna species and remnant condition from surveys of CMN members' sites and other sites

- Minimum condition criteria and assessment method developed to assist land managers in identification of listed ecological communities
- Development of regional models using remote sensing
- Mapping of Box-Gum Grassy Woodland extent
- Surveys conducted during research programs through various organisations.

The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads include:

- Predation by cane toads
- Larval competition with frog tadpoles or mosquitoes
- Parasite transfer
- Competition for terrestrial food
- Competition for shelter sites.

Threat abatement actions for cane toads (*Rhinella marina*) include:

- \$11 million in funding from the Australian Government provided for the development of a broad-scale control method
- \$9 million in funding from the Australian Government for research and management activities
- Identification of native species, ecological communities and off-shore islands that are known to have a high to moderate risk
- Identify the impacts that toads have on listed native species and ecological communities
- Where the impact is expected to be high on native species and ecological communities establish support research techniques in aiding the recovery of priority native species and ecological communities
- Develop a prioritisation tool to aid in the direction of resources for the protection of native species and ecological communities.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pigs (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

The consequences of potential infection outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Inability of infected plants to develop new shoots, flowers, fruit and seed
- Complete loss of some flora populations

- Dramatic alteration to the structure and composition of native plant communities
- A severe reduction in primary productivity and functionality
- Irreversible habitat loss and degradation of dependent flora and fauna
- Loss of shelter and nesting sites and food sources resulting in major declines of fauna.

Objectives and actions outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Identifying and prioritising the protection of biodiversity assets that are, or may be, impacted by *Phytophthora* including listed threatened species, ecological communities and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act occur
- Reduce the spread and mitigate the impacts of *Phytophthora* to protect priority biodiversity assets and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act
- Inform the community through education on the impacts that *Phytophthora* has on biodiversity and actions to mitigate these impacts
- Encourage research on *Phytophthora* species and option to manage infestations and protect biodiversity assets.

2.6.6 References

Department of the Environment and Energy (2018). White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, Department of the Environment and Energy, Canberra. Available from: <http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=43> [Accessed 4 September 2018].

Office of Environment and Heritage, NSW (2017). White Box Yellow Box Blakely's Red Gum Woodland. Available from: <https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10837> [Accessed 4 September 2018].

Threatened Species Scientific Committee (2006). Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the List of Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* [Accessed 4 September 2018].

Beadle, N.C.W. (1981). *The Vegetation of Australia*. Cambridge University Press, Cambridge.

Yates, C.J. and R.J. Hobbs (1997). Temperate Eucalypt Woodlands: a review of their status, processes threatening their persistence and techniques for restoration in *Australian Journal of Botany* 45: 949-973

NSW Scientific Committee (2002). White Box Yellow Box Blakely's Red Gum Woodland – endangered ecological community listing. Final Determination. Available from: <http://www.nationalparks.nsw.gov.au/npws.nsf/content/boxgum+woodland+endangered+ecological+community+listing> [Accessed 4 September 2018].

3 Flora species

3.1 *Androcalva procumbens*

3.1.1 Status

EPBC Act – Vulnerable

3.1.2 Biology and ecology

3.1.2.1 Characteristic

Androcalva procumbens also known as *Commersonia procumbens*, is a prostrate shrub with slender trailing stems up to 30 cm long. The plants are covered with star-shaped hairs on all parts. The leaves are rounded to lance-shaped, 2 to 5 cm long, 15 to 25 mm wide, with wavy or lobed margins, upper surface green and sprinkled with star-shaped hairs. The lower surface is also densely hairy. The petals are about 2 mm long and pinkish-white. Fruit capsules are 6 to 8 mm in diameter and covered with both star-shaped hairs and bristles (OEH 2017).

3.1.2.2 Known distribution

It is endemic to New South Wales (NSW), mainly confined to the Dubbo-Mendooran-Gilgandra region, but also in the Pilliga and Nymagee areas (refer Figure 3.1). Recent collections have been made from the Upper Hunter region, and Goonoo Strategic Cropping Area (OEH 2017).

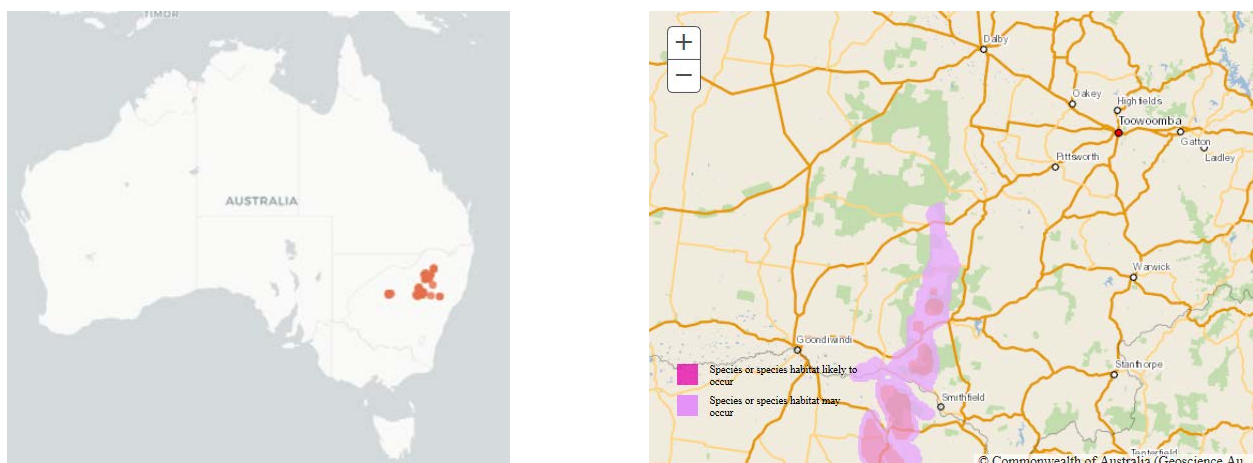


Figure 3.1 Distribution range of *A. procumbens*

Source: ALA (2018)

3.1.2.3 Distribution in relation to project

Androcalva procumbens was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint, MNES impact assessment area or from within a 50 km radius of the Project. Database records indicate the nearest record of the species (2000) is more than 100 km from the Project in Mount Kaputar National Park. This species also occurs in the Pilliga East State Forest, Pilliga Nature Reserve and surrounding protected areas north of Coonabarabran in NSW (refer Figure 3.2).

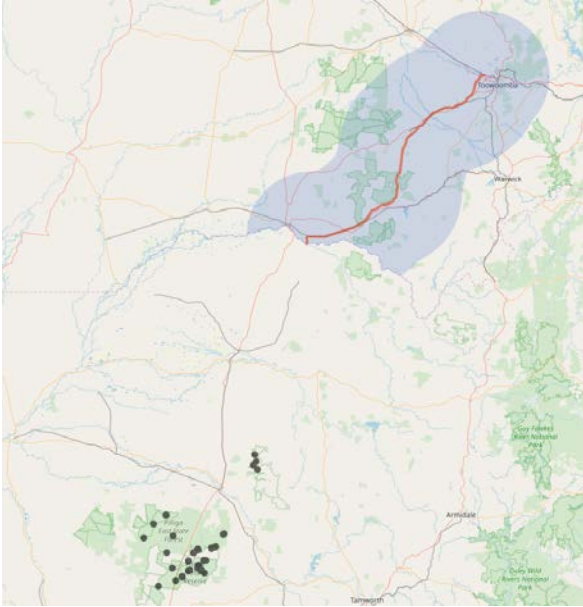


Figure 3.2 Distribution range of *A. procumbens* in relation to the Project

3.1.2.4 Biology and reproduction

Fruiting period is summer to autumn and flowering is from August to December. Their seeds appear to persist for some time in the seed bank, fire regimes also seem to aid germination and clusters of individuals may be clonal (OEH 2017).

3.1.3 Habitat

A. procumbens grows in sandy sites often along roadsides, edges of quarries, gravel stockpiles and cleared easements under power lines. It has been recorded in *Eucalyptus dealbata* and *Eucalyptus sideroxylon* communities, *Melaleuca uncinata* scrub, under mallee eucalypts with a *Calytrix tetragona* understorey, and in a recently burnt Ironbark and *Callitris* area. Also in *Eucalyptus fibrosa* subsp. *nubila*, *Eucalyptus dealbata*, *Eucalyptus albens* and *Callitris glaucophylla* woodlands north of Dubbo (OEH 2017).

3.1.4 Threatening processes

The following have been identified as potentially threatening processes to *A. procumbens*:

- Cessation or modification of pre-historic disturbance regimes
- Woody shrub competition (particularly thick stands of *Acacia triptera*)
- Continued grading of roads and roadsides (OEH 2017).

3.1.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.1.6 References

- Atlas of Living Australia (2018). *Androcalva procumbens*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2911037#> [Accessed 28 August 2018].
- Champan A. (1974). *Androcalva procumbens*. (Image) [Online] Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2911037#> [Accessed 28 August 2018].

Office of Environment and Heritage (2017). *Commersonia procumbens*. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10735> [Accessed 28 August 2018].

3.2 Austral cornflower (*Rhaponticum australe*)

3.2.1 Status

EPBC Act – Vulnerable

3.2.2 Biology and ecology

3.2.2.1 Characteristic

Austral cornflower (*Rhaponticum australe*) is an erect perennial herb that grows to 60 cm in height (refer Photograph 3.1). The branches are slightly woolly. Leaves are oblanceolate and toothed to deeply pinnatifid. The lower leaves are up to 18 cm long and 6 cm wide, reducing in size up the stem. The upper leaves are few, small and nearly sessile (DotEE 2018).



Photograph 3.1 Austral cornflower (*Rhaponticum australe*)

Source: Queensland Herbarium (2007)

3.2.2.2 Known distribution

Austral cornflower is currently confined to Queensland. The species was known to previously occur in NSW and Victoria but is now presumed extinct in those states. The current distribution of *R. australe* extends from Allora (north of Warwick) to Callide (northwest of Biloela), Queensland (TSSC 2008) (refer Figure 3.3).

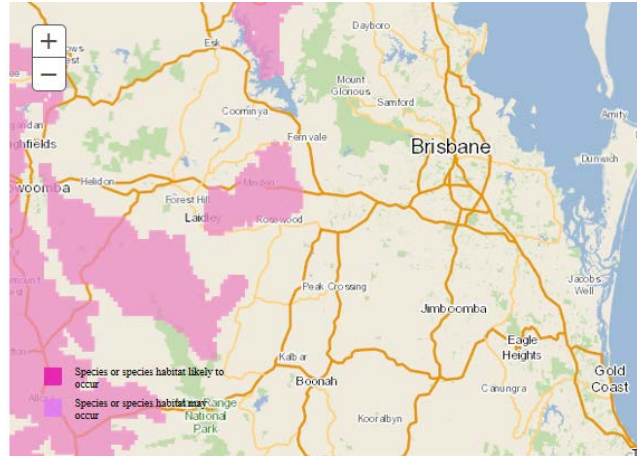


Figure 3.3 Distribution range of the Austral cornflower

Source: ALA (2018); DotEE 2018

3.2.2.3 Distribution in relation to project

Austral cornflower was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint however there are several records within the MNES impact assessment area. A recent record from 17 years ago exists to the west of Pittsworth at the Gore Highway and Tip Road junction. Another record occurs at the eastern end of the Project to the north of the alignment at Draper Road approximately 4 km west of Gowrie township. This is a recent record from 4 years ago. Records from within a 50 km radius of the Project occur as far north as Jondaryan, west to Pittsworth, south to Allora and east to Helidon Spa (refer Figure 3.4).

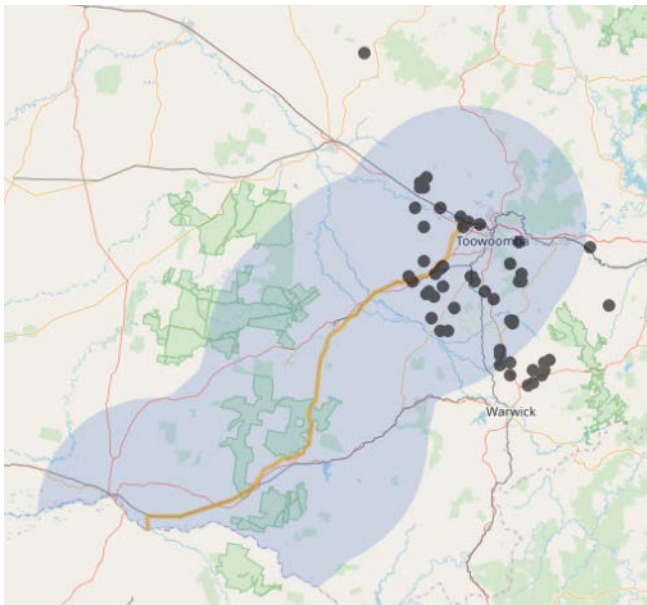


Figure 3.4 Distribution range of the Austral cornflower in relation to the Project

Source: ALA (2020)

3.2.2.4 Biology and reproduction

The flowering and fruiting period for Austral cornflower typically occurs in Spring, through to Autumn. The dead flowering stems can remain on the plant for several months after the seeds have dispersed (DotEE 2018).

3.2.3 Habitat

Austral cornflower typically grows in Eucalypt open forests, with grassy understory. This species often occurs on roadsides and on road reserves alongside Rhodes grass (*Chloris gayana*), Spear thistle (*Cirsium vulgare*), Queensland blue gum (*Eucalyptus tereticornis*) and Rough-barked apple (*Angophora floribunda*) on black clay soil derived from basalt. This species is considered to be a poor competitor and prefers habitat where grass competition has been reduced by fire, or other forms of disturbance. However, Austral cornflower is unlikely to benefit from disturbance that allows the development of a dense cover of exotic grasses (DotEE 2018).

3.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Austral cornflower:

- Woodland clearing for agriculture and urban development and livestock grazing has caused the local extinction of the Austral Cornflower in Victoria and NSW
- The invasion of exotic grass species into Austral Cornflower habitat may also threaten extant populations. As most populations occur on highly disturbed roadsides, they must compete with introduced species (DotEE 2018).

3.2.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.2.6 References

Atlas of Living Australia (2018). *Rhaponticum australe*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2908264> [Accessed 27 August 2018].

Department of the Environment and Energy (2018). *Rhaponticum australe* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=23949 [Accessed 27 August 2018].

Queensland Herbarium (2007). Department of Science, Information Technology and Innovation (DSITI), Queensland Government.

Threatened Species Scientific Committee (2008). *Approved Conservation Advice for Rhaponticum australe (Austral cornflower)*.

3.3 Austral toadflax (*Thesium australe*)

3.3.1 Status

EPBC Act – Vulnerable

3.3.2 Biology and ecology

3.3.2.1 Characteristic

Austral toadflax is a small, straggling herb growing to 40 cm tall. Leaves are pale green to yellow-green, somewhat succulent, 1 to 4 cm long and 0.5 to 1.5 mm wide (refer Photograph 3.2). Flowers are minute and white, emerging where the leaves meet the stems and appearing in spring. The fruit is small and nut-like, developing in summer. This species is often hidden amongst grasses and herbs (OEH 2017).



Photograph 3.2 Austral toadflax (*Thesium australe*)

Source: Hunter (2018)

3.3.2.2 Known distribution

Austral toadflax occurs in NSW, the ACT, Queensland and Victoria (refer Figure 3.5). It is also known from eastern Asia. Its current distribution is sporadic but widespread, occurring between the Bunya Mountains in southeast Queensland to northeast Victoria and as far inland as the southern, central and northern tablelands in NSW and the Toowoomba region (ALA 2018; OEH 2017; DotEE 2018).

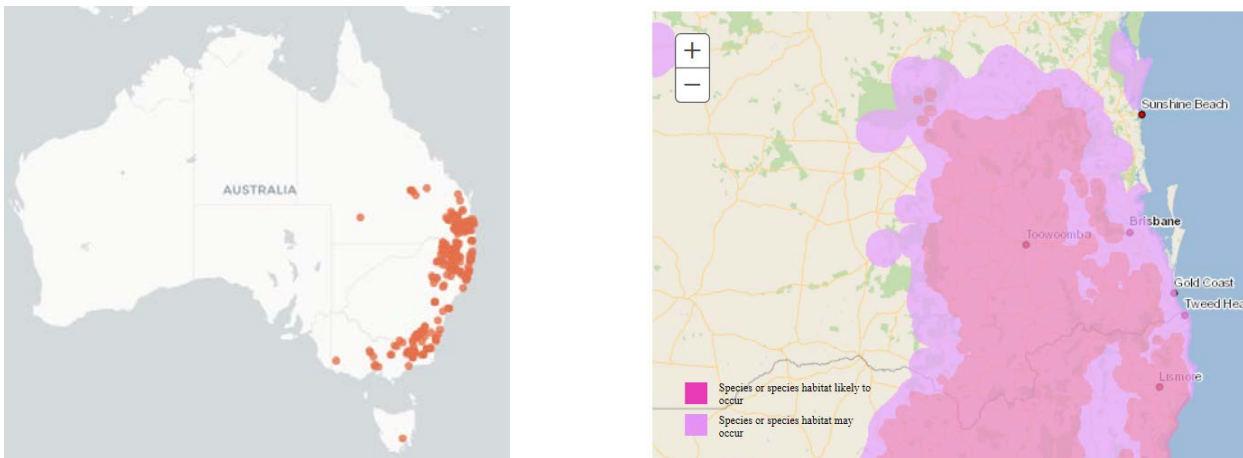


Figure 3.5 Distribution range of the Austral toadflax

Source: ALA (2018); DotEE (2018)

3.3.2.3 Distribution in relation to project

Austral toadflax was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint or MNES impact assessment area. The nearest records in relation to the Project occur approximately 12 km east of the eastern end of the disturbance footprint at Toowoomba. The record at this location is recent from 20 years ago. Other records from within a 50 km radius of the Project are sparsely scattered from Bowenville, to Grapetree to the north, to Gatton east of the Project, Allora south of the Project and west to Ellangowan (refer Figure 3.6).

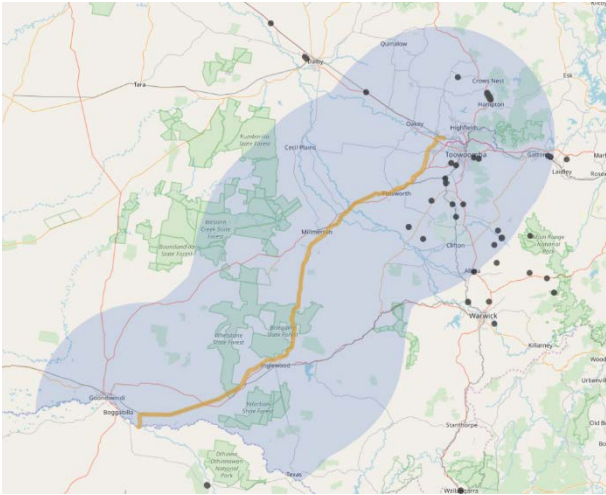


Figure 3.6 Distribution range of the Austral toadflax in relation to the Project

Source: ALA (2020)

3.3.2.4 Biology and reproduction

Austral toadflax flowers and fruits throughout the year on the coast, and during summer at higher altitudes. In subalpine and tableland climates, the species dies back to rootstock during winter and resprouts in spring. In coastal areas, the species persists all year round and may live for longer than two years. The existence of buds near the soil surface allows the species to resprout after disturbance. It is observed to germinate well after fire, however fire is not essential for germination (DotEE 2018).

3.3.3 Habitat

It is semi-parasitic on the roots of certain grass species; occurring in shrubland, grassland or woodland, often on damp sites. It occurs in subtropical, temperate and subalpine climates over a wide range of altitudes. It occurs on soils derived from sedimentary, igneous and metamorphic geology on a range of soils, including black clay loams to yellow podzolics and peaty loams (Leigh et al.1984; Hunter et al. 1999; Cohn 2004).

Vegetation types include open grassy heath dominated by Swamp myrtle (*Leptospermum myrtifolium*), Small-fruit hakea (*Hakea microcarpa*), Alpine bottlebrush (*Callistemon sieberi*), Woolly grevillea (*Grevillea lanigera*), Coral heath (*Epacris microphylla*) and *Poa* spp., Kangaroo grass grassland surrounded by Eucalypt woodland and grassland dominated by Barbed-wire grass (*Cymbopogon refractus*) (DotEE 2018).

3.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Austral toadflax:

- Lack of fire/disturbance
- Existing and intensified grazing by livestock, native herbivores and feral herbivores
- Residential, infrastructure and agricultural development
- Weed invasion
- Infrastructure (road and rail) maintenance (DotEE 2018; NSW OEH 2018).

3.3.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2016). *Threat abatement plan for competition and land degradation by rabbits*. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016>. In effect under the EPBC Act from 07-Jan-2017.

3.3.6 Summary of threat abatement/recovery plan

Threats identified in the Threat abatement plan for competition and land degradation by rabbit relevant to Austral toadflax include:

- Preventing plant regeneration
- Overgrazing and general damage to plant species
- Reversing the normal processes of plant succession
- Altering ecological communities and changing soil structure and nutrient cycling, leading to significant erosion.

Relevant management strategies relevant to Austral toadflax include population control. Following the plan, control efforts should be:

- targeted to protect sites where rabbits pose the greatest threat to biodiversity
- undertaken in a strategic manner to take advantage of the environmental conditions and other complementary activities
- monitored to ensure that objectives are met and allow management options to be adapted to changing circumstances.

3.3.7 References

Atlas of Living Australia (2018). *Thesium australe*. Available from:

https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2898274#tab_recordsView [Accessed 30 August 2018].

Department of the Environment and Energy (2018). *Thesium australe* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from:

http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=23949 [Accessed 27 August 2018].

Office of Environment and Heritage, NSW (2018). Austral toadflax. Available from:

<https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10802> [Accessed 30 August 2018].

3.4 Belson's panic (*Homopholis belsonii*)

3.4.1 Status

EPBC Act – Vulnerable

3.4.2 Biology and ecology

3.4.2.1 Characteristic

Belson's panic (*Homopholis belsonii*) is a perennial grass capable of growing up to 0.5 m high, with leaf ligule at 0.8 to 1.5 mm and long leaf blades spanning between 2 to 4.5 mm in width (refer Photograph 3.3). The leaves of the plant are often glabrous however can also be found with ciliates at the base (TSSC 2008; OEH 2017).

Along the lowermost branch two to three laterally compressed 4.8 to 8 mm spikelet feature whilst the common axis of the inflorescence and the primary branches both reach a length of 8 to 15 cm. The primary branches however contain hairy axils (OEH 2017).



Photograph 3.3 Belson's panic (*Homopholis belsonii*)

Source: OLD Herb (2018)

3.4.2.2 Known distribution

Belson's panic is known to occur along the northwest slopes and plains of NSW, near Goondwindi, and in Queensland along the southern Brigalow Belt near the Darling Downs area west of Toowoomba, Oakey and Millmerran. In Queensland, Belson's panic has been identified to cover an area of over 80,000 km² (DotEE 2018) (refer Figure 3.7).

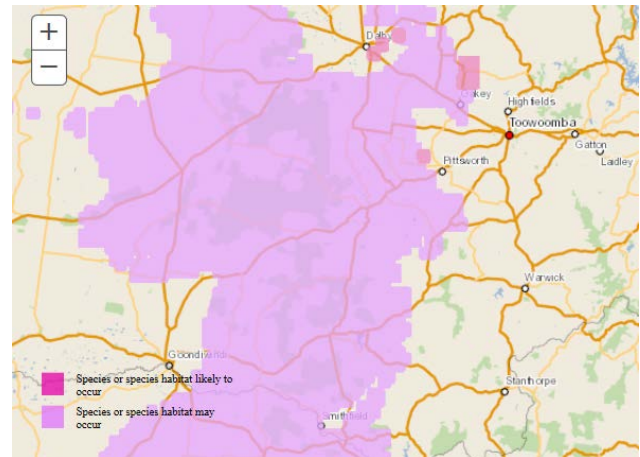


Figure 3.7 Distribution range of Belson's panic

Source: ALA (1998)

3.4.2.3 Distribution in relation to the Project

This species was identified during Project-associated field investigations in 2018 between Bringalily and Millmerran. The species was not detected during limited Regional Ecosystem, Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs during surveys conducted by Arup in 2016. Database records (i.e. AoLA) did not indicate the presence of this species within the Project disturbance footprint. The species was however within the MNES impact assessment area. Two of these records were contributed to the Atlas of Living Australia database after being recorded during 2018 Aurecon field investigations. One was located along a section of Millmerran-Inglewood Road between Paton and Nicol Creek Road. More than 100 individuals were found growing in a non-remnant road reserve on poor dark brown soils in large clumps at this location. The second record is located to the south-east of Millmerran at the junction of Owens Scrub Road and Lovell Road. Database records indicate a further two records within the MNES impact assessment area. One was located between Lovell Road and Lindenmayer Road east of Millmerran and the second at Yarranlea along Yarranlea Road dated 2002 and 2016 (refer Figure 3.8). Records within a 50 km radius of the Project occur at numerous locations including Bendidee State Forest, Millmerran, and the area surrounding Jondaryan and Acland. Database records outside of a 50 km radius of the Project indicate the species occurs from Wandoan in the north, west to Roma in Queensland and south to Gunnedah in New South Wales.

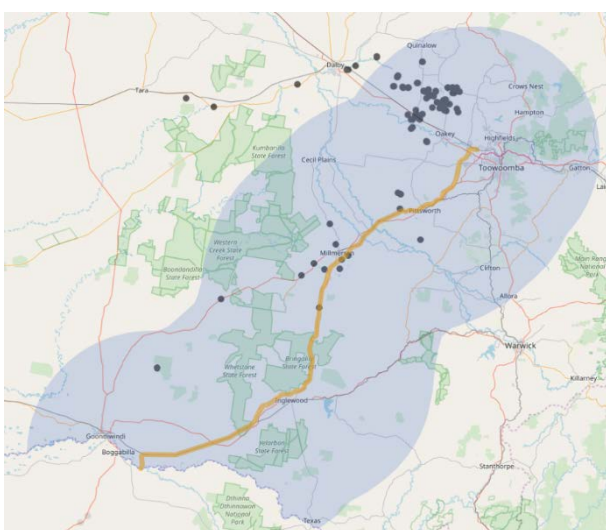


Figure 3.8 Distribution range of Belson's panic in relation to the Project

Source: ALA (2020)

3.4.2.4 Biology and reproduction

Belson's panic is known to occur in isolated areas of remnant vegetation with an ability to recolonise cleared or highly disturbed environments. The species is often found in regenerating vegetation along roadsides in sufficiently large populations producing seeds, despite viability time not known (DotEE 2018).

Flowering of the species usually occurs between February to May and possibly in November to December as fruiting has been recorded in February. Belson's panic has indicated the ability to germinate readily without the need for a dormancy period and dispersal through wind occurs when panicles dry after seed formation (DotEE 2018).

3.4.3 Habitat

Belson's panic has been known to grow often in poor soils in dry woodlands specially in NSW as well as in areas which receive irregular or intermittent flooding, where Belson's panic can be found on higher, well-drained rises. An elevation level of 200 to 520 m is required for the species in NSW whilst in Queensland, the species range from 342 to 500 m elevation (DotEE 2018).

The species can be classified to grow in three specific habitats which include:

- Rocky and basaltic hills featuring White Box (*E. albens*) and Wilga (*G. parviflora*) woodlands with various shrub and grass species
- Flat to gently undulating alluvial areas featuring Belah (*Casuarina cristata*) forests and occasionally Brigalow (*Acacia harpophylla*) forests
- Drainage lines featuring Belah and sandy country dominated by Cypress Pine-Bloodwood-Ironbark-She-Oak Forest (TSSC 2008).

3.4.4 Threatening processes

The following have been identified as potentially threatening processes to Belson's panic:

- Habitat clearing for agriculture, development and/or pasture improvement
- Overgrazing by domestic stock
- Invasion of habitat by introduced species
- Encroachment of native vegetation impacting survival and reproduction in locations (OEH 2017).

3.4.5 Threat abatement/recovery plans

The following Threat Abatement/Recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=1055&ReportProfileID=10925>. In effect under the BC Act 2016.

3.4.6 Summary of threat abatement/recovery plan

The conservation strategy for Belson's panic identifies two priority management sites in NSW:

- Kirramingly Nature Reserve in Noree Plains LGA
- Gurley Road in Moree Plains LGA.

Threats specific to Belson's panic identified in the strategy include:

- Invasion of habitat by introduced weeds
- Inappropriate roadside management.

Management strategies relevant to Belson's panic include:

- Physical control of Mimosa bush
- Species monitoring at the management site including monitoring for evidence of disturbance by road/track works on the species, assessment of weed abundance/density and baseline census and mapping, in addition to annual population estimates.

3.4.7 References

Atlas of Living Australia (1998). *Homopholis belsonii*. Available from:

<https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2912755#overview> [Accessed 17 August 2018].

Department of the Environment (2018). *Homopholis belsonii* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. [Accessed 17 August 2018].

Office of Environment and Heritage (2017). Belson's Panic – profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10925> [Accessed 17 August 2018].

Queensland Herbarium. (2018). Belson's panic (*Homopholis belsonii*). [Image] [Online] Available from: <https://images.ala.org.au/image/details?imageId=b5335e13-c937-4b4c-a7c0-5e725c5ee083>. [19 September 2019].

Threatened Species Scientific Committee (2008). Commonwealth Conservation Advice on *Homopholis belsonii*. Available from <http://www.environment.gov.au/biodiversity/threatened/species/pubs/2406-conservation-advice.pdf> [Accessed 17 August 2018].

3.5 *Bertya opposens*

3.5.1 Status

EPBC Act – Vulnerable

3.5.2 Biology and ecology

3.5.2.1 Characteristic

Bertya opposens is a slender shrub (refer Photograph 3.4) growing to 4 m in height. It may be have a single trunk as a small tree or be multi stemmed. (Austen, 1999)



Photograph 3.4 *Bertya opposens*

Source: Donald (2019)

3.5.2.2 Known distribution

This species occurs north from Torrens Creek in Queensland, around Emerald, west of Charleville, east to Somerset near Brisbane, and south to Narrabri and Cobar (TSSC 2011) (refer Figure 3.9).

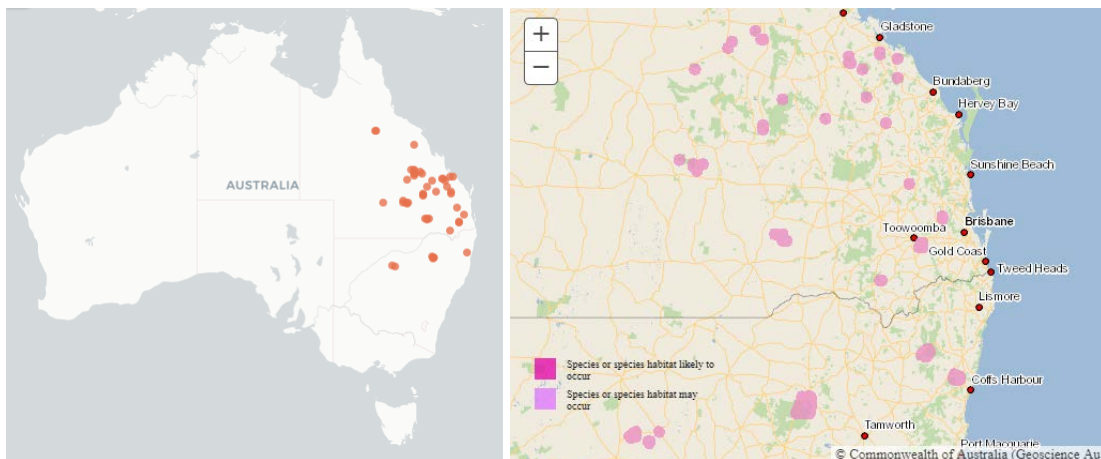


Figure 3.9 Distribution range of the *B. opposens*

Source: ALA (2019); DotEE (2019)

3.5.2.3 Distribution in relation to project

Bertya opposens was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint or MNES impact assessment area. Records within a 50 km radius of the Project occur at Devine State Forest approximately 13 km east of the Project. Most of these records are recent from within the last 14 to 26 years. These records occur in woodland consisting of *Eucalyptus panda*, *E. curtisii*, *E. fibrosa* subsp. *nubila* and *Corymbia trachyphloia* on calcareous sandstone. A number of record from the late 1980s early 1990s occur between Mount Whitestone and West Haldon approximately 35 km north-east of the Project (refer Figure 3.10). No other records occur for this species within a 50 km radius of the Project. Outside of a 50 km radius this species occurs throughout inland Queensland north to Torrens Creek and west to Charleville (ALA 2020).

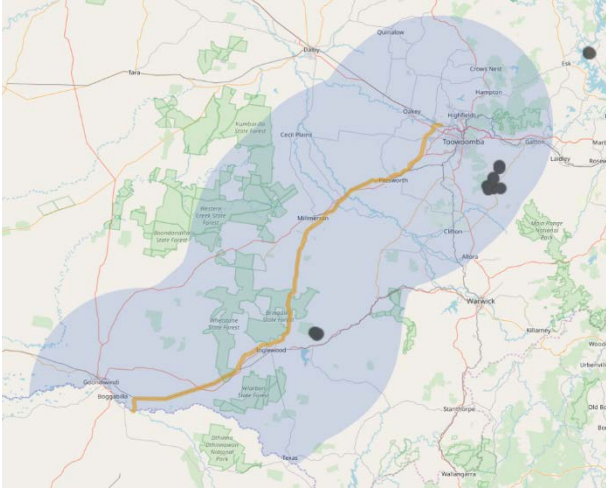


Figure 3.10 Distribution range of the *B. opposens* in relation to the Project

Source: ALA (2020)

3.5.2.4 Biology and reproduction

Plants are monoecious or dioecious, and flowers have been recorded in June to November, January and March and fruits between June, August and November (DotEE 2016; TSSC 2011).

3.5.3 Habitat

Bertya opposens grows in mixed shrubland, lancewood woodland, mallee woodland, eucalypt/acacia open forest with shrubby understorey, eucalypt and callitris open woodland and semi-evergreen vine-thicket. The soils are recorded as generally shallow sandy loams or red earths associated mostly with sandstone, but also with rhyolite, shale and metasediments. (DotEE 2016; TSSC 2011).

3.5.4 Threatening processes

The following has been identified as potentially threatening processes to *B. opposens*:

- Inappropriate fire regimes such as repeated annual burns
- loss or fragmentation of species populations or species habitat through vegetation clearing;
- the frequent low-intensity burning of shrubby understorey woodlands/forests to reduce fuel loads or promote grass growth for cattle grazing;
- the construction of firebreaks in ecotones; and,
- the absence of high intensity fires in ecotones (DotEE 2016).

3.5.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- NPWS (2002). *Bertya sp. Cobar-Coolabah (Cunningham & Milthorpe s.n., 2/8/73) Recovery Plan*. NSW National Parks and Wildlife Service, Hurstville NSW. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-bertya-sp-cobar-coolabah-cunningham-milthorpe-sn-2873>. In effect under the EPBC Act from 13-Oct-2003 as *Bertya opposens*.

The following threat abatement plan have been identified as being relevant for this species:

- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). *Threat abatement plan for competition and land degradation by unmanaged goats*. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-unmanaged-goats>. In effect under the EPBC Act from 01-Oct-2008.

3.5.6 Summary of threat abatement/recovery plan

The *Bertya sp. Cobar-Coolabah* Recovery Plan is specific to *Bertya sp. Cobar-Coolabah*. *Bertya sp. Cobar-Coolabah* is only known from four sites in New South Wales: Coolabah, Jacks Creek State Forest, Kangaroo River State Forest and Gibraltar Range National Park.

Threats identified in the recovery plan include:

- Grazing
- Inappropriate fire and disturbance regimes
- Clearing
- Drought.

Management strategies for *B. opposens* are focused on protection of the Coolabah population. Recovery objectives include:

- Limit grazing impacts at the Coolabah population
- Survey potential habitat for further populations
- Ensure there is recruitment at senescent populations
- Raise awareness of the conservation and involve community in the recovery program.

Threats identified in the threat abatement plan for competition and land degradation by unmanaged goats relevant this species include:

- Overgrazing by goats and resulting soil erosion
- Introduction of weeds through seeds carried in their dung.

The primary focus of the abatement plan is the control of unmanaged goat populations. The main objectives of controlling unmanaged goats are:

- Prevent unmanaged goats from occupying new areas in Australia and eradicate them from high-conservation value areas
- Promote the maintenance and recovery of native species and ecological communities that are affected by competition and land degradation by unmanaged goats
- Improve knowledge and understanding of unmanaged goat impacts and interactions with other species and other ecological processes
- Improve the effectiveness, target specificity, integration and humaneness of control options for unmanaged goats
- Increase awareness of all stakeholders of the objectives and actions of threat abatement plan, and of the need to control unmanaged goats.

3.5.7 References

Atlas of Living Australia (2019). *Bertya opposens*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2914143> [Accessed 22 July 2019].

Department of the Environment and Energy (2016). *Conservation Advice Bertya opposens*. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/13792-conservation-advice-16122016.pdf>.

Department of the Environment and Energy (2019). Distribution map - *Bertya opposens* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=13792 [Accessed 22 July 2019].

Donald, M. (2019) *Bertya oppositifolia* (image) [Online] Available from: <https://www.flickr.com/photos/13639096@N06/48102487467/in/photostream/>

Threatened Species Scientific Committee (2011). *Bertya opposens*, advice to the Minister for Sustainability, Environment, Water, Population and Communities on amendment to the list of Threatened Species under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/13792-conservation-advice-16122016.pdf> [Accessed 22 July 2019].

3.6 Blotched sarcochilus (*Sarcochilus weinthalii*)

3.6.1 Status

EPBC Act – Vulnerable

3.6.2 Biology and ecology

3.6.2.1 Characteristic

Blotched sarcochilus (*Sarcochilus weinthalii*) is an epiphyte orchid that grows on rainforest trees, either projecting or hanging from the trunk, or grows on rock surfaces. It has fleshy aerial roots and a short stem with several leathery leaves. The hanging flowering stems are up to 7 cm long with up to 12 flowers on each (refer Photograph 3.5). Each flower is 15 mm across and is cream to greenish with purple to reddish blotches (DEE 2018; DECCW 2010; OEH 2018).

3.6.2.2 Known distribution

Blotched sarcochilus has been recorded in northern NSW and southeast Queensland (refer Figure 3.11). The species occurs north of the Richmond River to the Bunya Mountains and the Gallangowan area. There are no available data on area of occupancy, extent of occurrence or population numbers. Illegal collection has occurred in accessible areas (DotEE 2018; OEH 2018; Quinn et al. 1995).

This species occurs within the Brigalow Belt South and southeastern Queensland IBRA bioregions and the Condamine, Northern Rivers and southeast Queensland Natural Resource Management regions (DotEE 2018).



Photograph 3.5 Blotched sarcochilus (*Sarcochilus weinthalii*)

Source: OEH (2015)

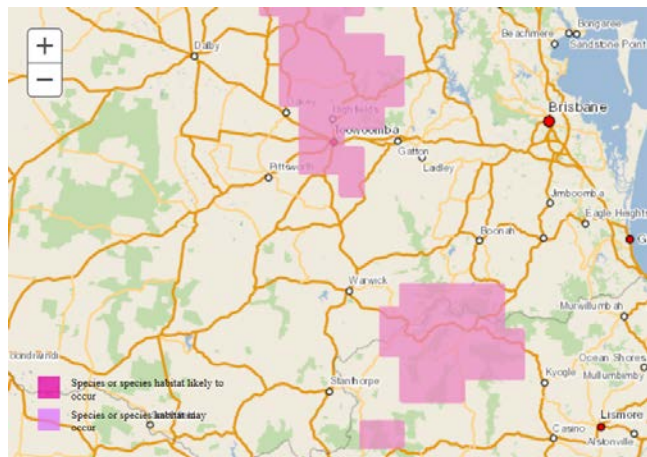


Figure 3.11 Distribution range of Blotched sarcochilus

Source: ALA (2018)

3.6.2.3 Distribution in relation to the Project

Blotched sarcochilus was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) indicate the nearest record occurs approximately 13 km east of the northern section of the Project. This record is old and was recorded more than 100 years previously. Two records, one relatively recent from the early 1980s occur at the Toowoomba Range approximately 16 km east of the northern section of the Project (refer Figure 3.12). An additional record is also located approximately 50 km northeast of the Project footprint at the eastern section of Deongwar State Forest. Records outside of a 50 km radius of the Project occur in association with the Great Diving Range north to Wrattens National Park and south to Port Macquarie in New South Wales.

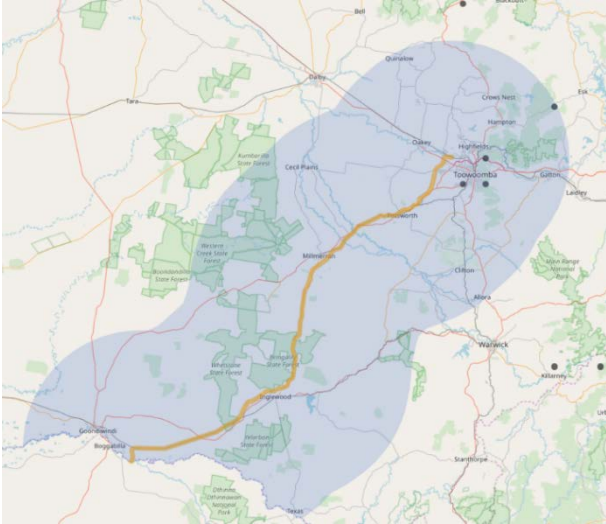


Figure 3.12 Distribution range of Blotched sarcocochilus in relation to the Project

Source: ALA (2020)

3.6.2.4 Biology and reproduction

Blotched sarcocochilus flowers from June to October and fruits persist for 6 to 8 months after fertilisation. When ripe, the fruits release numerous light brown seeds (ALA 2015; BDEE 2018).

3.6.3 Habitat

Blotched sarcocochilus grows on trees in rainforest, dry rainforest and drier scrub of sub-coastal ranges and associated foothills inland from the coast at altitudes of 400 to 700 m above sea level. In southeast Queensland, the Blotched sarcocochilus has been recorded growing in a number of microphyll and notophyll rainforest types and also occurs in patches of isolated scrub. The species is known in the Bunya Mountain area (DotEE 2018; Queensland CRA/RFA Steering Committee 1998).

3.6.4 Threatening processes

The following have been identified as potentially threatening processes to the Blotched sarcocochilus:

- Habitat loss through land clearing and forestry operations
- Inappropriate fire regimes
- Illegal collection
- Localised extinction as a result of small population sizes (DotEE 2018; OEH 2013).

3.6.5 Threat abatement/recovery plans

The following Threat Abatement/Recovery plans have been identified as being relevant for this species:

- Department of Environment, Climate Change and Water NSW (2010). Borders Range Rainforest Biodiversity Management Plan. Available from: <https://www.environment.gov.au/system/files/resources/4249147f-26eb-416b-ae78-e982a7099e4f/files/brrb-management-plan.pdf>
- Office of Environment and Heritage (n.d.), Saving our Species Programme. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=1192&ReportProfileID=10221>. In effect under the BC Act 2016.

3.6.6 Summary of threat abatement/recovery plan

The *Borders Range Biodiversity Plan* the Australian Government's Border Ranges North and South (Queensland and New South Wales) Biodiversity Hotspot, listing *S. weinthalii* as a priority flora species.

Priority areas outlined in this biodiversity plan identify the following locations for priority action:

- Big Scrub remnants
- Slots Island Nature Reserve
- Tumbunan fauna refugia
- Gondwana Rainforests of Australia.

Key threatening processes identified in this plan that are relevant to *S. weinthalii* include:

- Anthropogenic climate change
- Habitat loss or change (clearing, eucalypt dieback, high frequency fire)
- Weeds (invasion and establishment of exotic species such as Bitou Bush and Boneseed, exotic perennial grasses and Lantana)
- Pests (Grazing by feral European Rabbit, feral Goats, feral Deer, feral Pig, Red Imported Fire Ants and Yellow Crazy Ant)
- Infection of native plants by *Phytophthora cinnamomi*.

Key management outcomes that have been identified in this biodiversity plan include:

- Reduce organisational-related constraints to the conservation of biodiversity
- Minimise the impact of climate change on biodiversity
- Protect rainforest, related vegetation and species from land clearing, fragmentation, modification, degradation and from weed incursion
- Protect rainforest from fire and promote the implementation of appropriate fire regimes in related vegetation
- Protect the rainforest and related vegetation from the impact of pest animals
- Minimise the impacts associated with Bell minor associated dieback on rainforest and associated wet sclerophyll forest
- Engage landholders and community members in the conservation of biodiversity for this forest community
- Establish effective monitoring of biodiversity-related projects.

The *Save our Species* conservation strategy identifies this species as being data-deficient. As such, the objective of the strategy is to fill knowledge gaps in order to develop a targeted management strategy. The priority action is to define distribution through surveys targeting fallen branches of host plant during flowering season (September to October).

3.6.7 References

Atlas of Living Australia (2013). Atlas of Living Australia. Available on the Internet at: <http://www.ala.org.au/>

Atlas of Living Australia (2018), *Sarcochilus weinthalii*, accessed 23 August 2018, available <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2890229#>.

Department of Environment, Climate Change and Water (2010), Border Ranges Rainforest Biodiversity Management Plan - NSW and Queensland. Sydney South, New South Wales: DECCW.

Department of the Environment (2014). Approved Conservation Advice for *Sarcochilus weinthalii* (blotched sarcochilus). Canberra: Department of the Environment. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/12673-conservation-advice.pdf>. In effect under the EPBC Act from 11 April 2014.

Department of the Environment (2018). *Sarcochilus weinthalii* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Fri, 24 Aug

Office of Environment and Heritage (2018). *Blotched sarcochilus* – profile. Sydney, New South Wales: OEH. Available on the Internet at: <http://www.environment.nsw.gov.au/threatenedspecies/>

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Queensland CRA/RFA Steering Committee (1998), Survey of Threatened Plant Species in South East Queensland Biogeographical Region.

Quinn F, Williams JB, Gross CL and Bruhl J (1995), Report on rare and threatened plants of northeastern New South Wales. Armidale: University of New England

3.7 Bluegrass (*Dichanthium setosum*)

3.7.1 Status

EPBC Act – Vulnerable

3.7.2 Biology and ecology

3.7.2.1 Characteristic

Bluegrass (*Dichanthium setosum*) is an upright perennial grass less than 1 m tall. It has mostly hairless leaves about 2 to 3 mm wide. The flowers are densely hairy and clustered together along a stalk in a cylinder shape (refer Photograph 3.6) and appear mostly during summer. The species can form pure swards or occur as scattered clumps (DotEE 2018).



Photograph 3.6 Bluegrass (*Dichanthium setosum*)

Source: Rose (2013)

3.7.2.2 Known distribution

Bluegrass occurs on the northern tablelands in the Saumarez area, west of Armidale, and 18 to 30 km east of Guyra. It has been found sparsely on the north-western slopes, central western slopes and north-western plains of NSW, extending west to Narrabri. In Queensland, it has been documented to occur from the Leichhardt, Morton, North Kennedy and Port Curtis regions (refer Figure 3.13). This species occurs in the Mistake Range, in Main Range National Park, and possibly in Glen Rock Regional Park, adjacent to the Main Range National Park (DotEE 2018).

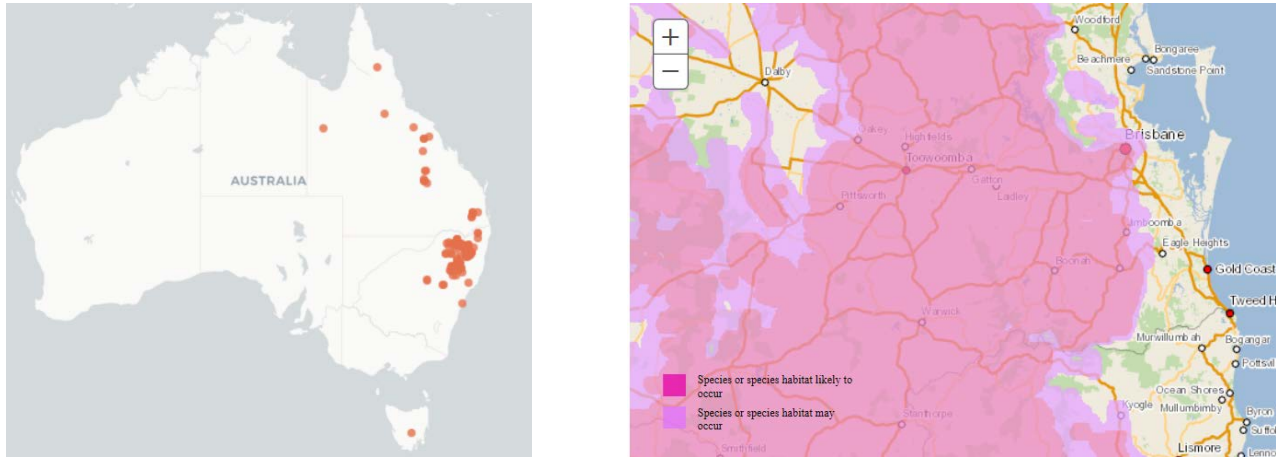


Figure 3.13 Distribution range of bluegrass

Source: ALA (2018), DotEE (2018)

3.7.2.3 Distribution in relation to the Project

Bluegrass was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint or MNES impact assessment area. Records within a 50 km radius of the Project occur approximately 10 km south of the southern end of the Project in New South Wales. This is a recent record from 2018 and is located to the south and between North Star Road and the Bruxner Highway along an existing rail corridor. To the north and north-east of the northern end of the Project three records occur at the Toowoomba Range approximately 15 km from the disturbance footprint (refer Figure 3.14). These records are recent from within the last 24 years and are located at Preston Peak, Picnic Point and the Holmes railway easement. Additional records are also located approximately 40 km northeast of the Project footprint in the surrounds of Crows Nest. Specimen backed records for this species outside of a 50 km radius of the Project occur as far north as Gamboola in north Queensland, inland to Mount Isa and south to Willandra National Park in New South Wales with most records occurring west of the Great Dividing Range.

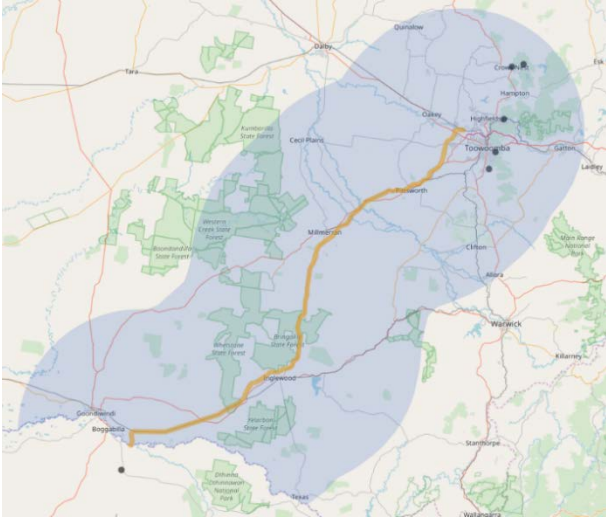


Figure 3.14 Distribution range of bluegrass in relation to the Project

Source: ALA (2020)

3.7.2.4 Biology and reproduction

Bluegrass is a warm season perennial grass, that commences growing in springs, flowers in summer and becomes dormant in late autumn. A fire frequency of greater than five years has been recommended for the species (DotEE 2019).

3.7.3 Habitat

Bluegrass is associated with heavy basaltic black soils and stony red-brown hardsetting loam with clay subsoil and is found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The extent to which this species tolerates disturbance is unknown. The species occurs within the Border Rivers–Gwydir, Central West, Namoi, Northern Rivers (NSW), South East and Fitzroy (Queensland) Natural Resources Management regions (DotEE 2018; DEC 2005).

3.7.4 Threatening processes

The following have been identified as potentially threatening processes to Bluegrass:

- Heavy grazing by agricultural animals
- Clearing of habitat for pasture and cropping
- Frequent irregular fires for agricultural purposes
- Road widening
- Invasion by introduced grasses (DotEE 2018).

3.7.5 Summary of threat abatement/recovery plan

The *Saving our Species* conservation strategy for *Dichanthium setosum* identifies five priority management sites in NSW:

- East of Guyra in Armidale Regional LGA
- Apex Lookout in Armidale Regional LGA
- Armidale Arboretum in Armidale Regional LGA
- Saumarez North TSR in Armidale Regional, Uralla LGA
- Wallabadah Cemetery in Liverpool Plains LGA.

Threats identified at the management sites include:

- Heavy grazing by domestic stock
- Invasion by introduced grasses such as Coolatai, African Lovegrass, Phalaris and ox-eye daisy.
- Inappropriate slashing regimes
- Distribution and recruitment/germination issues due to low species numbers.

Management activities to protect *Dichanthium setosum* at the *Saving our Species* sites are:

- Appropriate grazing management, including excluding stock from the sites September-December or following rainfall events and fencing off areas of high density plants from stock
- Targeted, physical removal of invasive grasses
- Track species abundance/condition over time, including assessment of reproduction/seed set, weed encroachment and grazing/mowing or slashing impacts.
- Liaise with local government to ensure awareness of the species' locations and importance
- Collect and sow seeds during the species' flowering/seeding period to enhance recruitment and population density.

Threats identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Land use and management change
- Agricultural and horticultural development
- Public Infrastructure upgrades in travelling stock routes (TSRs)
- Firewood collection and 'tidying up'
- Changed fire regimes
- Increase in soil nutrients and use of chemicals
- Mowing and slashing regimes
- Revegetation management
- Weed invasion
- Climate change
- Salinity
- Acid soils
- Declining tree health and regeneration
- Increased grazing pressure from invasive herbivores
- Disease – *Phytophthora cinnamomi*
- Collection and removal of native flora.

Recovery actions identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Collect baseline data on the locations, quality and management regimes of remnant sites
- Extent and condition mapping
- Component species surveys
- Protection of existing habitat in priority areas including on private land
- Engagement with the community, particularly where remnants occur on private land to provide information on appropriate management and with Aboriginal communities.

Summary of baseline information actions undertaken to date:

- The establishment of databases comprising of information on CMN members (land managers with Box-Gum Grassy Woodland remnants), remnant locations, composition of flora and fauna species and remnant condition from surveys of CMN members' sites and other sites
- Minimum condition criteria and assessment method developed to assist land managers in identification of listed ecological communities
- Development of regional models using remote sensing
- Mapping of Box-Gum Grassy Woodland extent
- Surveys conducted during research programs through various organisations.

Threats identified in the Threat abatement plan for competition and land degradation by rabbit relevant to *Dichanthium setosum* include:

- Preventing plant regeneration
- Overgrazing and general damage to plant species
- Reversing the normal processes of plant succession
- Altering ecological communities and changing soil structure and nutrient cycling, leading to significant erosion.

Management strategies relevant to *Dichanthium setosum* in the Threat abatement plan for rabbits include population control. Following the plan, control efforts should be:

- targeted to protect sites where rabbits pose the greatest threat to biodiversity
- undertaken in a strategic manner to take advantage of the environmental conditions and other complementary activities
- monitored to ensure that objectives are met and allow management options to be adapted to changing circumstances.

3.7.6 References

Atlas of Living Australia (2018). Distribution of *Dichanthium setosum*, viewed 24 August 2018, available: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2905357>.

AusGrass2 (2018). *Dichanthium setosum*, viewed 24 August 2018, available: <http://ausgrass2.myspecies.info/content/dichanthium-setosum>.

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Department of Environment and Conservation New South Wales (2005), *Dichanthium setosum* – Profile, viewed 11 December 2007, <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10221>.

Rose, H. (2013). *Dichanthium setosum*. [image] [online] Available at: <https://www.flickr.com/photos/73840284@N04/8675273472>. [13 September 2019]

3.8 Brush sophora (*Sophora fraseri*)

3.8.1 Status

EPBC Act – Vulnerable

3.8.2 Biology and ecology

3.8.2.1 Characteristic

Sophora fraseri (Brush sophora), is a softly pubescent, sparsely branched leguminous shrub that grows to 1 to 2 m high. Leaves are pinnate and are 6 to 15 cm long with a 10 to 20 mm stalk. Leaves have 21 to 35 oblong to ovate leaflets 5 to 25 mm long, 3 to 10 mm wide, with smooth margins and stalks 1 to 2 mm long. Flowers occur in racemes about 10 cm long during spring (refer Photograph 3.7). Petals are pale yellow, about 10 mm long, and the sepals are about 5 mm long. The fruit, 3 to 10 cm long and up to 8 mm in diameter, is irregularly restricted between the seeds and does not open at maturity. There are 2 to 7 seeds, about 6 mm long (WetlandInfo 2018; Harden 2002; Stanley and Ross 1983).



Photograph 3.7 Brush sophora (*Sophora fraseri*)

Source: Scott (2016)

3.8.2.2 Known distribution

Brush sophora is found north of Casino in northern NSW, where it is very rare, and into southeast Queensland (refer Figure 3.15), where it is widespread but not common. Brush sophora is conserved in Lamington National Park and Mount Mistake National Park (Briggs and Leigh 1995).



Figure 3.15 Distribution range of the Brush sophora

Source: ALA (2018)

3.8.2.3 Distribution in relation to the project

Brush sophora was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint or MNES impact assessment area. The nearest records in relation to the Project occur approximately 1.3 km north of the eastern end of the disturbance footprint at Mount Kingsthorpe Reserve east of Kingsthorpe. Two records from this site indicate the species was recorded relatively recently from 1997 and recently in 2011. Other records from within a 50 km radius of the Project occur sporadically at Coalbank, Kilbirnie, Ballard north-east of Toowoomba, Iredale to the east of Toowoomba Range and two records near Fordsdale (refer Figure 3.16).

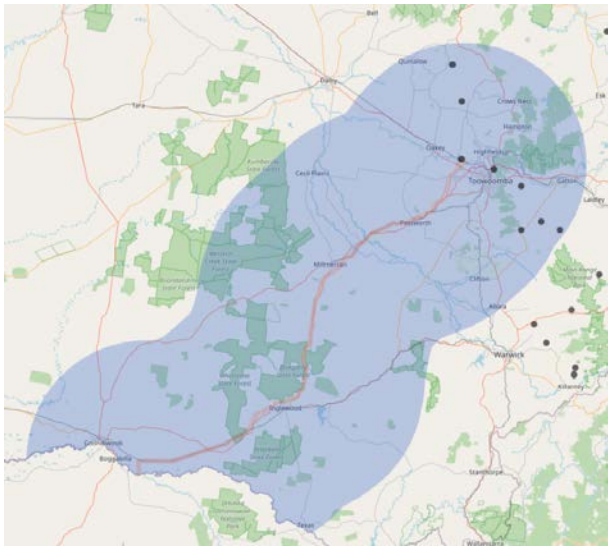


Figure 3.16 Distribution range of the Brush sophora in relation to the Project

Source: ALA (2020)

3.8.2.4 Biology and reproduction

Flowering of Brush sophora has been recorded in April and from late August to mid November. Fruiting has been recorded in January, April, July, August and November (Barker and Borsboom 1997; WetlandInfo 2018).

3.8.3 Habitat

Brush sophora normally grows in wet sclerophyll forest and a range of rainforest types. It has been reported growing in hilly terrain on hillslopes at altitudes at altitudes from 60 to 660m, in mostly shallow stony to shaly soils, of loam to clay texture derived from sandstone or basalt rocks. The shrub appears to prefer growing along rainforest margins, in eucalypt forests in the vicinity of rainforests or in large canopy gaps in closed forest communities (Barker and Borsboom 1997; WetlandInfo 2018).

3.8.4 Threatening processes

The following have been identified as potentially threatening processes to the Brush sophora:

- Loss of habitat through clearing for agriculture and development
- Timber harvesting
- Weed infestation
- Inappropriate fire regimes
- Loss of individuals from road/track works or maintenance

- Grazing by domestic stock
- Risk of local extinction because populations are small (OEH 2018).

3.8.5 Threat abatement/recovery plans

The following recovery plans have been identified as being relevant for this species:

- Department of Environment and Energy (2010). National recovery plan for the Semi-evergreen vine thickets of the Bigalow Belt (North and South) and Nandewar Bioregions ecological community. Canberra, ACT: Australian Government. Available from: <http://www.environment.gov.au/resource/national-recovery-plan-semi-evergreen-vine-thickets-brigalow-belt-north-and-south-and>.
- Office of Environment and Heritage (2016), *Saving our Species Program*. Available from: <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10764>. In effect under the BC Act 2016.

3.8.6 Summary of threat abatement/recovery plan

The threats outlined in the National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community include:

- Broad-scale land clearing of remnant vegetation
- Fire where SEVT is not protected by topography or substrate and where fuel characteristics have been altered by the introduction of introduced pasture grasses
- Incursion by exotic flora including Buffel grass *Pennisetum ciliare*, Green panic *Megathyrsus maximus* var. *pubiglumis*, Parthenium weed *Parthenium hysterophorus*, Velvet tree pear *Opuntia tomentosa*, Lantana *Lantana camara*, Rubber vine *Cryptostegia grandiflora* and Brazilian nightshade *Solanum seaforthianum*. Of these *L. camara* and *C. grandiflora* pose the most serious threat to this TEC.
- Trampling from cattle grazing opening up the understorey of SEVT habitat facilitating the incursion of invasive flora
- Invertebrate pest species including feral pigs, foxes, rabbits and cane toads impacting the vegetation structure and associated native fauna
- Coastal development where remnant vine thicket occurs on coastal beach ridges.

Threat abatement actions outlined in the National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community include:

- Identify and evaluate the extent, biodiversity value and condition of remnant and regrowth areas of this TEC in the Brigalow Belt (North and South) and Nandewar Bioregions
- Complete mapping of this TEC in New South Wales and refine mapping of remnants in Queensland
- Establish a condition assessment methodology establishing benchmark sites for each component regional ecosystem
- Determine the extent and condition of SEVT areas that have been impacted by invasive flora, particularly weeds of national significance
- Survey data deficient species within SEVT communities
- Identify key ecosystem components and processes determining their response to management actions
- Monitor selected populations of EPBC-Act listed species that occur within SEVT communities including *Cadellia pentastylis*, *Cossinia australiana*, *Denhamia parvifolia*, *Macropus dorsalis*, *Paradelma orientalis*, *Turnix melanogaster* and *Zieria verrucosa*
- Establish a comprehensive, adequate and representative system of SEVT ecological community across the Brigalow Belt (North and South) and Nandewar Bioregions, protected by either reservations or conservation agreements (including MOU's)

- Ensure best practice management to sites containing SEVT
- Involve landholders and community members in the conservation and management of SEVT ecological communities
- Enhance the ability of government and non-government organisations at the national, regional and local level (including consent authorities) to recognise and incorporate SEVT ecological community conservation issues into all planning processes.

The *Saving our Species* conservation strategy for *Sophora fraseri* identifies five priority management sites:

- Cougal in Kyogle LGA
- Toonumbar in Kyogle LGA
- Ettrick in Kyogle LGA
- Bungabee in Lismore LGA
- Richmond Range in Kyogle LGA.

Threats identified at the management sites include:

- Loss of habitat through clearing or agriculture
- Weed infestation, especially by Lantana
- Inappropriate fire regimes
- Loss of individuals from road/track works or maintenance.

Management activities to protect *Sophora fraseri* at the *Saving our Species* sites are:

- Encourage landholders to enter into voluntary management agreement to maintain or enhance the species and its habitat
- Physical and chemical control of weeds, including splatter gun and foliar spray to control Lantana
- Track species abundance/condition over time by counting individuals and juveniles, monitoring weed densities and other potential threats (species surveys to be conducted when flowering in Spring/Summer)
- Liaise with relevant agency to incorporate species requirements into the Flora Fire Response Database and Reserve Fire Management Strategy
- Monitor species recruitment and adult condition post fire event
- Install green posts to indicate locations of sensitive threatened species to reduce impacts of slashing and track maintenance and monitor for evidence of disturbance.

3.8.7 References

Atlas of Living Australia (2018). *Sophora fraseri*. Available from:

<https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2909150#overview> [Accessed 30 August 2018].

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Office of Environment and Heritage, NSW (2018). Brush sophora. Available from:

<https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10764> [Accessed 21 August 2018].

Scott E. (2016). *Sophora fraseri* (Image) [Online] Available from:

<https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2909150#> [Accessed 30 August 2018].

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Threatened Species Scientific Committee (2008). Conservation Advice on *Sophora fraseri* (Brush sophora). <http://www.environment.gov.au/biodiversity/threatened/species/pubs/8836-conservation-advice.pdf> [Accessed 31 August 2018].

3.9 Hawkweed (*Picris evae*)

3.9.1 Status

EPBC Act – Vulnerable

3.9.2 Biology and ecology

3.9.2.1 Characteristic

Hawkweed (*Picris evae*) is a soft-stemmed annual plant, up to 130 cm tall with most of the leaves growing around the base of the plant. The leaves are sometimes toothed, have a pointed tip, and are sparsely hairy with split-end hairs (the hairs divided into two for half their length). Leaves are 2.5 to 15 cm long and 4 to 30 mm wide. The small, yellow flowers grow in dense heads 8 to 10 mm wide at the ends of the stems (OEH 2018) (refer Photograph 3.8).



Photograph 3.8 Hawkweed (*Picris evae*)

Source: Bennett (2019)

3.9.2.2 Known distribution

Hawkweed is known to occur in the areas of northern NSW (e.g. Inverell, Elsmore, Tamworth) and the Darling Downs and Moreton pastoral districts in southeast Queensland (Bostock and Holland 2007) (refer Figure 3.17).



Figure 3.17 Distribution range of the Hawkweed

Source: ALA (2018), DotEE (2018)

3.9.2.3 Distribution in relation to the Project

Hawkweed was identified during Project-associated field investigations in 2018 within the disturbance footprint in a road reserve to the north of Pittsworth along the Gore Highway between Tip Road and Oakey-Pittsworth Road. The species was not detected during limited Regional Ecosystem, Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs during surveys conducted by Arup in 2016. Further specimen backed records have been identified from database searches (i.e. AoLA) further indicating this species occurs within the Project disturbance footprint. Two recent records exist from 2002 at the junction of the Gore Highway and Elsdon Road in *Dicanthium sericeum* grassland adjacent to cultivated land growing on black clay soil. A number of record occur within the MNES impact assessment area between Pittsworth and Southbrook. The most recent of these was recorded 4 years ago at the Gore Highway-Toowoomba Road junction and 13 years ago along Toowoomba-Pittsworth Road 0.6 km west of the Southbrook turnoff. The latter record noted the species growing on brown clay soil amongst grasses and forbes in open woodland dominated by *Eucalyptus crebra* on a low hill. Several other records occurring in a similar location in the surrounds of Southbrook were dated from the mid 1980's. Other records within a 50 km radius of the Project occur from Muldu to Allora along the eastern Darling Downs (refer Figure 3.18).

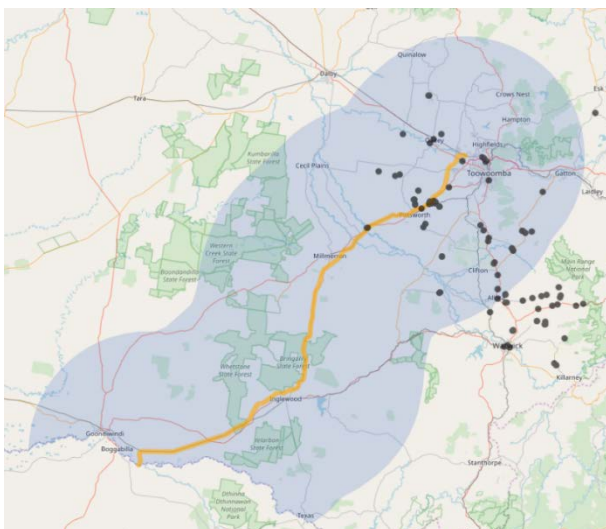


Figure 3.18 Distribution range of the Hawkweed in relation to the Project

Source: ALA (2020)

3.9.2.4 Biology and reproduction

The flowering and fruiting period occurs during October to January and sometimes until May (OEH 2017).

3.9.3 Habitat

Hawkweed typically occurs in Eucalypt open woodlands, with grassy understories characteristically represented by *Dichanthium* spp. Upper stratum species include *Eucalyptus melliodora*, *E. crebra*, *E. populnea*, *E. albens*, *Angophora subvelutina*, *Allocasuarina torulosa*, and *Casuarina cunninghamiana*. This species has been collected along roadsides, and in cultivated areas (i.e. paddocks), on black, dark grey or red-brown soils, reddish clay-loam or medium clay soils (Holzapfel 1994; TSSC 2008).

3.9.4 Threatening processes

The following have been identified as potentially threatening processes to Hawkweed:

- Weed invasion
- Inappropriate fire regimes
- Habitat fragmentation
- Clearing of vegetation for cropping and grazing (DECC 2005).

3.9.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), Saving our Species Programme. Available from: <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10627>. In effect under the BC Act 2016.
- Department of Environment, Climate Change and Water NSW (2010). *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland*. Department of Environment, Climate Change and Water NSW, Sydney. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/white-box-yellow-box-blakelys-red-gum-grassy-woodland-and-derived-native-grassland-national> In effect under the EPBC Act from 22-Mar-2013.

No threat abatement plans has been identified as being relevant for this species.

3.9.6 Summary of threat abatement/recovery plan

The *Save our Species* conservation strategy for *Picris evae* identifies two priority management sites:

- Myall Creek in Inverell LGA
- Barayamal in Inverell LGA.

Threats identified at the management sites include:

- Clearing of habitat for cropping and grazing
- Accidentally and illegally lit fires
- Accidental damage during road maintenance activities
- Invasion of habitat by introduced weeds.

Management activities to protect this species at the *Save our Species* sites include:

- Minimise impacts and incidences of clearing by providing advice to local council in order to inform planning decisions and environmental assessment
- Reduce the risk of adverse fire at the site by liaising with private landholders and local Bushfire Committee to educate on appropriate time to burn and encourage the building of fire breaks and slashing on road-edge to reduce likelihood of accidental ignition of the site
- Reduce and maintain weed densities at low levels by slashing and poisoning, spot spraying.

Threats identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Land use and management change
- Agricultural and horticultural development
- Public Infrastructure upgrades in travelling stock routes (TSRs)
- Firewood collection and 'tidying up'
- Changed fire regimes
- Increase in soil nutrients and use of chemicals
- Mowing and slashing regimes
- Revegetation management
- Weed invasion
- Climate change
- Salinity
- Acid soils
- Declining tree health and regeneration
- Increased grazing pressure from invasive herbivores
- Disease – *Phytophthora cinnamomi*
- Collection and removal of native flora.

Recovery actions identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Collect baseline data on the locations, quality and management regimes of remnant sites
- Extent and condition mapping
- Component species surveys
- Protection of existing habitat in priority areas including on private land
- Engagement with the community, particularly where remnants occur on private land to provide information on appropriate management and with Aboriginal communities.

Summary of baseline information actions undertaken to date:

- The establishment of databases comprising of information on CMN members (land managers with Box-Gum Grassy Woodland remnants), remnant locations, composition of flora and fauna species and remnant condition from surveys of CMN members' sites and other sites
- Minimum condition criteria and assessment method developed to assist land managers in identification of listed ecological communities
- Development of regional models using remote sensing
- Mapping of Box-Gum Grassy Woodland extent
- Surveys conducted during research programs through various organisations.

3.9.7 References

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<https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2887141> [Accessed 27 August 2018].

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<https://images.ala.org.au/image/details?imageld=cb7b2387-d111-4637-92da-edb043bb98e8>. [19 September 2019].

Bostock, PD and Holland, AE (2007). *Census of Queensland flora*, CD-ROM, Queensland Herbarium, Brisbane.

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Holzappel, S (1994). A revision of the genus *Picris* (Asteraceae, Lactuceae) s.l. in *Australia, Willdenowia*, vol. 24, pp. 97-218.

Office of Environment and Heritage (2018). Hawkweed. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10627> [Accessed 27 August 2018].

Sharp, D. (nd). Queensland Herbarium, Department of Science, Information Technology and Innovation (DSITI), Queensland Government.

Threatened Species Scientific Committee (2008). *Approved Conservation Advice for Picris evae (Hawkweed)* Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/10839-conservation-advice.pdf> [Accessed 27 August 2018].

3.10 King blue-grass (*Dichanthium queenslandicum*)

3.10.1 Status

EPBC Act – Endangered

3.10.2 Biology and ecology

3.10.2.1 Characteristic

King blue-grass (*Dichanthium queenslandicum*) is a perennial grass growing to 80 cm tall. Its culms are solitary or rarely branched, erect, glabrous, smooth with a single groove, 4 to 5-noded with nodes prominently hairy (refer Photograph 3.9). Leaf sheaths are hirsute with the hairs arising from wart-like projections. Inflorescences are single racemes of paired spikelets to 10 cm long. Sessile spikelets are bisexual, dorsally compressed, and straw-coloured to pale mauve. Pedicelled spikelets are male and straw-coloured to pale mauve (DotEE 2018; Sharp and Simon 2002).



Photograph 3.9 King blue-grass (*Dichanthium queenslandicum*)

Source: Ausgrass2 (2018)

3.10.2.2 Known distribution

King blue-grass is endemic to central and southern Queensland where it occurs in three disjunct populations; Hughenden district; Nebo to Monto and west to Clermont and Rolleston; and Dalby district, Darling Downs. The extent of the species occurrence is thought to be reduced from 1,100 km² to 245 km² (Accad et al. 2008; DotEE 2018).

King blue-grass occurs within the southeast Queensland, Brigalow Belt South, Brigalow Belt North, Central Mackay Coast, Desert Uplands, Mitchell Grass Downs and Einasleigh Uplands Bioregions; and the southeast Queensland, Condamine, Border Rivers Maranoa Balonne, Burnett Mary, Fitzroy, Burdekin, Mackay Whitsunday, Southern Gulf and Desert Channels Natural Resource Management regions (DotEE 2018) (refer Figure 3.19).



Figure 3.19 Distribution range of King blue-grass

Source: ALA (2018)

3.10.2.3 Distribution in relation to the project

King blue-grass was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Two recent records from within the last five years occur within the MNES impact assessment area to the south of the disturbance footprint north east of the township of Pittsworth. These records occur near the junction of the Gore Highway and Toowoomba Road. The next nearest records occur to the north of the McCoffery Gliding Airport, approximately 30 km north-west of the northern section of the Project footprint. The records occur along the Warrego Highway between Oakey and Dalby and are recent from within the last 20 years. The majority of records for this species occur outside of a 50 km buffer of the Project from Taroom to Collinsville. The Project associated database records occur at the southern limit of the species distribution (refer Figure 3.20).

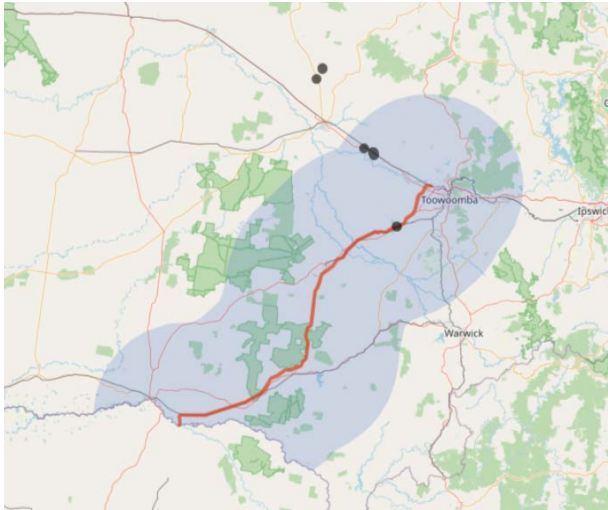


Figure 3.20 Distribution range of King blue-grass in relation to the Project

Source: ALA (2020)

3.10.2.4 Biology and reproduction

The species has been recorded with flowers throughout the year, however are more prevalent from March. Sessile spikelet is bisexual, dorsally compressed and straw-coloured to pale mauve. Pedicelled spikelets are male, straw-coloured to pale mauve (DEE 2018; Sharp and Simon 2002; Queensland Herbarium 2012).

3.10.3 Habitat

King blue-grass is endemic to central and southern Queensland. This species occurs on black cracking clay in tussock grasslands mainly in association with other species of Blue grasses (*Dichanthium* spp. and *Bothriochloa* spp.) but also with other grasses restricted to this soil type. It is mostly confined to natural bluegrass grasslands of central and southern Queensland, including the endangered EPBC ecological communities: Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin, and Natural Grasslands on Basalt and Fine-textured Alluvial Plains of northern NSW and southern Queensland. This habitat has been destroyed and greatly fragmented by cultivation (DotEE 2018; Fletcher 2001; Simon 1982).

3.10.4 Threatening processes

The following have been identified as potentially threatening processes to the King blue-grass:

- Loss of habit through agricultural and mining activities, road construction and other infrastructure developments
- Pastoral land and association activities
- Invasion from weeds (Butler 2007; Fensham 1999).

3.10.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species (DoEE 2018).

The following threat abatement plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2016). *Threat abatement plan for competition and land degradation by rabbits*. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016>. In effect under the EPBC Act from 07-Jan-2017.

3.10.6 Summary of threat abatement/recovery plans

Threats identified in the threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Suppress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

3.10.7 References

Accad A, Neldner VJ, Wilson B and Niehus RE. (2008), Remnant vegetation in Queensland: analysis of remnant vegetation 1997–1999–2000–2001–2003–2005, including regional ecosystem information. Queensland Herbarium, Environmental Protection Agency, Brisbane.

Atlas of Living Australia (2018), *Dichanthium queenslandicum*. Australia's species Database. Viewed 24 August 2018, available <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2901362>.

Ausgrass2, (2018), *Dichanthium queenslandicum*, viewed 24 August 2018, available: <http://ausgrass2.myspecies.info/content/dichanthium-queenslandicum>.

Butler DW (2007), Draft recovery plan for the 'Bluegrass (*Dichanthium* spp.) dominant grassland of the Brigalow Belt Bioregions (north and south)' endangered ecological community, 2007–2011. Report to Department of the Environment and Heritage, Canberra. Queensland Parks and Wildlife Service, Brisbane.

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Fletcher M (2001), Rare and threatened plants of the Central Highlands. Queensland Parks and Wildlife Service, Emerald.

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Simon BK (1982), New species of Gramineae from southeastern Queensland. *Austrobaileya* 1: 455–467.

3.11 Ooline (*Cadellia pentastylis*)

3.11.1 Status

EPBC Act – Vulnerable

3.11.2 Biology and ecology

3.11.2.1 Characteristic

Ooline (*Cadellia pentastylis*) is a very slow growing medium-sized tree that generally grows to 10 m high, but occasionally reaching 25 m. The species has glossy leaves with prominent venation that grow to 2 to 4 cm long, 1.5 to 2 cm wide and with broadly rounded tips (refer Photograph 3.10). The upper sides of the leaves are darker and glossier than the undersides. The white flowers are small and usually single. Each flower produces a cluster of up to five rounded, brown berries, 3 to 5 mm wide (OEH 2017).



Photograph 3.10 Ooline (*Cadellia pentastylis*)

Source: McMaster (2008)

3.11.2.2 Known distribution

Ooline occurs on the northwest slopes of NSW and in central and southern Queensland (refer Figure 3.21). The species occurs between 23° S to 30° S within the 500 mm and 750 mm rainfall isohyets. In Queensland, Ooline occurs from Balcomba (west of Rockhampton) south to the NSW border and west to near Blackall. In NSW, Ooline occurs in an area bounded by Gunnedah, Tenterfield and the Queensland border (ALA 2018; Leigh and Briggs 1992).

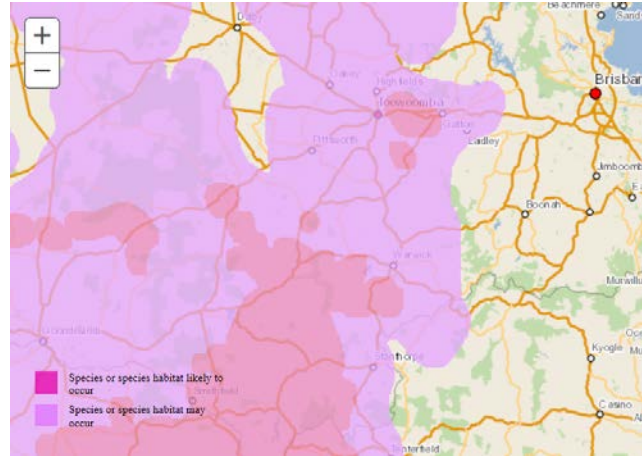


Figure 3.21 Distribution range of Ooline

Source: ALA (2018), DotEE (2018)

3.11.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint or MNES impact assessment area. Records within a 50 km radius of the Project occur at Bendidee State Forest and Kindon Station approximately 42 km east of the Project. These records are very old as they are dated from more than 80 years ago. A record occurs at Goondiwindi approximately 17 km from the Project however, the record is in New South Wales to the south of the MacIntyre River south of Kentucky Lane (refer Figure 3.22). Outside of a 50 km radius of the Project records are scattered throughout inland Queensland and New South Wales north to Claireview along the Queensland Coast, inland to Idalia National Park and south to Gennedah in New South Wales.

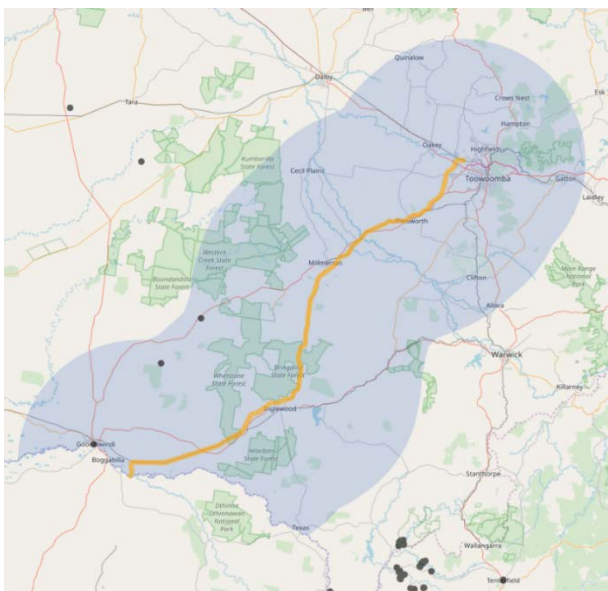


Figure 3.22 Distribution range of Ooline in relation to the Project

Source: ALA (2020)

3.11.2.4 Biology and reproduction

Ooline flowers sporadically. In NSW, flowering events occur in spring and summer and, in Queensland, flowering events occur in spring through to autumn. Fruits are borne in November to December and seed dispersal is probably via passive fall or birds. Seeds have shown a high rate of infertility at all sites. Fire germination is known to occur and vegetative growth has been noted as being very common. Ooline also has the capacity to re-sprout from rootstock and coppice vigorously from stumps. (Benson 1993; Harden 1991; QDNR 2000).

3.11.3 Habitat

Ooline grows in semi-evergreen vine thickets and sclerophyll vegetation on undulating terrain of various geology, including sandstone, conglomerate and claystone (Harden 1991). Soils generally have low to medium nutrient content and are normally associated with upper and mid-slopes in the landscape. The altitude is generally 300 to 460 m above sea level, with some stands known to occur at 600 m above sea level. Ooline has also been found in semi-evergreen vine thickets, pure stands and Brigalow-Belah communities (Benson 1993; Harden 1991).

3.11.4 Threatening processes

The following have been identified as potentially threatening processes to Ooline:

- Fragmentation and vegetation clearing
- Logging of tree species, such as *Callitris*, within habitat may have affected the microclimate in the understorey of the forest
- Inbreeding depression
- Inappropriate fire regimes
- Intensive grazing (i.e. where stocking is high, seedling recruitment is likely to be hampered due to grazing and soil compaction)
- Risk of local extinction due to small, scattered populations
- Tunnel and sheet erosion
- Low seed viability
- Damage to roadside populations during roadworks (OEH 2017).

3.11.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10118>. In effect under the BC Act 2016.

The following threat abatement plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2017). *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs* (*Sus scrofa*) (2017). Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017>. In effect under the EPBC Act from 18-Mar-2017.

3.11.6 Summary of threat abatement/recovery plan

Cadellia pentastylis is assigned as a keep-watch species under the NSW *Saving our Species Program* as relatively large populations are known to occur within reserves (Kaputar National Park and Gamillaroi Nature Reserve) where current management is sufficient to ensure their long-term security. State wide conservation actions identified for this species include:

- Identify a minimum of 3 sites for implementation of recovery actions and monitoring. The Tenterfield Creek population is of particular interest for investigation
- Establish a comprehensive monitoring program to determine the effectiveness of recovery actions
- Control feral goats in areas of known and potential habitat
- Erect signage and fence off roadside remnants to protect from damage and disturbance from road works and traffic
- Liaise with landholders where the species occurs on private property to discuss issues, management actions and fencing
- Restrict areas of habitat with fencing to protect from stock and feral animal grazing
- Improve knowledge and understanding of the species' ecology by conducting research into population dynamics, genetic variation and establishment & recruitment of new individuals
- Ensure the Threatened Species Hazard Reduction List is updated with the requirements of this species and that personnel undertaking burns are educated on its presence and fire sensitivity
- Provide advice and assistance for the removal of weed species within Ooline habitat such as Tiger Pear
- Review / include operational guidelines for Mt Kaputar NP and Gamilaroi NR Reserve Fire Management Strategies to protect this species from fire.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pigs (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

3.11.7 References

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McMaster I. (2008). *Cadellia pentastylis*. (Image) [Online] Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2912802#> [Accessed 28 August 2018].

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Queensland Department of Natural Resources (2000). *Species Management Manual*. Forest and Fauna Conservation and Ecology Section, Queensland Department of Natural Resources.

3.12 *Prostanthera* sp. Dunmore (D.M. Gordon 8A)

3.12.1 Status

EPBC Act – Vulnerable

3.12.2 Biology and ecology

3.12.2.1 Characteristic

Prostanthera sp. Dunmore (D.M. Gordon 84), is a low, upright, shrub up to 1 m tall. The leaves are whorled on the stem, linear, 0.8 to 1.2 cm long, 1 to 2 mm wide and have no stalks. The leaf margins curve downwards and inwards to the stem. Flower stems are at the ends of branches and the flowers are on stalks up to 2 mm long, are mauve to purple-blue and about 8 mm long (DotEE 2018; TSSC 2008).

No image available.

3.12.2.2 Known distribution

Prostanthera sp. Dunmore (D.M. Gordon 84) is known from four locations in a small area west of Millmerran in southern Queensland. One population occurs on private land and three in state forest, including one on the border with Wondul Range National Park (TSSC 2008) (refer Figure 3.23).

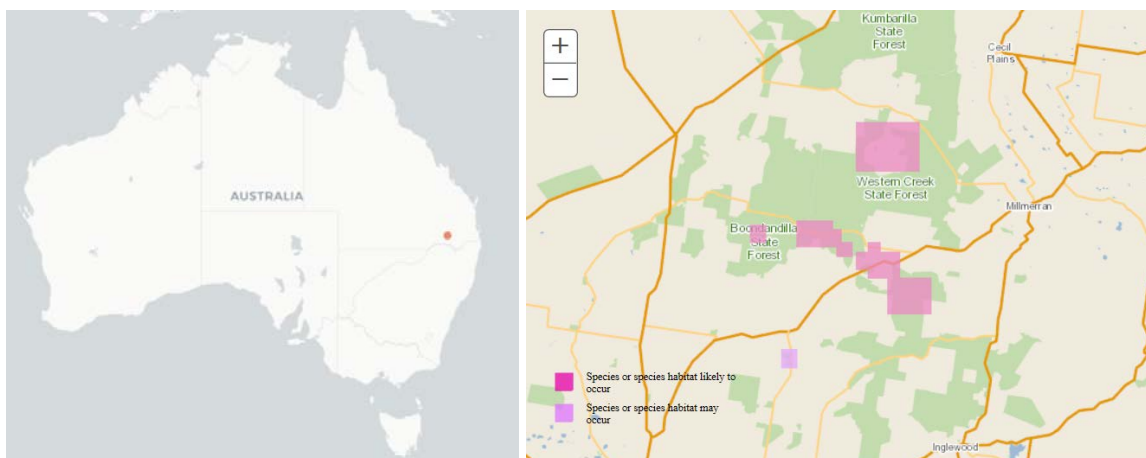


Figure 3.23 Distribution range of the *Prostanthera* sp. Dunmore (D.M. Gordon 8A)

Source: ALA (2018); DotEE (2018)

3.12.2.3 Distribution in relation to the Project

Prostanthera (sp. Dunmore) This species was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint or MNES impact assessment area or within a 50 km radius of the Project. The only database record that is available is located within state forest between Boondandilla and Western Creek State Forest at the southern end of the reserve along Boondandilla Road approximately 50 km west of the Project (refer Figure 3.24).

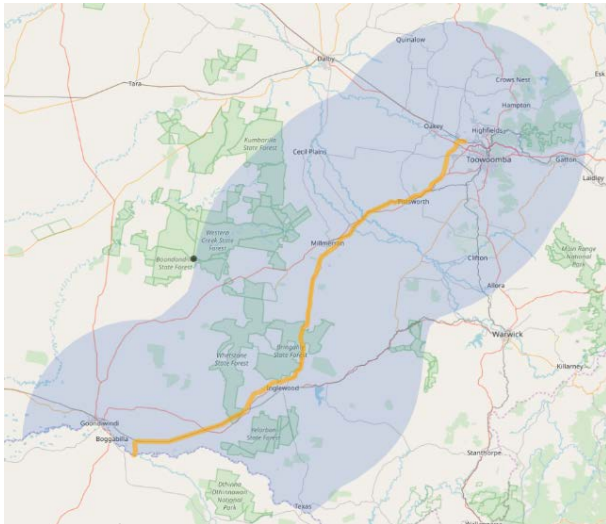


Figure 3.24 Distribution range of the *Prostanthera* sp. Dunmore (D.M. Gordon 8A) in relation to the Project

Source: ALA (2020)

3.12.2.4 Biology and reproduction

There is little to no information on the biology and reproduction of *Prostanthera* sp. Dunmore (Gordon 1984).

3.12.3 Habitat

It grows in *Eucalyptus* and *Callitris* woodland in shallow sandy soil or Eucalypt woodland on hard sandstone ridge tops (TSSC 2008).

3.12.4 Threatening processes

The following have been identified as potentially threatening processes to *Prostanthera* sp. Dunmore (D.M. Gordon 8A):

- Degradation of habitat through timber harvesting activities
- Too frequent hot fires which reduce the soil seed bank (DotEE 2018).

3.12.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.12.6 References

Atlas of Living Australia (2018). *Prostanthera* sp. Dunmore (D.M. Gordon 8A). Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2910678#overview> [Accessed 28 August 2018].

Threatened Species Scientific Committee (2008). *Approved conservation advice for Prostanthera sp. Dunmore (D.M. Gordon 8A)*. Available from:
<http://www.environment.gov.au/biodiversity/threatened/species/pubs/56748-conservation-advice.pdf>.

3.13.2.2 Known distribution

The Shiny-leaved ironbark is endemic to southeast Queensland, and is restricted to four disjunct localities near Mt Moffatt in the Carnarvon area, Brovinia area south of Mundubbera, Tara area west of Dalby and Coolmunda Dam east of Inglewood in southern Queensland (Brooker and Kleinig 1994) (refer Figure 3.25).

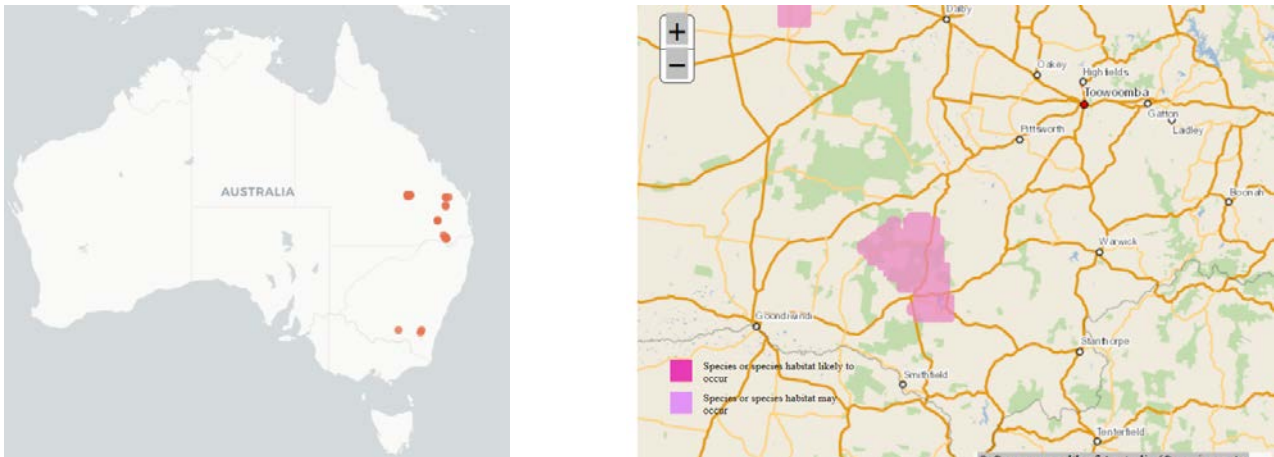


Figure 3.25 Distribution range of Shiny-leaved ironbark

Source: ALA (2018), DotEE (2018)

3.13.2.3 Distribution in relation to the Project

Eucalyptus virens was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint or MNES impact assessment area. Records within a 50 km radius of the Project occur approximately 11 km north of the Project at Bringalily State Forest and approximately 15 km to the south at Coolmunda and have been recorded between the early 1980s to early 1990s making them relatively recent (refer Figure 3.26).

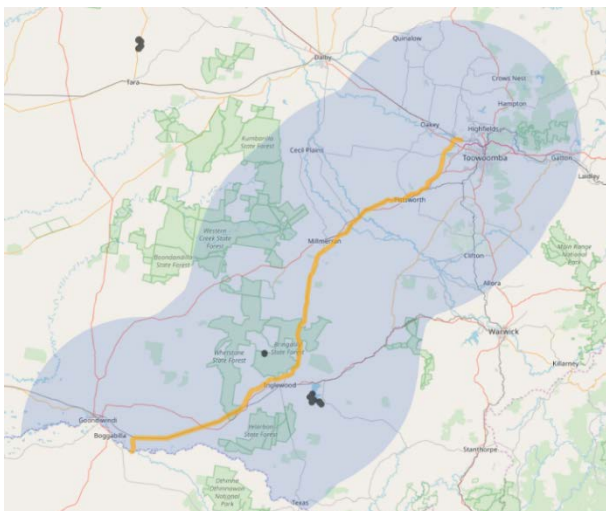


Figure 3.26 Distribution range of Shiny-leaved ironbark in relation to the Project

Source: ALA (2020)

3.13.2.4 Biology and reproduction

The Shiny-leaved ironbark flowers in late summer (February) (DoE 2008).

3.13.3 Habitat

It is found in woodlands dominated by Queensland peppermint (*Eucalyptus exserta*), Smooth-barked apple (*Angophora costata*), Tom Russell's mahogany (*Lysicarpus ternifolius*) and Woolly she-oak (*Allocasuarina inophloia*), in coarse sandy, skeletal soils on outcropping sandstone escarpments. Shiny-leaved ironbark is also found in forests dominated by Bulloak (*Allocasuarina leuhmannii*) and Mugga ironbark (*Eucalyptus sideroxylon*) in shallow, grey sandy soils on flat lands and woodlands dominated by similar species, in coarse white sandy soils over sandstone on undulating lands (DoE 2008).

3.13.4 Threatening processes

The following have been identified as potentially threatening processes to Shiny-leaved ironbark:

- Timber harvesting
- Disturbance of habitat during timber harvesting operations
- Loss of habitat due to vegetation clearing (DoE 2008).

3.13.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.13.6 References

- Atlas of Living Australia (2018). *Eucalyptus virens*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2901683#overview> [Accessed 28 August 2018].
- Boobook Pty Ltd (2010). Shiny-leaved ironbark. (Image). 'Significant flora' Boobook, version 1, October 2010.
- Brooker, MIH and Kleinig, DA (1994). Field guide to Eucalypts: Volume 3, Northern Australia. Inkata Press, Sydney.
- Department of the Environment (2008). Approved Conservation Advice *Eucalyptus virens*, s266B of the Environment Protection and Biodiversity Conservation Act 1999.
- Slee, AV, Brooker, MIH, Duffy, SM and West, JG (2006). Euclid: eucalypts of Australia. 3rd ed. (CSIRO: Canberra).
- Queensland Herbarium. (2018). Shiny-leaved ironbark (*Eucalyptus virens*). [Image] [Online] Available from <https://images.ala.org.au/image/details?imageId=9dd53557-c6da-45df-87db-42c2de1ccab3>. [19 September 2019].

3.14 Stream clematis (*Clematis fawcettii*)

3.14.1 Status

EPBC Act – Vulnerable

3.14.2 Biology and ecology

3.14.2.1 Characteristic

Stream clematis (*Clematis fawcettii*) is a weak climber with stems 1 to 2 m long. The paired leaves are divided once (biternate) or twice (triternate) into three toothed leaflets. Leaflets are 0.6 to 4 cm long and 0.5 to 3 cm wide (refer Photograph 3.12). Flowers are white to pink-purple. Fruit form achenes, 4 mm long and less than 1 mm wide that are three-ridged and have a feathery tail (awn) 2 to 2.5 cm long that assists with wind dispersal of seeds (DECC 2005; Harden 1990; Stanley and Ross 1983).



Photograph 3.12 Stream clematis (*Clematis fawcettii*)

Source: QLD Herb (2018)

3.14.2.2 Known distribution

Stream clematis occurs from the Richmond River in northeast NSW to the Bunya Mountains in southeast Queensland. This species is conserved within the Richmond Range National Park, Toonumbar National Park, Lamington National Park, Main Range National Park and Mt Barney National Park. This species occurs over a range of 65,000 km² and herbaria collections have been made from about 35 locations (refer Figure 3.27). This species occurs within the Northern Rivers (NSW), Condamine (Queensland) and southeast Queensland Natural Resource Management regions (Briggs and Leigh 1996; NSW NPWS 2005; QLD CRA/RFA Steering Committee 1998).

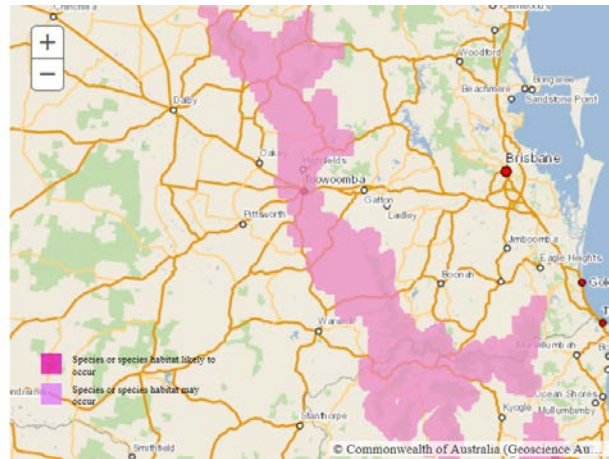


Figure 3.27 Distribution range of Stream clematis

Source: ALA (2018), DotEE (2018)

3.14.2.3 Distribution in relation to the Project

Clematis fawcettii was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) indicated no records within the Project disturbance footprint or within the MNES impact assessment area. The nearest records were identified approximately 7 km north of the Project footprint near Pittsworth recently (2011) at Irongate Reserve on sedimentary soils in Semi-evergreen vine thicket. Other records are located approximately 20 km north of the Project footprint at Goombungee with records dated from more than 30 years previously. A third record within a 50 km radius of the Project occurs approximately 20 km to the east of the northern section of the Project at Mount Davidson near Toowoomba (refer Figure 3.28).

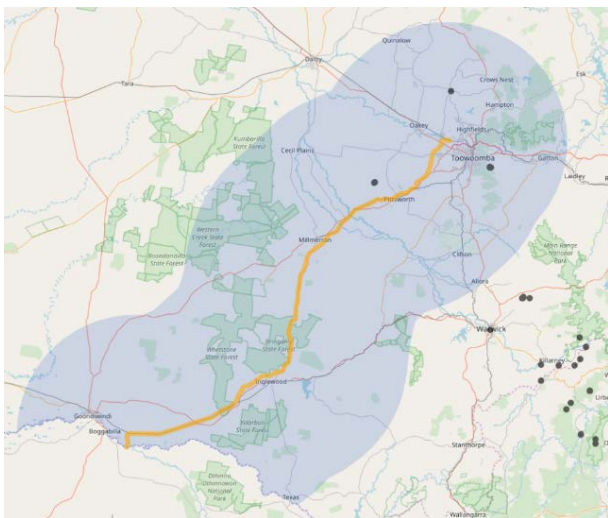


Figure 3.28 Distribution range of Stream clematis in relation to the Project

Source: ALA (2020)

3.14.2.4 Biology and reproduction

Flowering in this species is known to occur from October through to December and fruits have been recorded in January, June and December. The pollination mechanism is unknown. It is not known whether the species is capable of vegetative reproduction. Vines generally only flower and fruit in high light conditions, and therefore the species favours disturbance that would open up the tree canopy (Bean pers. comm. 2009).

3.14.3 Habitat

The Stream clematis is a perennial climbing vine found in drier rainforests near streams. The species is mostly found in semi-evergreen vine thicket, *Araucarian microphyll* vine forest or in complex notophyll vine forest, but occasionally in Eucalypt woodland communities that are close to vine thicket or rainforest. Soil types vary, though mainly fertile clays have been recorded from specific location where the species has been observed (DotEE 2018).

3.14.4 Threatening processes

The following have been identified as potentially threatening processes to the Stream clematis:

- Invasion by introduced weeds (DotEE 2018)
- Habitat loss from land clearing, grazing by domestic stock
- Frequent fire events
- Forest eucalypt dieback associated with over-abundant Bell Miners (*Manorina melanophrys*) and psyllid insects (*Glycaspis* spp.) (NSW DECC 2007).

3.14.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Department of Environment and Energy (2010). National recovery plan for the Semi-evergreen vine thickets of the Bigalow Belt (North and South) and Nadewat Bioregions ecological community. Canberra, ACT: Australian Government. Available from: <http://www.environment.gov.au/resource/national-recovery-plan-semi-evergreen-vine-thickets-brigalow-belt-north-and-south-and>. In effect under the EPBC Act from 12-Mar-2010.
- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10169>. In effect under the BC Act 2016.

No threat abatement plan has been identified as being relevant for this species.

3.14.6 Summary of threat abatement/recovery plan

The threats outlined in the National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community include:

- Broad-scale land clearing of remnant vegetation
- Fire where SEVT is not protected by topography or substrate and where fuel characteristics have been altered by the introduction of introduced pasture grasses
- Incursion by exotic flora including Buffel grass *Pennisetum ciliare*, Green panic *Megathyrsus maximus* var. *pubiglumis*, Parthenium weed *Parthenium hysterophorus*, Velvet tree pear *Opuntia tomentosa*, Lantana *Lantana camara*, Rubber vine *Cryptostegia grandiflora* and Brazilian nightshade *Solanum seaforthianum*. Of these *L. camara* and *C. grandiflora* pose the most serious threat to this TEC.
- Trampling from cattle grazing opening up the understorey of SEVT habitat facilitating the incursion of invasive flora
- Invertebrate pest species including feral pigs, foxes, rabbits and cane toads impacting the vegetation structure and associated native fauna
- Coastal development where remnant vine thicket occurs on coastal beach ridges.

Threat abatement actions outlined in the National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community include:

- Identify and evaluate the extent, biodiversity value and condition of remnant and regrowth areas of this TEC in the Brigalow Belt (North and South) and Nandewar Bioregions
- Complete mapping of this TEC in New South Wales and refine mapping of remnants in Queensland
- Establish a condition assessment methodology establishing benchmark sites for each component regional ecosystem
- Determine the extent and condition of SEVT areas that have been impacted by invasive flora, particularly weeds of national significance
- Survey data deficient species within SEVT communities
- Identify key ecosystem components and processes determining their response to management actions
- Monitor selected populations of EPBC-Act listed species that occur within SEVT communities including *Cadellia pentastylis*, *Cossinia australiana*, *Denhamia parvifolia*, *Macropus dorsalis*, *Paradelma orientalis*, *Turnix melanogaster* and *Zieria verrucosa*
- Establish a comprehensive, adequate and representative system of SEVT ecological community across the Brigalow Belt (North and South) and Nandewar Bioregions, protected by either reservations or conservation agreements (including MOU's)
- Ensure best practice management to sites containing SEVT
- Involve landholders and community members in the conservation and management of SEVT ecological communities
- Enhance the ability of government and non-government organisations at the national, regional and local level (including consent authorities) to recognise and incorporate SEVT ecological community conservation issues into all planning processes.

Clematis fawcettii is assigned as a keep-watch species under the NSW *Saving our Species Program* as large populations (e.g. over 500 individuals) are known to occur within reserves where current management is sufficient to ensure their long-term security. State wide conservation actions identified for this species include:

- Assess weed threats to populations, manage as necessary, take precautions against accidental damage to threatened vines during weed management
- Collect baseline population data, using detailed census methods at priority sites and rapid assessment techniques at others
- Increase community awareness to assist in detecting new locations, and with habitat rehabilitation projects
- Confirm existing records, estimate abundance and extent of populations
- Identify information and resource needs required to ensure land managers and other stakeholders are aware of populations and habitat.
- Ensure that PoMs, fire plans, pest management plans take account of requirements for the recovery of *Clematis fawcettii*
- Ensure the species is considered in statutory plans for LGA's relevant to its distribution
- Establish a data recording system for the species
- Model habitat to identify sites for further survey
- Protect areas of known habitat from timber harvesting and other land clearing.
- Regional fire plans, protected area Fire Plans and hazard reduction burn guidelines to include protection for the species and its habitat
- Survey before road and track maintenance in the habitat of the species, assess need to protect trackside plants

- Use molecular techniques to investigate genetic variation within and between populations
- Identify critical factors limiting the recovery of the species.
- Research fire response
- Map populations and habitats.

3.14.7 References

Atlas of Living Australia (2018), *Clematis fawcettii* - Stream clematis, viewed 24 August 2018, available: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2889478#gallery>.

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Eichler HJ and Jeanes JA (2007), *Clematis*. In: 'Flora of Australia, vol. 2' (ed. AJG Wilson). Australian Biological Resources Study. Canberra.

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NSW National Parks and Wildlife Service (2005), The parks and reserves of the Northern Richmond Range – Plan of Management, Department of Environment and Climate Change, viewed 24 August 2018.

Queensland CRA/RFA Steering Committee (1998), Survey of Threatened Plant Species of South East Queensland Biological Region, Department of Environment.

Queensland Herbarium. (2018). Stream clematis (*Clematis fawcettii*). [Image] [Online] Available from <https://images.ala.org.au/image/details?imageId=e8911df9-98c1-42b3-b349-1ddbe1365fed>. [19 September 2019].

Stanley, TD and Ross, EM (1983), 'Clematis' in Flora of southeastern Queensland, vol. 1, Brisbane, Queensland Dept. of Primary Industry, pp. 169–170.

3.15 Tara wattle (*Acacia lauta*)

3.15.1 Status

EPBC Act – Vulnerable

3.15.2 Biology and ecology

3.15.2.1 Characteristic

Tara wattle (*Acacia lauta*) is a shrub 1.5 to 3 m high, branching from the base. It has yellowish, angular branches with persistent stipules that are scarious, linear and up to 0.7 mm long. The pulvinis is about 1 mm long. The phyllodes are straight to slightly incurved (2 cm x 4 cm x 1.5 mm), flat, narrowed at the base, abruptly contracted at the apex with a sharp terminal point, midrib slightly raised and with one or two other obscure longitudinal veins. They have heads of 25 to 30 flowers borne on stalks 5 to 7 mm long, singly in the angles between phyllodes and stems (refer Photograph 3.13). The pods are linear and 6 cm x 4 mm and the seeds are longitudinal and 4.5 to 5 mm x 2.5 to 2.7 mm (Stanley and Ross 1983).



Photograph 3.13 Tara wattle (*Acacia lauta*)

Source: Fagg (n.d.)

3.15.2.2 Known distribution

Known populations of the Tara wattle occur in restricted areas between Inglewood and Tara in the Darling Downs District, southeast Queensland (DoE 2008) (refer Figure 3.29).

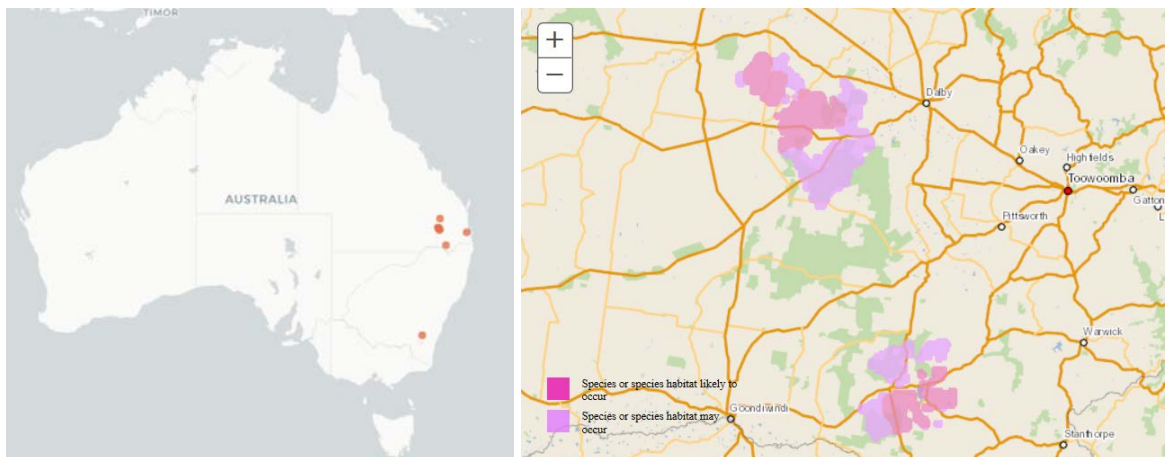


Figure 3.29 Distribution range of the Tara wattle

Source: ALA (2018); DotEE (2018)

3.15.2.3 Distribution in relation to the Project

Tara wattle was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) indicate the species has been recorded in the wider region surrounding the Project. The nearest of database record is located approximately 16 km south of the Project disturbance footprint at the south-eastern section of Coolmunda Conservation Park. This record is almost 30 years old (1989) and the only one within a 50 km radius of the Project. Other records for the species occur to the north of the Project at Vickery and Condamine State Forests. These consist of recent (1994) and older (1961) records and are located approximately 105 km north of the Project. A single record also exists at Barakula State Forest approximately 165 km north of the Project (refer Figure 3.30).

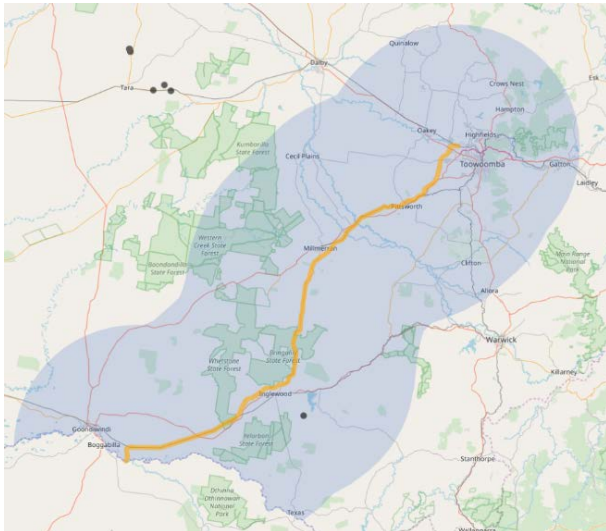


Figure 3.30 Distribution range of the Tara wattle in relation to the Project

Source: ALA (2020)

3.15.2.4 Biology and reproduction

Tara wattle flowers in August/September and sets fruit in December and is dependent upon specific fire regimes for germination (potentially within the 11 to 15 year interval) (DoE 2008).

3.15.3 Habitat

Tara wattle occurs on sandy soils in open woodland. The area where this species grows has a sub-humid subtropical climate and the localities are characterised by a gently undulating to flat landforms. Soils are moderately deep and hard-setting with a weakly acidic to neutral sandy loam surface grading into neutral to alkaline sandy clay subsoil (DoE 2008; Halford 1995).

3.15.4 Threatening processes

The following have been identified as potentially threatening processes to Tara wattle:

- Susceptibility to disturbance such as road widening
- Too frequent fire (DoE 2008).

3.15.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.15.6 References

Atlas of Living Australia (2018). *Acacia lauta*. Available from:

<https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2886854#overview> [Accessed 28 August 2018].

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<http://www.environment.gov.au/biodiversity/threatened/species/pubs/4165-conservation-advice.pdf>.

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<https://images.ala.org.au/image/details?imageId=746f0ac2-d9ee-474d-8de6-b9b9cb43579f>. [19 September 2019].

Stanley, TD and Ross, EM (1983). Flora of southeastern Queensland. Volume 1. Queensland Department of Primary Industries.

3.16 Slender tylophora (*Tylophora linearis*)

3.16.1 Status

EPBC Act – Endangered

3.16.2 Biology and ecology

3.16.2.1 Characteristic

Tylophora linearis is a slender, almost hairless twiner with a clear sap. Its leaves are dark green, linear and 1-5 cm x 0.5 to 3 mm. The flowers are purplish, 3 to 6 mm in diameter, hairy and in radiating groups of 3 to 8 (refer Photograph 3.14). The fruit is cigar shaped, hairless, up to 100 mm long and approximately 5 mm diameter (OEH 2017).



Photograph 3.14 *Tylophora linearis*

Source: Carr (n.d.)

3.16.2.2 Known distribution

There are records of *T. linearis* from Goonoo, Pillaga West, Pillaga East, Bibblewindi, Cumbil and Eura State Forests, Coolbaggie Nature Reserve, Goobang National Park and Beni Strategic Cropping Area. There has also been records near Glenmorgan in the western Darling Downs, Queensland (OEH 2017) (refer Figure 3.31).

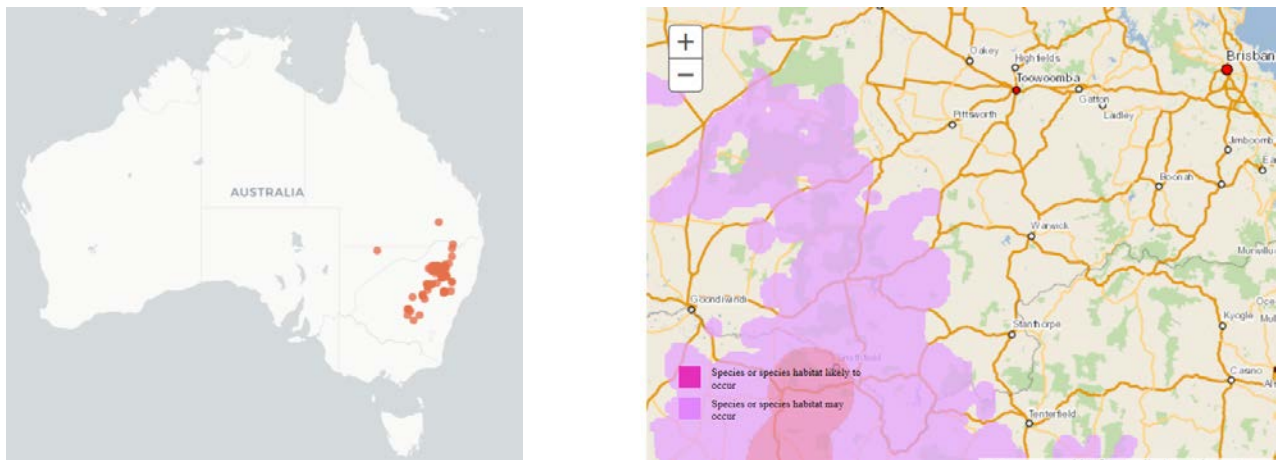


Figure 3.31 Distribution range of *T. linearis*

Source: ALA (2018), DotEE (2018)

3.16.2.3 Distribution in relation to the Project

Tylophora linearis was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). There are no database records (i.e. AoLA, WildNet) that occur for this species within the Project disturbance footprint or within the MNES impact assessment area. The nearest record is recent (<20 years) however this record occurs in New South Wales near Dhinna Dhinawan National Park approximately 42 km south of the Project. The record is located to the south of the Bruxner Highway and east of Middle Creek towards the southern section of the national park. In Queensland the nearest record occurs approximately 175 km north-west of the Project to the north of Glenmorgan (refer Figure 3.32).

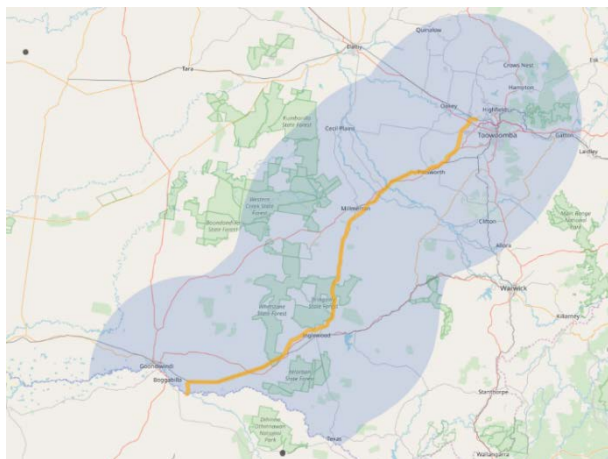


Figure 3.32 Distribution range of *T. linearis* in relation to the Project

Source: ALA (2020)

3.16.2.4 Biology and reproduction

Tylophora linearis flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later (OEH 2017).

3.16.3 Habitat

Tylophora linearis grows in dry scrub and open forest. It has been recorded in low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *Eucalyptus sideroxylon*, *Eucalyptus albens*, *Callitris endlicheri*, *Callitris glaucophylla* and *Allocasuarina luehmannii*. It also grows in association with *Acacia hakeoides*, *Acacia lineata*, *Melaleuca uncinata*, *Myoporum* species and *Casuarina* species (OEH 2017).

3.16.4 Threatening processes

The following have been identified as potentially threatening processes to *T. linearis*:

- Track maintenance
- Forestry activities
- Inappropriate disturbance regimes (OEH 2017).

3.16.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.16.6 References

Atlas of Living Australia (2018). *Tylophora linearis*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2906372#> [Accessed 28 August 2018].

Carr G. (n.d.). Flowers, buds and foliage, *Tylophora linearis*. (Image) [Online] Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10815> [Accessed 28 August 2018].

Department of the Environment, Water, Heritage and the Arts. (2008). *Approved Conservation Advice for Tylophora linearis*. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/55231-conservation-advice.pdf>. [Accessed 28 August 2018].

Office of Environment and Heritage, NSW (2017). *Tylophora linearis*. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10815> [Accessed 28 August 2018].

3.17 Wandering pepper-cress (*Lepidium peregrinum*)

3.17.1 Status

EPBC Act – Endangered

3.17.2 Biology and ecology

3.17.2.1 Characteristic

Wandering pepper-cress (*Lepidium peregrinum*) is a perennial plant that grows to 10 to 80 cm tall, sometimes ascending to 2 m in surrounding vegetation. The lower cauline leaves are deeply divided with a large broad-lanceolate terminal lobe and measure 6 to 10 cm long by 15 to 25 mm wide (refer Figure 3.33). Leaf edges are fringed with eyelash-like hairs. The mid-cauline leaves are lanceolate in outline with serrate to serrulate margins and measure 4 to 9 cm long by 4 to 9 mm wide. The small flowers are less than 1 mm long and arranged in hairy, terminal racemes (ALA 2018; DotEE 2018; OEH 2018).



Figure 3.33 Wandering pepper-cress (*Lepidium peregrinum*)

Source: OEH (n.d.)

3.17.2.2 Known distribution

Wandering pepper-cress occurs from the Bunya Mountains, southeast Queensland, to near Tenterfield, in northern NSW. This species occurs within the New England Tableland and southeast Queensland Bioregions and the southeast Queensland, Condamine and Border-Rivers Maranoa-Balonne Natural Resource Management regions (OEH 2018; DotEE 2018) (refer Figure 3.34).

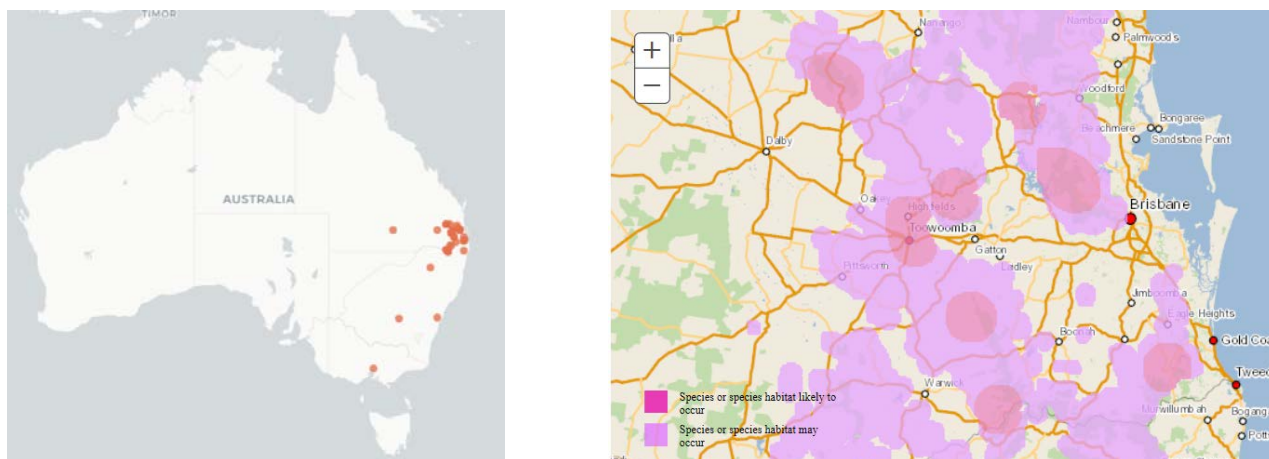


Figure 3.34 Distribution range of the Wandering pepper-cress

Source: ALA (2018), DotEE (2018)

3.17.2.3 Distribution in relation to the Project

Wandering pepper-creep was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). This species has not been identified within or near the Project disturbance footprint or the MNES impact assessment area. The nearest database record is from Highfield Falls north of Toowoomba (2007) approximately 10 km east of the north-eastern extent of the Project footprint. Several records exist at this location, potentially for the same group of plants. Records note several plants growing at the location 10 m uphill from the edge of the walking track. There are also records (collected in 2007) on the eastern edge of Toowoomba (Picnic Point Park) approximately 15 km south-east of the Project. Several records exist approximately 40 km north-east of the northern end of the Project footprint east of Hampton dated between 2007 to 2011 (refer Figure 3.35). This species is known from numerous locations outside of a 50 km buffer from the Project footprint north of Kumburilla State Forest, at Bunya Mountains National Park, south of Yarraman State Forest, Deer Reserve State Forest, D'Aguilar National Park and at Main Range National Park (AoLA 2020).

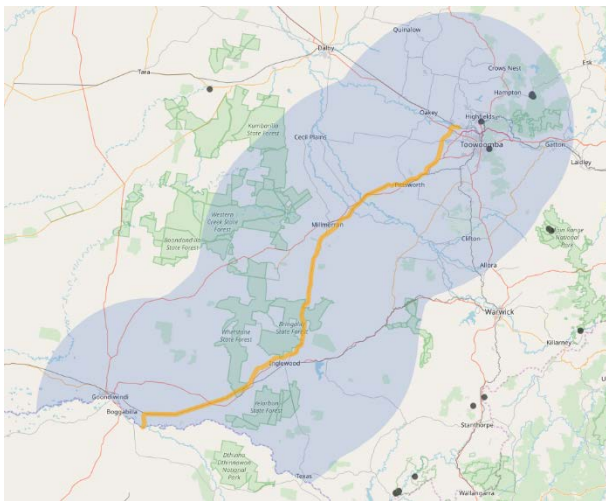


Figure 3.35 Distribution range of the Wandering pepper-creep in relation to the Project

Source: ALA (2020)

3.17.2.4 Biology and reproduction

Wandering pepper-creep flowers from January to April. Initial studies of Wandering pepper-creep subpopulations found some have little or no recruitment, while others have juvenile plants in the absence of mature plants. This could be indicative that the species requires specific triggers to break seed dormancy, and naturally experiences 'boom and bust' cycles in the number of mature plants. It is possible the species persists in some locations as dormant seed with no vegetative specimens being evident (OEH 2018).

3.17.3 Habitat

The species has been recorded growing in riparian open forest dominated by *Eucalyptus camaldulensis* and *Casuarina cunninghamiana* with variably dense shrubby understorey. The species was most abundant in the tussock grassland fridge of the riparian open forest, with some plants reaching a height of 2 m in thickets of *Hymenanthera*. It has also been recorded in shade under shrubs close to the creek bank, in which cases most plants have been small, approximately 30 cm in height. Herbarium records and observations in the wild suggest this species responds to disturbance events, due to observations along walking tracks, native pine plantations and car parks, and therefore population densities may fluctuate as a response to such events (Scarlett 2000; OEH 2018; DotEE 2018).

3.17.4 Threatening processes

The following have been identified as potentially threatening processes to the Wandering pepper-creep:

- Populations are fragmented and generally very small, with recruitment spasmodic or limited
- Clearing of habitat for agriculture and grazing
- Grazing
- Introduced weeds
- Destruction of plants following misidentification
- Extended drought periods and other forms of land degradation (OEH 2018).

3.17.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016>. In effect under the EPBC Act from 07-Jan-2017.

3.17.6 Summary of threat abatement/recovery plan

Threats identified in the Threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Suppress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

3.17.7 References

Atlas of Living Australia (2018). Wandering pepper-creep. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2896651#> [Accessed 30 August 2018].

Department of the Environment and Energy (2018). *Lepidium peregrinum* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=14035t. Accessed Fri, 24 August 2018

Office of Environment and Heritage, NSW (2018). Wandering pepper-creep. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10464> [Accessed 30 August 2018].

Scarlet, N. 2000. Flora and Fauna Guarantee Action Statement Draft; Winged Pepper-cress *Lepidium monolocoides*, Department of National Resources and Environment, Melbourne.

Threatened Species Scientific Committee (TSSC). (2003). *Lepidium peregrinum* (a herb) – Commonwealth Listing Advice. Department of Environment, Water, Heritage and the Arts, Canberra. Available at: <http://www.environment.gov.au/biodiversity/threatened/species/l-peregrinum.html>.

3.18 *Westringia parvifolia*

3.18.1 Status

EPBC Act – Vulnerable

3.18.2 Biology and ecology

3.18.2.1 Characteristic

Westringia parvifolia is a spreading shrub growing up to 1 m high. Young shoots and flowers are covered with small, white hairs pressed closely to the surface and the branchlets are often hexagonal. Leaves are 1.5 to 3 mm long, oval-shaped, margins slightly recurved and arranged along the stem with three leaves forming a whorl at each node (refer Photograph 3.15). Flowers are pale purple to white with reddish spots and occur in the upper leaf axils, forming a terminal leafy head of 3 to 7 flowers (White and Francis 1921; Boivin 1949).



Photograph 3.15 *Westringia parvifolia*

Source: Johnson (1974)

3.18.2.2 Biology and reproduction

Flowering has been recorded in September and November (DotEE 2018).

3.18.3 Habitat

This species grows with *Eucalyptus bakeri*, *E. viridis* and between clumps of Spinifex (*Triodia* sp.) on sandy and stony soils (White and Francis 1921).

3.18.3.1 Known distribution

Westringia parvifolia is known from a small area near Yelarbon and Inglewood in southeast Queensland (ALA 2018) (refer Figure Figure 3.36).

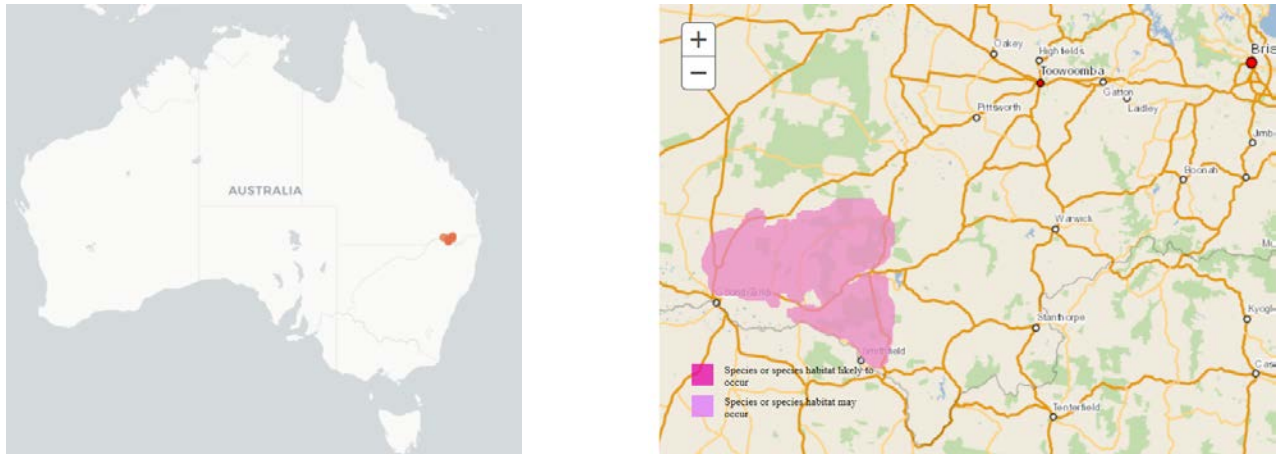


Figure 3.36 Distribution range of *Westringia parvifolia*

Source: ALA (2018), DotEE (2018)

3.18.3.2 Distribution in relation to the Project

Westringia parvifolia was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) indicate two records from 1919 and 1948 present within the impact assessment area at Yelarbon. These records are very old and have a large degree of spatial uncertainty bringing into question the validity of the records. An additional record is located southeast of the Project disturbance footprint near Inglewood approximately 3.5 km south of the Project. This record is similarly old dated more than 100 years ago with a large degree of spatial uncertainty. The most reliable and recent record within a 50 km radius of the Project occurs to the south of Inglewood approximately 8 km from the disturbance footprint. However, this record is still relatively old dated almost 50 years ago. A further two records occur within a 50 km radius of the Project. One is located approximately 18.5 km south of Inglewood at Allambie Wildlife Reserve and the second located approximately 25 km to the west near Goondiwindi. Both records are old and share a large degree of spatial uncertainty as with other records in the region. Several other records are also located approximately 25 km south across the border in New South Wales near Dthinna Dthinnawan Nationa Park (refer Figure 3.37).

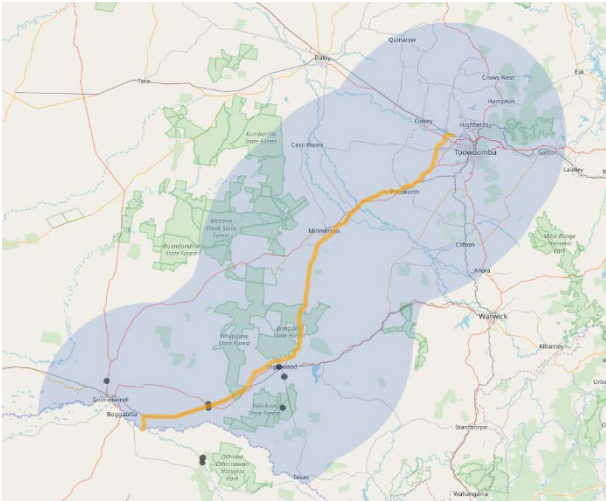


Figure 3.37 Distribution range of *Westringia parvifolia* in relation to the Project

Source: ALA (2020)

3.18.4 Threatening processes

The following have been identified as potentially threatening processes to *W. parvifolia*:

- Broad-scale vegetation clearing
- Increasing fragmentation and loss of remnants
- Hydrological change
- Pollution (ANRA 2009).

3.18.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.18.6 References

Atlas of Living Australia (2018). *Westringia parvifolia*. Available from:

<https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2920137#overview> [Accessed 28 August 2018].

Australian Natural Resources Atlas (2009). *Biodiversity Assessment - Species at risk and their Recovery Process*. Available from: <http://www.anra.gov.au/topics/vegetation/assessment/index.html>. [Accessed 28 August 2018].

Boivin, B. (1949). *Westringia*, an Australian genus of Labiatae. *Proceedings of the Royal Society of Queensland*. 60(9):99-110.

Department of the Environment and Energy (2018). *Westringia parvifolia* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=4822 [Accessed 28 August 2018].

Johnson R.W. (1974). *Westringia parvifolia*. (Image) [Online] Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2920137#overview> [Accessed 28 August 2018].

White, C.T. and W.D. Francis (1921). Contributions to the Queensland Flora. *Proceedings of the Royal Society of Queensland*. 33:152-165.

3.19 Winged pepper-cress (*Lepidium monoplocoides*)

3.19.1 Status

EPBC Act – Endangered

3.19.2 Biology and ecology

3.19.2.1 Characteristic

Winged pepper-cress (*Lepidium monoplocoides*) is an erect annual herb or perennial forb, 15 to 20 cm high, with angular and striped stems roughened with small warts. Leaves are narrow and linear and usually 2 to 7 cm long (refer Photograph 3.16). Flowers are small, borne in elongated clusters and the petals are minute or absent. Fruit are two-celled, flattened circular pods on a spreading stalk, 5 mm long and about 4 mm wide, with pointed wings extending to a narrow notch at the tip (OEH 2018).



Photograph 3.16 Winged pepper-cress (*Lepidium monoplocoides*)

Source: Copeland (n.d.)

3.19.2.2 Known distribution

Winged pepper-cress is widespread in the semi-arid western plains regions of NSW into north-western Victoria. It has been recorded from widely scattered localities. In Queensland, several specimens have been recorded near the border of NSW around Goondiwindi and Yelarbon (ALA 2018) (refer Figure 3.38).

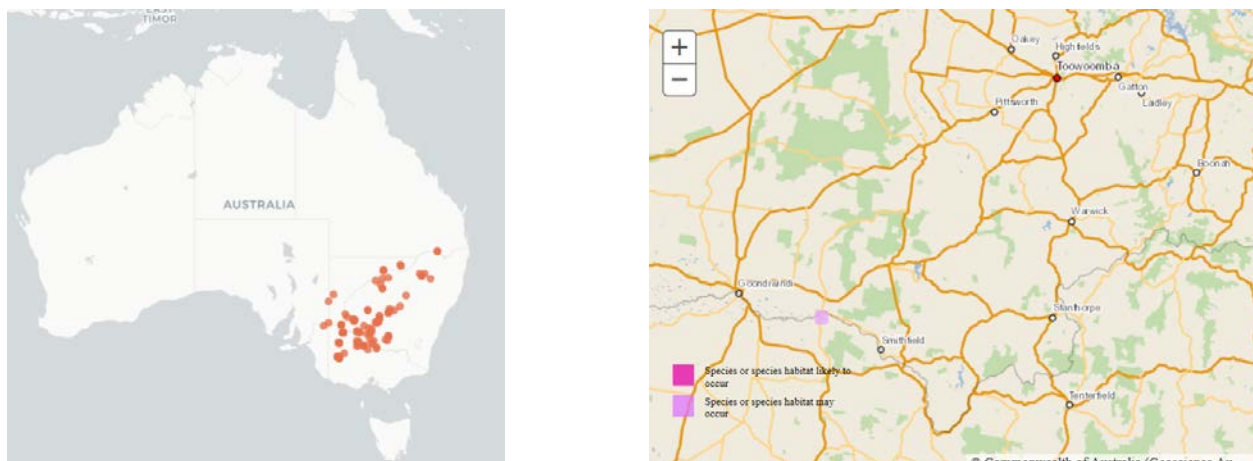


Figure 3.38 Distribution range of the Winged pepper-cress

Source: ALA (2018), DotEE (2018)

3.19.2.3 Distribution in relation to the Project

Winged pepper-creep was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Four records for this species occur in Queensland, all of which have been identified within the MNES impact assessment area. Most of these records are recent having been identified within the last 25 years. One record is older and is dated 1919. The two closest records are from 2015 occurring almost on the edge of the Project disturbance footprint. These records appear to occur within a road reserve adjacent to Yelarbon Keetah Road/Wondalli Street at the western edge of the Yelarbon township. The record to the north of the Project disturbance footprint occurs in remnant habitat that exists between the Cunningham Highway and Merton Road. The Project associated database records occur at the northern limit of the species distribution and are the only records in Queensland (refer Figure 3.39).

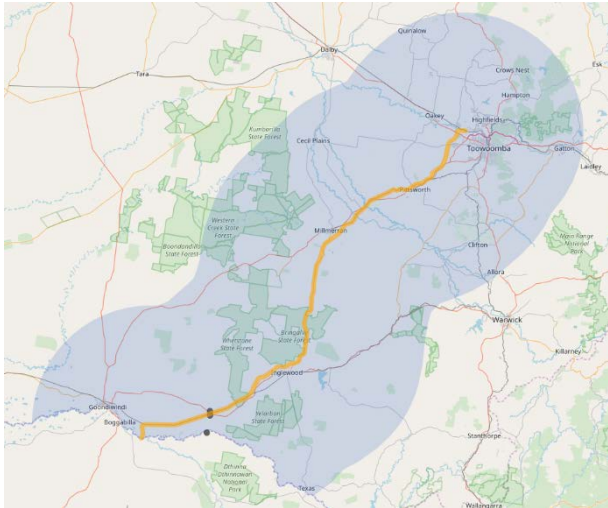


Figure 3.39 Distribution range of the Winged pepper-creep in relation to the Project

Source: ALA (2020)

3.19.2.4 Biology and reproduction

Winged pepper-creep flowers from August to October and is highly dependent on seasonal conditions (OEH 2018).

3.19.3 Habitat

Winged pepper-creep occurs on seasonally moist to waterlogged sites and on heavy fertile soils with a mean annual rainfall of around 300 to 500 mm. Predominant vegetation is usually an open woodland dominated by *Allocasuarina luehmannii* (Bullock) and/or eucalypts, particularly *Eucalyptus largiflorens* (Black Box) or *Eucalyptus populnea* (Poplar Box). The field layer of the surrounding woodland is dominated by tussock grasses (OEH 2018).

3.19.4 Threatening processes

The following have been identified as potentially threatening processes to the Winged pepper-creep (OEH 2018):

- Agricultural development
- Habitat removal
- Grazing and trampling
- Disturbances associated with communications tower, service roads and fire-breaks
- Recreational 4WD vehicles.

3.19.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10463>. In effect under the BC Act 2016.

The following threat abatement plans has been identified as being relevant for this species:

- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016>. In effect under the EPBC Act from 07-Jan-2017
- Department of the Environment and Energy (2017). Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (2017). Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017>. In effect under the EPBC Act from 18-Mar-2017.

3.19.6 Summary of threat abatement/recovery plans

The conservation strategy for Winged pepper-creep identifies one priority management site in NSW:

- Pilliga National Park in Narrabri LGA

The conservation strategy identifies the following key threat specific to the species:

- Recreational 4WD vehicles disturbing solid surface and habitat infrastructure.

Management strategies relevant to Winged pepper-creep include:

- Install gates and security cameras at key access points to prevent 4WD access to northern boundary fence
- Collect evidence of disturbance to the species at the site
- Monitor species abundance and condition and for any potential threats.

Threats identified in the Threat abatement plan for competition and land degradation by rabbit relevant to *Lepidium monolocoides* include:

- Preventing plant regeneration
- Overgrazing and general damage to plant species
- Reversing the normal processes of plant succession
- Altering ecological communities and changing soil structure and nutrient cycling, leading to significant erosion.

Relevant management strategies relevant to *Lepidium monolocoides* include population control. Following the plan, control efforts should be:

- targeted to protect sites where rabbits pose the greatest threat to biodiversity
- undertaken in a strategic manner to take advantage of the environmental conditions and other complementary activities
- monitored to ensure that objectives are met and allow management options to be adapted to changing circumstances.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality

- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pigs (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering point and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

3.19.7 References

Atlas of Living Australia (2018). *Lepidium monoplacoides*. Available from:

https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2898274#tab_recordsView [Accessed 30 August 2018].

Copeland, L. (n.d.). *Lepidium monoplacoides* (Image) [Online] Available from:

<https://www.nationalparks.nsw.gov.au/conservation-programs/winged-peppercress-conservation-program> [18 September 2019].

Mavromihalis, J. 2010. National Recovery Plan for the Winged Peppercress *Lepidium monoplacoides*. Department of Sustainability and Environment, Melbourne.

Office of Environment and Heritage, NSW (2018). Winged Peppercress. Available from:

<https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10463> [Accessed 30 August 2018].

3.20 Xerothamnella herbacea

3.20.1 Status

EPBC Act – Endangered

3.20.2 Biology and ecology

3.20.2.1 Characteristic

Xerothamnella herbacea is a sparse, sprawling, perennial herb growing to a height of 30 cm. Stems extend from a central point but can root at the nodes where they make contact with the soil. The leaves are arranged in opposite pairs and are soft, linear to narrowly ovate in outline, dark green above and paler beneath. Flowers are small, bright pink to mauve, two lipped, up to 6.5 mm long and occur in the upper leaf axils (Barker 1986) (refer Photograph 3.17).



Photograph 3.17 *Xerothamnella herbacea*

Source: QLD Herb (2018)

3.20.2.2 Known distribution

Xerothamnella herbacea is restricted to the Chinchilla – Goondiwindi region of southern Queensland (DoE 2008) (refer Figure 3.40).

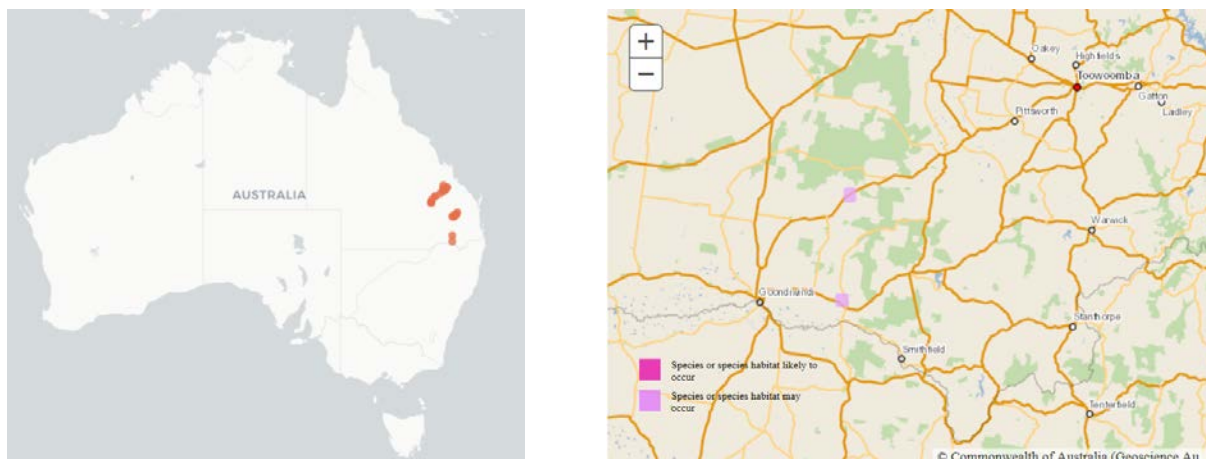


Figure 3.40 Distribution range of *Xerothamnella herbacea*

Source: ALA (2018), DotEE (2018)

3.20.2.3 Distribution in relation to the Project

Xerothamnella herbacea was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). There are no database records (i.e. AoLA, WildNet) that occur for this species within the Project disturbance footprint or within the MNES impact assessment area. A record occurs approximately 5 km from the Project north of Yelarbon and is recent within the last 14 years. The record details the occurrence 5.59 km along Merton Road, in a shallow gilgai depression with occasional plants scattered amongst Brigalow along the road reserve. A second recent record occurs approximately 40 km from the Project within a road reserve along the Gore Highway located at the southern end of the Western Creek State Forest. Further details of this record state approximately 10 individuals at this location growing amongst Brigalow and Belah dominated vegetation. These are the only records for this species within 50 km of the Project. Other records occur to the north along the southern and south-eastern boundary of Barakula and Jarrah State Forests. These records occur more than 145 km north of the Project (refer Figure 3.41).

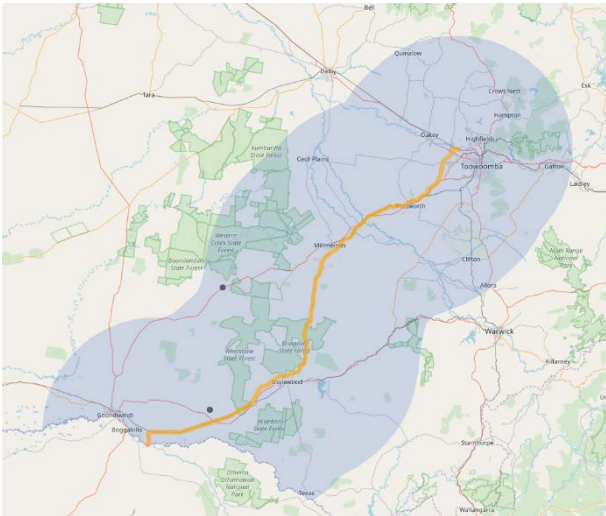


Figure 3.41 Distribution range of *Xerothamnella herbacea* in relation to the Project

Source: ALA (2020)

3.20.2.4 Biology and reproduction

There is no information available on the reproduction of *X. herbacea*.

3.20.3 Habitat

Xerothamnella herbacea is found in Brigalow (*Acacia harpophylla*) dominated communities in shaded situations, often in leaf litter and in association with gilgais, on heavy, grey to dark brown clay soils (DoE 2008).

3.20.4 Threatening processes

The following have been identified as potentially threatening processes to *X. herbacea*:

- Competition and alteration of fire regimes from invasive plant species
- Road widening and maintenance activities
- Surface erosion
- Grazing and trampling by cattle and native macropods (WetlandInfo 2018).

3.20.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.20.6 References

Atlas of Living Australia (2018). *Xerothamnella herbacea*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2908833> [Accessed 28 August 2018].

Department of the Environment (2008). Approved Conservation Advice for *Xerothamnella herbacea*, Approved Conservation Advice (s266B of the Environment Protection and Biodiversity Conservation Act 1999).

Department of the Environment, Water, Heritage and the Arts. (2008). *Approved Conservation Advice for Xerothamnella herbacea*. Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/4146-conservation-advice.pdf>.

Queensland Herbarium, (2018). *Xerothamnella herbacea* (Image) [Online] Available from: <https://images.ala.org.au/image/details?imageId=1e1f4219-a6d5-4017-8d5c-fbb96314e78e> [18 September 2019].

WetlandInfo, Department of Environment and Science, Queensland (2018). *Xerothamnella herbacea*. [Online] Available from: <https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?xerothamnella-herbacea> [Accessed 28 August 2018].

3.21 Hairy-joint grass (*Arthraxon hispidus*)

3.21.1 Status

EPBC Act – Vulnerable

3.21.2 Biology and ecology

3.21.2.1 Characteristic

Hairy-joint grass (*Arthraxon hispidus*) is a slender tufted creeping grass that roots at the nodes, with erect to semi-erect stems. The leaves are reddish to purplish, with long white hairs around the edge, broad at the base and tapering abruptly to a sharp point (refer Photograph 3.18). Flowers appear in March to July and summer to autumn. The fruit is a caryopsis (simple, dry single seeded fruit, with seed fused to the wall of the fruit and remaining closed at maturity). The seed-heads are held above the plant on a long fine stalk. Once thought to be an annual species, more recent information suggests it is a perennial that tends to die down in winter (TSSC 2008).



Photograph 3.18 Hairy-joint grass (*Arthraxon hispidus*)

Source: Dalgial (2015)

3.21.2.2 Known distribution

Hairy-joint grass has been recorded from scattered locations throughout Queensland and on the northern tablelands and north coast of NSW. In Queensland, the species occurs north to Port Douglas, and west to disjunct occurrences around mound springs in Carnarvon National Park. However, the most common occurrences are from Noosa southwards. This species has been recorded within the Border River–Gwydir, Northern Rivers (NSW), Fitzroy, Border Rivers–Maranoa Balonne, Condamine, South East, Burnett Mary and Wet Tropics (Queensland) Natural Resource Management regions (refer Figure 3.42). It is also known to be reserved in Carnarvon Cooloola NP, Noosa NP, Carnarvon NP, and Daintree NP (DotEE 2018).

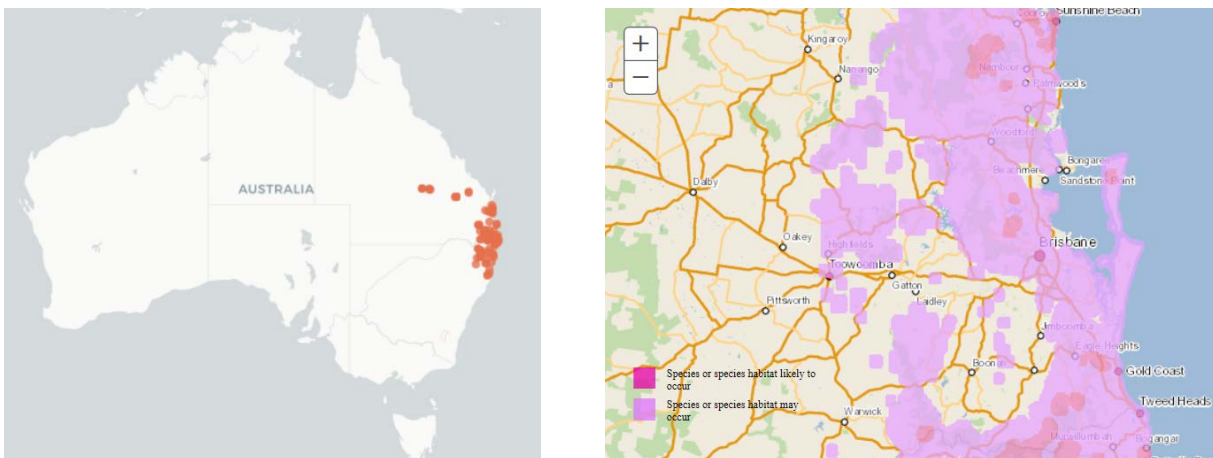


Figure 3.42 Distribution range of Hairy-joint grass

Source: ALA (2018), DotEE (2018)

3.21.2.3 Distribution in relation to the Project

Arthraxon hispidus was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not reveal any specimen backed records within the Project disturbance footprint or MNES impact assessment area. Records within a 50 km radius of the Project occur at Toowoomba approximately 13 km from the Project (refer refer Figure 3.43). Most of these records are recent from within the last 15 years and one record is old dated 1875 occurring in an area that is now part of an industrial area of Toowoomba.

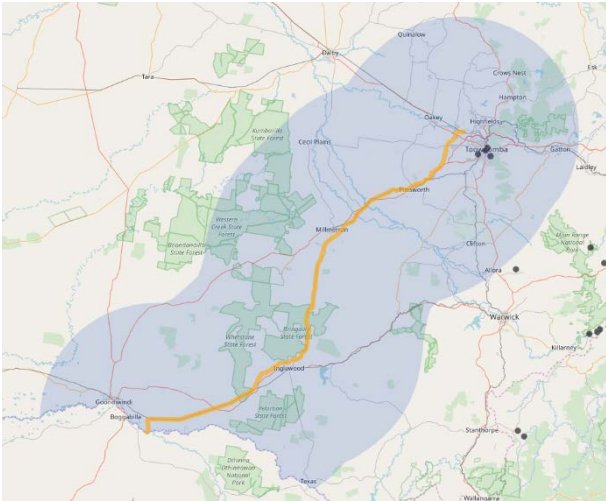


Figure 3.43 Distribution range of Hairy-joint grass in relation to the Project

Source: ALA (2020)

3.21.2.4 Biology and reproduction

Fertile material of Hairy-joint grass has been collected from March to May, and July. The species has been reported as flowering during summer-autumn. Hairy-joint grass was once considered an annual, but is now thought to be a perennial that tends to die down in winter (TSSC 2008).

3.21.3 Habitat

Hairy-joint grass is found in or on the edges of rainforest and in wet Eucalypt forest, often near creeks or swamps, as well as woodland. The species has been recorded growing around freshwater springs on coastal foreshore dunes, in shaded small gullies, on creek banks, and on sandy alluvium in creek beds in open forests. It has also been recorded with bog mosses in mound springs (TSSC 2008).

3.21.4 Threatening processes

The following have been identified by DotEE as potentially threatening processes to the Hairy-joint grass:

- Trampling and over grazing by stock
- Clearing for agriculture and development
- Inappropriate fire regimes
- Competition from introduced grasses.

3.21.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10066>. In effect under the BC Act 2016.

No threat abatement plan has been identified as being relevant for this species.

3.21.6 Summary of threat abatement/recovery plan

Arthraxon hispidus is assigned as a keep-watch species under the NSW *Saving our Species Program* as it is widespread with many small populations across NSW. State wide conservation actions identified for this species include:

- Educate the public on *Arthraxon hispidus*, particularly landowners adjacent to areas of known occurrence
- Reserve Fire Management Strategy to include operational guidelines to protect this species from fire
- Develop and implement site management plans for some of the known populations
- Establish monitoring sites to determine trends in habitat condition and population size
- Maintain populations ex situ at suitable botanic gardens, regional gardens or nurseries
- Map extent of known populations and survey areas of potential habitat near known occurrences for additional populations
- Assess weed threats to populations, manage as necessary. Implement Bitou bush control as described in the approved TAP
- Control feral animals in known habitat for this species.

3.21.7 References

Atlas of Living Australia, (2018), Distribution of Hairy-joint grass, accessed 24 August 2018, available <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2902385>.

Department of the Environment and Energy (2018). *Arthraxon hispidus* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=9338 [Accessed 30 August 2018].

Dalgial. (2015). Hairy-joint grass (*Arthraxon hispidus*). [image] [online] Available from: <https://biocache.ala.org.au/occurrences/43d70452-9eee-4b0e-9310-c434a5179f85>. [16 September 2019].

Office of the Environment and Heritage, (2015a), Threatened Species Website, image of: *Arthraxon hispidus* - Hairy-joint grass, accessed 23 August 2018, available <https://images.ala.org.au/image/viewer?imageId=3c1642c2-522e-495d-95cc-f8f60a4f2f9a>.

Office of the Environment and Heritage, (2015b), Threatened Species Website, image of: *Arthraxon hispidus* - Hairy-joint grass, accessed 23 August 2018, available <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2902385#gallery>.

Threatened Species Scientific Committee (2008). *Commonwealth Listing Advice on Arthraxon hispidus*. Department of the Environment, Water, Heritage and the Arts. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/9338-conservation-advice.pdf>.

3.22 Bunya Mountains bluegrass (*Bothriochloa bunyensis*)

3.22.1 Status

EPBC Act – Vulnerable

3.22.2 Biology and ecology

3.22.2.1 Characteristic

Bunya Mountains bluegrass (*Bothriochloa bunyensis*) is an erect or geniculately (bent abruptly), ascending perennial to 60 cm tall without lateral branches. Leaf-blades are 6 to 12 cm long with scaberulous margins and acuminate apex (refer Figure 3.44). The inflorescence consists of 2 to 4 digitate racemes. The spikelets are in pairs with the fertile spikelet sessile. Bunya Mountains bluegrass has the largest spikelets (8 to 9 mm long) and companion spikelets (12 to 13 mm long) of the genus (Sharp and Simon 2002).



Figure 3.44 Bunya Mountains bluegrass (*Bothriochloa bunyensis*)

Source: Simon (1982), drawn by Margaret Saul cited in Ausgrass (2015)

3.22.2.2 Known distribution

Bunya Mountains bluegrass is endemic to southeast Queensland where populations occur on Bunya Mountains north of Dalby, near Toowoomba, Crows Nest and the Main Range (Mt Mistake Plateau) (refer Figure 3.45).

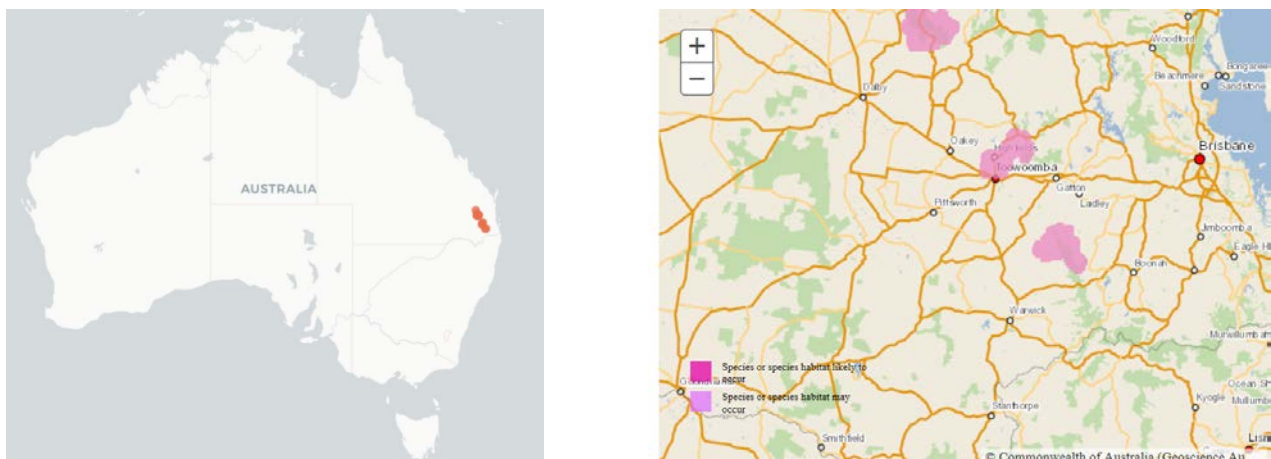


Figure 3.45 Distribution range of Bunya Mountains bluegrass

Source: ALA (2018), DotEE (2018)

3.22.2.3 Distribution in relation to the Project

Bothriochloa bunyensis was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA) do not indicate records for this species within the Project disturbance footprint or from within the MNES impact assessment area. The nearest record is recent from 2004 and is located approximately 10 km east of the northern section of the Project footprint in Blue Mountain Heights, just north of Toowoomba. A second record is located approximately 12 km to the east in Toowoomba. Another record is also located approximately 25 km to the northeast between Mount Lawson and White Mountain in Lockyer National Park (refer Figure 3.46). Records outside of a 50 km radius of the Project occur at Bunya Mountains National Park to the north and Main Range National Park to the south.

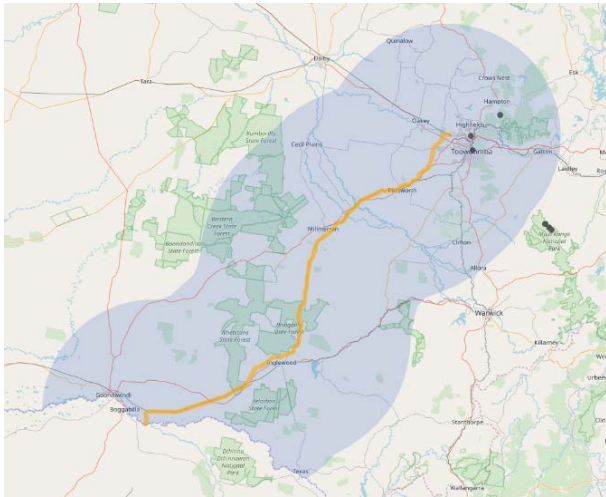


Figure 3.46 Distribution range of Bunya Mountains bluegrass in relation to the Project

Source: ALA (2020)

3.22.2.4 Biology and reproduction

Leaf-blades are 6 to 12 cm long with scaberulous margins and acuminate apex. The inflorescence consists of 2 to 4 digitate racemes. The spikelets are in pairs with the fertile spikelet sessile (Sharp and Simon, 2002). *Bothriochloa bunyensis* has the largest spikelets (8 to 9 mm long) and companion spikelets (12 to 13 mm long) of the genus (Sharp and Simon 2002).

3.22.3 Habitat

This species is endemic to southeast Queensland, associated with fertile soils in grassland or woodland with grassy understorey. The species is endemic to southeast Queensland where populations occur on the Bunya Mountains. Bunya Mountains bluegrass occurs on relatively fertile krasnozems (dark brown) soils derived from basalt on upper slopes and hill crests at altitudes of 600 to 1,100 m, in grassland or woodland with a grassy understorey (DotEE 2018; Halford 1998).

The majority of populations are located in protected estate within the Main Range and Bunya Mountains National Parks. Bunya Mountains bluegrass occurs within the Burnett, Mary, Condamine and southeast Queensland Natural Resource Management Regions (Environmental Protection Agency 2007; Fensham and Fairfax 1996; Halford 1998).

3.22.4 Threatening processes

The following have been identified as potentially threatening processes to the Bunya Mountains bluegrass:

- Encroachment of woody open forest and rainforest species, possibly caused by changes in fire regime since European settlement
- Invasion of exotic weeds (Fensham and Fairfax 1996).

3.22.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.22.6 References

Atlas of Living Australia (2018), Distribution of *Bothriochloa bunyensis* – Bunya Mountains Bluegrass, viewed 24 August 2018, available <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2900237>.

Ausgrass (2018), *Bothriochloa bunyensis* -*Austrobaileya*, viewed 24 August 2018, available <http://ausgrass2.myspecies.info/content/bothriochloa-bunyensis>.

Department of the Environment and Energy (2018). *Bothriochloa bunyensis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Fri, 24 August 2018

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Approved Conservation Advice for *Bothriochloa bunyensis* (Satin-top Grass). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/15961-conservation-advice.pdf>. In effect under the EPBC Act from 03 July 2008

Fensham, RJ and Fairfax, RJ (1996), 'The grassy balds on the Bunya Mountains, southeastern Queensland: Floristics and conservation issues', *Cunninghamia*, vol. 4, no. 3, pp. 511–523.

Halford, DA (1998), Survey of Threatened Plant Species in south east Queensland Biogeographical Region, Queensland CRA/RFA Steering Committee.

Sharp, D and Simon, BK (2002), *AusGrass: Grasses of Australia*, CSIRO Publishing, Melbourne.

3.23 Miniature moss-orchid (*Bulbophyllum globuliforme*)

3.23.1 Status

EPBC Act – Vulnerable

3.23.2 Biology and ecology

3.23.2.1 Characteristic

Miniature moss-orchid or Hoop pine orchid (*Bulbophyllum globuliforme*) is a tiny rhizomatous orchid that grows only on the bark of Hoop pine trees (*Araucaria cunninghamii*), forming a dense mat. It produces green, globular, bulb-like stems 1 to 2 mm in diameter. Leaves are narrow-triangular, 1 to 2 mm long, 0.2 to 0.3 mm wide, papery and concave. The inflorescence is 1 to 1.5 cm long, bearing one flower (refer Photograph 3.19). The sepals and petals are white to pale yellow. Miniature moss-orchid flowers from September to November (DotEE 2018).



Photograph 3.19 Miniature moss-orchid (*Bulbophyllum globuliforme*)

Source: ALA (2018)

3.23.2.2 Known distribution

Endemic to eastern Australia, the species is recorded from near Paluma, northeast Queensland, south to the McPherson Range on the Queensland/NSW border (refer Figure 3.47). This species is known to occur in four locations including Puzzle Creek near Paluma (northeast Queensland), Kroombit Tops near Calliope (central Queensland), Cainbale Creek in Lamington National Park (southeast Queensland) and Levers Plateau (northeast NSW) (DotEE 2018).

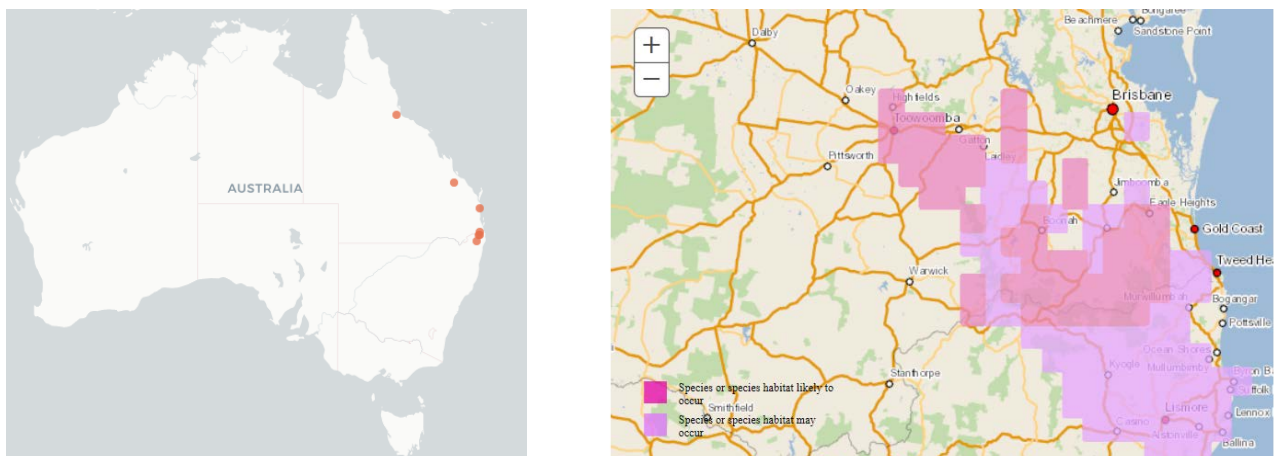


Figure 3.47 Occurrence record of Miniature moss-orchid

Source: ALA (2018), DotEE (2018)

3.23.2.3 Distribution in relation to the Project

Bulbophyllum globuliforme was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) did not reveal any specimen backed records within the Project disturbance footprint, the MNES impact assessment area or within 50 km of the Project. The nearest record is old from 1946 and is located approximately 175 km to the southeast in Border Ranges National Park (refer Figure 3.48). Outside of a 50 km radius of the Project this species occurs at Noosa Heads National Park, Lamington National Park and Border Ranges National Park.

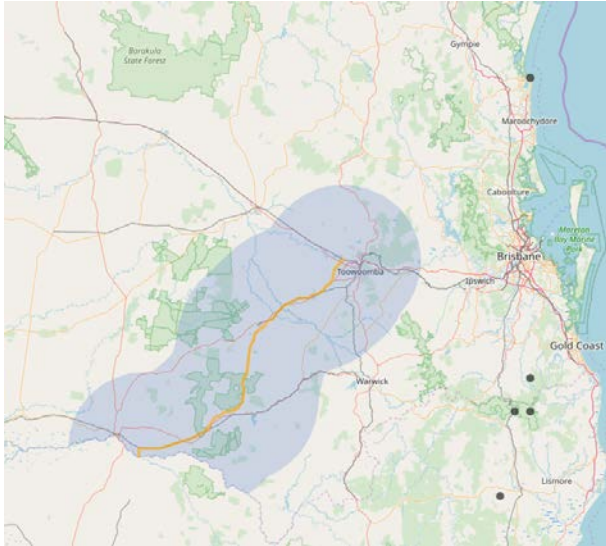


Figure 3.48 Occurrence record of Miniature moss-orchid in relation to the Project

Source: ALA (2020)

3.23.2.4 Biology and reproduction

Miniature moss-orchid flowers in May to November. The growth form of this species is unusual, as it forms mats of tiny bulbs (leaves) on the wrinkled bark of hoop pine, making it very difficult to identify in the field. Generation length is unknown however, as the plant forms colonies by rhizome growth, each clump may be very long-lived (DotEE 2018).

3.23.3 Habitat

This species has been previously recorded in the Bunya Mountains. The species grows only on Hoop pines, colonising the upper branches of mature trees in upland rainforest. Miniature moss-orchid are conserved in Noosa National Park, Lamington National Park and Bunya Mountains National Park, Queensland, and the Border Ranges National Park, NSW (; DotEE 2018; Harrison 2002).

3.23.4 Threatening processes

The following have been identified as potentially threatening processes to the Miniature moss-orchid:

- Destruction of habitat by clearing of Hoop pine host-trees
- Disturbance of habitat by timber harvesting and road works
- Inappropriate fire regimes
- Disturbance of habitat by weeds
- Damage and collection by orchid enthusiasts (Barker 1999).

3.23.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10112>. In effect under the BC Act 2016.

No threat abatement plan has been identified as being relevant for this species.

3.23.6 Summary of threat abatement/recovery plan

Bulbophyllum globuliforme is assigned as a keep-watch species under the NSW *Saving our Species Program* as relatively large populations are known to occur within reserves where current management is sufficient to ensure their long-term security. State wide conservation actions identified for this species include:

- Assess all known sites for population condition, habitat quality and threats
- Ensure that managers are aware of populations, habitat and threats and that fire plans, pest management plans take account of requirements for the recovery of the orchid
- Ensure confidentiality is applied to information about locations of the orchid to protect against illegal collection
- Avoid damage to and lopping of Hoop Pines within the habitat and range of the orchid
- Investigate and apply appropriate method for estimating populations.

3.23.7 References

Atlas of Living Australia (2018), *Bulbophyllum globuliforme*, accessed 23 August 2018, available from: <https://images.ala.org.au/image/viewer?imageId=050ae1de-9eb1-4f7d-926f-073d9e7ab02c>.

Department of the Environment and Energy (2018). *Bulbophyllum globuliforme* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Thu, 23 August 2018

Harrison, M (2002), 'Bulbophyllum species of Australia', Australian Orchid Review Dec 2001/Jan 2002, pp. 4–19.

3.24 Durikai mallee (*Eucalyptus infera*)

3.24.1 Status

EPBC Act – Vulnerable

3.24.2 Biology and ecology

3.24.2.1 Characteristic

Durikai Mallee is a slender-stemmed mallee that grows up to 8m high (refer Photograph 3.11). Juvenile leaves are 4-7 cm x 4-7 cm, stalked, alternate, ovate to orbicular and glossy green. Adult leaves are 6-11 cm x 2-5 cm, alternate, narrowly lanceolate, concolourous and glossy green. Flowerbuds are 1-1.3 cm x 0.3-0.4cm elongated ovoid to fusiform with operculum longer than hypanthium. The flowers are white. Fruit are 0.4 cm x 0.8 cm, hemispherical with discs raised and 3 to 4 valves strongly exserted (Brooker and Kleinig 1994; Bean 1990).



Photograph 3.20 Durikai Mallee (*Eucalyptus infera*)

Source: Qld Herb (2018)

3.24.2.2 Known distribution

Durikai Mallee is known only from a small area west of Warwick, Queensland (refer Figure 3.49). The main population at the southern end of SF444 has an estimated total number of 1,000 plants (A.R. Bean, 2008, pers. comm.). The extent or number of other populations is unknown.

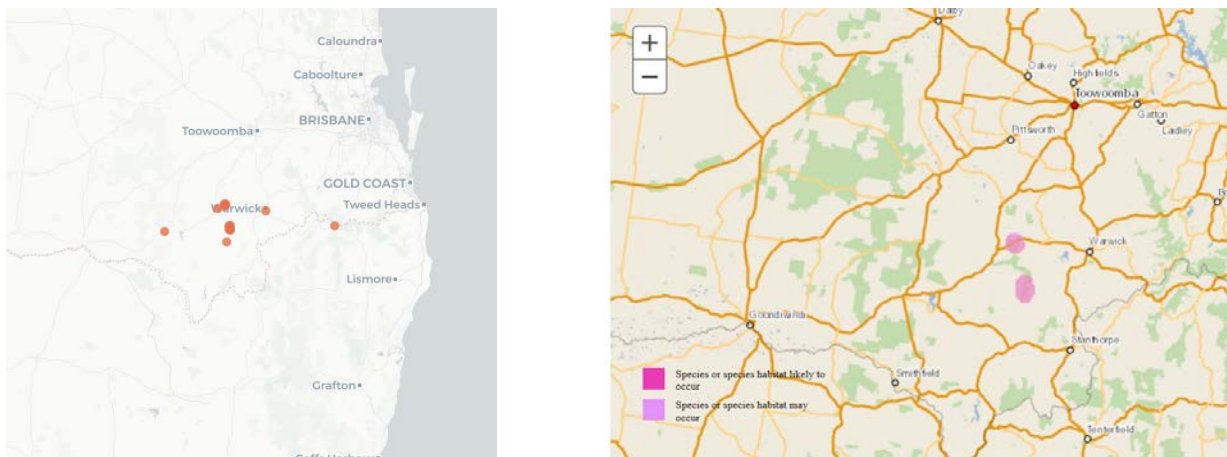


Figure 3.49 Distribution range of Durikai Mallee

Source: ALA (2019), DotEE (2018)

3.24.2.3 Distribution in relation to the Project

Eucalyptus infera was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database record (i.e. AoLA, WildNet) did not reveal any specimen backed records from within the Project disturbance footprint or the MNES impact assessment area. The nearest record is old dated more than 100 years ago and is located approximately 4 km south of the Project footprint at Inglewood. Other records including recent are located between 40 to 50 km to the southeast of the Project Talgai and Durikai State Forests (refer Figure 3.50).

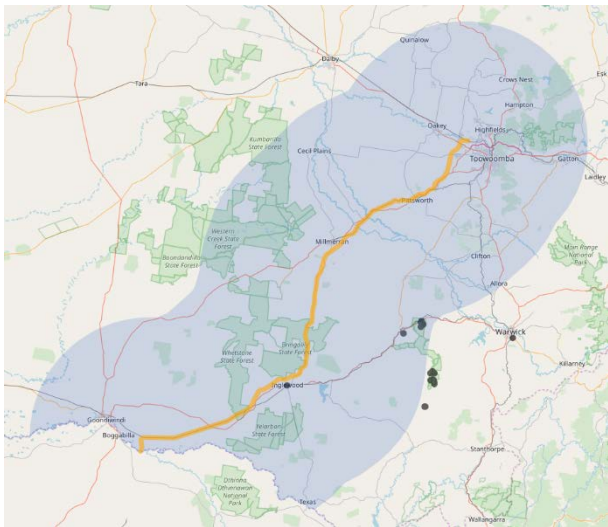


Figure 3.50 Distribution range of Durikai Mallee in relation to the Project

Source: ALA (2020)

3.24.2.4 Biology and reproduction

Flowering has been recorded in September and November (Bean, 1990).

3.24.3 Habitat

The species grows in small drainage lines, in association with Grey Box (*E. moluccana*), Broadleaved Ironbark (*E. fibrosa* subsp. *fibrosa*) and Spotted Gum (*Corymbia citriodora* subsp. *variegata*) in undulating terrain (Bean, 1990). It occurs in sandy duplex soils derived from metamorphosed sediments (DoE 2008).

3.24.4 Threatening processes

The following have been identified as potentially threatening processes to Durikai Mallee:

- Timber harvesting
- Disturbance of habitat during timber harvesting operations
- Loss of habitat due to vegetation clearing (DoE 2008).

3.24.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.24.6 References

- Atlas of Living Australia (2019). *Eucalyptus infera*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2900453> [Accessed 24/07/2019].
- Bean, A.R., (1990) A New Species of *Eucalyptus* L'Herit. (Myrtaceae) from Southern Queensland. *Austrobaileya* 3(2): 291.
- Brooker, MIH and Kleinig, DA (1994). Field guide to Eucalypts: Volume 3, Northern Australia. Inkata Press, Sydney.
- Department of the Environment (2008). Approved Conservation Advice *Eucalyptus infera*, s266B of the Environment Protection and Biodiversity Conservation Act 1999.
- Queensland Herbarium. (2018). Durikai Mallee (*Eucalyptus infera*) (Image) [Online] Available from: <https://images.ala.org.au/image/details?imageId=43bd7f77-631b-4417-be09-e1aa88b7576e> [19 September 2019].

Slee, AV, Brooker, MIH, Duffy, SM and West, JG (2006). Euclid: eucalypts of Australia. 3rd ed. (CSIRO: Canberra).

3.25 Coolmunda leucopogon (*Leucopogon* sp. Coolmunda) (D. Halford Q 1635)

3.25.1 Status

EPBC Act –Endangered

3.25.2 Biology and ecology

3.25.2.1 Characteristic

Leucopogon sp. *Coolmunda* (D.Halford Q 1635), is a small shrub up to 70 cm high, with shortly pubescent branches and short, erect, minutely toothed leaves 2– 5 mm long, 1–1.5 mm wide, pointed at the tip. One or two small white flowers are borne in the leaf axils. This species is closely related to *L. confertus* and *L. attenuatus*. *L. confertus* is distinguished from this species by the larger leaves (5–7.5 mm long) and *L. attenuatus* by the oblong to linear leaves and obtuse sepals (Halford 1993, DoE 2008).

3.25.2.2 Known distribution

Leucopogon sp. *Coolmunda* (D. Halford Q 1635) is known from a small area south-east of Inglewood, within the McIntyre River catchment, occurring within the Border Rivers Maranoa–Balonne (Queensland) Natural Resource Management Region (refer Figure 3.51). The total population in the Coolmunda could be as high as 67 000 individuals. It is also known to occur in Yelarbon State Forest (DoE 2008).

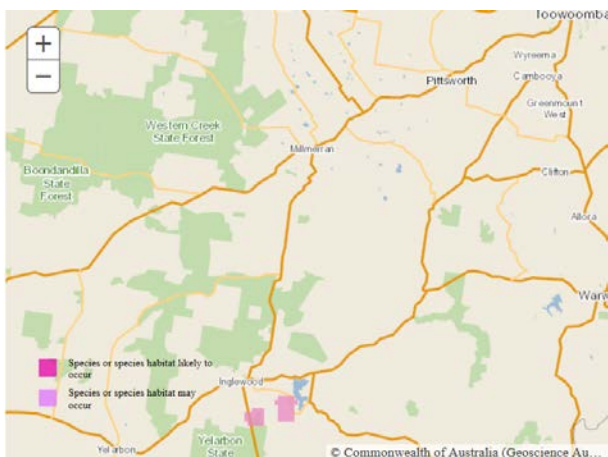


Figure 3.51 Distribution range of *Leucopogon* sp. *Coolmunda* (D.A. Halford Q1635)

Source: DotEE (2018)

3.25.2.3 Distribution in relation to the Project

Leucopogon sp. Coolmunda was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). This species has not been identified within or near the ecology study area. The nearest database record (i.e. AoLA, WildNet) is less than 30 years old occurring near Inglewood approximately 10 km south east of the southern section of the Project footprint (refer Figure 3.52). This record is located approximately one kilometre downstream from the MacIntyre Brook overflow between Coolmunda Access and Tobacco Road. Several records occur at the north-eastern corner of the Coolmunda Conservation Park. Other records exist between Yelarbon State Forest and Lake Coolmunda within 20 km of the Project footprint including recent and old records dated between 1977-2013. The only other database record for this species outside of a 50 km buffer from the Project footprint occurs in north Brisbane dated 2003. This record is likely unreliable as the record occurs well outside the species natural distribution.

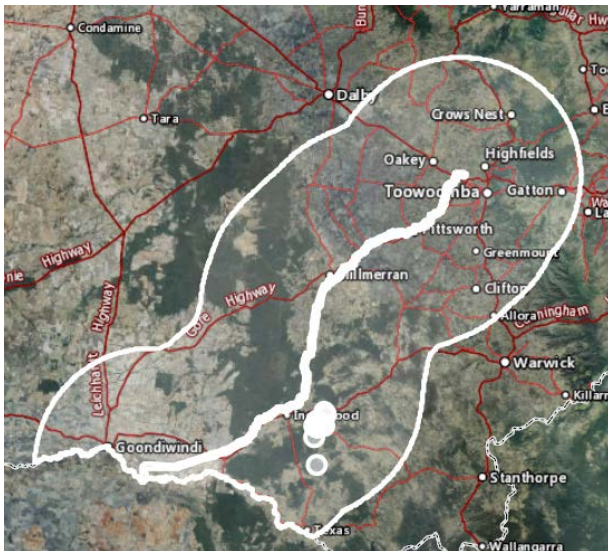


Figure 3.52 Distribution range of *Leucopogon* sp. Coolmunda (D.A. Halford Q1635) in relation to the Project

Source: QLD Globe (2020)

3.25.2.4 Biology and reproduction

Flowering in *Leucopogon* sp. Coolmunda (D.A. Halford Q1635) is known to occur in the latter half of the year between June and January (DoE 2008).

3.25.3 Habitat

Leucopogon sp. Coolmunda (D. Halford Q 1635) occurs in undulating terrain between 300 and 340 metres above sea level. The area is subtropical with hot, moist summers and mild dry winters and an annual rainfall of 640 mm, predominantly in summer. The soils are shallow to 1 m in depth, light coloured sandy loams with mottled orange clayey subsoils (Halford, 1993). The vegetation is predominantly open forest to woodland with a dense lower stratum of heath to 1.5 m high. *Eucalyptus terrica*, *Corymbia trachyphloia*, *E. virens* and *Callitris endlicheri* co-dominate the upper storey, while the lower stratum is very diverse with common species being *Calytrix tetragona*, *Triodia* sp., *Grevillea floribunda*, *Boronia glabra*, *Xanthorrhoea johnsonii*, *Brachyloma daphnoides*, *Ricinocarpus linearifolius* and *Melichrus urceolatus* (DoE, 2008).

3.25.4 Threatening processes

The following have been identified as potentially threatening processes to the Cooneana olive:

- Land disturbance – land clearing, substrate disturbance, mining activities, urban development and soil dumping

- Weed invasion – weeds compete for moisture and light, inhibit seedling regeneration and increase localised fuel load
- Inappropriate fire regimes – high intensity fire can kill individuals and inhibit seed recruitment (DoE 2008).

3.25.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.25.6 References

Atlas of Living Australia. 2019. *Leucopogon* sp. Coolmunda Available from:

https://bie.ala.org.au/species/ALA_Leucopogon_sp_Coolmunda_D_Halford_Q1635 [Accessed 29 July 2019].

Department of the Environment (2008). Commonwealth Listing Advice on *Leucopogon* sp. Coolmunda. Department of the Environment, Water, Heritage and the Arts. Available from:

https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64928 Accessed: 30 February 2020.

Department of the Environment and Energy (2019). *Leucopogon* sp. Coolmunda in Species Profile and Threats Database Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64928 [Accessed 29 July 2019].

Halford, D 1993, 'Leucopogon sp. (Coolmunda Halford Q1635) (Epacridaceae). Conservation Research Statement', Department of Environment and Heritage, Queensland.

3.26 Queensland nut tree (*Macadamia integrifolia*)

3.26.1 Status

EPBC Act – Vulnerable

3.26.2 Biology and ecology

3.26.2.1 Characteristic

Queensland nut tree (*Macadamia integrifolia*) is a medium sized tree that grows to 20 m in height with a 20 m wide crown. This species produces cream or creamy-white flowers that have been recorded in January, March and June to November. Flowers occur on the end of 30 cm long racemes (refer Photograph 3.21). Fruit is a hard brown spherical nut encased in a green leathery outer shell with a diameter of 2 to 3 cm (DotEE 2018).



Photograph 3.21 Queensland nut tree (*Macadamia integrifolia*)

Source: McMaster (2019)

3.26.2.2 Known distribution

Queensland nut tree occurs from Mt Bauple, near Gympie, to Currumbin Valley in the Gold Coast hinterland, southeast Queensland (refer Figure 3.53). The species occurs as a scattered rare to occasional tree, and population sizes have been noted as difficult to estimate (Barry and Thomas 1994).

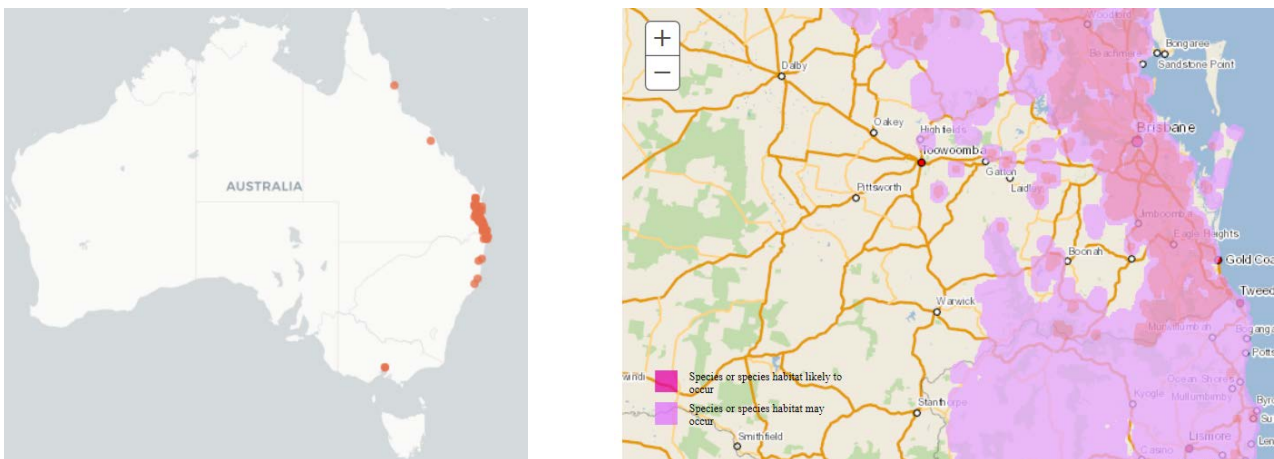


Figure 3.53 Distribution range of Queensland nut tree

Source: ALA (2018), DotEE (2018)

3.26.2.3 Distribution in relation to the Project

Macadamia integrifolia was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) did not reveal any specimen backed records from within the Project disturbance footprint, MNES impact assessment area or from within a 50 km radius of the Project (refer Figure 3.54). The nearest record is recent from 2019 and is located approximately 70 km to the northeast of the Project footprint, southwest of Toogoolawah.

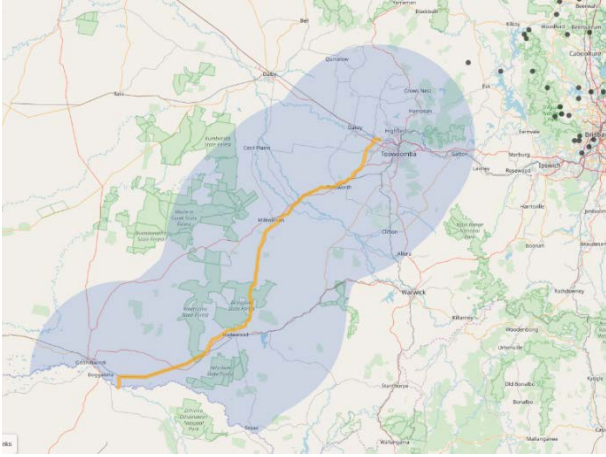


Figure 3.54 Distribution range of Queensland nut tree in relation to the Project

Source: ALA (2020)

3.26.2.4 Biology and reproduction

Queensland nut tree flowers in January, March and June to November. Fruits have been recorded from November to January and March to April. Macadamia nuts begin to produce viable nut loads at around 10 years of age. Reproduction is by seed, with a seed viability of 3 to 6 months. The species has a juvenile period of over six years. The seeds are eaten by mammals and are dispersed by stream. The plant re-sprouts when damaged (DotEE 2018, DEWHA 2008).

3.26.3 Habitat

Queensland nut tree grows in remnant rainforest, including complex mixed notophyll forest, and prefers partially open areas such as rainforest edges (DEWHA 2008). This species occurs within the Northern Rivers (NSW) and southeast Queensland Natural Resource Management regions.

Queensland nut tree is known to prefer to grow in mild frost-free areas with a reasonably high rainfall. There have been records of planted specimens bearing fruit as far south as Sydney (DotEE 2018).

Vegetation communities in which the Queensland nut tree is found range from complex notophyll mixed forest, extremely tall closed forest, simple notophyll mixed very tall closed forest to simple microphyll-notophyll mixed mid-high closed forest with *Araucaria* and *Argyrodendron* emergents (DotEE 2018).

3.26.4 Threatening processes

The following have been identified as potentially threatening processes to the Queensland nut tree:

- Land clearing for urban and agricultural development (DotEE 2018).
- Inappropriate fire regimes (DotEE 2018)
- Land clearing making them more susceptible to wind damage, as well as reducing the availability of natural pollinators (DotEE 2018)
- Invasive weed species
- Compaction of the soil layer (DotEE 2018).

3.26.5 Threat abatement/recovery plans

No threat abatement plan has been identified as being relevant for this species. The following recovery plan is relevant to this species:

- Costello, G., M. Gregory & P. Donatiu (2009). Southern Macadamia Species Recovery Plan. Report to Department of the Environment, Water, Heritage and the Arts, Canberra by Horticulture Australia Limited, Sydney. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/southern-macadamia-species-recovery-plan>. In effect under the EPBC Act from 13-Nov-2009 as *Macadamia integrifolia*.

3.26.6 Summary of threat abatement/recovery plans

The threats outlined in the Southern Macadamia Species Recovery Plan include:

- Land clearing, fragmentation and loss of connectivity
- Inappropriate fire regimes
- Habitat modification by weeds
- Lack of appropriate grazing regimes
- Reduce gene flow
- Climate change.

Current recovery actions include:

- Restoration of rainforest habitat for private landholders under SEQ Rainforest Recovery Project
- Designation of ecologically appropriate fire regimes under the Hotspots Fire Project
- Rebates for fencing under Australian Government funding programs to assist in managing grazing
- Studies on the genetic characterisation of macadamia species and impacts of habitat fragmentation.

Future actions proposed by the Southern Macadamia Species Recovery Plan include:

- Assist landholders in accessing resources to protect macadamia habitat on their property through grazing control, weed management and rehabilitation strategies
- Provide fire and biodiversity workshops to land managers
- Continue research on population genetics
- Model the projected impact of climate change on the ecology, distribution and habitat of southern macadamia species.

3.26.7 References

Atlas of Living Australia (2018), *Macadamia integrifolia*, accessed 24 August 2018, available: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2890419>.

Department of the Environment and Energy (2018). *Macadamia integrifolia* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Fri, 24 August 2018

Department of the Environment, Water, Heritage and the Arts (2008). Approved Conservation Advice for *Macadamia integrifolia* (Macadamia Nut). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/7326-conservation-advice.pdf>. In effect under the EPBC Act from 16 December 2008.

McMaster, I. (2019). *Macadamia integrifolia*. [image] [online] Available from: <https://biocache.ala.org.au/occurrences/88cb72d2-8082-49f5-aeb1-1eea15566a39>. [16 September 2019].

Queensland CRA/RFA Steering Committee (1997). Forest taxa at risk, threats, conservation needs and recovery planning in southeast Queensland. Queensland Government and Commonwealth of Australia.

3.27 Macrozamia conferta

3.27.1 Status

EPBC Act – Vulnerable

3.27.2 Biology and ecology

3.27.2.1 Characteristic

Macrozamia conferta has a branching underground stem 15-30cm in diameter, forming clumps of up to twelve crowns per plant. The sparse crown has 1-5 erect leaves 35-60 cm long, hairless except for light fawn wool at the base. Each leaf consists of 50-90 leaflets arranged along the spirally twisted (2-3 times) rachis (central stalk). The shiny, dark green leaflets are moderately thick, 6-30cm long by 2-6mm wide. The tips of the leaflets are tapered to an asymmetrical point and the leaflet bases are slightly thickened and greenish to greenish-yellow, rarely reddish.

The plants reproduce by cones that are somewhat pineapple-like in appearance. Male and female cones develop on separate plants. Male cones are more or less cylindrical and 7 to 18 cm long by 2.5 to 4 cm in diameter. Female cones are more or less ovoid (egg-shaped) 6 to 12 cm long, and 3.5 to 6 cm in diameter. Seeds are more or less ovoid (egg-shaped), 2 to 2.5cm long, 1.6 to 2 cm in diameter and red when ripe.

3.27.2.2 Known distribution

This species occurs within the Condamine (Queensland) Natural Resource Management region. There are three known populations located in, or adjacent to, three State Forests (SF444, SF341 and SF595) west of Warwick, with a total of approximately 10 000 individuals and an extent of occurrence of 25 km² (DoE 2008) (refer Figure 3.55).

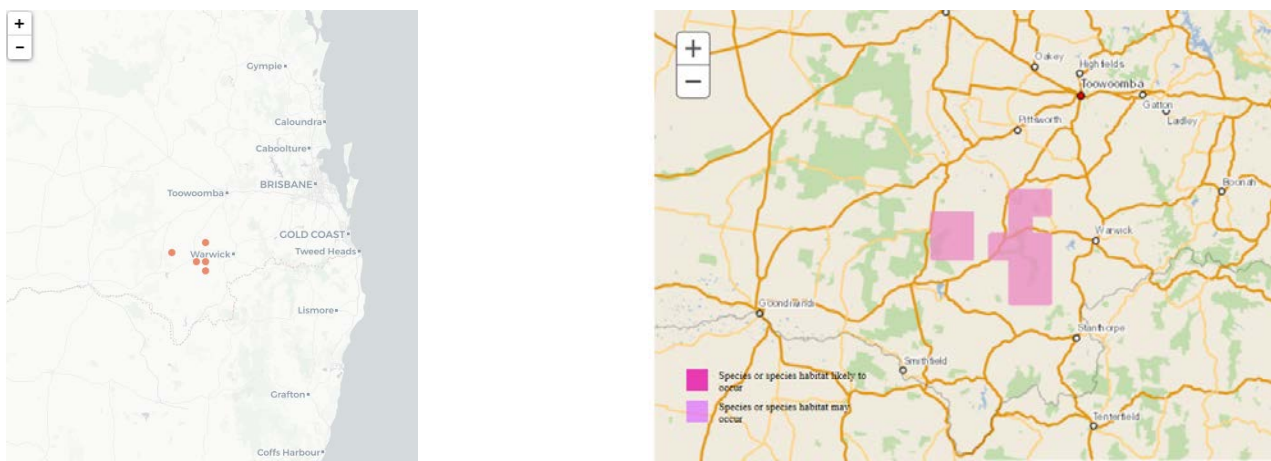


Figure 3.55 Distribution range of *M. conferta*

Source: ALA (2019), DotEE (2018)

3.27.2.3 Distribution in relation to the Project

Macrozamia conferta was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) indicate that the nearest record is relatively recent from 1995 and is located approximately 10 km east of the Project footprint at the north-eastern corner of Bringalily State Forest (refer Figure 3.56). Several other records are located approximately 45 km east of the Project footprint in the surrounds of Durikai State Forest.

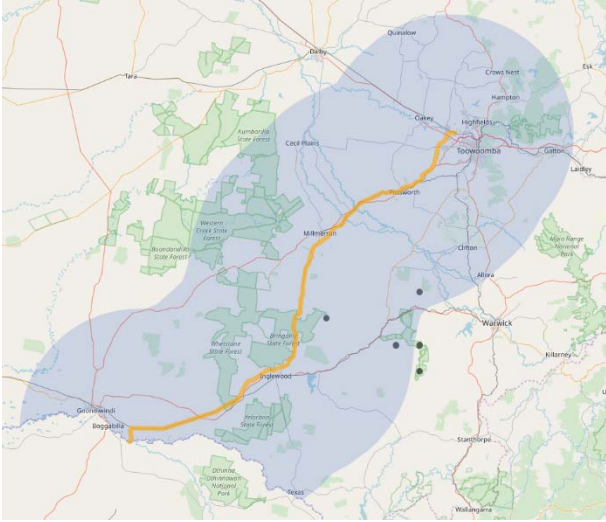


Figure 3.56 Distribution range of *M. conferta* in relation to the Project

Source: ALA (2020)

3.27.2.4 Biology and reproduction

Macrozamia conferta has been recorded with mature cones in October and November. Ripe seeds have been recorded in February and March. Cones may not be produced annually when conditions are unfavourable (Halford 1997).

3.27.3 Habitat

Macrozamia conferta occurs in open forest communities dominated by Lemon-scented Gum (*Corymbia citriodora* var. *variegata*), Broad-leaved Red Ironbark (*Eucalyptus fibrosa*), Yellow Box (*E. melliodora*), Narrow-leaved Ironbark (*E. crebra*) and Grey Box (*E. moluccana*). It grows on flat areas or low ridges in ash-grey to white, silty loam or on skeletal, grey-white soils on steep slopes (DoE 2008).

3.27.4 Threatening processes

The following have been identified as potentially threatening processes to *M. conferta*:

- Inappropriate legal collection
- Illegal collection
- Disturbance/destruction of habitat
- Inappropriate fire regimes
- Deliberate killing by poisoning (poisonous to domestic stock)
- Climate change
- Genetic inbreeding (DoE, 2008).

3.27.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.27.6 References

Atlas of Living Australia (2019). *Macrozamia conferta*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2891883> [Accessed 24 July 2019].

Department of the Environment (2008). Approved Conservation Advice *Macrozamia conferta*, s266B of the Environment Protection and Biodiversity Conservation Act 1999.

Department of the Environment and Energy (2018). *Macrozamia conferta* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Fri, 24 August 2018

Forster (n.d.). *Macrozamia machinii* (plant plus seeds). (Image) [Online] Available from: <https://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?macrozamia-machinii#prettyPhoto> [Accessed 28 August 2018].

Forster, P.I. (2004). The cycads of Queensland - diversity and conservation. *Palms and Cycads*. 82:4-28.

Halford, D (1997). *Macrozamia conferta*, in Species Management Manual. Department of Natural Resources, Brisbane.

Hill K. (2010). *Macrozamia conferta*. [Online] Available from: <http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/cycadpg?taxname=Macrozamia+conferta> [Accessed 24/07/2019].

Hill, K.D. (1998a). Cycadophyta. In: *Flora of Australia*. 48:597-661. Melbourne: CSIRO.

Jones, D.L. and Forster, P.I. (1994). Seven new species of *Macrozamia* section *Parazamia* (Miq.) Miq. (*Zamiaceae* section *Parazamia*) from Queensland. *Austrobaileya*. 4(2):269-288.

Queensland Department of Natural Resources (2000). Species Management Manual. Forest and Fauna Conservation and Ecology Section, Queensland Department of Natural Resources.

3.28 *Macrozamia machinii*

3.28.1 Status

EPBC Act – Vulnerable

3.28.2 Biology and ecology

3.28.2.1 Characteristic

Macrozamia machinii is acaulescent with a stem diameter of 20 to 30 cm. It has 1 to 8 grey-green, semiglossy leaves in a crown that are 60 to 90 cm long, moderately keeled, with 80 to 140 leaflets. The rachis is strongly spirally twisted, straight, stiff or recurved, arching stiffly downwards. Petioles are 13 to 21 cm long, straight or recurved, unarmed and 9 to 14 mm wide at the lowest leaflets. The basal leaflets are not reduced to spines. Leaflets are 80 to 320 mm x 2.5 to 10 mm, simple, strongly discolorous with margins that are flat or incurved. The leaflet apex is entire and not spinescent. Pollen cones are fusiform, 8 to 20 cm long and 4 to 6 cm in diameter. The microsporophyll lamina is 15 to 24 mm x 12 to 24 mm with an apical spine that is 0 to 14 mm long. Seed cones are ovoid, 8 to 22 cm long and 5 to 9 cm in diameter. The stipe is 20 to 25 mm long with megasporophyll that has an expanded peltate apex 25 to 50 mm wide and 15 to 20 mm high. The apical spine is 0 to 20 mm long, the seeds are 20 to 34 mm x 20 to 24 mm and ovoid and the sarcotesta is red (Hill 2010).

3.28.2.2 Known distribution

Macrozamia machinii occurs on the Darling Downs in Queensland between Texas and Wondul Range National Park, in around Inglewood (ALA 2018) (refer Figure 3.57).

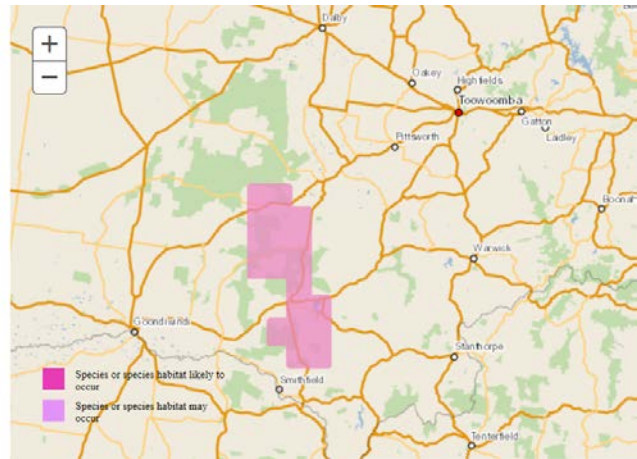


Figure 3.57 Distribution range of *M. machinii*

Source: ALA (2018), DotEE (2018)

3.28.2.3 Distribution in relation to the Project

Macrozamia machinii was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) did not reveal any specimen backed records from within the Project disturbance footprint or the MNES impact assessment area. The nearest record is very old from 1922 and is located approximately 2.5 km south of the Project near Inglewood to the north-east of the township and west of the Millmerran-Inglewood Road. Additional records are located within in state forests to the north and south of Inglewood in the surrounds of Wondul Range National Park and within 40 km to the southwest in the area surrounding Texas State Forest 1, Greenup State Forest, and Yelarbon State Forest (refer Figure 3.58).

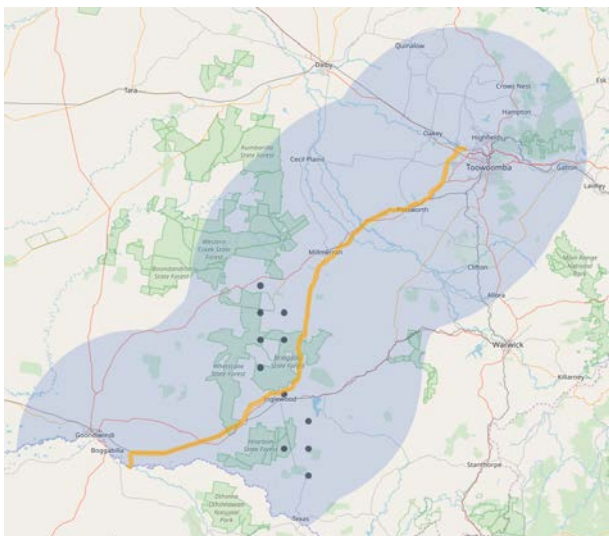


Figure 3.58 Distribution range of *M. machinii* in relation to the Project

Source: ALA (2020)

3.28.2.4 Biology and reproduction

Macrozamia machinii cones mature in September to December and seeds ripen February to April. Beetles are thought to affect cross-pollination between individuals. Populations show little obvious recruitment, perhaps because the putative pollinators are not present. Fires have also been known to create large cone and seed production some years later (Forster 2004; Jones and Forster 1994; Qld DNR 2000).

3.28.3 Habitat

Most *M. machinii* populations occur in deep sandy soils in flat areas of open forest dominated by *Angophora leiocarpa*, *Allocasuarina inophloa*, White Cypress-pine (*Callitris glaucophylla*), Budgeroo (*Lysicarpus angustifolius*) and Crowded-leaf Wattle (*Acacia conferta*). However, they can occur on red lateritic ridges at about 320 to 460 m above sea level (Jones and Forster 1994; Hill 1998).

3.28.4 Threatening processes

The following have been identified as potentially threatening processes to *M. machinii*:

- Inappropriate legal collection
- Illegal collection
- Disturbance/destruction of habitat
- Inappropriate fire regimes
- Deliberate killing by poisoning (poisonous to domestic stock)
- Climate change (DNR 2000).

3.28.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.28.6 References

Atlas of Living Australia (2018). *Macrozamia machinii*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2914591#overview> [Accessed 28 August 2018].

Department of the Environment and Energy (2018). *Macrozamia machinii* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Fri, 24 August 2018

Forster (n.d.). *Macrozamia machinii* (plant plus seeds). (Image) [Online] Available from: <https://wetlandinfo.ehp.qld.gov.au/wetlands/ecology/components/species/?macrozamia-machinii#prettyPhoto> [Accessed 28 August 2018].

Forster, P.I. (2004). The cycads of Queensland - diversity and conservation. *Palms and Cycads*. 82:4-28.

Hill K. (2010). *Macrozamia machinii*. [Online] Available from: <http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/cycadpg?taxname=Macrozamia+machinii> [Accessed 28 August 2018].

Hill, K.D. (1998a). Cycadophyta. In: *Flora of Australia*. 48:597-661. Melbourne: CSIRO.

Jones, D.L. and Forster, P.I. (1994). Seven new species of *Macrozamia* section *Parazamia* (Miq.) Miq. (*Zamiaceae* section *Parazamia*) from Queensland. *Austrobaileya*. 4(2):269-288.

Department of Natural Resources (2000). *Species Management Manual*. Forest and Fauna Conservation and Ecology Section, Queensland Department of Natural Resources.

3.29 Mt. Berryman phebalium (*Phebalium distans*)

3.29.1 Status

EPBC Act – Critically Endangered

3.29.2 Biology and ecology

3.29.2.1 Characteristic

The Mt. Berryman phebalium (*Phebalium distans*) is a small tree growing to 8 m and up to 15 cm in diameter. The bark is grey mottled and distinctly rough and flaky with a strong aromatic scent (DotEE 2018). The flowers of the species are cream, and the leaves are 1.5 to 5 cm long, 2 to 10 mm wide, and more or less smooth on the upper surface (refer Photograph 3.22). The leaves have a variable shape and are usually linear to oblong or lance-shaped but may also be elliptic to broad-elliptic or egg-shaped (DotEE 2018; Forster 2003).



Photograph 3.22 Mt. Berryman phebalium (*Phebalium distans*)

Source: Simmonds (2003)

3.29.2.2 Known distribution

Mt. Berryman phebalium is endemic to southeastern Queensland, where it is currently known from ten populations at three locations. Five of the known populations are in close proximity at Mt. Berryman (Lockyer Valley Regional Council), four are near Kingaroy (South Burnett Regional Council) and the tenth at Mt Walla, near Coalstoun Lakes (North Burnett Regional Council) (DotEE 2018) (refer Figure 3.59).

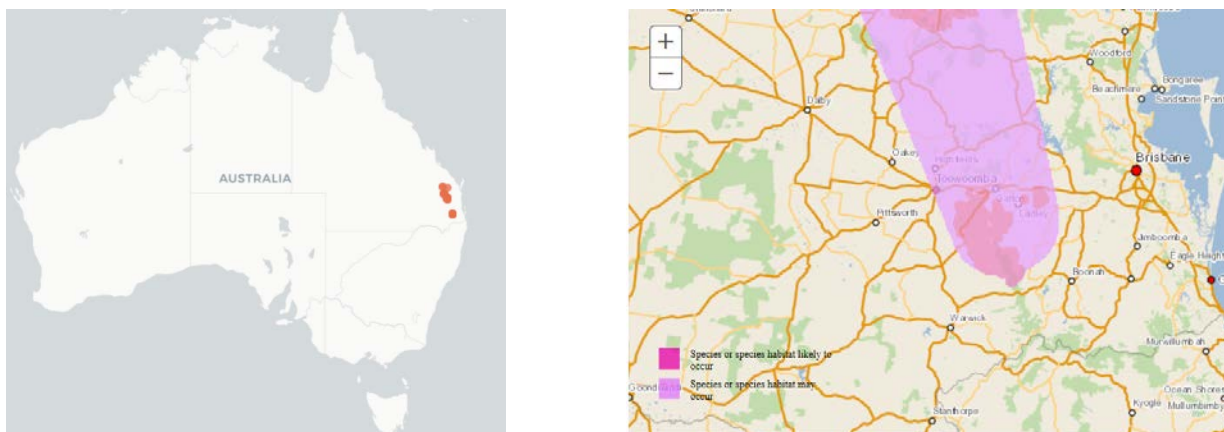


Figure 3.59 Distribution range of Mt. Berryman phebalium

Source: ALA (2018), DotEE (2018)

3.29.2.3 Distribution in relation to the Project

Phebalium distans was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) did not reveal any specimen backed records from within the Project disturbance footprint, MNES impact assessment area or from within a 50 km radius of the Project. A number of records, both recent and old occur near Berlin Scrub Nature Refuge north-west of Mulgowie between Laidley, Sandy and Gully Creeks. Other records for this species occur to the north of the Project between Kingaroy and Binjour State Forest (refer Figure 3.60).

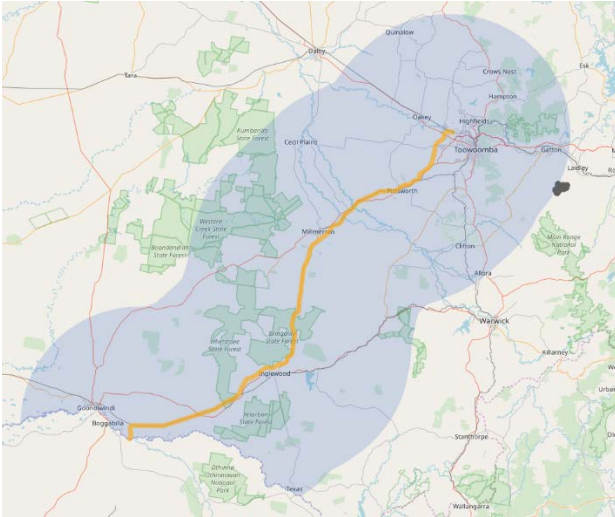


Figure 3.60 Distribution range of Mt. Berryman phebalium in relation to the Project

Source: ALA (2020)

3.29.2.4 Biology and reproduction

Mt. Berryman phebalium generally flowers during spring, however, opportunistic flowering can occur at other times after moderate falls of rain. Fruiting generally occurs during late summer and early autumn. The capsular fruit produce small seeds that have a limited dispersal ability. Plants become sexually mature after they reach 1 to 2 m in height. The plant has not been recorded as reproducing vegetatively, and monitoring indicates that this species does not readily reproduce under disturbance regimes (DEWHA 2008).

3.29.3 Habitat

Mt. Berryman phebalium is found in semi-evergreen vine thicket on red volcanic soils, or in communities adjacent to this vegetation type in small groups or as solitary specimens. Soils where the species occurs range from red-brown earths to brown clays (derived from siltstone and mudstones), and lithosols to shallow, gravelly krasnozems (very dark brown loam), derived from the Main Range Volcanics of the Tertiary period (DotEE 2018; DEWHA 2008).

3.29.4 Threatening processes

The following have been identified as potentially threatening processes to the Mt. Berryman phebalium:

- Habitat fragmentation and clearing
- Road works and roadside maintenance
- Irregular fire events
- Weed invasion
- Drift of agricultural chemicals

- Erosion and soil compaction due to human traffic
- Dumping of rubbish (DotEE 2018).

3.29.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.29.6 References

Atlas of Living Australia (2018), *Phebalium distans*. Australia's species Databas, accessed 26 August 2018, available: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2908293>.

Department of the Environment, Water, Heritage and the Arts (2008). Approved Conservation Advice for *Phebalium distans* (Mt. Berryman Phebalium). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/81869-conservation-advice.pdf>. In effect under the EPBC Act from 24 December 2008.

Department of the Environment and Energy (2018). *Phebalium distans* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Sun, 26 August 2018.

Simmonds, J.H. (2003). Mt. Berryman phebalium (*Phebalium distans*). [image] [online] Available from: <https://biocache.ala.org.au/occurrences/4ab51c21-6c5a-4fe4-98b1-f56fe9301877>. [16 September 2019].

3.30 *Microcarpaea agonis*

3.30.1 Status

EPBC Act – Endangered

3.30.2 Biology and ecology

3.30.2.1 Characteristic

Microcarpaea agonis, family Scrophulariaceae, is a terrestrial herb to 5 cm high and 10 cm wide with angular, glabrous stems. Leaves are opposite and connected across nodes, linear, 5 to 9 mm long and 0.3 to 0.5 mm wide (refer Photograph 3.23). Flowers are solitary, axillary and bracteoles are absent. The calyx tube is ovoid, 1.4 to 1.7 mm long, white, unribbed or weakly ribbed and sparsely hairy. The calyx teeth are green and the margins are hairy. The corolla tube is approximately 3 mm long, two-lipped and slightly exerted from calyx tube (DoE 2008).



Photograph 3.23 *Microcarpaea agonis*

Source: QLD Herb (2019)

3.30.2.2 Known distribution

The only known population occurs in a state forest area in remnant vegetation (DoE, 2008) as defined under the Vegetation Management Act 1999 (QLD) and is therefore protected from broad-scale clearing. This species occurs within the Maranoa–Balonne (Queensland) Natural Resource Management Region. The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities; Brigalow (*Acacia harpophylla* dominant and co-dominant), and White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (refer Figure 3.61).

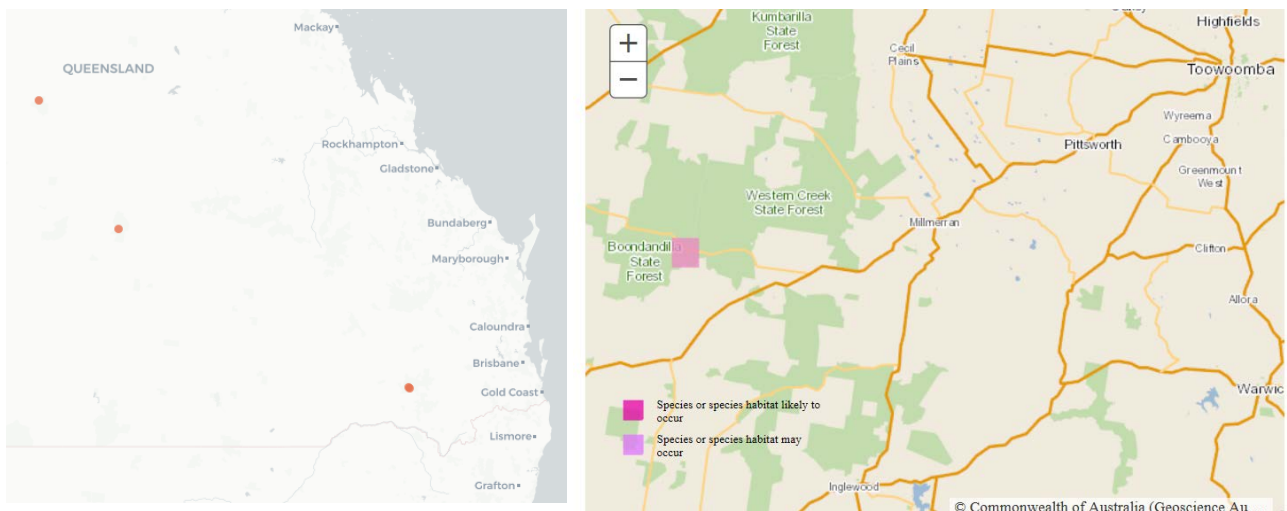


Figure 3.61 Occurrence record of *Microcarpaea agonis*

Source: ALA (2019), DotEE (2019)

3.30.2.3 Distribution in relation to the Project

Microcarpaea agonis was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) do not indicate any species records from within the Project disturbance footprint or from within the MNES impact assessment area. The nearest records were recorded 24 years ago at Boondandilla State Forest approximately 52 km north of the Project (refer Figure 3.62). There are four records at this location with each described as occurring at Yarra Creek near Boondandilla Road west of Millmerran. One record noted the specimen was found in seasonal swamp and that individuals of the species were rare at the site. The only other records that occur in Queensland are located at Idalia and Bladensburg National Parks some 700 and 1000 km north-west of the Project.

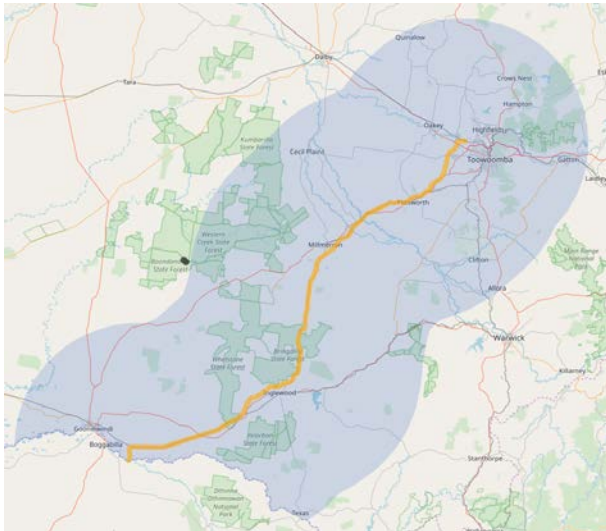


Figure 3.62 Occurrence record of *Microcarpaea agonis* in relation to the Project

Source: ALA (2020)

3.30.2.4 Biology and reproduction

Specimens of *Microcarpaea* collected in February were bearing both flowers and fruit. Other than the flowering observation, the biology of this species is unknown (Appleby, 2009).

3.30.3 Habitat

Microcarpaea agonis is known only from the type locality between Goondiwindi and Millmerran, Southern Queensland, on the margins of an Eleocharis- Cyperus dominated seasonal swamp with approximately 10 plants known (Bean, 1997).

3.30.4 Threatening processes

The following have been identified as potentially threatening processes to the *Microcarpaea agonis*:

- Grazing pressure and trampling, especially by cattle
- Road works
- Disturbance of habitat by weeds.

3.30.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.30.6 References

Appleby, L. (2009). Threatened Flora Management Plan. Australia Pacific LNG Upstream, Origin.

Atlas of Living Australia (2019), *Microcarpaea agonis*, accessed 24 July 2019, available from:

<https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2920991>

Bean, AR 1997, 'Microcarpaea agonis (Scrophulariaceae), a new species from south-eastern Queensland', *Austrobaileya*. vol. 5, no. 1, pp. 149–152.

Department of the Environment and Energy (2019). *Microcarpaea agonis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from:

<http://www.environment.gov.au/biodiversity/threatened/species/pubs/64933-conservation-advice.pdf>

Accessed Thu, 23 July 2019.

3.31 Kogan waxflower (*Philothea sporadica*)

3.31.1 Status

EPBC Act – Vulnerable

3.31.2 Biology and ecology

3.31.2.1 Characteristic

Kogan waxflower, Family Rutaceae, is an open to compact shrub to 150 cm high, with numerous branches (DoE 2008). Each branch has many small, 1 to 4 mm long, hairless, club-shaped leaves along its length. The white flowers are solitary and occur on short stalks to 0.7 mm long at the end of branchlets (DoE 2008) (refer Photograph 3.24).



Photograph 3.24 Kogan waxflower

Source: Munday (2018)

3.31.2.2 Known distribution

Kogan waxflower is known from south-east Queensland, from just north of Tara, to approximately 12 km east of Kogan (refer Figure 3.63). The Queensland Herbarium has recorded 11 populations. Seven of these occur on road verges, seven extend onto freehold land (Halford, 1995) and another population is within Braemar State Forest (SF 4).

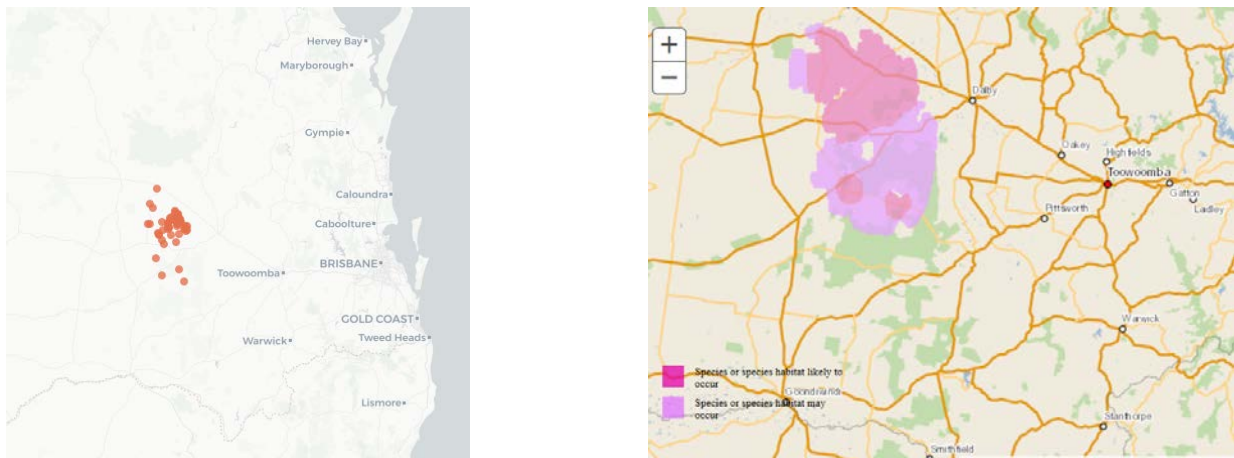


Figure 3.63 Distribution range of the Kogan waxflower

Source: ALA (2019), DotEE (2019)

3.31.2.3 Distribution in relation to the Project

Philothea sporadica was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) did not reveal any specimen backed records from within the Project disturbance footprint or within the MNES impact assessment area. The nearest records from within a 50 km radius of the Project occur approximately 47 km north-west from the disturbance footprint between Cecil Plains-Moonie Road and Weir River at the norther tip of Western Creek State Forest. These records are recent from within the last 20 years and they occur in woodland dominated by eucalypts and *Callitris* on sandy soils. Records outside of a 50 km radius of the Project occur between Tara north to Chinchilla and east to Dalby State Forest representing the extent of the distribution for this species.

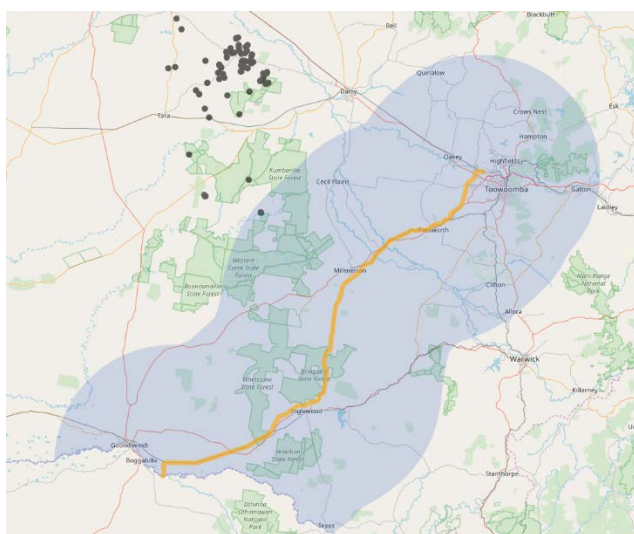


Figure 3.64 Distribution range of the Kogan waxflower in relation to the Project

Source: ALA (2020)

3.31.2.4 Biology and reproduction

Individual shrubs can live for 20 years however longevity of individual plants beyond 20 years has not been studied. Flowering of *P. sporadica* has been recorded from August to October, and mature fruits have been observed in late November. Flower petals are white and open during the day and nectar is produced from glands at the base of the ovary (Halford, 1995).

3.31.3 Habitat

Philotheca sporadica is found on residual hills which are remnants of laterised Cretaceous sandstones, where the soils are shallow, uniform sandy loams to clay loams of extremely low fertility and poor condition (DoE, 2008). It occurs primarily in low open forest of *Acacia burrowii*, *Eucalyptus exserta*, *E. crebra*, *E. fibrosa* subsp. *nubila* and *Callitris glaucophylla* (Halford, 1995). The species occurs within the Condamine and Border Rivers Maranoa–Balonne (Queensland) Natural Resource Management Regions. The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities: • Brigalow (*Acacia harpophylla* dominant and co-dominant); and • White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

3.31.4 Threatening processes

The following have been identified as potentially threatening processes to *Philotheca sporadica*:

- Weed invasion
- Inappropriate fire regimes
- Habitat loss and fragmentation
- Clearing of vegetation for cropping and grazing (DoE 2008).

3.31.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

3.31.6 References

Atlas of Living Australia (2019). *Philotheca sporadica*. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2896544> overview [Accessed 22 July 2019].

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Department of the Environment (2008). Approved Conservation Advice *Philotheca sporadica*, s266B of the Environment Protection and Biodiversity Conservation Act 1999.

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Munday, B. (2018). Kogan waxflower (*Philotheca sporadica*). (Image) [Online] Available from: <https://biocache.ala.org.au/occurrences/1b17f50c-58cd-4474-8dea-7e3d98db6c12>. [19 September 2019].

3.32 Waxy sarcochilus (*Sarcochilus hartmannii*)

3.32.1 Status

EPBC Act – Vulnerable

3.32.2 Biology and ecology

3.32.2.1 Characteristic

Waxy sarcochilus (*Sarcochilus hartmannii*) is an epilithic, (grows on rocks) orchid. Stems are 8 to 100 cm long, sometimes found in dense groups of upright tufted shoots (DoEE 2018). The leaves are narrow oblong to triangular 5 to 20 cm long, 10 to 20 mm wide, deeply channelled, acute or obliquely emarginate, sometimes falcate (DoEE 2018). The inflorescence consists of 5 to 25 flowers, 6 to 25 cm long with the rachis much shorter than the peduncle. The elliptic to spoon-shaped white sepals and lateral petals often have red or reddish-brown spots at the base. The labellum (flower lip) is hairless, 1.5 to 3 mm long, about one fifth the length of the dorsal sepal (refer Photograph 3.25). Flowering occurs in October and November. The capsules are cylindrical, up to about 8.5 cm long (ALA 2018; DoEE 2018; Stanley and Ross 1989; Weston 1993).



Photograph 3.25 Waxy sarcochilus (*Sarcochilus hartmannii*)

Source: Clemets (2015)

3.32.2.2 Known distribution

Waxy sarcochilus is known from the Richmond River in northern NSW to Main Range National Park in southeastern Queensland (refer Figure 3.65). The species is conserved in Lamington National Park, Main Range National Park, Tambourine Mountain National Park, Mount Warning National Park, and Nightcap National Park. It is also known to occur within the Northern Rivers (NSW) and Condamine and southeast Queensland Natural Resource Management regions (Briggs and Leigh 1995).



Figure 3.65 Distribution range of Waxy sarcophilus

Source: ALA (2018); DOEE (2018)

3.32.2.3 Distribution in relation to the Project

Sarcophilus hartmanii was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database records (i.e. AoLA, WildNet) did not reveal any specimen backed records for this species within the Project disturbance footprint or from within the MNES impact assessment area. The only record from within a 50 km radius of the Project occurs to the east of Toowoomba approximately 20 km east of the northern section of the Project (refer Figure 3.66). This record has a large degree of spatial uncertainty to protect the species and there is no definitive collection date for this record. The specimen was on loan to the Sydney herbarium in 1965 giving an indication that this is probably an old record. Records outside of a 50 km radius of the disturbance footprint occur from near Squirrel Creek State Forest inland of the Sunshine Coast to national parks to the south including Main Range, Border Ranges, Mount Barney, Lamington, Springbrook and Tambourine National Parks.

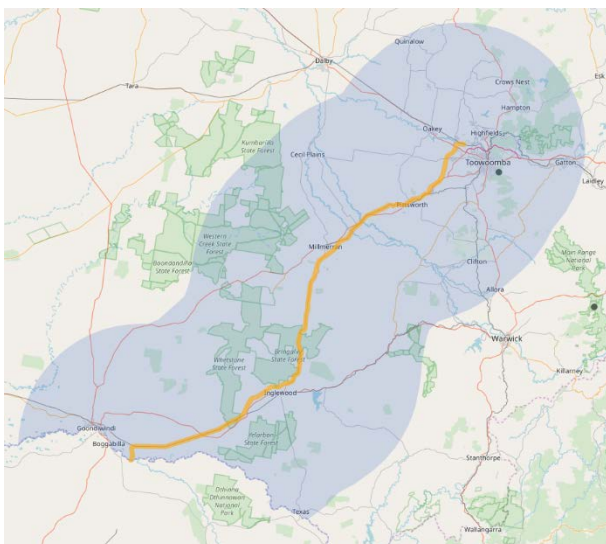


Figure 3.66 Distribution range of Waxy sarcophilus in relation to the Project

Source: ALA (2020)

3.32.2.4 Biology and reproduction

Waxy sarcochilus flowers from September to November. The petals, sepals and labellum are very broad, fairly thick-textured and widely spreading. The petals and sepals are more or less ovate with the sepals slightly broader than the petals. The labellum is projected forward, has three lobes and is very small – generally about one-fifth as long as the sepals. Seed capsules are cylindrical and reach 8.5 cm in length (ALA 2018; DoEE 2018).

3.32.3 Habitat

This species is a lithophytic orchid that favours cliff faces on steep narrow ridges supporting Eucalypt forest. It grows on volcanic rocks, in shallow soils and exposed cliffs in sclerophyll forests, rainforest margins or open areas at 500 to 1,000 m altitude. It is also found occasionally at the base of fibrous trunks of trees, including cycads and grasstrees (DoEE 2018; DECC 2005; Stanley and Ross 1989; Weston 1993).

3.32.4 Threatening processes

The following have been identified as potentially threatening processes to the Waxy sarcochilus:

- Illegal collection
- Localised extinction due to small populations
- Invasion of weeds
- Inappropriate fire regimes (DECC 2005).

3.32.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10745>. In effect under the BC Act 2016.

The following threat abatement plans has been identified as being relevant for this species:

- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). *Threat abatement plan for competition and land degradation by unmanaged goats*. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-unmanaged-goats>. In effect under the EPBC Act from 01-Oct-2008.

3.32.6 Summary of threat abatement/recovery plan

The conservation strategy for Waxy sarcochilus identifies four priority management sites in NSW:

- Toonumbar National Park in Kyogle LGA
- Blue Knob in Lismore, Tweed LGA
- Goonengerry National Park in Byron LGA
- Richmond Range National Park in Kyogle LGA.

Threats specific to the species identified in the strategy include:

- Small populations having a high risk of local extinctions
- Poor knowledge of current species distribution within its historic range.

Management strategies relevant to Waxy sarcochilus include:

- Restricting access to sites where the species is known to occur

- Collect seeds and cultivate in an ex-situ environment such as at botanical gardens and reintroduce into the wild
- Undertake targeted surveys to establish the presence of potential nearby locations where suitable habitat occurs, including along rocky ridgelines, cliffs and vine forest
- Map and document all known occurrences and estimate total population size during the flowering season (October – November)
- Conduct monitoring over a three-year period to establish the health of individual plants and any evidence of recruitment.

Threats identified in the threat abatement plan for competition and land degradation by unmanaged goats relevant this species include:

- Overgrazing by goats and resulting soil erosion
- Introduction of weeds through seeds carried in their dung.

The primary focus of the abatement plan is the control of unmanaged goat populations. The main objectives of controlling unmanaged goats are:

- Prevent unmanaged goats from occupying new areas in Australia and eradicate them from high-conservation value areas
- Promote the maintenance and recovery of native species and ecological communities that are affected by competition and land degradation by unmanaged goats
- Improve knowledge and understanding of unmanaged goat impacts and interactions with other species and other ecological processes
- Improve the effectiveness, target specificity, integration and humaneness of control options for unmanaged goats.

3.32.7 References

Atlas of Living Australia (2018), *Sarcochilus hartmannii*. Australia's species Database. Available from: <https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2898379>. Accessed 23 August 2018.

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Department of the Environment and Energy (2018). *Sarcochilus hartmannii* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=4124. Accessed Thu, 23 August 2018

Department of Environment and Climate Change NSW (2005), Hartman's Sarcochilus – Priority actions (New South Wales Threatened Species Priority Action Statement), viewed 23 August 2018.

Stanley, TD and Ross, EM (1989), Flora of southeastern Queensland, vol. 3, Queensland Department of Primary Industries, Brisbane.

Weston, PH (1993), '*Sarcochilus*', In: Harden, GJ Flora of New South Wales, vol. 4, University of New South Wales Press, Sydney.

4 Fauna species – threatened species – invertebrates

4.1 Brigalow woodland snail (*Adclarkia cameroni*)

4.1.1 Status

EPBC Act – Endangered

4.1.2 Biology and ecology

4.1.2.1 Characteristic

The Brigalow woodland snail (*Adclarkia cameroni*) has a medium to large shell (diameter 20 mm) that is thin and light brownish-yellow, with a reddish band on the whorls. The shell is somewhat flattened, with a low, domed spire. The whorls are rounded and tightly coiled and the last whorl is flared. The sutures are weakly present and the tip of the shell bares small rounded knobs. Much of the rest of the shell bares fine, scaly knobs on the upper half of the whorls and is glossy underneath. The shell also bares very fine, wavy ridges running across each whorl (DotEE 2018).

4.1.2.2 Known distribution

It is endemic to southeast Queensland, where it occurs in a small number of remnant and scattered Brigalow (*Acacia harpophylla*) and eucalypt woodland patches on the Condamine River floodplain, especially in the area around Dalby and Chinchilla (DotEE 2018) (refer Figure 4.1).

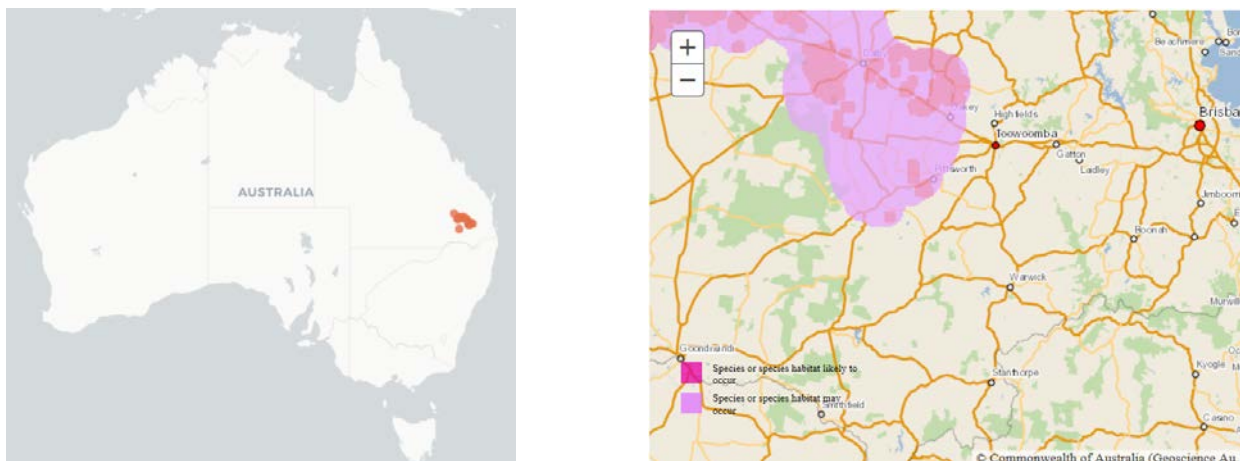


Figure 4.1 Distribution range of Brigalow woodland snail

Source: ALA (2018), DotEE (2018)

4.1.2.3 Distribution in relation to the Project

Adclarkia cameroni was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database record (i.e. AoLA, WildNet) did not reveal any specimen backed records within the Project disturbance footprint or within the MNES impact assessment area. There is only one record from within a 50 km radius of the Project which is located approximately 45km west of the northern section of the alignment. This record is recent dated 2002 and was found near Bowenville beside the Warrego Highway (refer Figure 4.2). Species records outside of a 50 km radius of the Project are concentrated between Dalby and Miles.

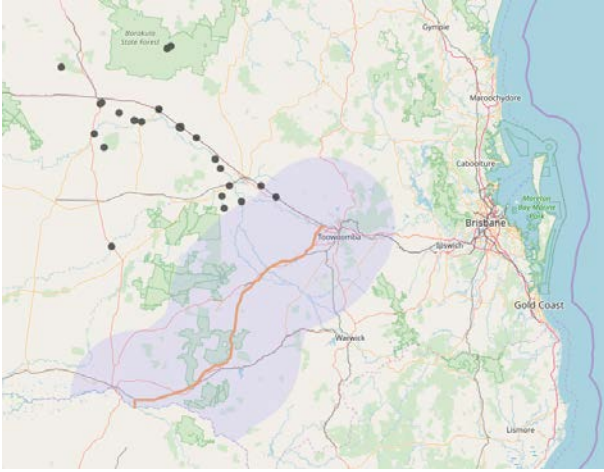


Figure 4.2 Distribution range of Brigalow woodland snail in relation to the Project

Source: ALA (2020)

4.1.2.4 Biology and reproduction

It likely feeds on fungi, lichen, algae and other detritus/biofilm growing on and underneath forest debris (DotEE 2018).

Although egg-laying has not been recorded for this species it is likely it lays its eggs in depressions in the soil under logs and other debris, similar to other snails. They aestivate during drier phases and require moisture and therefore canopy cover to keep their eggs from desiccating. Based on other snail species from the same family, sexual maturity is most likely reached at two years and life expectancy five years. Mature snails lay eggs on an annual basis depending on favourable weather conditions and can lay more than one clutch if the summer rainy period is long enough (DotEE 2018).

4.1.3 Habitat

They are found primarily in Brigalow forest which occur on alluvial black soils. Within the narrow Condamine River riparian corridor, the canopy cover is dense where scattered timber is greatest and environmental moisture is at its most stable (DotEE 2018).

4.1.4 Threatening processes

The following have been identified as potentially threatening processes to Brigalow woodland snail:

- Land clearing and habitat disturbance from agriculture and mining
- Invasive species (i.e. predation by introduced rat species and pigs)
- Trampling by livestock
- High intensity fires (TSSC 2016).

4.1.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

4.1.6 References

Atlas of Living Australia (2018). *Adclarkia cameroni*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:29be1f07-f78f-4c27-8379-82858d45f7cf> [Accessed 3 September 2018].

Department of the Environment and Energy (2019). *Adclarkia cameroni* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83886. Accessed 3 September 2018

The Snail Whisperer (n.d.). *Adclarkia cameroni* (Image) [Online] Available from: <https://factsaboutsnailes.com/snail-facts/endangered-species/> [Accessed 3 September 2018].

Threatened Species Scientific Committee (2016). *Approved Conservation Advice for Adclarkia cameroni* Available from: www.environment.gov.au/biodiversity/threatened/species/pubs/83886-conservation-advice-07122016.pdf [Accessed 3 September 2018].

4.2 Dulacca woodland snail (*Adclarkia dulacca*)

4.2.1 Status

EPBC Act – Endangered

4.2.2 Biology and ecology

4.2.2.1 Characteristic

The Dulacca woodland snail (*Adclarkia dulacca*) has a medium-sized shell (diameter 17 mm) which is pale greenish brown, with a brown band above the periphery of the spirals on the shell. It is also somewhat flattened, with a very low spire with rounded spirals, evenly and tightly coiled. The sutures are weakly present and the tip of the shell bears small rounded knobs. Much of the rest of the shell bears weak growth lines with fine scales on the upper half of the spirals and smooth and glossy beneath. The animal itself is orange-brown. It differs from the Brigalow woodland snail by having a flatter shell and tighter coiling (TSSC 2016).

No image available.

4.2.2.2 Known distribution

It is endemic to south-east Queensland, where it occurs as a small number of isolated and fragmented populations between Miles and Dulacca, and south to Meandarra (TSSC 2016) (refer Figure 4.3).

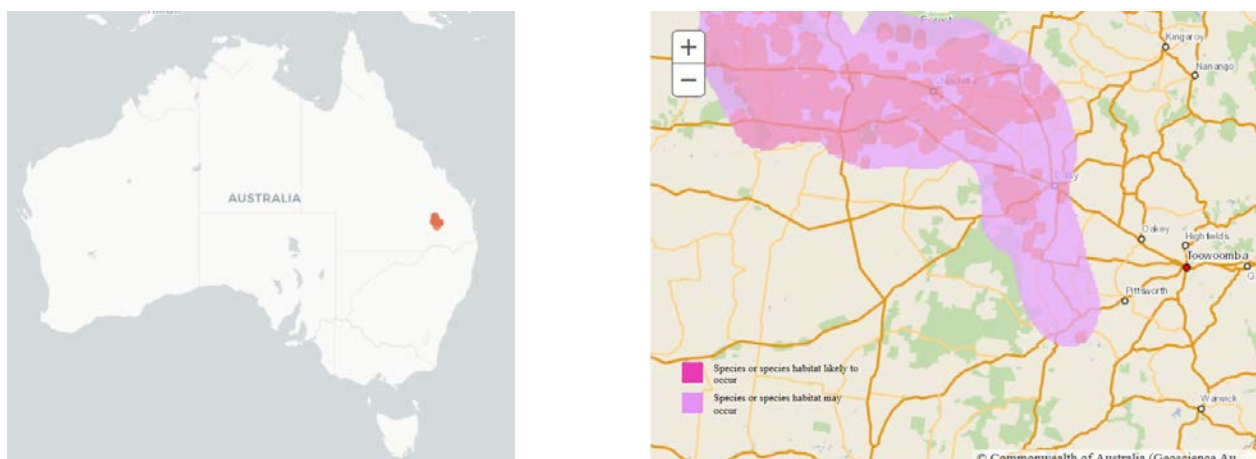


Figure 4.3 Distribution range of Dulacca woodland snail

Source: ALA (2018), DotEE (2018)

4.2.2.3 Distribution in relation to the Project

Adclarkia dulacca was not identified within any Project-associated field surveys including limited Regional Ecosystem and Threatened Ecological Community assessments and Protected Plant Flora Surveys within the alignment where this species occurs (Arup 2016; Aurecon 2018). Database record (i.e. AoLA, WildNet) did not reveal any specimen backed records within the Project disturbance footprint, the MNES impact assessment area or within a 50 km radius of the Project. Records primarily occur between Yuleba State Forest and Barakula State Forest nearly 200 km north-west of the Project (refer Figure 4.4).

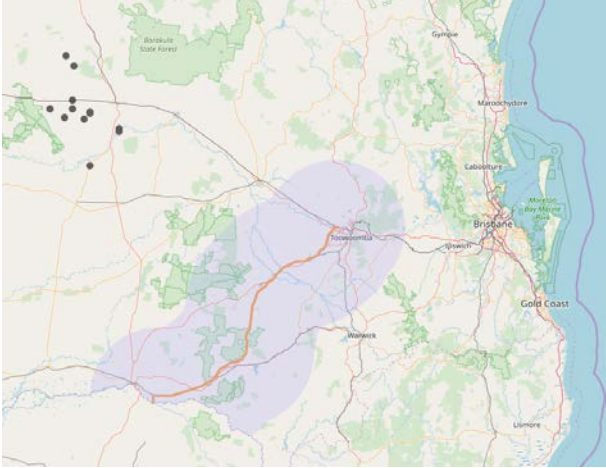


Figure 4.4 Distribution range of *Dulacca* woodland snail in relation to the Project

Source: ALA (2020)

4.2.2.4 Biology and reproduction

Though never observed feeding, it likely feeds on fungi, lichen, algae and other detritus/biofilm growing on and underneath forest debris (TSSC 2016).

The *Dulacca* woodland snail requires both canopy and on-ground timber cover for survival and egg-laying. Like other Camaenid snails, it likely lays its eggs in depressions in the soil under logs and other debris. Mature snails will lay eggs on an annual basis but can lay more than a single clutch of eggs in one year depending on the summer rain period. A single observed incidence resulted in 20 eggs being laid in one clutch (TSSC 2016).

4.2.3 Habitat

The *Dulacca* woodland snail lives under rocks, timber and loose bark at the base of trees. The species inhabits a variety of remnant and scattered habitats, such as vine thicket and *Acacia harpophylla* woodland patches on rocky outcrops with clay to loam soils. It is also found in ironbark and *A. shirleyi* woodlands on ridges, and *Eucalyptus woollsiana* woodland. Given that logs, woody debris or other suitable shelter is available, it is able to exist in areas of brigalow regrowth and even in cleared paddocks (TSSC 2016).

4.2.4 Threatening processes

The following have been identified as potentially threatening processes to *Dulacca* woodland snail:

- Land clearing and habitat disturbance from agriculture and mining
- Invasive species (i.e. predation by introduced rat species and pigs)
- Trampling by livestock
- High intensity fires (TSSC 2016).

4.2.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

4.2.6 References

Atlas of Living Australia (2018). *Adclarkia dulacca*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:4c4da640-15ee-48db-8590-cdb449d49f0d#overview> [Accessed 16 October 2018].

Department of the Environment and Energy (2019). *Adclarkia dulacca* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83885. Accessed 16 October 2018

Threatened Species Scientific Committee (2016). *Approved Conservation Advice for Adclarkia dulacca* Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/83885-conservation-advice-07122016.pdf> [Accessed 16 October 2018].

5 Fauna species – threatened species – fish

5.1 Murray cod (*Maccullochella peelii*)

5.1.1 Status

EPBC Act – Vulnerable

5.1.2 Biology and ecology

5.1.2.1 Characteristics

The Murray cod (*Maccullochella peelii*) is the largest freshwater species of fish in Australia, measuring up to 1.8 m in length and weighing about 10 kg although some records indicate the species may reach over 100 kg in weight. The Murray cod has a broad head, rounded snout, equal length jaws and has a concaved facial profile. The light olive to dark green scales of the fish has mottled pattern, with a white ventral colouration. The pectoral fins of the fish are rounded and large with soft dorsal, anal and caudal fins with distinctive red or white edging (DotEE 2018) (refer Photograph 5.1).



Photograph 5.1 Murray cod (*Maccullochella peelii*)

Source: flagstaffotos (2006)

5.1.2.2 Known distribution

The Murray cod was once a widespread species and abundant in the lower and mid reaches of the Murray-Darling Basin between Queensland and South Australia (refer Figure 5.1). However, the distribution of the species has now reduced to several bioregions between Queensland and Victoria, including the Brigalow Belt South Bioregion (National Murray Cod Recovery Team 2010).

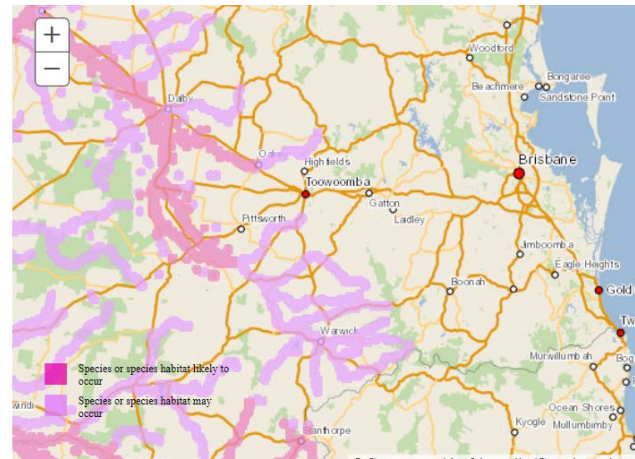


Figure 5.1 Distribution range of Murray cod

Source: ALA (2018), DotEE (2018)

5.1.2.3 Distribution in relation to the Project

Murray cod was recorded within the Macintyre River and Macintyre Brook during targeted Project surveys for fish species. Database records (i.e. AoLA) indicate the species is known from within 10 km of the Project footprint. Records indicate the species has been found as recently as 2011 on the Macintyre River on the NSW border, approximately 4km to the south of the project between Yelarbon and Goondawindi. There are several other records upstream and downstream of the Project crossing on the Macintyre River. Another record of this species occurs within 5 km west of the Project footprint from 1998 in the Millmerran area. Two recent records (2015) are located upstream of the Project from Kings Creek (tributary feeding into the Condamine River) located nearly 50 km west in the Clifton area. Other records exist between Dalby and Oakey along Oakey Creek downstream of the northern extent of the Project footprint.

As noted above, the species was recorded during Project surveys in the Macintyre River and Macintyre Brook. The species was not recorded elsewhere along the alignment and aquatic habitat assessments indicated waterways associated with the Project footprint on the Condamine River floodplain and Oakey Creek were not suitable for the permanent presence of the species. These areas, particularly on the Condamine floodplain, are only likely to be used by the species during and following large flooding events.

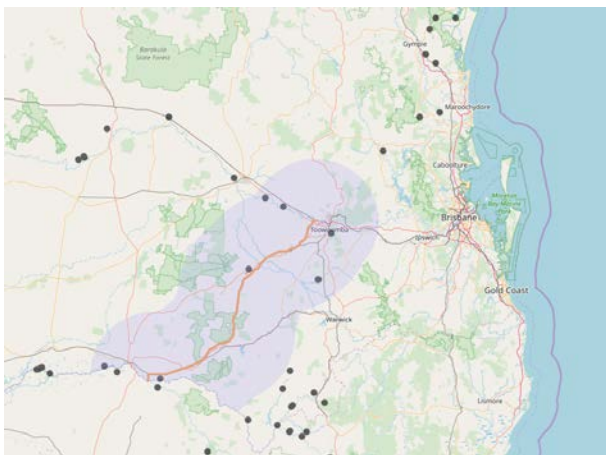


Figure 5.2 Distribution range of Murray cod

Source: ALA (2020)

5.1.2.4 Biology and reproduction

Due to the size of the Murray cod, it is considered the apex predator of the Murray-Darling river system and known to ambush its prey. The demersal species is known to hunt from sunset to sunrise, feeding on spiny crayfish and shrimp as well as reptiles and other fish species including cod (DotEE 2018).

The Murray cod has relatively low fertility compared to many other freshwater fish with the species generally reaching sexual maturity, which is heavily dependent on size, at 5 years of age. Male Murray cod, who are known to guard and fan the eggs during incubation, mature at a larger size than females with the species breeding as a pair. A female cod weighing 3 kg can produce up to 10,000 eggs often laid in logs or snags after developing them through winter until spawning, which is triggered by an increase in temperature and day length (DotEE 2018).

Upon hatching larvae tend to remain clustered in their nest for up to 11 days with the male continually providing protection before the larvae leave the nest to drift downstream and feed on zooplankton as well as aquatic insects (DotEE 2018).

5.1.3 Habitat

The habitat of the species is diverse, ranging from clear rocky streams to slow-flowing, turbid lowland rivers or billabongs where the fish is found frequently in the main channel. Due to the species preferred breeding environment, it is often found in streams containing large rock, snags, overhanging vegetation, stumps or other woody structures (DotEE 2018).

The species is known to take long distance journeys prior to spawning travelling up to several hundred kilometres upstream despite their naturally sedentary nature (Koehn et al. 2009).

5.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Murray cod:

- Impoundment of streams and altered water flow
- Loss of riparian vegetation
- Habitat removal, modification and degradation (DotEE 2018).

5.1.5 Threat abatement/recovery plans

No threat abatement plan has been identified as being relevant for this species. The following recovery plan is applicable to this species:

- National Murray Cod Recovery Team (2010). National Recovery Plan for the Murray Cod *Maccullochella peelii peelii*. Department of Sustainability and Environment, Melbourne. Available from: <http://www.environment.gov.au/resource/national-recovery-plan-murray-cod-maccullochella-peelii-peelii>. In effect under the EPBC Act from 16-Dec-2010 as *Maccullochella peelii*.

5.1.6 Summary of threat abatement/recovery plans

Important populations outlined in the National Recovery Plan for the Murray Cod *Maccullochella peelii peelii* that could be relevant to the Project include:

- New South Wales: Darling River main channel and tributaries
- New South Wales: Murray River main channel and tributaries
- New South Wales: Murrumbidgee River from Wagga to Hay
- New South Wales: Edwards River and tributaries
- New South Wales: Naomi River, Peel River junction to Wee Waa
- New South Wales: Gwydir River and major tributaries from Copeton Dam to Gwydir River
- New South Wales: Birder rivers (Barwon and Macintyre) including major tributaries in NSW
- Queensland: Border Rivers
- Queensland: Condamine River

- Queensland: Warrego River between Charleville and Cunnamulla
- Queensland: McIntyre River downstream of Texas.

Threats identified in the National Recovery Plan include:

- Flow regulation
- Habitat degradation
- Lowered water quality
- Barriers
- Exotic/alien species
- Commercial fishing
- Recreational fishing
- Illegal fishing
- Stocking and translocations
- Genetic issues
- Disease
- Climate change.

Objectives outlined in the National Recovery Plan include:

- Determine the distribution, structure and population dynamics across the MDB
- Manage river flows in a way that enhances recruitment
- Risk assess the threats and evaluate benefits of recovery actions
- Determine habitat requirements for various life stages
- Manage recreational fishing in a sustainable manner taking into account the social, economic and recreational value of the fishery
- Encourage community ownership of conservation for the species
- Manage recovery plan implementation.

5.1.7 References

Atlas of Living Australia. (2018). *Maccullochella peelii*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:54e10f17-f08c-4f93-b576-681f361ffe56> [Accessed 22 August 2018].

Department of Environment and Energy. (2018). *Maccullochella peelii* (Murray Cod) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66633 [Accessed 22 August 2018].

Koehn J.D., J.A. McKenzie, D.J. O'Mahony, S.J. Nicol, J.P. O'Connor and W.G. O'Connor. (2009). Movements of Murray cod (*Maccullochella peelii peelii*) in a large Australian lowland river. *Ecology of Freshwater Fish*. 18:594-602. John Wiley and Sons A/S.

Flagstaffotos. (2006). *Maccullochella peelii* - Murray Cod. [image] [online] Available from: https://commons.wikimedia.org/wiki/File:Murray_cod_melb_aquarium.jpg. [16 September 2019].

Murray Darling Basin Authority. (2007). Native Species – Murray Cod (*Maccullochella peelii peelii*). Available from: https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2202_factsheet_native_murray_cod.pdf [Accessed 22 August 2018].

National Murray Cod Recovery Team (2010). National Recovery Plan for the Murray Cod *Maccullochella peelii peelii*. Department of Sustainability and Environment, Melbourne. Available from: <http://www.environment.gov.au/resource/national-recovery-plan-murray-cod-maccullochella-peelii-peelii> [Accessed 22 August 2018].

5.2 Silver perch (*Bidyanus bidyanus*)

5.2.1 Status

EPBC Act – Critically Endangered

5.2.2 Biology and ecology

5.2.2.1 Characteristics

Silver perch are an elongate fish with a laterally compressed, oval-shaped body. They have a pointed head and snout and a relatively small mouth with equal jaws and narrow bands of very fine villiform (needle-like) teeth. The spiny dorsal fin is moderately high and strong and merges with the soft dorsal fin without a distinct notch or break (refer Photograph 5.2). The tail is slightly forked. Very large specimens assume a slightly disproportionate appearance with a strongly humped forehead, strong lateral compression and a more distinctly pointed, almost beak-like head and snout. Silver perch colouration varies based on water clarity (darker colouration is associated with clearer water) but specimens are generally a dusky bronze or green colour on the back, with silvery-grey flanks and a white belly. On some specimens dark edges to the scales create a subtle cross-hatched or checkered appearance on the flanks (DoE 2008).



Photograph 5.2 Silver perch (*Bidyanus bidyanus*)

Source: Michelle (2017)

5.2.2.2 Known distribution

Silver perch are endemic to the Murray-Darling system (including all states and sub-basins) (Allen et al., 2002; Lintermans, 2007). Hatchery-bred silver perch are also stocked out of their range in a number of impoundments on east coast river systems, where they seemingly fail to reproduce. However, a self-sustaining population of silver perch occurs in Cataract Dam in the Hawkesbury Nepean system (refer Figure 5.3).

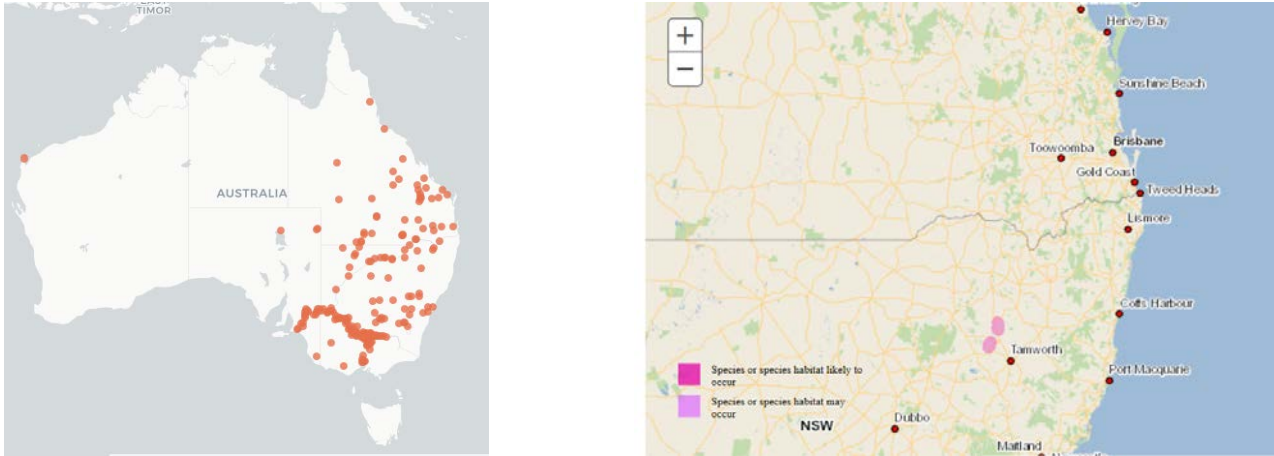


Figure 5.3 Distribution range of Silver perch

Source: ALA (2019), DotEE (2018)

5.2.2.3 Distribution in relation to the Project

Targeted fish surveys were undertaken to detect Silver perch in the Macintyre River and Macintyre Brook in both June 2018 and May 2019 (Eco logical 2020). Dry conditions during the 2018 survey did not result in this species being detected. Aquatic surveys within river and creek systems associated with the Project did not capture the species or identify habitat suitable for the species (fast-flowing waters). Database records (i.e. AoLA) indicate the species is known from approximately 4.5 km north of the Project to the north-east of Millmerran at Back Creek. This record is relatively recent form 1998. Another record occurs to the east of the northern section of the Project recent from 2014. The record is detailed to occur at the Bicentennial Waterbird Habitat at Alderley Street in Toowoomba. The only other record from within a 50 km radius of the Project occurs at Cecil Plains approximately 35 km north of the Project however, this is an old record from 1950.

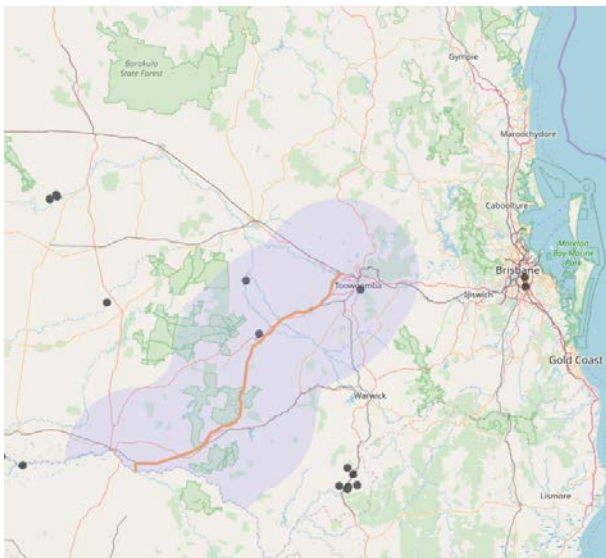


Figure 5.4 Distribution range of Silver perch in relation to the Project

Source: ALA (2020)

5.2.2.4 Biology and reproduction

Silver perch move upstream to spawn and breeding is initiated by a combination of rising water temperatures and water levels. Silver Perch are a slow-growing and long-lived species, living to more than 17 years of age. An individual recorded from the Cataract Dam, ACT, was 27 years old. They are oviparous pelagic spawners and spawn in spring or summer. Spawning is preceded by courtship behaviours, and occurs in late afternoon, dusk or shortly after nightfall. Spawning occurs in shoals at or near the surface, involves simultaneous release of milt (sperm) and eggs by male and female fish respectively, and is often accompanied by thrashing at the surface (DoE 2008).

The cumulative evidence indicates that silver perch reproduction is flexible in terms of flow conditions and temperature; reproduction can occur in both within-channel flows and floods and at relatively cool water temperatures. Spawning is not flood dependent but does appear to be dependent on suitable flows and suitable flood events do appear to maximise spawning efforts and presumably recruitment. The former occurrence of silver perch in some cooler upper reach habitats with gravel and rock substrates suggest silver perch are also flexible in the type of river environments in which they can reproduce (DoE 2008).

5.2.3 Habitat

Silver perch are consistently reported by anglers and researchers to show a general preference for faster-flowing water, including rapids and races, and more open sections of river, throughout the Murray-Darling Basin (MDBA 2007). In the upper Murrumbidgee River during the 1960s and 1970s, the species was renowned for migrating into clear fast-flowing rapids in summer, in which anglers observed and targeted them (DoE 2008).

5.2.4 Threatening processes

The following have been identified as potentially threatening processes to the silver perch:

- Impoundment of streams and altered water flow
- Loss of riparian vegetation
- Habitat removal, modification and degradation
- Introduce fish and pathogens (DoE 2008).

5.2.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as being relevant for this species:

- Threatened Species Recovery Planning Program: Silver Perch *Bidyanus bidyanus* NSW Recovery Plan. Available from: https://www.dpi.nsw.gov.au/_data/assets/pdf_file/0007/636388/NSW-Silver-Perch-Recovery-Plan.pdf. In effect under the NSW Department of Primary Industries, prepared in accordance with the threatened species provision of the New South Wales *Fisheries Management Act 1994*.

5.2.6 Summary of threat abatement/recovery plans

Key priority management sites that could be relevant to the project include:

- Tocumwal in Berrigan LGA
- Corowa in Federation LGA
- Murray Riparian Corridor in Albury City, Federation, Greater Hume Shire LGA
- Thurgoona in Albury City LGA.

Threats identified in the recovery plan includes:

- Lack of knowledge on the species
- River regulation and barriers to fish passage

- Changes to river flood and flow patterns
- Changes to temperature regimes and cold-water pollution
- Barriers to fish movement
- Degradation of riparian vegetation, loss of aquatic vegetation, removal of in-stream habitat, salinity, algal blooms, agricultural chemical use and sedimentation
- Introduced species
- Diseases
- Commercial and recreational fishing
- Aquaculture and fish stocking practices.

Management actions outlined in the recovery plan include:

- Sampling of existing populations to determine current distributions and abundance along with the location of significant populations
- Encouraging the local community to report sightings of Silver perch through the Threatened, Protected and Pest Species Sighting Program
- Determine the level of genetic diversity within the wild and stocked populations and the origin of extant river populations
- Better understand habitat requirements, ecology and key threats to the species through the support of research into these areas
- Protect and restore habitat important for the various life stages of the species
- Improve awareness and status of the species to recreational fishers, review and if necessary amend fishing regulations to reduce impacts on the species
- Improve the management of aquaculture and fish stocking practices in order to minimise the risk of genetic impacts on wild populations
- Evaluate through ongoing monitoring the status of the species and the effectiveness of recovery actions.

5.2.7 References

Atlas of Living Australia. (2019). Silver Perch *Bidyanus bidyanus*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:05866f31-1adb-4709-91f4-41dbff54459f> [Accessed 22 July 2019].

Bray, D.J. & Thompson, V.J., *Bidyanus bidyanus* in Fishes of Australia, Museums Victoria, accessed 25 Jul 2019, <http://fishesofaustralia.net.au/home/species/689>

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Michelle, M. (2017). Silver perch (*Bidyanus bidyanus*). [image] [online] Available from:

<https://images.ala.org.au/image/details?imageId=4d93d98a-ed5-4ad8-bd8e-40cc74a1c861>. [19 September 2019].

Murray Darling Basin Authority. (2007). *Bidyanus bidyanus* (Silver Perch). Available from:

https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2203_factsheet_native_silver-perch.pdf [Accessed 22 July 2019].

5.3 Mary River cod (*Maccullochella mariensis*)

5.3.1 Status

EPBC Act – Endangered

5.3.2 Biology and ecology

5.3.2.1 Characteristics

The Mary River cod (*Maccullochella mariensis*) is a pale green to golden-yellow fish with dark brown mottled scales featuring heavily on the fish's body. This fish species has a protruding lower jaw, concaved head profile and soft dorsal fins as well as thin white edged anal and caudal fins (refer Photograph 5.3). The average weight of this species is approximately 5 kg with a total body length of 70 cm (DotEE 2018; DAF 2018).



Photograph 5.3 Mary River cod (*Maccullochella mariensis*)

Source: DAF (2018)

5.3.2.2 Known distribution

The Mary River cod is endemic to the Mary River catchment in southeast Queensland (refer Figure 5.5). Creek systems which feed off the Mary River such as Six Mile, Tinana-Coondoo and Obi Obi Creek are all well known areas of distribution for the Mary River cod (Simpson and Jackson 1996).

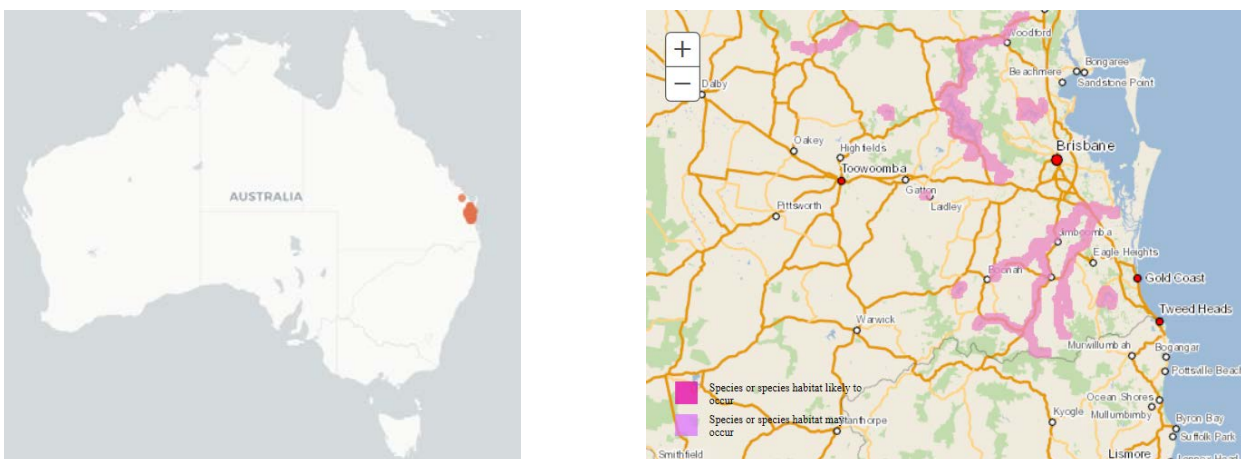


Figure 5.5 Distribution range of the Mary River cod

Source: ALA (2018), DotEE (2018)

5.3.2.3 Distribution in relation to the Project

Maccullochella mariensis has been predicted to occur within the region and associated habitat within the impact assessment area. However, there are no current database records (i.e. AoLA, WildNet) for this species within 50 km of the temporary and permanent Project footprint. The impact assessment area is located within incorrect drainage system, that is outside of natural distribution of the species. The species is restricted to the Mary River catchment. The most recent records (2020) were recorded from Conodale/Maleny, 100km north east of the project.

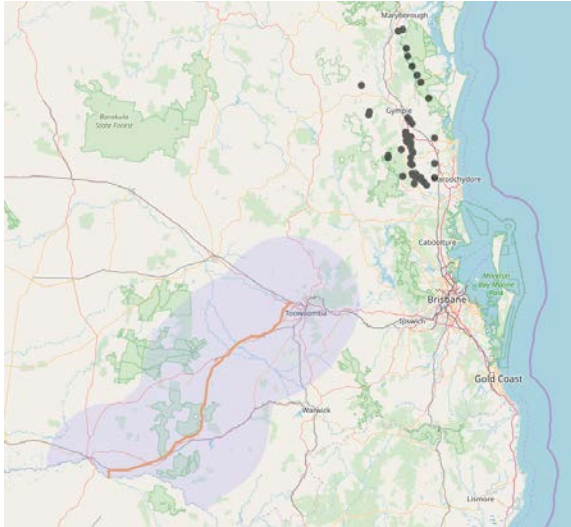


Figure 5.6 Distribution range of the Mary River cod in relation to the Project

Source: ALA (2020)

5.3.2.4 Biology and reproduction

Adult Mary River cod feed on a variety of prey such as fish, freshwater crayfish, shrimp, mussel, frogs and even small reptiles. Juvenile Mary River cod feed on crustaceans including crayfish and shrimp, insect larvae. Newly hatched cod consume zooplankton and aquatic insects such as chironomid larvae (Gomon and Bray 2018).

The Mary River cod form pairs and spawn annually around spring, as water temperature reaches 20°C with the male selecting and guarding the nest site which is thought to be a hollow log in the wild. Eggs, which may be as many as 2,000 eggs per kilogram of the female fish's bodyweight, are deposited as a layer inside the log which are opaque in colour with hatching occurring towards the end of the fourth day and complete by the seventh day (TSSC 2016).

5.3.3 Habitat

The preferred habitat for the species is a high gradient, rocky, upland stream or slow-flowing pools in lowland areas. Deep, shaded areas of water with snags and log-piles are often inhabited as they provide good conditions of the species to spawn. The Mary River cod is known to migrate over 30 km into smaller tributaries in late winter either up or down stream and have a long home range returning after long absences (Simpson and Jackson 1996; TSSC 2016).

5.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Mary River cod:

- Impoundment of streams
- Loss of riparian vegetation
- Competition by invasive species (DotEE 2018).

5.3.5 Summary of threat abatement/recovery plans

Important populations outlined in the National Recovery Plan for the *Mary River Cod Maccullochella mariensis* that could be relevant to the Project include:

- Tinana-Coondoo Creek
- Six Mile Creek
- Obi Obi Creek.

Threats identified in the National Recovery Plan include:

- Habitat change
- Overfishing
- Introduced fish species.

Recovery actions outlined in the National Recovery Plan include:

- Establishing a program of community involvement/education in order to foster public support or the conservation of the species
- Develop and implement regulations and administration actions to protect the species and their habitat
- Manage captive breeding and restocking efforts into suitable habitat
- Research biological requirements to improve captive-breeding techniques
- Implement programs to rehabilitate riparian and instream habitats in the Mary river system along with targeted restocking sites
- Develop and implement a long-term monitoring program for assessment of the species.

5.3.6 References

Atlas of Living Australia. (2018). *Maccullochella mariensis*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:9d455adb-4fa8-4853-a3a6-f7d28d838fc6> [Accessed 22 August 2018].

Department of Agriculture and Fisheries. (2018). Mary River Cod. Queensland Government. Available from: <https://www.daf.qld.gov.au/business-priorities/fisheries/species-identification/freshwater-fish/mary-river-cod> [Accessed 22 August 2018].

Department of Environment and Energy. (2018). *Maccullochella mariensis* (Mary River Cod) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83806 [Accessed 22 August 2018].

Gomon M.F. and Bray D.J. (2018). *Maccullochella mariensis* in Fishes of Australia, accessed 30 August 2018, <http://fishesofaustralia.net.au/home/species/3000> [Accessed 22 August 2018].

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Threatened Species Scientific Committee (2016). *Maccullochella mariensis* in Species Profile and Threats Database. Department of Environment and Energy. Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/83806-conservation-advice-16122016.pdf> [Accessed 22 August 2018].

6 Fauna species – threatened species – reptiles

6.1 Border thick-tailed gecko (*Uvidicolus sphyrurus*)

6.1.1 Status

EPBC Act – Vulnerable

6.1.2 Biology and ecology

6.1.2.1 Characteristic

The Border thick-tailed gecko (*Uvidicolus sphyrurus*) is pale fawn to brown and growing to 7 cm long. It has darker brown flecks and small white spots scattered across its upper body. It has a dark grey-brown/black tail with alternate dark and pale cross-bands formed by rows of large tubercles. The tail is fat and rectangular with a thin tapering tip and with up to four pale rings (Cogger 2000; OEH 2017) (refer Photograph 6.1).



Photograph 6.1 Border thick-tailed gecko (*Uvidicolus sphyrurus*)

Source: Fordyce & White (2018)

6.1.2.2 Known distribution

The Border thick-tailed gecko occurs only on the tablelands and slopes of northern NSW and southern Queensland. In Queensland, it is found south of Warwick around the border to NSW where its distribution extends down to Tamworth (ALA 2018; OEH 2017) (refer Figure 6.1).

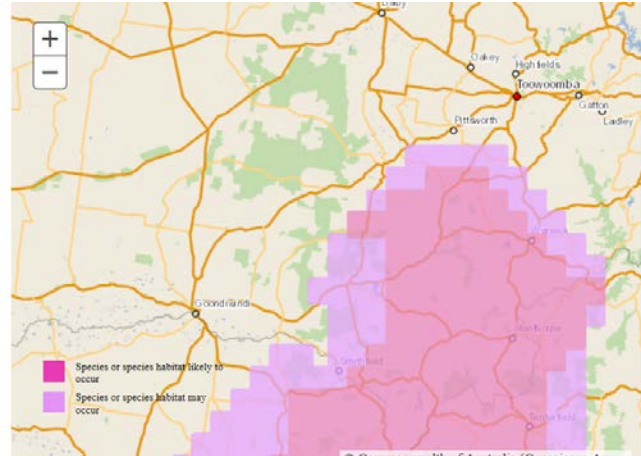


Figure 6.1 Distribution range of Border thick-tailed gecko

Source: ALA (2018), DotEE (2018)

6.1.2.3 Distribution in relation to the Project

The Border tick-tailed gecko has been predicted to occur within the region and associated habitat within the impact assessment area. However, there are few records within a 50 km radius of the Project. The only record associated with the Project is recent from 2005 and exists approximately 29 km east of the alignment near Leyburn. The location for this record has been generalised due to the sensitivity of the species. Most records occur outside of the 50 km buffer areas to the south east around the New England Tablelands.

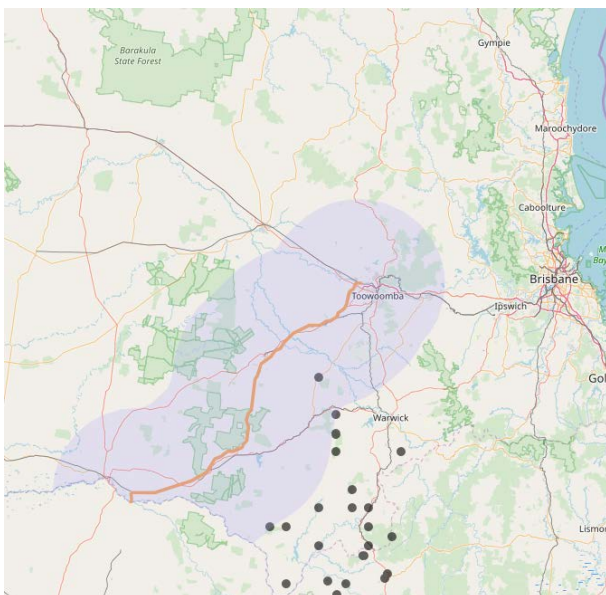


Figure 6.2 Distribution range of Border thick-tailed gecko in relation to the Project

Source: ALA (2020)

6.1.2.4 Biology and reproduction

The Border thick-tailed gecko preys upon invertebrates primarily on the ground, with insects and spiders forming the bulk of its diet (NSWSC 2010).

It is estimated that sexual maturity of the Border thick-tailed gecko typically occurs at 30 months. Clutch size is restricted to two hard-shelled eggs (DotEE 2018; Curtis et al. 2012). Like other species of gecko, this species has the potential to produce several clutches per year.

6.1.3 Habitat

The Border thick-tailed gecko most commonly occurs in undisturbed remnant vegetation on rocky outcrops and stony hills within eucalypt and cypress-pine open forest or woodland. Altitudinal gradient used by the species is restricted to 500 to 1,100 m above sea level. During the day the gecko shelters in well-shaded micro-habitat amongst boulders, rock slabs, timber debris, bark and deep leaf litter (OEH 2017).

6.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Border thick-tailed gecko:

- Clearing and fragmentation of rocky dry open forest and woodland
- Frequent burning
- Removal of fallen timber
- Grazing and trampling of habitat
- Predation by foxes and feral cats
- Poor knowledge of species' distribution and population dynamics
- Infestation by weeds (OEH 2017).

6.1.5 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this species. The following threat abatement plan is applicable to this species:

- Department of the Environment (2015). *Threat abatement plan for predation by feral cats*. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.

6.1.6 Summary of threat abatement/recovery plans

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

6.1.7 References

Atlas of Living Australia (2018). *Uvidicolus sphyrurus*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7a6bad30-8da4-4fb4-b0e9-c8a01a95d11d> [Accessed 3 September 2018].

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NSW Scientific Committee (NSWSC) (2010). Border Thick-tailed Gecko *Underwoodisaurus sphyrurus* - reject delisting of vulnerable species. Available from: <http://www.environment.nsw.gov.au/determinations/borderthicktailedgeckorejectremovalFD.htm>.

Office of Environment and Heritage, NSW (2017). Border Thick-tailed Gecko. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10823> [Accessed 3 September 2018].

6.2 Collared delma (*Delma torquata*)

6.2.1 Status

EPBC Act – Vulnerable

6.2.2 Biology and ecology

6.2.2.1 Characteristics

The Collared delma (*Delma torquata*) is a flap-footed lizard that has no forelimbs but retains vestigial hind limbs in the form of small scaly flaps. The body of the Collared delma is brown to reddish-brown in colour becoming grey to bluish-grey on the tail. It has large black bands across the head and nape interspaced by four cream-yellow stripes (refer Photograph 6.2). This species moves with a snake-like gait through the matrix but travel with a series of wriggling leaps over open ground. The Collared delma is a small cryptic species reaching a maximum size of 7 cm (snout-vent) and a maximum total length of approximately 190 mm (DotEE 2018; Santos 2012).



Photograph 6.2 Collared delma (*Delma torquata*)

6.2.2.2 Known distribution

The Collared delma is endemic to southeast Queensland. The known distribution of the species occurs at Lockyer Forest Reserves, Western Creek near Millmerran, the Toowoomba Range eastward to Moggill on the western outskirts of Brisbane (refer Figure 6.3). The largest known occurrence of this species occurs on the Toowoomba range where large numbers of this species were subject to translocation activities associated with the Toowoomba second range crossing project (DotEE 2018; Schell and Stark pers. obs. 2017).

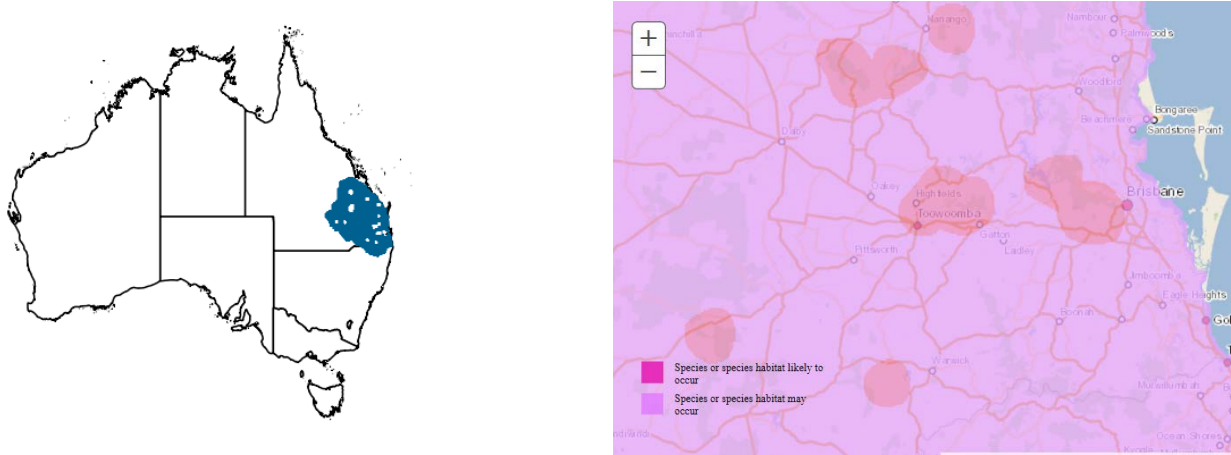


Figure 6.3 Distribution range of the Collared delma

Source: ALA (2018), DotEE (2018)

6.2.2.3 Distribution in relation to the Project

Collared delma was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). The Collared delma has not been recorded within or adjacent to the Project footprint. The nearest database records are two from 2003 taken from the east of Toowoomba at Jones Road, Withcott approximately 12 km east of the northern section of the Project. Another nearby record with no date occurs approximately 17 km from the Project at Table Top Drive, Toowoomba. Towards the south of the Project a record occurs approximately 29 km north of the alignment at the southern boundary of Western Creek State Forest dated 1998 (refer Figure 6.4). Further north and west the species occurs in Bunya Mountains National park and Yarraman State Forest and surrounds (AoLA 2020). The Project footprint is located near the southern limit of the species range. Project associated surveys noted potential habitat for the species (woodlands with loose surface rocks) as occurring where the Project disturbance footprint passes between the township of Pampas and the Condamine River (north branch).

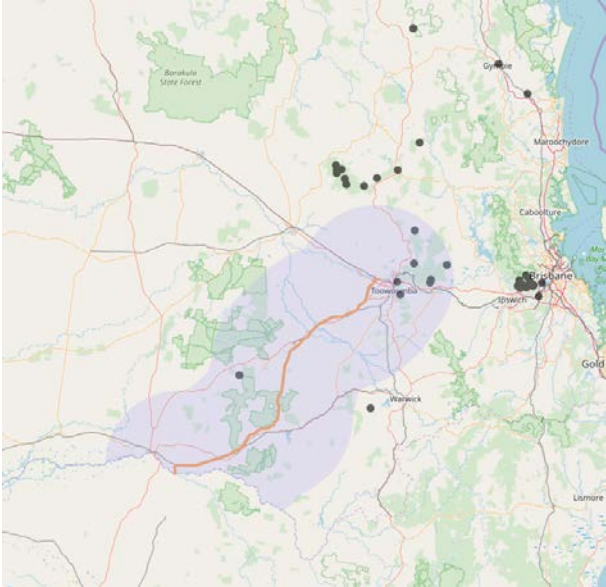


Figure 6.4 Distribution range of the Collared delma in relation to the Project

Source: ALA (2020)

6.2.2.4 Biology and reproduction

The Collared delma feeds on insects and spiders, with small cockroaches the most common prey item. Some individuals have been captured in subterranean termite colonies (Davidson 1993; Porter 1998; Schell and Stark pers. obs. 2017).

As with all members of the Pygopodidae family, the Collared delma produces two small white, elongated eggs in December. These hatch in February to March (Peck and Hobson 2007; Schell and Stark pers. obs. 2017).

6.2.3 Habitat

The Collared delma typically inhabits Eucalypt-dominated woodlands and open-forests in Queensland RE Land Zones 3, 9 and 10 (Brigalow Belt Reptiles Workshop 2010). However, recent studies associated with the species indicate that the species is most frequently associated with open *Eucalyptus crebra* woodland (canopy cover between 10 to 30%) located on northwest facing slopes (Schell and Stark pers. obs. 2017).

The Collared delma has been recorded from rocky areas associated with dry open forests. This species occurs in open Eucalypt and acacia woodland with an understorey of native grasses and loose rocks. The Collared delma has also been recorded from Eucalypt woodland adjacent to semi-evergreen vine thicket. This species shelters under rocks, fallen timber, leaf litter and in soil cracks (Richardson 2006).

The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of the Collared delma microhabitat and is always present where the species occurs (Brigalow Belt Reptiles Workshop 2010; Davidson 1993; Schell and Stark pers. obs. 2017).

6.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Collared delma:

- Loss and modification of habitat due to urban and agricultural development
- Landscaping activities removing surface rocks
- Invasive weed species such as Dwarf lantana (*Lantana montevidensis*) (DotEE 2018).

6.2.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species. The Priority Threat Management for Imperilled Species of the Queensland Brigalow Belt has been identified as being relevant for this species. Available from:

<https://publications.csiro.au/rpr/download?pid=csiro:EP154521&dsid=DS5> (Ponce Reyes, R., J. Firn, S. Nicol, I. Chadès, D.S. Stratford, T.G. Martin, S. Whitten & J. Carwardine, 2016).

6.2.6 Summary of threat abatement/recovery plans

Given the difficulty in detecting the Collared delma (*Delma torquata*) the Commonwealth environmental department considers that the presence of suitable and important habitat for this species is a surrogate for an important population of the species. Important habitat as described in the Draft referral guidelines for the nationally listed Brigalow Belt reptiles (available from:

<http://www.environment.gov.au/system/files/resources/570964ac-15bf-4e07-80da-848fead7b0cd/files/draft-referral-guidelines-comment-brigalow-reptiles.pdf>) includes:

- Open forest eucalypt woodland dominated by ironbarks
- Woodland adjacent to exposed rocky areas
- RE Land Zones 3, 9 and 10

Threats to the Brigalow belt environmental community outlined in the Threat Management for Imperilled Species of the Queensland Brigalow Belt includes:

- Grazing
- Cultivation of arable crops
- Coal mining
- Coal Seam Gas industry development and associated infrastructure
- Changes in hydrology and pollution
- Invasive animals
- Invasive flora
- Fire
- Climate change.

Conservation management outcomes identified in the Threat Management for Imperilled Species of the Queensland Brigalow Belt document includes:

- Management of 29 national parks through the Department of National Parks, Sport and Racing
- Management of four Conservation Parks and one Resource Reserve that protects the brigalow ecosystems through the Department of Natural Resources and Mines supporting conservation and rehabilitation of the natural environment
- Encouraging sustainable agriculture to improve biodiversity and farm practices
- 'Back on Track' initiative prioritising the conservation, management and recovery of Queensland's native species
- Indigenous land management practices implemented for weed and fire management by Traditional Owners
- Biodiversity offsets through voluntary or mandatory investments in conservation management.

6.2.7 References

- Atlas of Living Australia (2018). *Delma torquata* Kluge. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:3796d07c-7e2c-4d8b-be2d-3846aa4c2bf1> [Accessed 2 September 2018].
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- Department of Environment and Energy (2018). *Delma torquata* (Adorned Delma/Collared Delma) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1656 [Accessed 22 August 2018].
- Peck, S. and R. Hobson. (2007). Survey results and management options for the Collared delma (*Delma torquata*) along the proposed Toowoomba Bypass, Toowoomba Range, Southeast Queensland, November 2006. Queensland Parks and Wildlife Service.
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- Richardson, R. (2006). Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012, Report to the Department of the Environment, Water, Heritage and the Arts, Canberra. WWF-Australia, Brisbane.
- Santos. (2012). GLNG Project. Available from: <https://www.santos.com/media/3820/significant-species-management-plan-smmp-part-2-p.pdf> [Accessed 22 August 2018].
- Schell, C and J. Stark (2017). Personal observations of *Delma torquata* associated with the implementation of the Collared Delma translocation Management Plan for the Toowoomba Second Range Crossing Project.
- Steve Wilson. (2018). Arkive - Collared delma (*Delma torquata*). Available from: <https://www.arkive.org/collared-delma/delma-torquata/image-G82236.html> [Accessed 22 August 2018].

6.3 Condamine earless dragon (*Tympanocryptis condaminensis*)

6.3.1 Status

EPBC Act – Endangered

6.3.2 Biology and ecology

6.3.2.1 Characteristics

The Condamine earless dragon (*Tympanocryptis condaminensis*) is a small, plump, spiny earless dragon lizard that grows to an average size of 12 cm. The species colour ranges from reddish-brown to almost black with prominent pale banding of brown-black or white. The throat and chin of the Condamine earless dragon can be yellow and marbled with black. Its body colour affords the species good camouflage in their environment (DES 2017).

Currently limited information is known about the difference in gender and life stages (juveniles or adults) of Condamine earless dragon. However, studies of similar species in the Agamidae family have identified males tend to be more animated than females as well as having a set of distinct pre-anal pores between the back legs and hemi-penal bulges at the vent area (Phipps and Titmuss 2006).

6.3.2.2 Known distribution

The known distribution of the Condamine earless dragon is within the eastern Darling Downs region in southeast Queensland (refer Figure 6.5). Condamine earless dragons are often found in the Condamine River floodplains surrounded by Jimbour in the northeast, Millmerran in the southwest, Clifton in the southeast and Toowoomba in the northeast with records from Oakey, Bongeen, Bowenville, Brookstead and Mt Tyson (TSSC 2016).

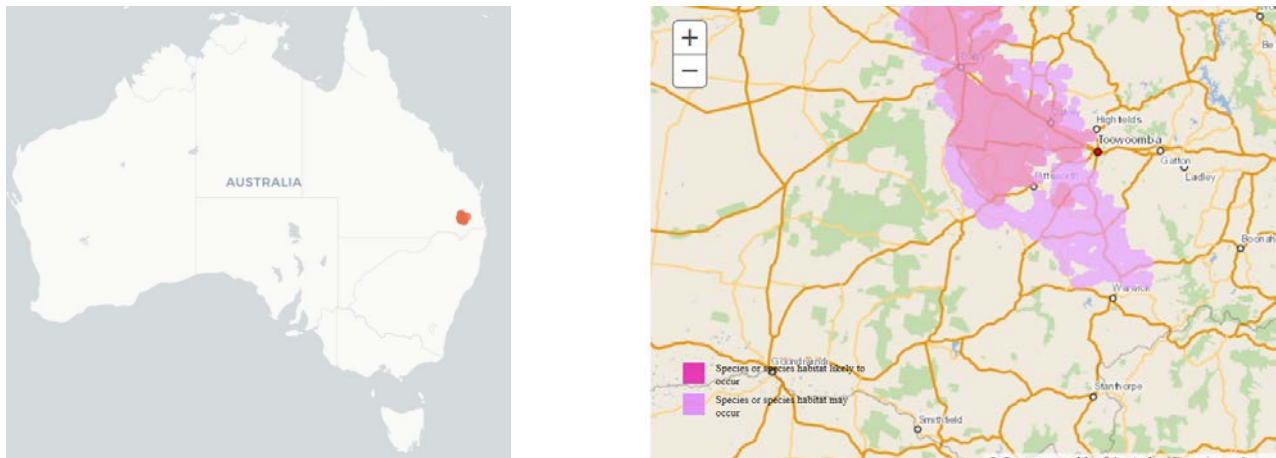


Figure 6.5 Distribution range of the Condamine earless dragon

Source: ALA (2018)

6.3.2.3 Distribution in relation to the Project

Condamine earless dragon was recorded during Project-associated surveys in an existing rail line easement located within the Project footprint approximately 13 km north-east of Millmerran. There are a number of database records north-west of this area, located largely to the north of the Project footprint. The nearest record (2009) is located 1.5 km south of the Project footprint near Brookstead. There are several records (2003 to 2014) variously between 3 km to 4 km to the north of the Project footprint between Brookstead and Pittsworth, with many records located further north (refer Figure 6.6). The only other records located south of the Project are from agricultural lands located north of the Pittsworth-Felton Road (15 km south-west of Pittsworth).

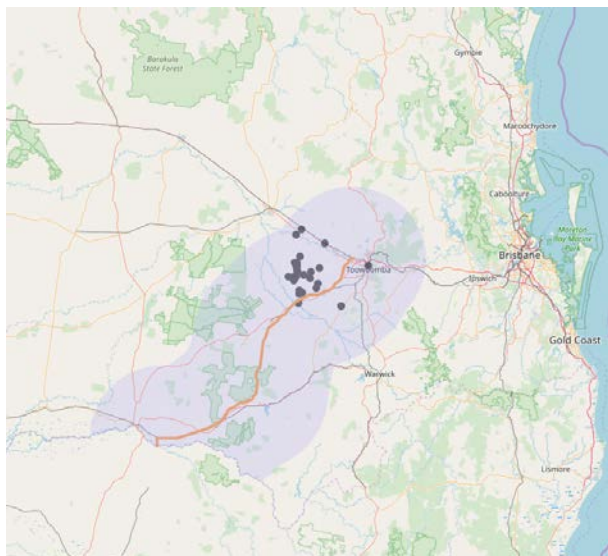


Figure 6.6 Distribution range of the Condamine earless dragon in relation to the Project

Source: ALA (2020)

6.3.2.4 Biology and reproduction

Knowledge of Condamine earless dragon diet is still limited; however it is thought the species feeds on small invertebrates with anecdotal evidence suggesting ants are a popular source of food (DES 2017).

Limited information is also known about the reproductive behaviour and biology of the Condamine earless dragon, but it has been observed males will take on their breeding colours, which are canary yellow at the throat and chin, during December and a gravid female was recorded in November (Melville et al. 2017).

All Agamidae species are known however to be oviparous and deposit their eggs in burrows with snout to vent length a measure of sexual maturity. Clutch size studies undertaken for the Eyrean earless dragon (*Tympanocryptis tetraporophora*), a species of the *Tympanocryptis* genus, was found to produce an average clutch size of 8 eggs. Body size of females was also found to be a strong determinant of clutch size (Uetz 2011).

6.3.3 Habitat

This dragon species appears to survive in areas that are intensely cropped and previously occupied as naturally treeless grassland. The dragon uses ballast, surface rocks and rocky outcrops as shelter, while cracks in the black clay of the Condamine River floodplain appear provide them with plenty of holes to seek alternate shelter when disturbed (DES 2017).

6.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Condamine earless dragon:

- Habitat loss due to development
- Soil degradation due to changed agricultural practices
- Predation by cats and foxes (Melville et al. 2017).

6.3.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Robertson, P. & M. Evans (2009). *National Recovery Plan for the Grassland Earless Dragon* *Tympanocryptis pinguicolla*. As varied October 2012. ACT Department of Territory and Municipal Services, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-grassland-earless-dragon-tympanocryptis-pinguicolla>. In effect under the EPBC Act from 13-Aug-2010.

The following threat abatement plan is applicable to this species:

- Department of the Environment (2015). *Threat abatement plan for predation by feral cats*. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.

6.3.6 Summary of threat abatement/recovery plans

Important populations for the Grassland earless dragon includes:

- All extant populations
- All currently known, and subsequently discovered populations should be considered in conservation strategies for this species.

Summary of threats outlined in the National Recovery Plan for the Grassland Earless Dragon include:

- Habitat loss and fragmentation as a result of urban, industrial and agricultural development

- Degradation of existing habitat resulting from ploughing, inappropriate fire regimes, overgrazing, weed invasion, agricultural chemicals and rock removal
- Introduced animals including foxes, cats, rabbits, mouse, sheep and cows impacting the species as a result of predation or by grazing
- Threats to existing suitable habitat sites include airport modifications, railway expansion, new roads, road construction, industrial development, landfill extensions, urban or rural residential development
- Frequent fires and high intensity grazing particularly resulting in the loss of tussock grasses, which are used as shelter for the species
- Ploughing and cropping of grasslands

Summary of recovery actions outline in the National Recovery Plan for the Grassland Earless Dragon include:

- Determine the distribution and abundance of the species in order to define habitat critical to the survival of the species
- Maintain and improve the current abundance and distribution by better understanding the species through ecological research to enable effective management
- Better understand and address the threats faced by the species and their habitat so that impacts can be measured and abated
- Protect and manage suitable habitat
- Ongoing monitoring to enable adaptive management
- Salvage and translocate existing populations at sites that are not suitable for the long-term survival of the local population.

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

6.3.7 References

Ashdown, R (2014). Condamine earless dragon. Available from:

<http://ashdown4628.clients.cmdwebsites.com/blog/?p=6941> [Accessed December 2015].

Atlas of Living Australia (2018). *Tympanocryptis condaminensis*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:6bce6afb-6a46-47f2-970d-15567172d8be> [Accessed 2 September 2018].

Department of Environment and Science (2017). Condamine earless dragon. Queensland Government.

Available from: <https://www.ehp.qld.gov.au/wildlife/animals-az/condamine-earless-dragon.html> [Accessed 22 August 2018].

Melville, J. Hutchinson, M. Wilson, S. Hobson, R. and Venz, M. (2017). *Tympanocryptis condaminensis*. The IUCN Red List of Threatened Species 2017. Available from: <http://www.iucnredlist.org/details/83494956/0> [Accessed 2 September 2018].

Phipps, G. and Titmus, A. (2006). Husbandry Manual for Bearded Dragons. Available from: http://www.parrotgarden.com.au/wp-content/uploads/2016/05/Bearded_Dragons__Nelson_.pdf [Accessed 2 September 2018].

Threatened Species Scientific Committee (2016). *Tympanocryptis condaminensis* in Species Profile and Threats Database. Department of Environment and Energy. Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/87888-conservation-advice-05052016.pdf> [Accessed 22 August 2018].

Uetz, P. (2011). *Tympanocryptis tetraporophora* (Australian Earless Lizard). Encyclopedia of Life. Available from: <http://eol.org/pages/461641/details#Reproduction> [Accessed 22 August 2018].

6.4 Dunmall's snake (*Furina dunmali*)

6.4.1 Status

EPBC Act – Vulnerable

6.4.2 Biology and ecology

6.4.2.1 Characteristics

Dunmall's snake (*Furina dunmali*) is a small to medium-sized, venomous (family Elapidae), snake that typically grows to a length of up to 75 cm. It has a uniform dark grey-brown colour on the top of the body, which fades to white at its lower flanks and has 21 rows on the mid-section. Most of the scales near the upper lip exhibit pale blotches. The head is large and distinct from the neck (DES 2017).

6.4.2.2 Known distribution

Dunmall's snake is endemic to Australia and inhabits areas near the Queensland border within the Brigalow Belt South bioregion to the Nandewar bioregion in NSW (refer Figure 6.7). In Queensland, the snake is often found in areas 200 to 500 m above sea level with recorded sightings in Oakey and Inglewood. In NSW, the species is predominantly found in the northeast inland region (DotEE 2018).

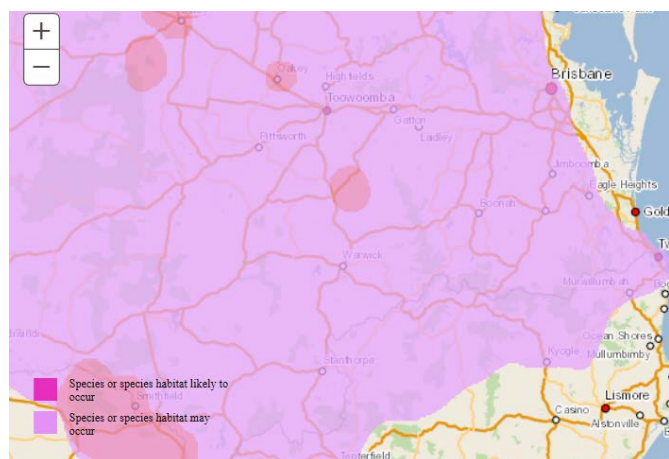


Figure 6.7 Distribution range of the Dunmall's snake

Source: ALA (2018), DotEE (2018)

6.4.2.3 Distribution in relation to the Project

This species was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Ecological 2016; Aurecon 2018). The nearest database record is recent from 2011 and occurs within the impact assessment area on the Millmerran – Inglewood Road north of Inglewood where the Project footprint traverses Bringalily State Forest. This is the only specimen backed record within the impact assessment area or disturbance footprint. Other records within a 50 km radius of the Project occur at the southern end of Yelarbon State Forest however this is somewhat recent dated 1996 and located 22 km south-east of the southern end of the Project. The only other record within the context of the Project occurs at Oakey approximately 13 km from north-east of the northern section of the Project (refer Figure 6.8). This record is not dated. The Project is located at the southern end of the species distribution, particularly at the southern end of the alignment.

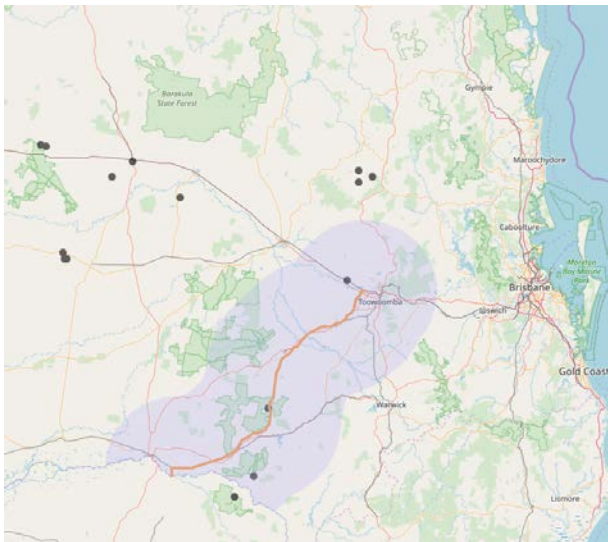


Figure 6.8 Distribution range of the Dunmall's snake in relation to the Project

Source: ALA (2020)

6.4.2.4 Biology and reproduction

Dunmall's snake are known to eat small lizards such as skinks and geckos. Analysis of the gut contents of this species yielded the remains of Tree skink (*Egernia striolata*). Limited knowledge is available on the snake's life cycle or reproductive behaviour, however, it is known that the species lays eggs rather than live young (DotEE 2018).

6.4.3 Habitat

Given the rarity, and difficulty of detecting Dunmall's snake, all suitable habitats (remnant or non-remnant vegetation) that are coincident with the known locations of the species are considered important habitats. Dunmall's snake has been found in a broad range of habitats, including:

- 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*)
- Various Spotted gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra* and *E. melanophloia*), White cypress pine (*Callitris glaucophylla*) and Bull-oak open forest and woodland associations on sandstone derived soils
- The edge of dry vine scrub near Tarong Power Station, Queensland, and hard ironstone country (Queensland RE Land Zone 7) at Lake Broadwater near Dalby, Queensland.

There is a paucity of information related to ecological requirements of this species, however it has been observed sheltering under fallen timber and ground debris and is known to utilise cracks in alluvial clay soils (DES 2017; DotEE 2018).

6.4.4 Threatening processes

The following have been identified as potentially threatening processes to Dunmall's snake:

- Habitat loss and fragmentation due to land clearing in core areas of the Darling Downs
- Predation by feral animals such as foxes, cats and pigs
- Inappropriate road side management (DES 2017).

6.4.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

6.4.6 References

Atlas of Living Australia (2018). *Furina dunmalli*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:9ba2edaa-574b-4c18-8503-d0b658b16cc4> [Accessed 2 September 2018].

Department of Environment and Energy (2018). *Furina dunmalli* (Dunmall's Snake) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59254 [Accessed 22 August 2018].

Department of Environment and Science (2017). Dunmall's snake. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/dunmall_s_snake.html [Accessed 22 August 2018].

Wilson, S (n.d). Dunmall's snake. In. Shy snake is hard to spot. ABC Wide Bay Publication. Available from: <http://www.abc.net.au/local/stories/2009/04/21/2548064.htm> [Accessed 22 August 2018].

6.5 Long-legged worm-skink (*Anomalopus mackayi*)

6.5.1 Status

EPBC Act – Vulnerable

6.5.2 Biology and ecology

6.5.2.1 Characteristic

The Long-legged worm-skink, also called the Five-clawed worm skink (*Anomalopus mackayi*), is a burrowing skink, which is characterised by three fingers and two toes. This species typically grows to 27 cm long. It has smooth scales with an overall greyish-brown upper body, with dark spots in longitudinal rows. Its ventral surface is yellow-green with dark flecking. In the southern region of its range, this species is unpatterned, while in the north, it has longitudinal rows of dark spots on the dorsal and lateral surfaces (DotEE 2018).

6.5.2.2 Known distribution

The known distribution of the Long-legged worm-skink is patchy in north-eastern NSW and south-eastern Queensland (refer Figure 6.9). In south-eastern Queensland, the species' known distribution is on the upper Condamine River floodplain, from Warwick in the south, to the Jimbour region in the north, and bordered by the western edge of the granite belt (Brigalow Belt Reptiles Workshop 2010; DotEE 2018).

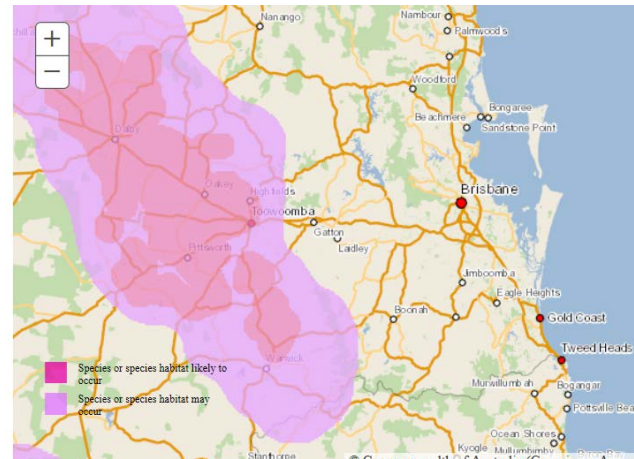


Figure 6.9 Distribution range of the Long-legged worm-skink

Source: ALA (2018), DotEE (2018)

6.5.2.3 Distribution in relation to the Project

This species was not identified during any Project-associated field surveys (Ecological 2016; Aurecon 2018). There are no known records of this species within the Project disturbance footprint however three specimen backed records occurs within the impact assessment area to the north-east of Pittsworth. These records are recent (2002 and 2009) and occur at the Broxburn railway siding where it meets Broxburn Road located within 300 m east of the Project footprint. There are other records in the wider the Pittsworth area to the north-west (1985 and 2009 – 20 km from the Project footprint) and south-east (2008 - 14 km from the Project footprint). Another record exists for this species to the east of the northern section of the alignment near Toowoomba dated 1983 located approximately 4 km from the Project footprint (ALA 2020). There are a number of records within 50 km to the north of the Impact assessment area at Allora and Felton East to the south of the northern section of the Project. To the north of the Project records occur at Bongeen and between Oakey and Bowerville Reserve (refer Figure 6.10).

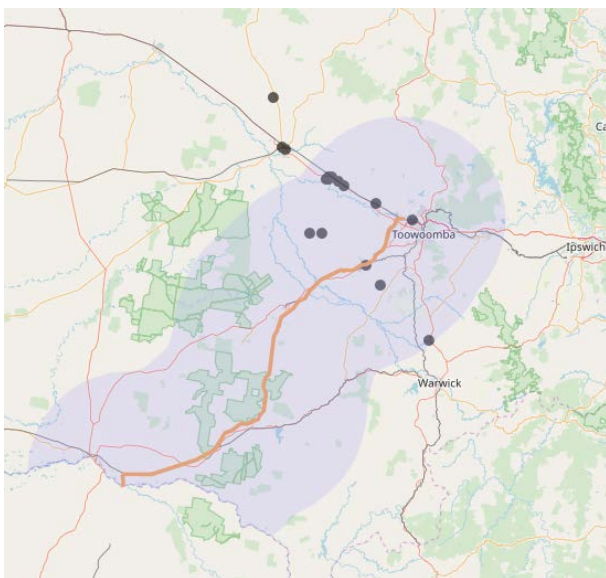


Figure 6.10 Distribution range of the Long-legged worm-skink in relation to the Project

Source: ALA (2020)

6.5.2.4 Biology and reproduction

Very little is known about the Long-legged worm-skink's reproduction and diet. However, it is believed to feed on arthropods, such as white ants and captive specimens have been recorded eating mealworms (DotEE 2018). Long-legged worm-skinks lay up to three eggs per clutch during Spring (DotEE 2018).

6.5.3 Habitat

The Long-legged worm-skink is known to occur in both remnant and non-remnant woodlands and grasslands, and in areas modified by agriculture and other human activities. It is typically found under timber, leaf litter and other debris. It is also known to inhabit rotting tree base cavities, logs and tussock bases. This species has been found sheltering under artificial materials lying flat on the ground, such as discarded railway sleepers, sheet metal and hay bales. On the Darling Downs, the species occurs in Bluegrass (*Dichanthium sericeum*) and/or Mitchell Grass (*Astrebla* spp.) dominated grasslands, or mixed grasslands dominated by other grass species (Brigalow Belt Reptiles Workshop 2010; DotEE 2018).

6.5.4 Threatening processes

The following have been identified as potentially threatening processes to the Long-legged worm-skink:

- Land clearing for agriculture has been particularly severe within the Long-legged worm-skink's range
- Overgrazing compacts soil making it difficult for the species to find suitable shelter
- Removal of logs and timber also reduces soil humidity and the amount of shelter available for the species. Agricultural chemicals may poison and pollute the soil which may adversely affect the species
- Predation by feral species, such as cats and foxes, is another threat facing much of Australia's native wildlife including the Long-legged worm-skink (Brigalow Belt Reptiles Workshop 2010; NSW NPWS 1999).

6.5.5 Threat abatement/recovery plans

No threat abatement/recovery plan exist for this species. The following recovery plans are relevant to this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10055>. In effect under the BC Act 2016.
- Department of Environment, Climate Change and Water NSW (2010). *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland*. Department of Environment, Climate Change and Water NSW, Sydney. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/white-box-yellow-box-blakelys-red-gum-grassy-woodland-and-derived-native-grassland-national>. In effect under the EPBC Act from 22-Mar-2013.

The following threat abatement plan is relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.

6.5.6 Summary of threat abatement/recovery plans

Anomalopus mackayi is assigned as a data-deficient species under the NSW *Saving our Species Program* as there is little known about the ecology and habitat requirements of this species. State wide conservation actions identified for this species include:

- Encourage community education, awareness and involvement
- Encourage landholders to enter voluntary conservation and site management agreements
- Create corridors to reduce isolation of known population sites
- Protect or fence areas to create high quality habitat that sustains a significant population or foraging area
- Develop and test artificial refuge habitat as an interim protection measure

- Monitor the species for movement patterns, habitat range, success of management actions and for new threats at the site, movement pa
- Develop a successful technique to survey
- Identify two targeted populations annually to focus recovery actions on
- Conduct fox baiting

Threats identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Land use and management change
- Agricultural and horticultural development
- Public Infrastructure upgrades in travelling stock routes (TSRs)
- Firewood collection and 'tidying up'
- Changed fire regimes
- Increase in soil nutrients and use of chemicals
- Mowing and slashing regimes
- Revegetation management
- Weed invasion
- Climate change
- Salinity
- Acid soils
- Declining tree health and regeneration
- Increased grazing pressure from invasive herbivores
- Disease – *Phytophthora cinnamomi*
- Collection and removal of native flora.

Recovery actions identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Collect baseline data on the locations, quality and management regimes of remnant sites
- Extent and condition mapping
- Component species surveys
- Protection of existing habitat in priority areas including on private land
- Engagement with the community, particularly where remnants occur on private land to provide information on appropriate management and with Aboriginal communities.

Summary of baseline information actions undertaken to date:

- The establishment of databases comprising of information on CMN members (land managers with Box-Gum Grassy Woodland remnants), remnant locations, composition of flora and fauna species and remnant condition from surveys of CMN members' sites and other sites
- Minimum condition criteria and assessment method developed to assist land managers in identification of listed ecological communities
- Development of regional models using remote sensing
- Mapping of Box-Gum Grassy Woodland extent
- Surveys conducted during research programs through various organisations.

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

6.5.7 References

Atlas of Living Australia (2018). *Anomalopus mackayi*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:bcb3f69-0f90-4b6d-a062-218439a61a51> [Accessed 23 August 2018].

Brigalow Belt Reptiles Workshop (2010). Proceedings from the workshop for the nine listed reptiles of the Brigalow Belt bioregions. 18-19 August. Brisbane: Queensland Herbarium.

Department of the Environment and Energy (2018). *Anomalopus mackayi* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=25934 [Accessed 23 August 2018].

Dolley, C (n.d.). Photograph: Long-legged worm-skink, Department of National Parks, Sport and Racing, (Image) [Online] Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/longlegged_wormskink.html [Accessed 23 August 2018].

6.6 Yakka skink (*Egernia rugosa*)

6.6.1 Status

EPBC Act – Vulnerable

6.6.2 Biology and ecology

6.6.2.1 Characteristic

The Yakka skink (*Egernia rugosa*) is a pale fawn reptile growing up to 40 cm long. It has a broad dark brown to black stripe from nape to tail bordered on either side by a narrow, pale fawn back/side stripe. Dark brown to pale brown to reddish-brown scales on the flanks form a faintly variegated orange-brown pattern (refer Photograph 6.3). The throat is cream-yellow in colour, with blackish flecks/spots, and the chest and abdomen are yellow-orange. Mid-body scales are in rows of 26 to 30 (DotEE 2018; DES 2017).



Photograph 6.3 Yakka skink (*Egernia rugosa*)

Source: Farquhar (2017)

6.6.2.2 Known distribution

The known distribution of the Yakka skink extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. Locations range from the Queensland/NSW border to the Brigalow Belt (North and South), Mulga Lands, Einasleigh Uplands and up to Cape York Peninsula (Brigalow Belt Reptiles Workshop 2010; DotEE 2018) (refer Figure 6.11).

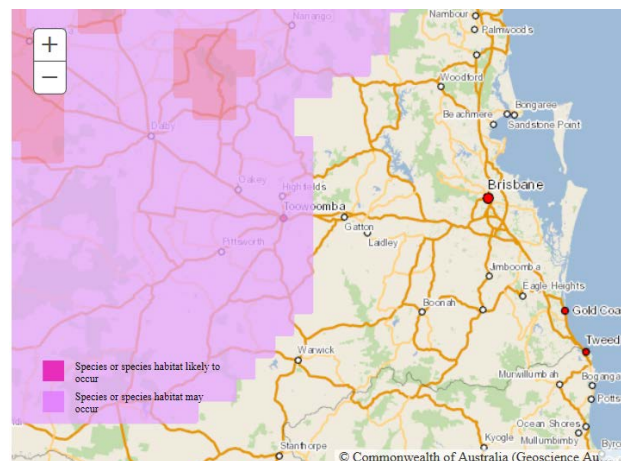


Figure 6.11 Distribution range of the Yakka skink

Source: ALA (2018), DotEE (2018)

6.6.2.3 Distribution in relation to the Project

Database records indicate Yakka skink has not been recorded within 50 km of the Project footprint (ALA 2020). The nearest specimen backed record exists 65 km north-west of the Project footprint (north of Goondiwindi). This record is not dated and has been generalised to protect the exact location of the record. Another record exists from 1994 at the Bunya Mountains National Park located over 70 km north of the Project footprint. This record also has unreliable spatial accuracy. All other occurrence records exist to the north-west of the Project (refer Figure 6.12). There are no records south or east of the Project.

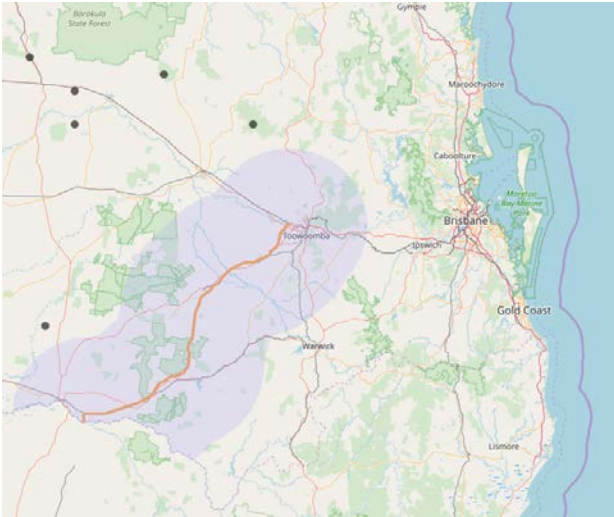


Figure 6.12 Distribution range of the Yakka skink in relation to the Project

Source: ALA (2020)

6.6.2.4 Biology and reproduction

The Yakka skink is omnivorous, consuming soft plant materials and fruits and a wide variety of invertebrates which they ambush from their burrows (TSN 2008).

The Yakka skink produces live young, with around six per litter. They are highly gregarious, with populations occurring primarily as colonies or aggregations. The breeding season for this species has not been recorded (QLD DERM 2010; TSN 2008).

6.6.3 Habitat

The Yakka skink is known to occur in open dry sclerophyll forest, woodland and scrub. It occurs in several different vegetation types within a wide variety of Queensland Regional Ecosystem Land Zones from alluvium (river and creek flats) to sandstone ranges (LZs 3, 4, 5, 7, 8, 9, 10). The Yakka skink is commonly found in vegetation types such as Brigalow, Mulga, Bendee, Lancewood, Belah, Poplar Box, Ironbark and White Cypress Pine (Brigalow Belt Reptiles Workshop 2010; DotEE 2018; QLD DERM 2010).

The Yakka skink is commonly found in cavities under and between partly buried rocks, hollow logs or tree stumps, root cavities and abandoned animal burrows. The species is known to excavate deep burrow systems, sometimes under dense ground vegetation (Brigalow Belt Reptiles Workshop 2010; DotEE 2018, TSN 2008).

6.6.4 Threatening processes

The following have been identified as potentially threatening processes to the Yakka skink:

- Habitat reduction and degradation due to agricultural and urban development
- Inappropriate roadside management
- Feral animal impacts include predation by Red foxes and Feral cats and the ripping of rabbit warrens (DotEE 2018; TSN 2008).

The Yakka skink exhibits high site-fidelity, low fecundity and are long-lived which makes the species susceptible to potential population crashes or local extinctions given large environmental disturbances (Brigalow Belt Reptiles Workshop 2010).

6.6.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

6.6.6 References

- Atlas of Living Australia (2018). *Egernia rugosa*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:b3a63292-e63d-480d-b2ba-6ea3d3924d74> [Accessed 23 August 2018].
- Brigalow Belt Reptiles Workshop (2010). Proceedings from the workshop for the nine listed reptiles of the Brigalow Belt bioregions. 18-19 August. Brisbane: Queensland Herbarium.
- Department of the Environment (2008). Yakka skin *Egernia rugosa* (Image) [Online] Available from: <https://www.environment.gov.au/system/files/resources/d91e2790-b7a9-482c-a4eb-4c02a2e89920/files/tsday08-skink.pdf> [Accessed 23 August 2018].
- Department of the Environment and Science (2017). Yakka skink. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/yakka_skink.html. [Accessed 23 August 2018].
- Farquhar, J. (2017). Yakka skink (*Egernia rugosa*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=737b7989-753b-45dc-b322-98918b9eeec7>. [19 September 2019].
- Queensland Department of Environment and Resource Management (2010). *Wildlife and Ecosystems- Yakka Skink*. Available from: http://www.derm.qld.gov.au/wildlife-ecosystems/wildlife/az_of_animals/yakka_skink.html [Accessed 23 August 2018].
- Threatened Species Network (2008). *Yakka Skink; Egernia rugosa; National Threatened Species Day Information Sheet*. World Wildlife Foundation; Threatened Species Network; Department of the Environment, Water, Heritage and the Arts. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tsday08-skink.html> [Accessed 23 August 2018].

6.7 Bell's turtle (*Wollumbinia belli*)

6.7.1 Status

EPBC Act – Vulnerable

6.7.2 Biology and ecology

6.7.2.1 Characteristic

Wollumbinia belli, Family Chelidae, also known as Bell's turtle, the Namoi River Elseya, Western Sawshelled Turtle or Bell's Saw-shelled Turtle, often has a pale to bright yellow streak/stripe extending from the lower jaw along the lower side of the neck, sometimes continuous with a yellow chin and throat. The head and neck are shorter in length than the shell, unlike the more common Snake-necked Turtle. The species can be very difficult to distinguish from the Saw-shelled turtle (*Wollumbinia latisternum*) (DoE 2008). This turtle weighs up to 3,200 g and have a carapace 300 mm long (Curtis et al 2012).

6.7.2.2 Known distribution

The Bell's turtle is found only in the upper reaches of the Namoi, Gwydir and MacDonald Rivers on the North West Slopes of NSW, with a separate population in south-east Queensland, in Bald Rock Creek near Stanthorpe (DoE 2008) (refer Figure 6.13). The Bell's turtle inhabits narrow sections of rivers in granite country, preferring shallow to deep pools in upper reaches or small tributaries of major rivers (DoE 2008).

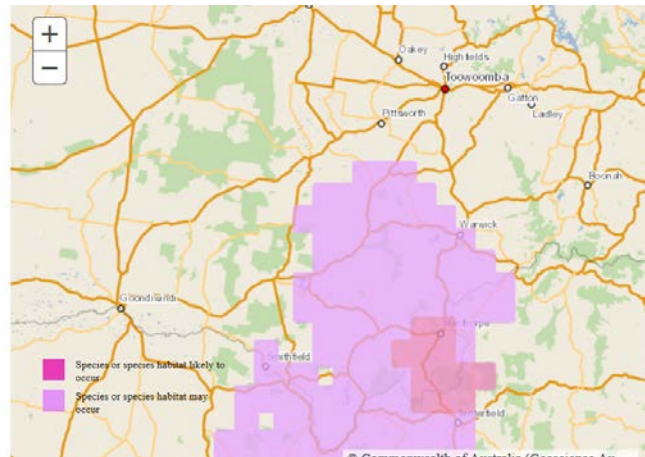
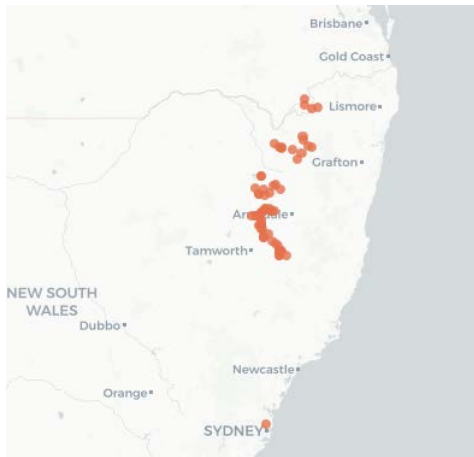


Figure 6.13 Distribution range of the Bell's turtle

Source: ALA (2019)

6.7.2.3 Distribution in relation to the Project

Wollumbinia belli has been predicted to occur within the region and associated habitat within the Impact assessment area. However, there are no current database records (i.e. AoLA, WildNet) for this species within 50 km of the temporary and permanent project footprint. Most records occur to the south west in the New England Tablelands, the closest record is from Girraween National Park (2003).

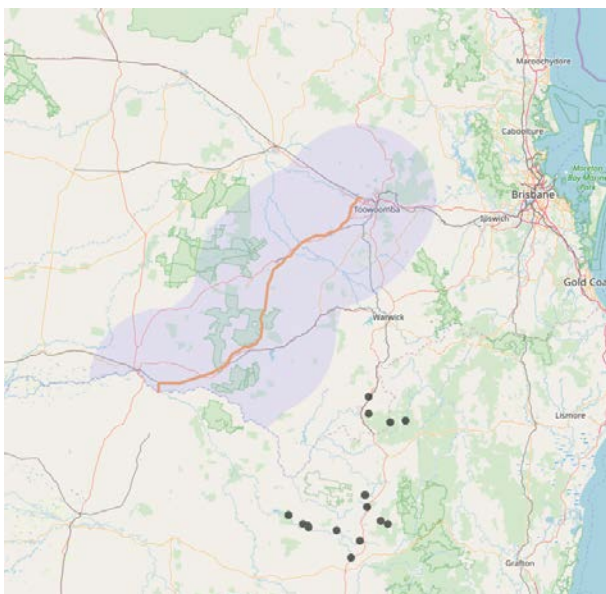


Figure 6.14 Distribution range of the Bell's Turtle in relation to the Project

Source: ALA (2020)

6.7.2.4 Biology and reproduction

Nests are dug out in riverbanks of sand or loam during late September to January. Eggs take 80 days to hatch and are thus vulnerable to nest predation for an extended period. Primarily a vegetarian, eating both aquatic plants and terrestrial leaves that fall into the watercourse. Also takes invertebrates ranging from insects to crayfish, other small animals and carrion.

6.7.3 Habitat

Bell's turtle can be found in shallow to deep pools in upper reaches or small tributaries of major rivers in granite country. Occupied pools are most commonly less than 3 m deep with rocky or sandy bottoms and patches of vegetation. Most typically uses narrow stretches of rivers 30 to 40 m wide. Most surrounding habitat has been converted to grazing land.

6.7.4 Threatening processes

The main identified threats to Bell's turtle are:

- Pollution and sedimentation of river habitat
- Trampling and damage to river banks and riverside vegetation by grazing stock
- Changes to natural stream flows through removal of water for irrigation, and
- Predation of nests by foxes (*Vulpes vulpes*).

In some areas, Bell's turtle also suffers from an eye ailment that can leave up to 50 per cent of an adult population blind, the cause of which is as yet unknown (DoE 2008). The species may also be periodically affected by extensive low rainfall conditions, as well as affects attributed to global climate change (DoE 2008)

6.7.5 Threat abatement/recovery plans

No threat abatement has been identified as being relevant for this species. The following Saving our Species program has been identified for this species: Help save the Western sawshelled turtle, Bell's turtle.

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=548&ReportProfileID=10266>. In effect under the BC Act 2016.

6.7.6 Summary of threat abatement/recovery plan

Threats identified in the Saving our Species plan includes:

- Pollution and sedimentation of river habitat
- Hybridisation and competitive exclusion by the Macquarie turtle, *Emydura macquarii*. In Copeton Reservoir, which will spread further into Bell's turtle habitat
- Water extraction for irrigation causing changes to natural stream flow
- Potentially fatal transfer of disease
- Predation on eggs by foxes, goannas and pigs
- Livestock causing damage to river banks and riversides trampling vegetation whilst grazing
- A yet to be determined disease causing cataracts and blindness, which potentially limits nutrition and reproduction for the species.

Management actions outline in the Saving our Species plan includes:

- Work with property owners to address and mitigate the impacts of water extraction on riffle-run and deep-water habitats for daytime and drought refuge
- Create interest and incentives with land owners to protect turtle habitat by fencing and creating non-riparian water points for stock
- Create feral pig exclusion sites where management implementation would be cost effective encouraging land owners to enter into land management agreements to manage habitat
- Determine the impact of flood on habitat quality, food resources, turtle health, reproduction and survival for the species

- Document current health of Bell's turtle through rapid surveys to detect animals showing disease symptoms following strict hygiene practices
- Determine the cost-effectiveness of using sniffer-dogs to locate turtle nests and protecting nests with mesh to exclude egg predators
- Identify high priority sites that would benefit from restoration and rehabilitation of locally native riverbank vegetation to improve water quality and nesting habitat
- Implement education and signage regarding hygiene protocols to identify sick turtles and prevent the spread of disease
- Encourage safe release of captured turtle by people fishing recreationally and provide information about the vulnerability of the species and hygiene requirements to prevent the transfer of disease
- Conduct research to establish population density and distribution
- Explore the possibility of raising hatchlings for safe release to avoid nest predation.

6.7.7 References

Atlas of Living Australia (2019), *Wollumbinia belli*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:3fb329bb-89d6-4589-b98a-3b1a6a284021> [Accessed 24 July 2019].

Cogger HG (2014) 'Reptiles and amphibians of Australia. 7th edition.' (CSIRO Publishing: Collingwood)

Curtis, L. et al (2012). Queensland's Threatened Animals. CSIRO Publishing.

Department of the Environment (2016). *Wollumbinia belli* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from (accessed 22 July 2019).

Department of the Environment (2008). *Wollumbinia belli* A statement for the purposes of approved conservation advice [Online] Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/86071-conservation-advice.pdf> (Accessed 24/07/2019)

Georges, A. & Thomson, S. (2010) Diversity of Australasian freshwater turtles, with an annotated synonymy and keys to species. *Zootaxa* 2496:28 (as *Myuchelys belli*)

Office of Environment and Heritage (2019) Western Sawshelled Turtle, Bell's Turtle profile. Available online: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10266> (Accessed 24/07/2019)

7 Fauna species – threatened species – mammals

7.1 Brush-tailed rock-wallaby (*Petrogale penicillata*)

7.1.1 Status

EPBC Act – Vulnerable

7.1.2 Biology and ecology

7.1.2.1 Characteristic

The male Brush-tailed rock-wallaby (*Petrogale penicillata*) is typically larger than the female and generally weigh 5.5 to 10.9 kg with females weighing 4.9 to 8.2 kg. Males grow to 529 to 586 mm and females to 510 to 570 mm in head-body length. Individuals are brown above, tending to be rufous on the rump and grey on the shoulders. Typically, the chest and belly are paler, with some individuals possessing a white blaze on the chest. The Brush-tailed rock-wallaby has a white to buff cheek stripe and a black dorsal stripe from the forehead to the back of the head. The exterior of the ears is black, and inside the ears is buff (refer Photograph 7.1). Individuals from the north of the species range tend to be lighter and have a less prominent tail brush (DotEE 2018).



Photograph 7.1 Brush-tailed rock-wallaby

Source: Bryant (2019)

7.1.2.2 Known distribution

Populations of the Brush-tailed rock-wallaby occur throughout the Great Dividing Range from the border with NSW to Nanango, 100 km northwest of Brisbane (refer Figure 7.1). Although there are no recent surveys published from Queensland, this species is considered to be declining and vulnerable, with the population in Lamington National Park now considered to be extinct (Clancy and Close 1997; Eldridge and Close 1992; Maxwell et al. 1996).

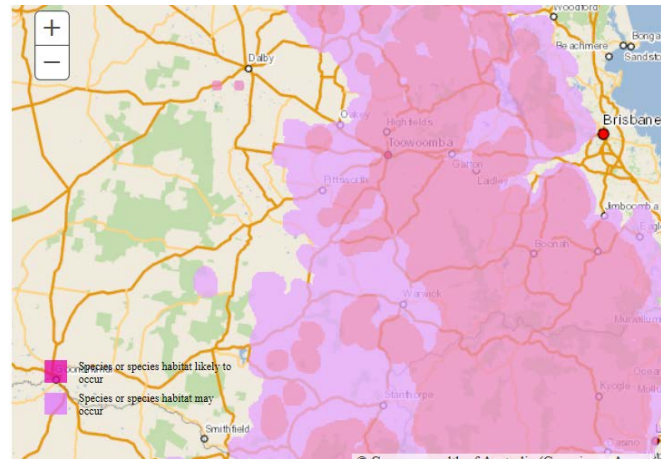
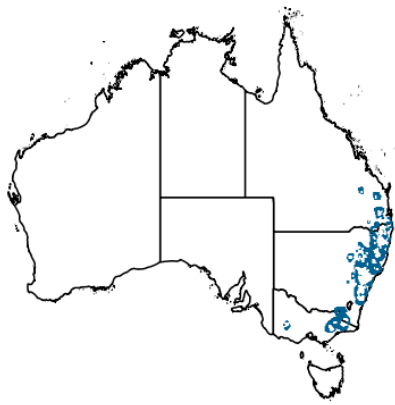


Figure 7.1 Distribution range of the Brush-tailed rock-wallaby

Source: ALA (2018), DotEE (2018)

7.1.2.3 Distribution in relation to the Project

Database records indicate Brush-tailed rock-wallaby has been recently recorded (2018) from within approximately 2 km of the Project footprint at Gowrie Mountain to the east of the northern section of the Project south of the intersection with the Warrego Highway. Other records occur to the east and north-east of the Project in the Toowoomba and Crows Nest areas, although none within 10 km of the Project footprint. Another record from 1992 exists approximately 12 km west of the Project footprint in Bulli State Forest (south-west of Milmerran) (ALA 2020) (refer Figure 7.2).

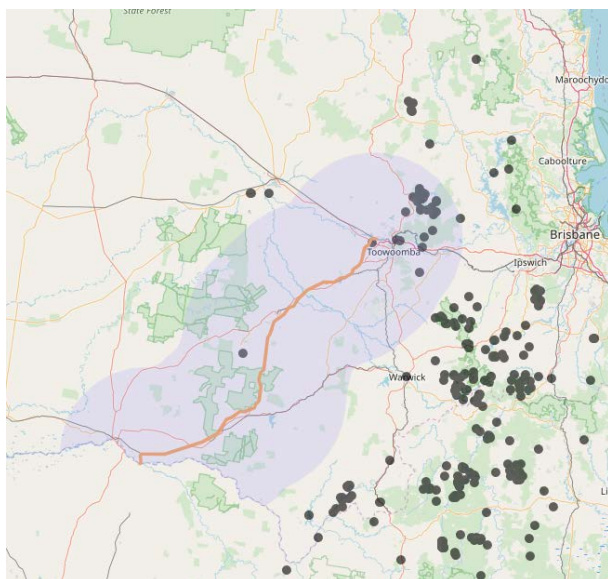


Figure 7.2 Distribution range of the Brush-tailed rock-wallaby in relation to the Project

Source: ALA (2020)

7.1.2.4 Biology and reproduction

The diet of the Brush-tailed rock-wallaby consists primarily of grasses (35 to 50%), forbs (25 to 40%) and "browse" (shrubs, trees and climbers) (12 to 30%) with ferns and sedges constituting a very minor component. Brush-tailed rock-wallabies typically forage at night (DotEE 2018).

Sexual maturation of females occurs at 18 months and males at 20 to 24 months. Brush-tailed rock-wallabies are a polygamous species and a dominant male will be found with up to four females. They appear to live in family groups of two to five adults and usually one or two juveniles and sub-adult individuals but are also known to occur in male-female pairs (DotEE 2018; DES 2018).

Females give birth to one pouch young at a time, after a gestation period of approximately 30 days. The young remain in the pouch for six months. Weaning is believed to occur 86 days after leaving the pouch, when the joey is nine months old (DotEE 2018).

7.1.3 Habitat

The Brush-tailed rock-wallaby prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks. However, it is also known to use tree limbs (DotEE 2018)

Rocky outcrops appear crucial to current habitat selection by rock-wallabies; however, vegetation structure and composition is also considered to be an important factor determining habitat suitability. In many parts of their range, including at the Warrumbungles, Brush-tailed rock-wallabies are closely associated with dense arboreal cover, especially fig trees. The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases may provide some protection from predation. A range of vegetation types are associated with Brush-tailed rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest (DotEE 2018).

Brush-tailed rock-wallabies are known to shelter during the day in rock crevices, caves and overhangs, but have been observed to bask in exposed sunny spots. Within their home range, rock-wallabies habitually use the same refuges, sunning spots, feeding areas and pathways and these are often defended vigorously (DotEE 2018).

Brush-tailed rock-wallabies select foraging locations that tend to be more open and with a greater abundance of short green grasses and forbs than other locations nearby. Foraging Brush-tailed rock-wallabies do not favour areas that are concealed by tussocks or near to the cliffs (DotEE 2018).

7.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Brush-tailed rock-wallaby:

- Habitat modification continues due to rural, residential and tourist developments have led to changes in vegetation structure, extent, species assemblages and species proportions (DEC 2005)
- Other impacts also include changed fire regimes, competition from exotic herbivores, land degradation, altered nutrient status, and even altered behaviour and numbers of other native animals (DEC 2005)
- The invasion of grassy feeding areas by weed species such as Lantana is thought to reduce habitat quality for the species (DotEE 2018)
- Predation from domestic cats, red foxes and wild dogs are known threats to *P. penicillata* (DotEE 2018)
- Brush-tailed rock-wallabies are found in small, fragmented populations which exhibit low migration rates and are highly vulnerable to local catastrophes, predations, inbreeding and the associated loss of genetic variation (DEC 2005)
- Bioclimatic changes resulting in lower rainfall and a decline in rainforest vegetation, may have contributed to the recently contracting distribution of *P. penicillata* throughout its range (DEC 2005).

7.1.5 Threat abatement/recovery plans

The following threat abatement Plan have been identified as being relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016>. In effect under the EPBC Act from 07-Jan-2017.

- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox>. In effect under the EPBC Act from 01-Oct-2008.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for competition and land degradation by unmanaged goats. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-unmanaged-goats>. In effect under the EPBC Act from 01-Oct-2008.

The following Recovery plan has been identified as being relevant to this species:

- Menkhorst, P. & E. Hynes (2010). National Recovery Plan for the Brush-tailed Rock-wallaby *Petrogale penicillata*. Department of Sustainability and Environment, East Melbourne. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/recovery/brush-tailed-rock-wallaby-petrogale-penicillata>. In effect under the EPBC Act from 10-Feb-2012.

7.1.6 Summary of threat abatement/recovery plan

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the Threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Suppress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

Threats identified in the threat abatement plan for competition and land degradation by unmanaged goats relevant this species include:

- Overgrazing by goats and resulting soil erosion
- Introduction of weeds through seeds carried in their dung.

The primary focus of the abatement plan is the control of unmanaged goat populations. The main objectives of controlling unmanaged goats are:

- Prevent unmanaged goats from occupying new areas in Australia and eradicate them from high-conservation value areas
- Promote the maintenance and recovery of native species and ecological communities that are affected by competition and land degradation by unmanaged goats
- Improve knowledge and understanding of unmanaged goat impacts and interactions with other species and other ecological processes
- Improve the effectiveness, target specificity, integration and humaneness of control options for unmanaged goats
- Increase awareness of all stakeholders of the objectives and actions of threat abatement plan, and of the need to control unmanaged goats.

The conservation strategy for National Recovery Plan for the Brush-tailed Rock-wallaby *Petrogale penicillata* identifies the following priority management sites:

- Victoria: Grampians Range - Moora Moora Creek (Grampians National Park)
- Victoria: East Gippsland – Little River Gorge (Snowy River National Park)
- New South Wales: Warrumbungle Range
- New South Wales: Mt Kaputar
- New South Wales: Wollemi National Park and Jenolan Caves
- New South Wales: Nattai National Park
- New South Wales: Shoalhaven
- New South Wales: Macleay Gorges region.

Threats outlined in the conservation strategy for National Recovery Plan for the Brush-tailed Rock-wallaby *Petrogale penicillata* include:

- Historical hunting and persecution for fur and meat
- Habitat degradation and loss
- Predation from native and feral species
- Competition with native and introduced herbivores
- Decline in genetic diversity.

Objectives and actions outlined in the conservation strategy for National Recovery Plan for the Brush-tailed Rock-wallaby *Petrogale penicillata* include:

- Determine threats faced by the species
- Determine current distribution, abundance and population trends
- Establish and maintain a captive population
- Perform translocations to improve the genetic robustness of existing populations
- Investigate key ecological and biological aspects of the species for conservation management
- Increase community awareness and support for the species' conservation.

7.1.7 References

- Atlas of Living Australia (2018), *Petrogale penicillata*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7a7a2817-26e7-44bd-bb34-1dc9c1ed4d38> [Accessed 21 August 2018].
- Bryant, A. (2019). *Petrogale penicillata* – Brush-tailed rock-wallaby. [image] [online] Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7a7a2817-26e7-44bd-bb34-1dc9c1ed4d38#gallery>. [16 September 2019].
- Department of Environment and Conservation (2005). Draft Recovery Plan for the Brush-tailed rock-wallaby, *Petrogale penicillata*. Sydney, NSW: Department of Environment and Conservation.
- Department of the Environment and Energy (2018). *Petrogale penicillata* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=225 [Accessed 21 August 2018].
- Fergus, G (1994). *Brush-tailed rock-wallaby* (Image) [Online] Available from: <http://thewebsiteofeverything.com/animals/mammals/Diprotodontia/Macropodidae/Petrogale/Petrogale-penicillata.html> [Accessed 21 August 2018].
- Jarman, P.J. and Phillips C.M. (1989). Diets in a community of macropod species. In: Grigg, G., P. Jarman and I. Hume, eds. Kangaroos, Wallabies and Rat-kangaroos. 1:143-149. Chipping Norton, NSW: Surrey Beatty and Sons.

7.2 Greater glider (*Petauroides volans*)

7.2.1 Status

EPBC Act – Vulnerable

7.2.2 Biology and ecology

7.2.2.1 Characteristic

The Greater glider (*Petauroides volans*) is the largest species of gliding possum with a head-body length of 350 to 460 mm and a long furry tail measuring 450 to 600 mm. It has large ears fringed with thick fur and a gliding membrane which attaches to the elbows and ankles. Its thick fur is white or cream below but the upperparts can vary from dark grey to dusky brown through to light mottled grey and cream (refer Photograph 7.2). It also has strongly reflective eyeshine in the beam of a spotlight (DotEE 2018; OEH 2018).



Photograph 7.2 Greater glider (*Petauroides volans*)

Source: Bowell (2019)

7.2.2.2 Known distribution

The Greater glider occurs in Eucalypt forests along the ranges and coastal plains of eastern Australia from Central Victoria near Daylesford to the Windsor Tablelands in far northern Queensland (refer Figure 7.3). It has an elevational range from sea level to 1,200 m above sea level (DotEE 2018, OEH 2018; TSSC 2016).

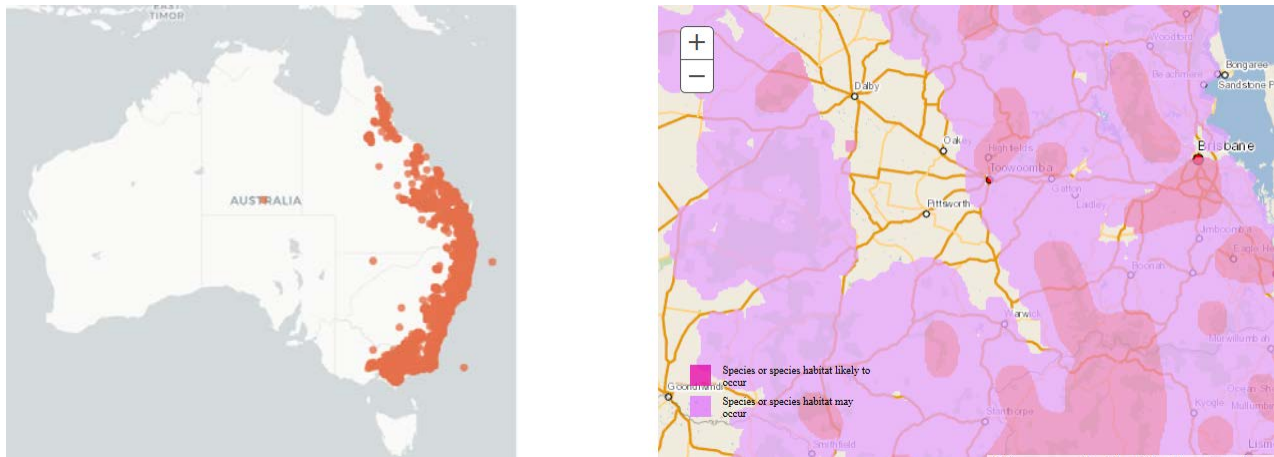


Figure 7.3 Distribution range of the Greater glider

Source: ALA (2018), DotEE (2018)

7.2.2.3 Distribution in relation to the Project

Database records indicate the nearest occurrence of Greater glider (from 1999) is from approximately 17 km south-east of the Project footprint in Yelarbon State Forest (south of Inglewood). A second more recent record (2011) from further south of the same area exists 27 km south-east of the Project from Texas State Forest. A number of records occur within 50 km of the Project footprint to the north of the alignment near Toowoomba and Crows Nest ranging in age from 1974 to 2003 (ALA 2020). The nearest of these are from the Highfield area (2010 and 2016) and are located approximately 10 km north-east of the Project footprint (refer Figure 7.4). The Project is not located near the limit of the species' range.

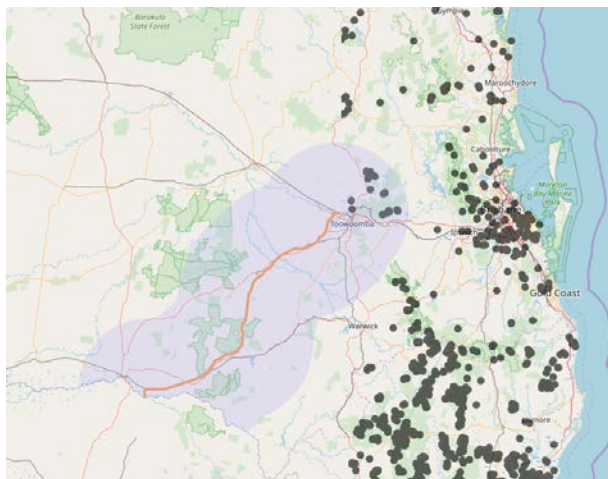


Figure 7.4 Distribution range of the Greater glider in relation to the Project

Source: ALA (2020)

7.2.2.4 Biology and reproduction

The Greater glider is nocturnal and feeds solely on young leaves and flower buds of specific eucalypts. Similarly to koalas, what eucalypt species Greater gliders feed on depends on what species are available to the specific populations in the immediate area. For example, in the Redlands, Queensland, their species of preference are *Eucalyptus tereticornis*, *Eucalyptus pilularis*, *Eucalyptus racemosa*, *Eucalyptus sideroxylon*, *Eucalyptus resinifera*, *Eucalyptus carnea*, *Eucalyptus crebra*, *Eucalyptus major*, *Eucalyptus propinqua*, *Eucalyptus microcorys* and *Corymbia maculata* (Menkhorst and Knight 2011; RCC 2008)

They are usually solitary, though mated pairs and offspring will share a den during the breeding season and until the young are independent. Mating occurs from March to June and the female gives birth to a single young in late autumn or early winter. The young remain in the pouch for approximately 4 months and then rides on the mothers back until the age of 9 months when it is considered independent. Sexual maturity is reached in the second year. Longevity is estimated at 15 years and they have a relatively low reproductive rate (DotEE 2018; OEH 2018; TSSC 2016).

7.2.3 Habitat

The Greater glider is largely restricted to eucalypt forests and woodlands. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows but the distribution may be patchy even in suitable habitat. The greater glider favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species. They tend to prefer more open woodlands with larger spaces between trees so they have room to glide (DotEE 2018).

During the day they shelter in large hollows in large, old trees. In southern Queensland, greater gliders require at least 2 to 4 live den trees for every 2 ha of suitable forest habitat. Home ranges are relatively small (1 to 4 ha), with male home ranges being largely non-overlapping. They are known to be very loyal to their territory (DotEE 2018).

7.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Greater glider:

- Habitat loss and fragmentation from development and clear fell operations are major issues for the Greater glider
- Fires that are too frequent or intense and unsustainable timber production can lead to direct impacts and or loss of habitat
- Changes in vegetation due to climate change, barbed wire fencing and increased predation from native and introduced predators are also threats facing the Greater glider populations (TSSC 2016).

7.2.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species

7.2.6 References

Atlas of Living Australia (2018). *Petauroides volans*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7e891f26-c72e-4b29-98db-1cd10c4eaa6d#overview> [Accessed 24 August 2018].

Bowell, J. (2019). *Petauroides volans* – Greater glider. [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=d277f106-c1fe-4d0d-a625-f0c424190f70>. [16 September 2019].

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Office of Environment and Heritage, NSW (2017). Greater Glider *Petauroides volans* in the Seven Mile Beach National Park area - profile. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20324> [Accessed 24 August 2018].

Redlands City Council (2008). Biodiversity Research Projects: Greater Gliders. Available from: <http://www2.redland.qld.gov.au/EnvironmentWaste/EnvironmentPlans/Documents/Greater%20Gliders.pdf> [Accessed 24 August 2018].

Threatened Species Scientific Committee (2016). Conservation Advice on greater glider (*Petauroides volans*). Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/254-conservation-advice-05052016.pdf> [Accessed 24 August 2018].

7.3 Grey-headed flying-fox (*Pteropus poliocephalus*)

7.3.1 Status

EPBC Act – Vulnerable

7.3.2 Biology and ecology

7.3.2.1 Characteristic

The Grey-headed flying-fox (*Pteropus poliocephalus*) weighs approximately 600 g to 1 kg, and typically measures 23 cm to 28 cm from head to body. The Grey-headed flying fox exhibits a collar of orange/brown around its neck, whilst its head is covered in light grey. The fur on the body is grey, often with flecks of white and ginger (refer Photograph 7.3). The fur on the back exhibits two morphs, which are possibly related to age, moult, or sub-population. Winter fur is typically darker than summer fur, and pronounced moulting is known to occur in June (DotEE 2018).



Photograph 7.3 Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Leo (2010)

7.3.2.2 Known distribution

The Grey-headed flying-fox occurs in the coastal belt of Eastern Australia, typically ranging from Rockhampton in central Queensland to Melbourne in Victoria (refer Figure 7.5). It is noted that only a small portion of this range is used at any one time, as the species selectively forages where resources are available (DotEE 2018).

The availability of food resources has a direct influence on the occurrence and relative abundance within the Grey-headed flying foxes distribution in various seasons and years (DotEE 2019).

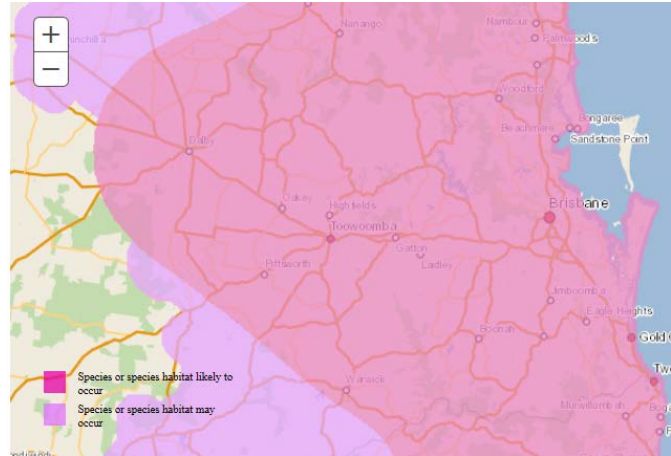


Figure 7.5 Distribution range of the Grey-headed flying-fox

Source: ALA (2018), DotEE (2018)

7.3.2.3 Distribution in relation to the Project

Grey-headed flying-fox (between 200 – 300 individuals present) was observed at a known flying-fox roost site in Inglewood (approximately 3 km south of the Project footprint) during surveys for the Inland Rail Project. Examination of State (DES 2020) flying-fox monitoring data which includes this roost site (data from 2008 – 2019) observes this species as never having been recorded at the site. The site is evidently not a regular roost site for the species. Database records indicate this species does not occur within the impact assessment area however has occurred within 50 km of the Project (ALA 2020). The nearest database record is from 1960 taken from Inglewood. Database searches indicate more recent records to the east of the Project in the Toowoomba area (refer Figure 7.6). The Project footprint is not at the limit of the species range. Several Flying-fox camps have been identified with 20 km of the Project including Goondiwindi, north of Millmerran, Pittsworth and around Toowoomba (DAWE 2020b). Flying-fox monitoring data has only recorded the species occurring at roost sites in the Toowoomba and Oakey areas.

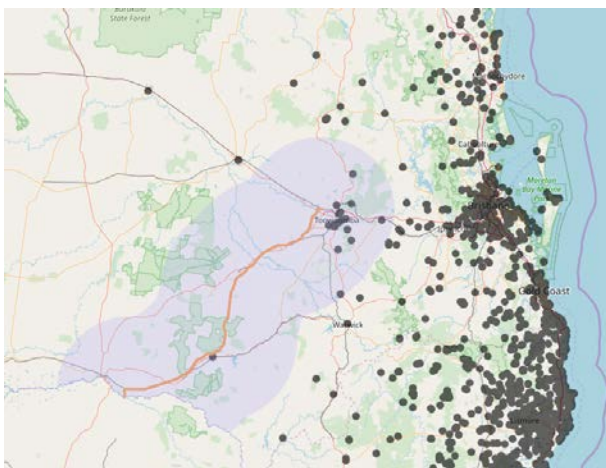


Figure 7.6 Distribution range of the Grey-headed flying-fox in relation to the Project

Source: ALA (2020)

7.3.2.4 Biology and reproduction

Nectar and pollen from *Eucalyptus*, *Corymbia*, *Angophora*, *Melaleuca*, and *Banksia* species are considered the primary food source for Grey-headed flying foxes. This species is known to supplement its diet with a wide range of rainforest fruits and introduced species (Duncan et al. 1999; DotEE 2019).

Mating is known to occur in the early autumn months, after which time the larger camps begin to separate, reforming in late spring/early summer when food resources become more abundant. Males and females typically separate in October, when the young are born. Each year, following six months of gestation, females bear a single young. For one month after giving birth, the mother carries her offspring on her ventral surface to feeding sites. When completely furred, the young are left in maternal camps, and are nursed until they are independent, at approximately 12 weeks of age. Sexual maturity typically occurs at about three years of age (DotEE 2018).

7.3.3 Habitat

The Grey-headed flying-fox is a canopy-feeding species that eats fruit and nectar. This species utilises a range of vegetated habitats, including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. In an urban setting, this species is known to feed on commercial fruit crops, and on introduced tree species (DotEE 2018).

Roost sites are generally located near water bodies. This species is known to roost in vegetation ranging from rainforest, *Melaleuca* stands, mangroves and riparian vegetation. The species has a high level of roost site fidelity, although new sites have been known to be colonised (DotEE 2018).

7.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Grey-headed flying-fox:

- Clearing of native vegetation for agriculture and forestry operations has accelerated the destruction and disturbance of roosting and foraging habitats of the species in eastern Australia (DotEE 2018; Duncan et al. 1999; SEAC 1996; Teagle 2002)
- Lack of foraging resources can also force Grey-headed flying-foxes into commercial fruit crops, increasing conflict with growers and subsequent culling of individuals (DotEE 2018)
- Urban-dwelling Grey-headed flying-foxes can accumulate lethal levels of lead from the environment and are prone to electrocution on powerlines (DotEE 2018)
- Displacement leading to competition and hybridisation with the Black Flying-fox (*P. alecto*) is also a known threat (DotEE 2018).

7.3.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2017). Saving our Species: Help save the Grey-headed Flying-fox. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=785&ReportProfileID=10697>.

7.3.6 Summary of threat abatement/recovery plan

Threats identified in the Saving our Species plan includes:

- Loss of roosting and foraging sites
- Human animal conflict
- Heat stress.

Management actions outline in the Saving our Species plan includes:

- Increase extent and viability of foraging and roosting habitat through habitat creation and restoration
- Liaise with landholders to strike agreements to protect and retain high quality foraging and roosting habitat

- Rehabilitate degraded nesting and foraging habitat managing invasive flora and understorey vegetation to provide suitable microclimate conditions establishing a buffer between bat camps to avoid conflict with people
- Provide education and awareness around the species to foster acceptance and reduce anti-sentiment
- Develop site-based heat stress management strategies recording and sharing data for future heat stress events.

7.3.7 References

Atlas of Living Australia (2018). *Pteropus poliocephalus*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:a2553aed-383a-4c9b-9534-c6058bcee81b#> [Accessed 24 August 2018].

Department of the Environment and Energy (2018). *Pteropus poliocephalus* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from:

http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186 [Accessed 24 August 2018].

Duncan, A., Baker, G.B and Montgomery, N. (1999), *The Action Plan for Australian Bats*. [Online]. Canberra: Environment Australia. Available from:

<http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/index.html>. [Accessed 24 August 2018].

Leo (2010). *Pteropus poliocephalus*. (Image) [Online] Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:a2553aed-383a-4c9b-9534-c6058bcee81b> [Accessed 24 August 2018].

7.4 Koala (*Phascolarctos cinereus*)

7.4.1 Status

EPBC Act – Vulnerable

7.4.2 Biology and ecology

7.4.2.1 Characteristics

The Koala (*Phascolarctos cinereus*) is an arboreal marsupial, with a stocky body, large rounded ears, sharp claws and has grey-coloured fur (refer Photograph 7.4). This species displays sexual dimorphism (males generally are larger than females), with male Koalas weighing approximately 6.5 kg (DotEE 2018).



Photograph 7.4 Koala (*Phascolarctos cinereus*)

Source: Walker (2017)

7.4.2.2 Known distribution

The Koala is distributed along the east coast of Australia extending from Queensland to NSW (refer Figure 7.7). In Queensland, the Koala's distribution extends across several bioregions, encompassing a great diversity of habitats with the greatest concentration on southeast Queensland. In NSW, the species occurs mostly in central and north coasts with populations known to inhabit the area west of the Great Dividing Range (DES 2018; OEH 2018).

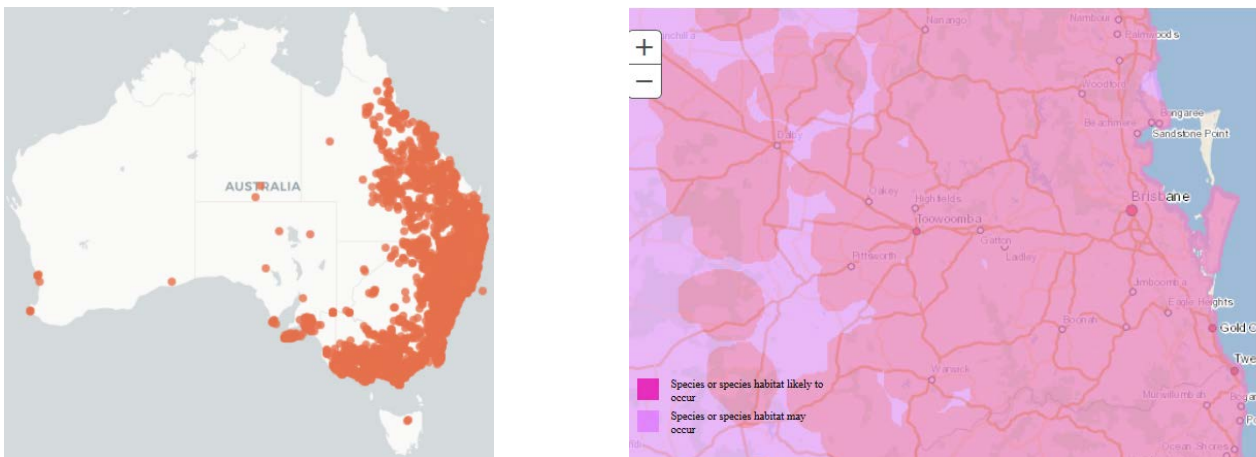


Figure 7.7 Distribution range of Koala

Source: ALA (2018), DotEE (2018)

7.4.2.3 Distribution in relation to the Project

Signs of Koala scat and scratch marks on large Red river gums *Eucalypts camaldulensis* were discovered during Eco Logical Project-associated field surveys where the Project disturbance footprint intersects the Condamine River in 2016. Koala food tree were also records along the proposed disturbance footprint during surveys with primary food tree species including *E. camaldulensis*, *E. tereticornis* and *E. chloroclada* along with other food trees including *E. microcarpa/pilligensis*, *E. populnea* and *E. orgadophila* (Eco logical 2016).

There are numerous database records (i.e. AoLA & Wildlife Online) indicating Koala occurring within the Impact assessment area and surrounds although these are largely concentrated north of Millmerran. Two records occur within the impact assessment area to the north of Yelarbon however one of these is very old (dated 1965) and the other is from 1987. Two recent records (2011) occur within the impact assessment area at Pittsworth and there a number of other nearby records in the surrounding area. A further two records occur within the impact assessment area to the north of Southbrook with one of these occurring in 2018 and the other in 2009. The 2018 record occurs along bushy Lane between Linthorpe Valley Road and the Gore Highway. Records for this species outside of the Project footprint and impact assessment area occur predominantly at the northern section of the alignment at Cecil Plains, Jondaryan, the area surrounding Pittsworth, Oakey, the Great Dividing Range from Crows Nest to West Haldon and the Lockyer Valley. At the southern end of the Project isolated records occur at Millmerran (1987), east towards Durakai State Forest, Bringalily State Forest (2006 and 3 km west of the Project footprint) and Texas State Forest (over 30 km south of the Project) (refer Figure 7.8).

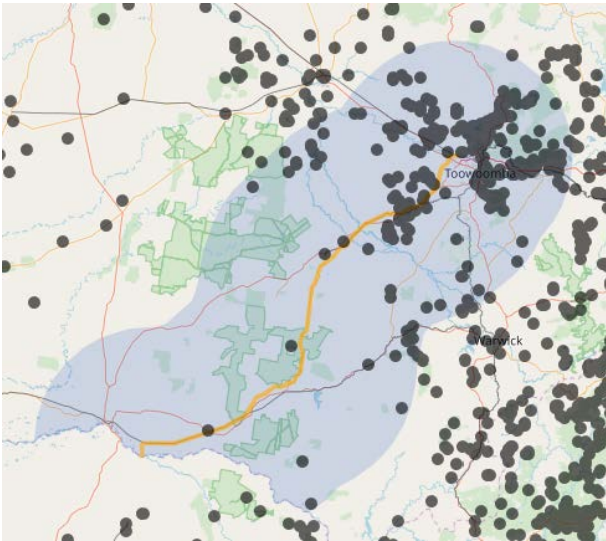


Figure 7.8 Distribution range of Koala in relation to the Project

Source: ALA (2020)

7.4.2.4 Biology and reproduction

The Koala is a leaf-eating specialist feeding primarily during dawn, dusk or during the night. Its diet is restricted mainly to foliage of *Eucalyptus* spp.; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. The Koala may, at times, supplement its diet with other species, including *Leptospermum* spp. and *Melaleuca* spp. (DotEE 2018).

Female Koalas can potentially produce one offspring each year with births occurring between October and May. The newly-born Koala lives in its mother's pouch for six to eight months and, after leaving the pouch, remain dependent on the mother, riding on her back. Young Koalas are independent from about 12 months of age (DotEE 2018).

7.4.3 Habitat

Koala habitat can be broadly defined as any environment containing Koala food tree species (*Eucalyptus* spp., *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp.) or shelter trees. Preferred food and shelter trees are naturally abundant on fertile clayey soils (DotEE 2018).

Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands mostly dominated by *Eucalyptus* species. Koalas are also known to occur in highly modified (e.g. urbanised) or regenerating native vegetation communities (DotEE 2018).

7.4.4 Threatening processes

The following have been identified as potentially threatening processes to the Koala:

- Habitat loss, modification or fragmentation as a result of urbanisation
- Secondary threats such as predation by domestic dogs, vehicle strikes and stress
- *Chlamydia* which reduces the life expectancy of the species (OEH 2018; DES 2018).

7.4.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified for this species. The following management strategy has been identified as being relevant for this species:

- National Koala Conservation and Management Strategy 2009-2014 (Natural Resource Management Ministerial Council (NRMCC), 2009) [Information Sheet].. Available from:
<http://www.environment.gov.au/system/files/resources/165139fc-3ab5-4c96-8b15-d11a1ad882ab/files/koala-strategy.pdf>.

7.4.6 Summary of threat abatement/recovery plan

Threats identified in the conservation and management strategy includes:

- Habitat loss, fragmentation and degradation
- Over-browsing
- Natural disasters
- Disease
- Vehicle collisions
- Predation by dogs
- Climate change.

Management actions outline in the conservation and management strategy includes:

- Identify key habitat with a high priority for protection
- Prioritise populations under immediate pressure
- Revegetate corridors between fragments to facilitate natural dispersal
- Establish a national database mapping habitat, distribution and density
- Establish and support existing surveying and monitoring programs
- Incorporate causes of habitat loss outside of land clearing into planning for habitat conservation
- Identify areas susceptible to severe tree defoliation early and regulate koala density
- Develop a national guideline for road design
- Implement strategies that minimise the impacts of dogs on koala populations
- Assess and develop appropriate methods to reduce vulnerability of populations to disease
- Encourage retention and restoration of koala habitat on private land
- Develop and distribute educational material
- Develop national guidelines that outline appropriate care, handling and management of captive, sick, injured or orphaned koalas
- Identify the direction of research required to address the impacts of climate change on the species.

7.4.7 References

Atlas of Living Australia. (2018). *Phascolarctos cinereus*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:e9d6fbbd-1505-4073-990a-dc66c930dad6> [Accessed 22 August 2018].

Department of Environment and Energy (2018). *Phascolarctos cinereus* (Koala) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=85104 [Accessed 22 August 2018].

Department of Environment and Science (2017). Koala facts. Queensland Government. Available from: <https://www.ehp.qld.gov.au/wildlife/koalas/koala-ecology.html> [Accessed 22 August 2018].

Office of Environment and Heritage (2018). Koala - Profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10616> [Accessed 22 August 2018].

Walker, B. (2017). *Phascolarctos cinereus* - Koala. [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=72044d32-05fc-47ef-96fd-cd5968d0ed03> [16 September 2019].

7.5 Large-eared pied bat (*Chalinolobus dwyeri*)

7.5.1 Status

EPBC Act – Vulnerable

7.5.2 Biology and ecology

7.5.2.1 Characteristic

The Large-eared pied bat (*Chalinolobus dwyeri*) is a medium-sized insectivorous bat measuring approximately 100 mm in length, and weighing 7 to 12 g. This species exhibits a shiny black coat, with a white stripe on the flank (underside) of each wing. The ears are large and the facial lobes are located on the lower lip, between the corner of the mouth and the bottom of the ear (refer Photograph 7.5). Its short, broad wings suggest that this species flies slowly, and with considerable manoeuvrability (DERM 2011; DotEE 2018).



Photograph 7.5 Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Musser (2017)

7.5.2.2 Known distribution

The former and current distribution of the Large-eared pied bat is poorly known. Records for current distribution exist from Shoalwater Bay and inland to Carnarvon in Queensland, through to Ulladulla, in NSW (refer Figure 7.9). It is thought that this species is uncommon and has a patchy distribution (DotEE 2018).

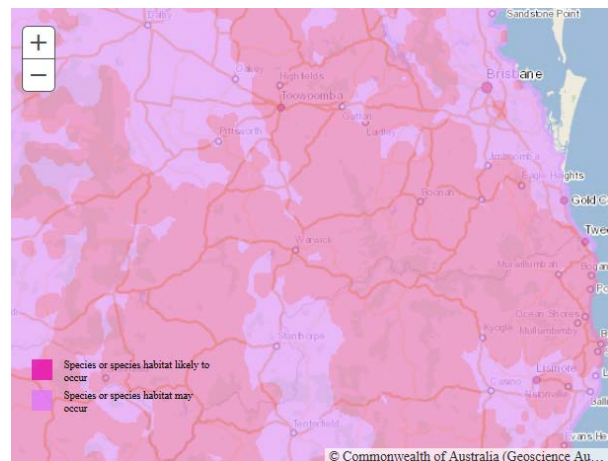


Figure 7.9 Distribution range of the Large-eared pied bat

Source: ALA (2018), DotEE (2018)

7.5.2.3 Distribution in relation to the Project

There are only two database records of Large-eared pied bat within 50 km of the Project footprint (AoLA 2020). One record is from 2011 and located in Toowoomba (approximately 14 south-east km of the Project). Consultation with the source of the record indicates this is erroneous and should be a different species (*Chalinolobus picatus*) (pers. Comm R. Hobson). Another database record (1997) exists 40 km west of the Project footprint from Western Creek State Forest located west of Millmerran. All other records exist well outside a 50 km radius around the Project footprint to the north-west in Carnarvon and Expedition National Parks and to the south-east in Main Range and Lamington National Parks (refer Figure 7.10). The species occurs from the Rockhampton region, inland to the Carnarvon Range, and potentially as far south as the Wollongong area. The Project footprint is not located near the limit of the species range (AoLA 2020).

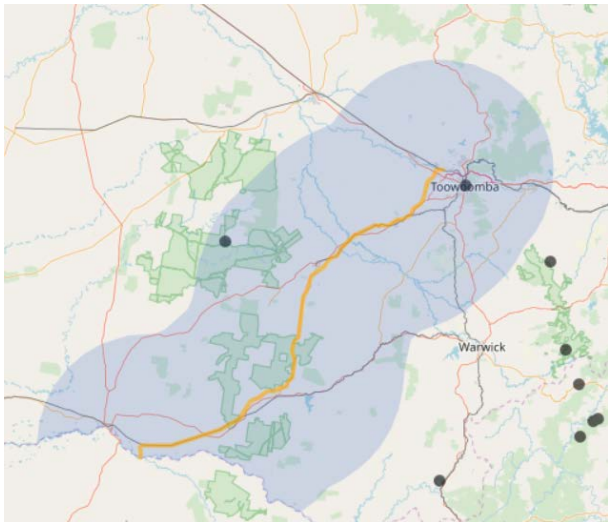


Figure 7.10 Distribution range of the Large-eared pied bat in relation to the Project

Source: ALA (2020)

7.5.2.4 Biology and reproduction

The Large-eared pied bat feeds on insects flying at 6 to 10 m off the ground and along creek lines. It is unknown if it targets particular groups of insects (DotEE 2018; DERM 2011).

Females can give birth at one year of age, and males also appear capable of breeding at this age. Mating appears to occur in early winter. A nursery colony is typically established in September by both adult females and males, with the majority of adult males leaving by the time the young are born in early summer. Females are known to give birth to one or two young per year. By the end of March the juveniles have left the roost. The adult females leave the roost after the juveniles, and the site is abandoned during the winter months. Life expectancy and natural mortality have not been determined (DotEE 2018).

7.5.3 Habitat

Available roosts are unevenly distributed throughout the landscape. Large-eared pied bats require a combination of sandstone cliffs/escarpments to provide roosting habitat that is adjacent to higher fertility sites (particularly box gum woodlands or river/rainforest corridors which are used for foraging) (DotEE 2018).

Large-eared pied bats have been observed in disused mine shafts, caves, overhangs and disused Fairy martin (*Hirundo ariel*) nests for shelter and to raise young. This species possibly also roosts in tree hollows, within dry and wet sclerophyll forest, Cyprus-pine dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland, Brigalow and sandstone outcrop country. In southeast Queensland, the species has primarily been recorded from higher altitude, among moist tall open forest adjacent to rainforest (DotEE 2018).

7.5.4 Threatening processes

The following have been identified as potentially threatening processes to the Large-eared pied bat:

- Disturbance and damage to primary nursery sites by animals (particularly goats) and humans (DotEE 2018; TSSC 2012)
- Populations can be easily displaced as they roost in disused mines which often become active if commodity prices make them economical or they can be filled for safety reasons (DotEE 2018; TSSC 2012).

7.5.5 Threat abatement/recovery plans

The following threat abatement/recovery plans have been identified as relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/Project.aspx?results=c&ProfileID=10157>. In effect under the BC Act 2016.

The following Recovery program is relevant for this species:

- Department of Environment and Resource Management (2011). National recovery plan for the large-eared pied bat *Chalinolobus dwyeri*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-large-eared-pied-bat-chalinolobus-dwyeri>. In effect under the EPBC Act from 10-Feb-2012.

7.5.6 Summary of threat abatement/recovery plan

Chalinolobus dwyeri is assigned as a data-deficient species under the NSW *Saving our Species Program* as there is insufficient information on ecology and distribution for effective management. Vegetation clearing for agricultural purposes is identified as the key threat. The key priority action is to address key knowledge gaps for this species through survey and investigating threat dynamics.

Major threatening processes for this species have not been clearly established, however threats to the *Chalinolobus dwyeri* in the National recovery plan for the large-eared pied bat are:

- Destruction of and interference to subterranean roosts and maternity sites
- Mining of roosts and mine induced subsidence of cliff lines
- Disturbance from human recreational activities such as bushwalking, caving and abseiling
- Habitat disturbance by other animals, including livestock and feral animals such as goats
- Predation by introduced predators such as cats, foxes and possibly rats
- Vegetation clearance in proximity of roosts causing habitat loss and fragmentation and reducing foraging resources
- Fire in proximity to roosts, potentially causing direct mortality from heat stroke and smoke.

Recovery objectives of the plan are:

- Identify priority roosts and maternity sites for protection and map known colonies in NSW and QLD
- Implement conservation and management strategies for priority sites, including foraging habitats
- Install bat gates to protect populations and stabilise site entrances (e.g. old mines)
- Implement fire prescriptions for areas around each identified priority roost or maternity site
- Control introduced species such as goats
- Undertake monitoring to assess the success of management strategies
- Conduct research to improve knowledge on species habitat requirements, roost and maternity sites, diet and foraging strategy and threatening process.

7.5.7 References

Atlas of Living Australia (2018). *Chalinolobus dwyeri*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:cddd224d-40ed-49d9-bb88-dcbfe064a35e#gallery> [Accessed 24 August 2018].

Department of the Environment and Energy (2018). *Chalinolobus dwyeri* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from:

http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=183 [Accessed 24 August 2018].

Musser, A. (2017). Large-eared pied bat (*Chalinolobus dwyeri*). [image] [online] Available from:

<https://images.ala.org.au/image/details?imageId=d05ddeaf-7807-489b-9269-50f79951560d>. [16 September 2019].

Threatened Species Scientific Committee (2012). *Commonwealth Listing Advice on Chalinolobus dwyeri (Large-eared Pied Bat)*. Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/183-listing-advice.pdf>. In effect under the EPBC Act from 29 June 2012.

7.6 New Holland mouse (*Pseudomys novaehollandiae*)

7.6.1 Status

EPBC Act – Vulnerable

7.6.2 Biology and ecology

7.6.2.1 Characteristics

The New Holland mouse (*Pseudomys novaehollandiae*) is a native small, burrowing rodent. The grey-brown mouse has a dusk-brown tail which is darker on the dorsal side with a head to body length of approximately 65 to 90 mm and a tail reaching 105 mm (DotEE 2018; OEH 2017) (refer Photograph 7.6).



Photograph 7.6 New Holland mouse (*Pseudomys novaehollandiae*)

Source: ALA (2018)

7.6.2.2 Known distribution

The known distribution of the New Holland mouse is fragmented along the east coast of Australian from Queensland through to Tasmania (refer Figure 7.11). The exact whereabouts of the New Holland mouse in Queensland, NSW, Victoria and Tasmania is still unknown however with further research currently being undertaken (DotEE 2018).

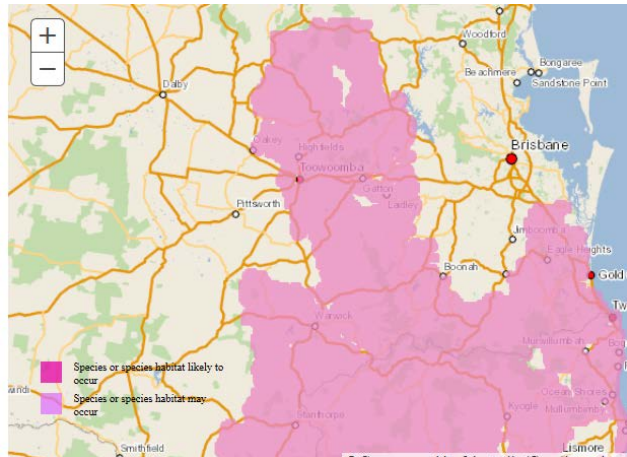


Figure 7.11 Distribution range of New Holland mouse

Source: ALA (2018), DotEE (2018)

7.6.2.3 Distribution in relation to the Project

Pseudomys novaehollandiae has been predicted to occur within the region and associated habitat within the impact assessment area. Database records (i.e. AoLA, WildNet) indicate this species has been recorded between 1982-2001 at Toowoomba Range to the north-east of the Project footprint from within approximately 30-40 km. No other records exist from within 50 km of the Project. There is a record from 1997 at Main Range National Park located approximately 65 km from the Project footprint. Other records for this species outside of a 50 km buffer occur to the south-east of the Project.

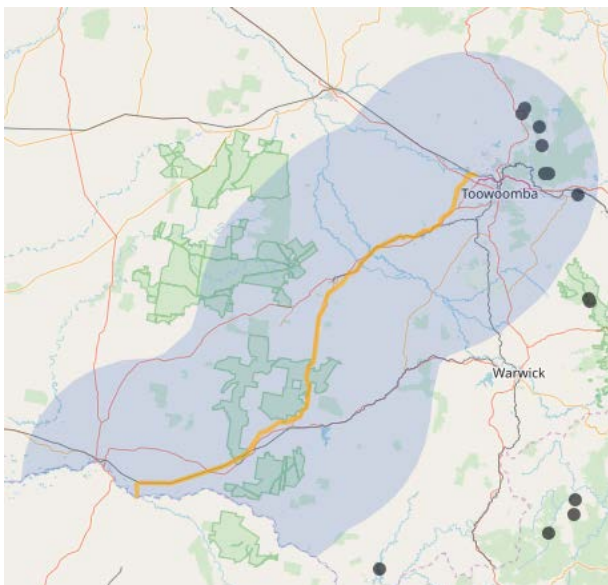


Figure 7.12 Distribution range of New Holland mouse

Source: ALA (2020)

7.6.2.4 Biology and reproduction

The New Holland mouse is a nocturnal and omnivorous species feeding on seeds, insects, leaves, flowers as well as fungi. This social species lives in shared burrows, spending considerable time foraging above ground for food (DotEE 2018).

The known breeding period for the species occurs between August and January but can extend to autumn with slight variation between years producing litters ranging from 2 to 6. Female New Holland mouse are capable of producing two litters in a breeding season, with first year females produce one litter per season, and reach sexual maturity after 13 weeks than males, who take 20 weeks, with a generation length assumed to be 1.5 years. Reproduction however is strongly dependent on rainfall, resource availability, adult survival and recruitment (Woinarski and Burbidge 2016; DotEE 2018).

7.6.3 Habitat

The New Holland mouse is known to inhabit open heathlands, woodlands and forests with heathland understorey as well as vegetated sand dunes with peak abundance though to be early to mid-stages of vegetation succession typically induced by fire. However, in areas such as Tasmania and Victoria the species has been found living amongst landscapes not burnt for 16 to 30 years post fire in dunes vegetated by *Banksia allocasuarina* woodland with understorey dominated by sedges and low shrubs. The mouse also has a large home range between 0.44 to 1.4 ha (DotEE 2018; OEH 2017; Woinarski and Burbidge 2016).

7.6.4 Threatening processes

The following have been identified as potentially threatening processes to the New Holland mouse:

- Inappropriate fire regimes, as the species heavily depends on early to mid-stages of vegetation recovery post fire
- Predation by feral and domestic cats
- Fragmentation caused by clearing and reduced rainfall activity (Woinarski and Burbidge 2016).

7.6.5 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this species. The following threat abatement plans are relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment and Energy (2018). Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*. Canberra: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/threat-abatement-plan-disease-natural-ecosystems-caused-phytophthora-cinnamomi-2018>. In effect under the EPBC Act from 22-Feb-2019.

7.6.6 Summary of threat abatement/recovery plans

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

The consequences of potential infection outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Inability of infected plants to develop new shoots, flowers, fruit and seed
- Complete loss of some flora populations
- Dramatic alteration to the structure and composition of native plant communities
- A severe reduction in primary productivity and functionality
- Irreversible habitat loss and degradation of dependent flora and fauna
- Loss of shelter and nesting sites and food sources resulting in major declines of fauna.

Objectives and actions outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Identifying and prioritising the protection of biodiversity assets that are, or may be, impacted by Phytophthora including listed threatened species, ecological communities and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act occur
- Reduce the spread and mitigate the impacts of Phytophthora to protect priority biodiversity assets and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act
- Inform the community through education on the impacts that Phytophthora has on biodiversity and actions to mitigate these impacts
- Encourage research on Phytophthora species and option to manage infestations and protect biodiversity assets.

7.6.7 References

Atlas of Living Australia (2018). *Pseudomys novaehollandiae*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:47a50ee8-7678-4d8e-8f8a-e11d12a46ec5> [Accessed 22 August 2018].

Department of Environment and Energy (2018). *Pseudomys novaehollandiae* (New Holland Mouse, Pookilain) Species Profile and Threats Database. Australian Government. Available from:

http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=96 [Accessed 22 August 2018].

Office of Environment and Heritage (2017). New Holland Mouse - Profile. New South Wales Government.

Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20253> [Accessed 22 August 2018].

Woinarski, J. and Burbidge, A.A. (2016). *Pseudomys novaehollandiae*. The IUCN Red List of Threatened Species 2016. Available from: <http://www.iucnredlist.org/details/18552/0>. [Accessed 26 August 2018].

7.7 Northern quoll (*Dasyurus hallucatus*)

7.7.1 Status

EPBC Act – Endangered

7.7.2 Biology and ecology

7.7.2.1 Characteristic

Male Northern quolls (*Dasyurus hallucatus*) have a head-body length of 270 to 370 mm, weighing between 340 to 1,120 g. Females are smaller with a head-body length of 250 to 310 mm, and weighing between 240 to 690 g. Northern quolls have reddish brown fur with white spots on their back and a cream underside. It has a long, sparsely-furred, unspotted tail (refer Photograph 7.7). Their tail length ranges between 202 and 345 mm and their hindfeet have striated pads and five toes (Oakwood 2008).



Photograph 7.7 Northern quoll (*Dasyurus hallucatus*)

7.7.2.2 Known distribution

Historically common across northern Australia, occurring almost continuously from the Pilbara, Western Australia, to near Brisbane, Queensland, the Northern quoll now occurs in five regional populations across Queensland, the Northern Territory and Western Australia (refer Figure 7.13). Known Queensland populations occur as far south as Gracemere and Mt Morgan, to Weipa in the north and west into central Queensland near Carnarvon Range National Park. The species is highly fragmented with severe reductions from the species' former distribution. There are occasionally records as far south as Maleny on the sunshine coast hinterland and the species and or species habitat is likely to extend as far south as Millmerran (DotEE 2018; DES 2018; McGoldrick 2013; Woinarski et al. 2008).

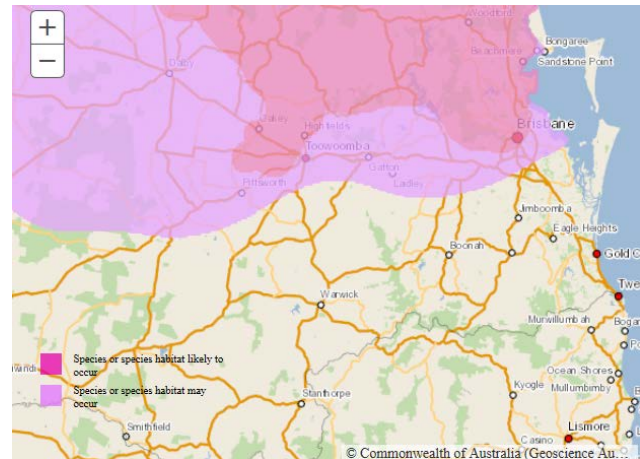


Figure 7.13 Distribution range of the Northern quoll

Source: ALA (2018), DotEE (2018)

7.7.2.3 Distribution in relation to the Project

Dasyurus hallucatus has been predicted to occur within the region and associated habitat within the impact assessment area. Database records (i.e. AoLA, WildNet) indicate this species occurs from within approximately 40 km from the Project footprint at Toowoomba Range to the north-east of the Project with records dated 1969-1966. A more recent record from 1985 was recorded from within approximately 45 km of the Project footprint to the east of Clifton.

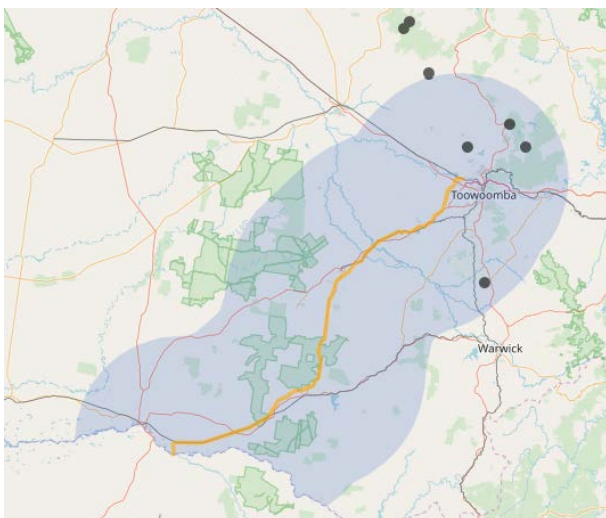


Figure 7.14 Distribution range of the Northern quoll in relation to the Project

Source: ALA (2020)

7.7.2.4 Biology and reproduction

Northern quolls are nocturnal predators of invertebrates such as beetles, grasshoppers, spiders, scorpions and centipedes, but they also eat small mammals, reptiles, amphibians, birds, carrion, nectar and fruit (DotEE 2018).

Northern quolls become sexually mature at one year of age. Around June to August, during the mating season, persistent fighting means males do not survive to breed a second year whilst females may live for two or three years. As a result, the Northern quoll population is comprised almost entirely of mature females and their young by the end of the breeding season. Females can raise a litter of up to eight young in tree hollows, hollow logs and rock crevices (DotEE 2018).

7.7.3 Habitat

The Northern quoll can be found in various habitats across its range including rocky areas, eucalypt forest and woodlands, sandy lowlands and beaches, rainforests, shrubland, grasslands and desert. They tend to require a habitat with some form of rocky area for denning purposes and surrounding vegetation used for foraging and dispersal. They are also known to inhabit areas around human dwellings and campgrounds (TSSC 2005).

7.7.4 Threatening processes

The following have been identified as potentially threatening processes to the Northern quoll:

- Lethal toxic ingestion caused by Cane toads (DotEE 2018)
- The removal, degradation and fragmentation of Northern quoll habitat - transport infrastructure, mining, offshore petroleum or gas processing facilities or agricultural activities such as land clearing, pasture improvement or grazing (DotEE 2018)
- The decline in shelter availability and habitat heterogeneity by fire (DotEE 2018)
- The invasion of northern Australia by Gamba grass (*Andropogon gayanus*) and other introduced grasses and increased fuel loads (DotEE; TSSC 2009)
- Predation by Feral cats (*Felis catus*) and European red foxes (*Vulpes vulpes*) and competition for food (DEWHA 2008; DotEE 2018).

7.7.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Hill, B.M. & S.J. Ward (2010). National Recovery Plan For the Northern Quoll *Dasyurus hallucatus*. Department of Natural Resources, Environment, The Arts and Sport, Darwin. Available from: <http://www.environment.gov.au/resource/national-recovery-plan-northern-quoll-dasyurus-hallucatus>. In effect under the EPBC Act from 16-Dec-2010.

The following threat abatement plans are relevant for this species:

- Department of Sustainability, Environment, Water, Population and Communities (2011). Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/resource/threat-abatement-plan-biological-effects-including-lethal-toxic-ingestion-caused-cane-toads>. In effect under the EPBC Act from 06-Jul-2011.
- Department of Sustainability, Environment, Water, Population and Communities (2012). Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses. Department of Sustainability, Environment, Water, Population and Communities. Available from: <http://www.environment.gov.au/resource/threat-abatement-plan-reduce-impacts-northern-australias-biodiversity-five-listed-grasses>. In effect under the EPBC Act from 11-Dec-2012.
- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.

7.7.6 Summary of threat abatement/recovery plan

Cane toads are identified as the main threat to the Northern quoll in the National Recovery Plan. Other threats identified include:

- Feral predators through direct predation and competition for food
- Inappropriate fire regimes

- Habitat degradation and destruction
- Weeds, particularly exotic pasture grasses
- Increased risk of disease due to isolation of populations
- Illegal hunting by humans
- Population isolation

Recovery actions outlined in the National Recovery Plan include:

- Protect populations on offshore islands from invasion and establishment of invasive pests including cane toads and cats
- Support the recovery of sub-populations that have survived cane toad establishment
- Maintain secure populations and source animals for potential reintroductions/introductions, including maintaining captive breeding populations
- Reduce risk of disease by improving knowledge of and monitoring for disease
- Improve public awareness of the species and the need for biosecurity control

The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads include:

- Predation by cane toads
- Larval competition with frog tadpoles or mosquitoes
- Parasite transfer
- Competition for terrestrial food
- Competition for shelter sites.

Threat abatement actions for cane toads (*Rhinella marina*) include:

- \$11 million in funding from the Australian Government provided for the development of a broad-scale control method
- \$9 million in funding from the Australian Government for research and management activities
- Identification of native species, ecological communities and off-shore islands that are known to have a high to moderate risk
- Identify the impacts that toads have on listed native species and ecological communities
- Where the impact is expected to be high on native species and ecological communities establish support research techniques in aiding the recovery of priority native species and ecological communities
- Develop a prioritisation tool to aid in the direction of resources for the protection of native species and ecological communities.

Threats identified in threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses includes:

- These highly invasive grasses can increase fuel loads
- Alter nitrogen cycling and water availability
- Degrade ecosystems through loss of habitat and biodiversity declines.

Management actions outlined in the threat abatement plan include:

- Determine the extent and spread pathways of infestation by the five listed grasses outlined in the plan
- Support and facilitate coordination management strategies through the design of tools, systems and guidelines
- Identify and prioritise key asset and areas for the implementation of management strategies

- Implement on the ground management strategies that are cost effective in high priority areas
- Monitor, evaluate and report back on the effectiveness of management programs.

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

7.7.7 References

Atlas of Living Australia (2018). *Dasyurus hallucatus*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:c4be3b87-b482-4b23-8086-a6634882fce1#overview> [Accessed 21 August 2018].

Department of Environment and Science (2018). *Queensland's quolls*. Available from: https://www.ehp.qld.gov.au/wildlife/threatened-species/endangered/endangered-animals/queenslands_quolls.html [Accessed 21 August 2018].

Threatened Species Scientific Committee (2005). *NON-APPROVED Conservation Advice on Northern Quoll (Dasyurus hallucatus)*. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/dasyurus-hallucatus.html#conservation>. [Accessed 21 August 2018]

Threatened Species Scientific Committee (2009). *Commonwealth listing advice on invasion of northern Australian by gamba grass and other introduced grasses*. Available from: www.environment.gov.au/biodiversity/threatened/ktp/pubs/northern-australia-introduced-grasses.pdf [Accessed 21 August 2018].

7.8 South-eastern long-eared bat (*Nyctophilus corbeni*)

7.8.1 Status

EPBC Act – Vulnerable

7.8.2 Biology and ecology

7.8.2.1 Characteristics

The Southeastern long-eared bat (*Nyctophilus corbeni*) is a relatively large microchiropteran bat species with a head and body length approximating 50 to 75 mm in length and tail length approximately 35 to 50 mm. The bat has long ears and a shallow muzzle ridge groove with dark-grey brown fur and slightly lighter tips (refer Photograph 7.8). The weight varies between genders with females weighing 14 to 21 g and being heavier than males who weigh 11 to 15 g. The body of the bat is covered with light brown fur (DES 2018; DotEE 2018).



Photograph 7.8 South-eastern long-eared bat (*Nyctophilus corbeni*)

Source: Zell (2019)

7.8.2.2 Known distribution

The South-eastern long-eared bat has a limited distribution restricted to the Murray-Darling Basin in south-eastern Australia (DotEE 2018) (refer Figure 7.15).

In Queensland, the majority of records for this species are from the Brigalow Belt South Bioregion, with the most easterly record from the Bunya Mountains National Park. The most northerly records are from the Expedition Range and Dawson River areas with the most westerly records from west of Bollon in the Mulga Lands Bioregion. In NSW, the species is often found in north-eastern NSW (DES 2017; DotEE 2018; OEH 2017; Schulz and Lumdsen 2010).

7.8.2.3 Distribution in relation to the Project

Microbat echolocation calls of the Genus *Nyctophilus* were recorded during the Project surveys in the south of the alignment including from the Canning Creek area (Eco logical 2016) and near Whetstone State Forest (Aurecon 2018). Three *Nyctophilus* species have potential to occur in the area and cannot be reliably distinguished from each other by call. South-eastern long-eared bat is well known to occur in the State Forests in the Inglewood area. As such, this assessment has taken a conservative approach and assumed the species as present and detected during Project surveys.

There are a number of database records in the region to the west and south of the central and southern sections of the Project. The nearest record occurs less than 3 km to the west of the Project at Millmerran however this is a very old record from 1927. Several records occur to the west of the Project footprint within Bringalily State Forest, Whetstone State Forest, Bulli State Forest and Wondul Range National Park. The nearest of these are two 2006 records occurring approximately 3 km west of the Project. The remaining records are located between 10 km and 20 km west with dates ranging from 1996 to 2006. Four records from 1999 occur within Yelarbon State Forest approximately 15.5 km south of the southern section of the Project (refer Figure 6.16 in Appendix B). The only other records within a 50 km radius of the Project occur south of the Queensland / New South Wales border at Dhinna Dhinawan National Park. Database records for this species are largely confined to remnant vegetation in State Forests and National Parks.

7.8.2.4 Biology and reproduction

The bat species feeds on insects which they hunt in the, from foliage and on the ground eating beetles, bugs, moths, grasshoppers and crickets (DES 2018).

There is little information currently available on this species reproductive biology, although it is thought that mating takes place during autumn and winter. Females are thought to store sperm until spring, when fertilisation and gestation occurs. Up to two young are born during late spring/early summer with young not fully weaned until mid-summer (OEH 2017; Curtis et al. 2012).

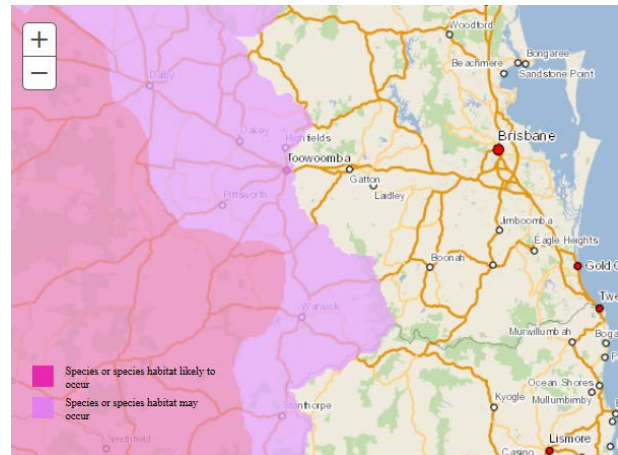
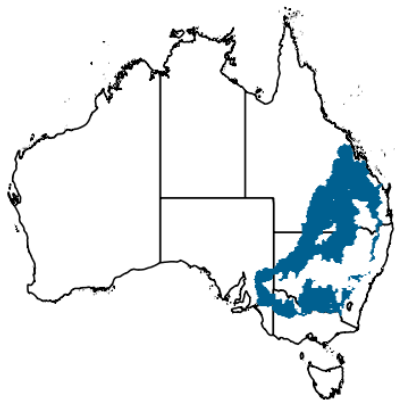


Figure 7.15 Distribution range of the Southeastern long-eared bat

Source: ALA (2018), DotEE (2018)

Nyctophilus corbeni has been identified as potentially occurring within the impact assessment area. Database records (i.e. AoLA, WildNet) that this species is known to occur from within approximately 5 km from the Project footprint with a record dated from 1927 at Millmerran. More recent records (1996-2006) at the southern end of the Project footprint at Yelarbon State Forest to the south and in Whetstone, Bringalily and Bulli State Forests to the north.

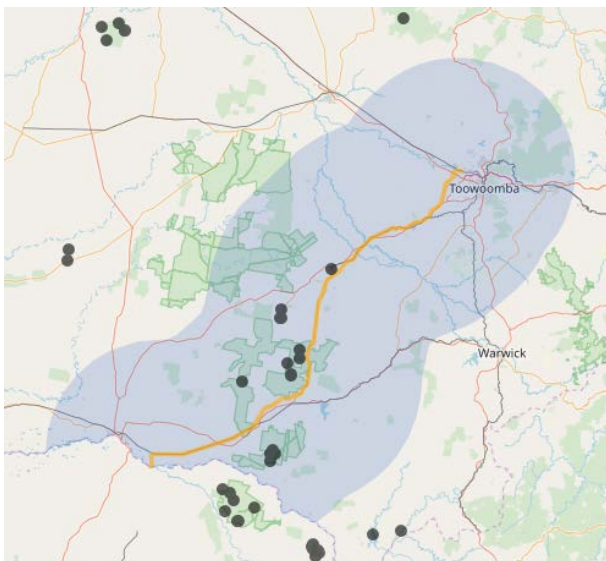


Figure 7.16 Distribution range of the Southeastern long-eared bat in relation to the Project

Source: ALA (2020)

7.8.3 Habitat

This species is known to inhabit a range of inland woodland vegetation types including; box, ironbark, cypress pine, mallee, bull-oak, brigalow and belah woodlands/forests. The species will roost in tree hollows, crevices and under loose bark within these communities (OEH 2017).

Essential habitat for the species is generally associated with large tracts of vegetation (100s to 1,000s of ha), including; open forest with open to dense understorey Semi Evergreen Vine Thicket/Brigalow/Belah communities and mixed Eucalyptus/Corymbia/Angophora communities. The species is known to fly large distances (>7 km in a night) from roosts to foraging areas (DES 2018; DotEE 2018).

7.8.4 Threatening processes

The following have been identified as potentially threatening processes to the Southeastern long-eared bat:

- Habitat loss and/or fragmentation
- Destruction of roosting sites and foraging habitat through fire
- Overgrazing and forestry activity
- Predation by feral species and competition for tree hollows
- Exposure to agrichemicals (DES 2018).

7.8.5 Threat abatement/recovery plans

No threat abatement has been identified as being relevant for this species. The following Saving our Species plan has been identified as being relevant to this species:

- Saving our Species: Help save the Corben's long-eared bat *Nyctophilus corbeni*. Available from: <https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=718&ReportProfileID=10568>. Saving our Species delivers on the NSW Government's legislative requirements under the Biodiversity Conservation Act 2016.

7.8.6 Summary of threat abatement/recovery plans

Threats identified in the Saving our Species plan for the Corben's long-eared bat include:

- Loss of remnant semi-arid woodland and mallee habitat
- Use of pesticides in or adjacent to foraging areas for the species
- Inappropriate fire regimes
- Disturbance to winter roosting sites
- Loss of modification of habitat.

Recovery objectives of the plan include:

- Encouraging land managers to enter into agreements that protect and restore key areas for the species
- Provide awareness to landholders regarding the importance of retaining large live and standing dead hollow-bearing trees within the landscape as important habitat for the species
- Raise awareness regarding the impacts of herbicide, pesticide and other chemical use within close proximity to maternity or roosting sites and discourage their use
- Identify and ensure relevant stakeholders are aware of roosting and overwintering site locations before hazard reduction burns
- Ensure a 100 m buffer is established around sites considered a biodiversity asset for the species
- Fires planned near maternity or roosting sites should be implemented outside of breeding season or during winter when bats are in residence
- Hazard reduction burns should not be implemented within known associated vegetation communities more than once every 20-50 years
- If burns are to occur within key habitat areas relevant managing bodies should ensure that prescribed burns are cool burns that will not kill hollow bearing trees or remove smaller hollow bearing trees
- Modify existing and future use of lighting and noise outputs at sensitive sites that are key for feeding and roosting for the species
- Raise awareness around the damage caused to habitat by thinning, slashing, underscrubbing and inappropriate grazing along with firewood collection

- Encourage land managers to maintain tree density, floristically and structurally diverse and variable mid and understorey across the landscape.

7.8.7 References

Atlas of Living Australia (2018) *Nyctophilus corbeni*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:8a111847-ee8b-4739-935f-248d37eb63ae> [Accessed 22 August 2018].

Department of Environment and Energy (2018). *Nyctophilus corbeni* (Corben's Long-eared Bat) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83395 [Accessed 22 August 2018].

Department of Environment and Science (2017). Eastern long-eared bat. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/micro-bats/eastern_longeared_bat.html [Accessed 22 August 2018].

Office of Environment and Heritage (2017). Corben's Long-eared Bat - Profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10568> [Accessed 22 August 2018].

Schulz, M. and Lumsden, L. (2010). (Draft) National Recovery Plan for the Southeastern long-eared bat *Nyctophilus corbeni*, Victorian Department of Sustainability and Environment

Zell, M. (2019). Southeastern long-eared bat (*Nyctophilus corbeni*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageld=2c438bfa-583a-4585-846c-135199ce39d6>. [19 September 2019].

7.9 Spotted-tail quoll (southeastern mainland population) (*Dasyurus maculatus maculatus*)

7.9.1 Status

EPBC Act – Endangered

7.9.2 Biology and ecology

7.9.2.1 Characteristic

Male Spotted-tail quolls (southeastern mainland population) (*Dasyurus maculatus maculatus*) have a head-body length of 380 to 759 mm, and females are 350 to 450 mm. Male tail lengths are between 370 to 550 mm and 340 to 420 mm for females. The average male Spotted-tail quoll weighs between 2.8 to 4.6 kg, whilst females average a weight of 1.5 to 2 kg. The fur on its back ranges in colour from rich red-brown to dark brown with white spots (refer Photograph 7.9). The Spotted-tail quoll is distinguished from other quolls by the spots running along the length of its tail. The fur on the underside is cream or white. They also have short, round ears which extend just above the outline of the head. Female Spotted-tail quolls have a poorly developed pouch (Belcher 2003; DotEE 2018; Green and Scarborough 1990; Jones 1997; Körtner et al. 2004; Queensland Museum 2015).



Photograph 7.9 Spotted-tail quoll (*Dasyurus maculatus maculatus*)

Source: Bennett (2012)

7.9.2.2 Known distribution

The Spotted-tail quoll (southern subspecies) was previously widely distributed from southeast Queensland, eastern NSW, Victoria, southeast South Australia and Tasmania (refer Figure 7.17), however, it is estimated that the range has reduced by 50 to 90%. Detailed distribution records and abundance estimates are lacking, due to the scale and intensity of survey effort that is required to detect the species across its entire range (DotEE 2018).

In Queensland, the Spotted-tail quoll occurs in the southeast, coastally from Bundaberg to the NSW border, and inland to Monto and Stanthorpe. Spotted-tail quolls are known from five broad geographic: four from coastal ranges and the Great Dividing Range from the NSW border to Gladstone. The fifth is centered on the eastern Darling Downs-Inglewood Sandstone provinces of the Brigalow Belt South Bioregion. Unconfirmed reports suggest the subspecies may occur in the Clarke and Conway Range areas, eastern Queensland (DotEE 2018).

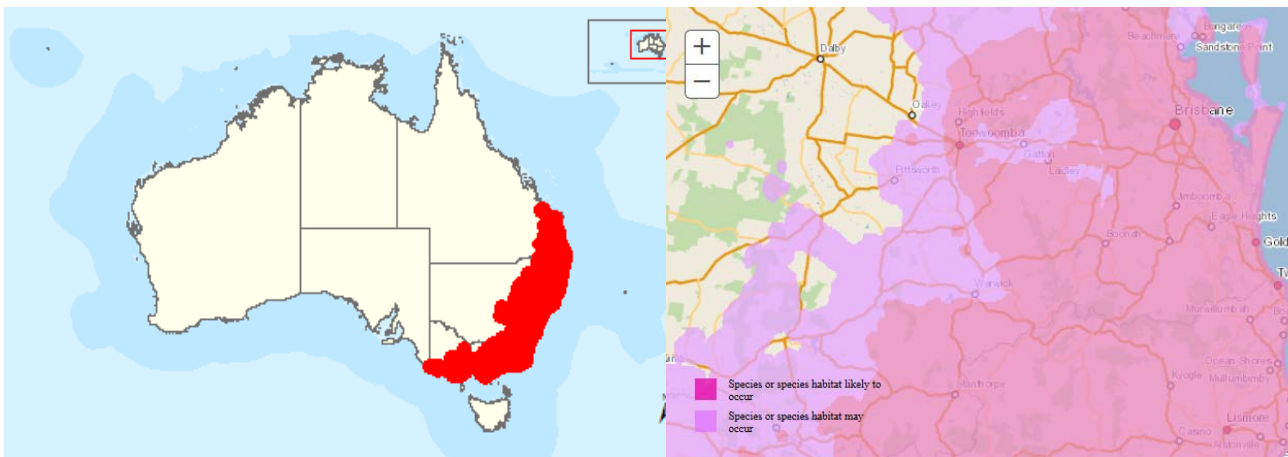


Figure 7.17 Distribution range of the Spotted-tail quoll (southern subspecies)

Source: DotEE (2018)

7.9.2.3 Distribution in relation to the Project

There are a number of Spotted-tail quoll database records in the region surrounding the eastern portion of the Impact assessment area. There is a single 1980 record from the Pittsworth area located just outside of the Impact assessment area (1.2 km from the Project footprint). There are a number of records to the east and south-east of Pittsworth all of which are relatively old (<1990). The most recent records in the vicinity of the Impact assessment area are from the Day Range located 38 km east of the Project (from 1993). There are also several records in the south around the Texas area including from Wilga Park Nature Refuge (2002) (47 km south-east of Project footprint) and a museum record from Yelarbon State Forest (20 km south-east of the Project footprint) although with no associated collection year. There are only two records located west of the Project footprint: one in the Biddeston region near Toowoomba (5.5 west of the Project footprint) in what is now cleared agricultural lands; and a record west of Dalby from 1980 (over 60 km north-west of the Project) (AoLA 2020) (refer Figure 7.18).

Woodland habitats within much of the Impact assessment area are small and heavily fragmented and are very unlikely to support the species. The Project passes through an area of extensive tracts of woodland north of Inglewood associated with several protected areas (National Park and State Forests). This is the only habitat within the Project footprint that has some potential to support the species. Nevertheless, it is noted there is only one (undated) record of the species within this area in Yelarbon State Forest to the south of the footprint, and no records at all to the west.

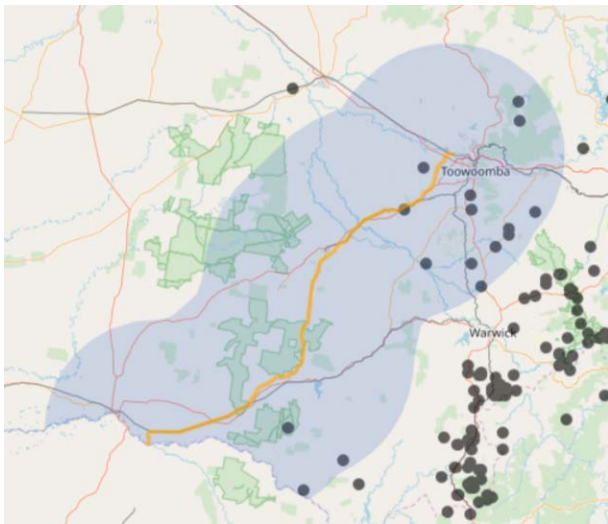


Figure 7.18 Distribution range of the Spotted-tail quoll (southern subspecies) in relation to the Project

Source: ALA (2020)

7.9.2.4 Biology and reproduction

Spotted-tail quolls are predominantly nocturnal and typically prey on medium-sized mammals. Typically, prey includes Ringtail possum (*Pseudocheirus pererinus*), Common brushtail possum (*Trichosurus vulpecula*), Mountain brushtail possum (*Trichosurus caninus*), Greater glider (*Petauroides volans*) and Rabbit. Additionally, this species consumes insects, lizards, crayfish, poultry, birds, small mammals, frogs, fish, plant material and refuse that has been discarded by humans (DotEE 2018).

Mating and births for the Spotted-tail quoll occur over the winter months (June to August). It is possible for roaming males to mate with more than one female per year (DotEE 2018).

After a gestation period of 21 days, litters of between four and six are born, in late-July to mid-August. Young are attached to the teat for about eight weeks from birth. Subsequently, young may be left in the maternal den while the mother is hunting for food to provide to her young. At 18 to 21 weeks the young are fully independent and 33% of the body size of the mother (Belcher 2003; DotEE 2018; Edgar and Belcher 2008; Fleay 1940; Green and Scarborough 1990; Jones et al. 2001).

7.9.3 Habitat

Spotted-tail quolls have been recorded from a wide range of habitats, including temperate and subtropical rainforests in mountain areas, wet sclerophyll forest, lowland forests, open and closed eucalypt woodlands, inland riparian and River red gum (*Eucalyptus camaldulensis*) forests, dry 'rainshadow' woodland, sub-alpine woodlands, coastal heathlands and occasionally in open country/other treeless areas. Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves. From a study in Kosciuszko National Park, home range estimates were 620 to 2560 ha for males, and 90 to 650 ha for females (DotEE 2018).

The Spotted-tail quoll is known to prefer mature wet forest habitat especially areas with rainfall 600 mm/year. Unlogged forest or forest that has had limited disturbance by timber harvesting is also preferable (TSSC 2004, DotEE 2018).

7.9.4 Threatening processes

The following have been identified as potentially threatening processes to the Spotted-tail quoll:

- The loss, fragmentation, disturbance and degradation of habitat through clearing of native vegetation, timber harvesting and other forest management practices (DotEE 2018)
- Predation from Red foxes, Dingos (*Canis lupus dingo*) and Domestic dogs. Dietary and habitat overlap with these species may also be leading to competitive effects (DotEE 2018)
- Spot-tailed quolls have been killed by landholders in response to poultry coop raids. The large home ranges of the Spotted-tail quoll, particularly males, makes them susceptible to road mortality in forested areas fragmented by roads and a tendency to scavenge carrion may increase this threat (DotEE 2018).
- Following various baiting programs using 1080 baits for invasive predators, the dosage for foxes and dogs is potentially fatal to the Spotted-tail quoll, particularly for smaller individuals, such as females and juveniles (DotEE 2018).

7.9.5 Threat abatement/recovery plans

The following threat abatement plans have been identified as being relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox>. In effect under the EPBC Act from 01-Oct-2008.

The following recovery plan has been identified as being relevant for this species

- Department of Environment, Land, Water and Planning (2016). National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus*. Australian Government, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/spotted-tailed-quoll>. In effect under the EPBC Act from 06-May-2016.

7.9.6 Summary of threat abatement/recovery plans

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the Threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

Important populations outlined in the National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus* that could be relevant to the Project include:

- New South Wales: Marylands National Park and adjacent freehold property 'Mowamba'
- New South Wales: Northern Tablelands: Tenterfield, Glen Innes, Armidale/Walcha, Dorrigo Plateau and Barrington
- New South Wales: Yuragir and Mariah
- New South Wales: Greater blue mountains
- New South Wales: Barren Grounds/Budderoo, Escarpment forest from Morton National Park to Victorian border, Tallaganda/Badja
- New South Wales: Kosciuszko National Park/Snowy Mountains Byadbo
- Queensland: Stanthorpe to Wallangarra, Granite Belt/New England Tablelands
- Queensland: Cherrabah Homestead (between Warwick and Killarney)
- Queensland: Main Range-McPherson Range west
- Queensland: Lamington Plateau-McPherson Range east
- Queensland: Burnett Range
- Queensland: Dalby region.

Threats identified in the National Recovery Plan include:

- Habitat loss and modification
- Fragmentation of habitat and populations
- Timber harvesting
- Poison baiting
- Competition and predation from introduced predators
- Deliberate killing
- Road mortality
- Bushfire and prescription burning

- Poisoning by Cane toads
- Climate change.

Recovery actions outlined in the National Recovery Plan include:

- Determine the distribution and status of populations throughout the species' range
- Investigate key aspects of the biology and ecology to acquire targeted information to aid recovery
- Reduce habitat loss and fragmentation on private land
- Evaluate and manage risk posed by silviculture
- Determine and manage impacts from introduced predators
- Reduce deliberate killing of Quolls
- Assess the threat Cane toads pose to the species and develop threat abatement actions
- Determine the likely impact of climate change on populations
- Increase community awareness and involvement in the recovery program.

7.9.7 References

Bennett, S. J. (2012). Spotted-tail quoll (southeastern mainland population) (*Dasyurus maculatus maculatus*). [image] [online] Available from: <https://www.flickr.com/photos/quollism/8470326020/in/photolist-otMpsh-dUuCPN-8i5qZD-8FyqvQ-8Fyrj9-8i5v82-8i5fv2-8i5dAx-8i8tbh-dUuJyw-3ibXyv-6ohk1i-6ohoxX-dUp7A8-6ompZ1-6omrpj-a9ZctU-9agNYm-28zD4py-MzPVJP-2bkFCPX>. [17 September 2019].

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Threatened Species Scientific Committee (2004). Commonwealth Listing Advice on *Dasyurus maculatus maculatus* (Spotted-tail quoll, Spotted-tail quoll, Tiger Quoll). [Online]. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/tiger-quoll.html> [Accessed 21 August 2018].

7.10 Long-nosed potoroo (SE mainland) (*Potorous tridactylus tridactylus*)

7.10.1 Status

EPBC Act – Vulnerable

7.10.2 Biology and ecology

7.10.2.1 Characteristic

The Long-nosed potoroo (*Potorous tridactylus tridactylus*) (SE Mainland) is a medium sized marsupial. Males and females have a body length (excluding the tail) between 287 to 410 mm and 259 to 378 mm respectively. Males have longer tails and are typically heavier than females (740 to 1,640 g for males and 660 to 1,350 g for females). They can be identified by a brown-grey upper body and paler underbody. They have small round ears and a long nose that tapers with a small patch of skin extending from the snout to the nose (refer Photograph 7.10). Their tail is sparsely furred, tapered and marked with a white tip. They have only two pads on their hindfeet (DotEE 2018).



Photograph 7.10 Long-nosed potoroo (*Potorous tridactylus tridactylus*)

Source: Augier (2015)

7.10.2.2 Known distribution

In NSW and Queensland, the Long-nosed potoroo (SE Mainland) has scattered populations east of the Great Dividing Range extending from south-eastern Queensland through to NSW (refer Figure 7.19). In Queensland the species has been recorded from southeast of Gladstone to Lamington National Park and the Border Ranges. The species is also found in southern Victoria (DotEE 2018).

7.10.2.3 Biology and reproduction

The Long-nosed potoroo (SE Mainland) is known to consume flowers, fruits, seeds, leaves, stems, roots and bulbs. They also feed on both hypogeous and epigeous components of fungal fruit bodies as well as invertebrates (DotEE 2018).

The Long-nosed potoroo (SE mainland) breeds all year round a single joey is born after a gestation of 37 days and they remain in their mothers pouch for 100 to 125 days reaching sexual maturity at about 12 months. They have a lifespan of about 10 years (DES 2017, DotEE 2018).

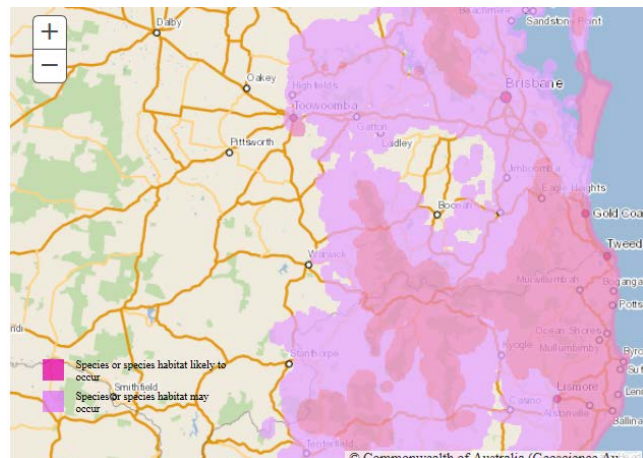


Figure 7.19 Distribution range of the Long-nosed potoroo (SE Mainland)

Source: ALA (2018), DotEE (2018)

7.10.2.4 Distribution in relation to the Project

Potorous tridactylus tridactylus has been predicted to occur within the region and associated habitat within the impact assessment area. However, there are few database records (i.e. AoLA, WildNet) for this species within 50 km of the temporary and permanent project footprint. The nearest record is dated 2015 within approximately 25 km of the Project footprint. Several records exist to the north-east of Toowoomba between 35-45 km from the Project footprint.

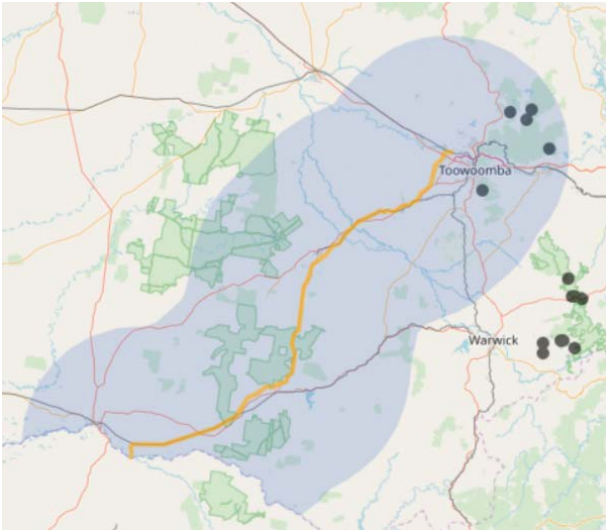


Figure 7.20 Distribution range of the Long-nosed potoroo (SE Mainland) in relation to the Project

Source: ALA (2020)

7.10.3 Habitat

In NSW and Queensland, there is no consistent pattern to the habitat of the Long-nosed potoroo (SE Mainland); it can be found in wet eucalypt forests to warm temperate rainforest and coastal heaths and scrubs. The main habitat requirements appear to be some form of dense vegetation for shelter and the presence of light soils and an abundance of fungi (DotEE 2018; DES 2017).

7.10.4 Threatening processes

The following have been identified as potentially threatening processes to the Long-nosed potoroo:

- The main threat to the Long-nosed potoroo (SE Mainland) is predation by European Red Foxes and Feral Cats (DotEE 2018)
- Residential and industrial development has also caused habitat loss, degradation and fragmentation (DotEE 2018).

7.10.5 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this species. The following threat abatement plans are relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox>. In effect under the EPBC Act from 01-Oct-2008.

7.10.6 Summary of threat abatement/recovery plans

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the Threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

7.10.7 References

Atlas of Living Australia (2018). *Potorous tridactylus*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:76cb4b83-1a55-4ff8-98ff-4e7eb6fc0c9b> [Accessed 23 August 2018].

Augier, J. (2015). Long-nosed potoroo (*Potorous tridactylus tridactylus*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=895e4d37-18f9-4c62-ae37-5af6803085c8>. [16 September 2019].

Department of the Environment and Energy (2018). *Potorous tridactylus* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66645 [Accessed 23 August 2018].

Department of the Environment and Science (2017). Long-nosed potoroo. Available from: https://www.ehp.qld.gov.au/wildlife/threatened-species/vulnerable/longnosed_potoroo.html [Accessed 23 August 2018].

8 Fauna species – threatened species – birds

8.1 Australasian bittern (*Botaurus poiciloptilus*)

8.1.1 Status

EPBC Act – Endangered

8.1.2 Biology and ecology

8.1.2.1 Characteristics

The Australasian bittern (*Botaurus poiciloptilus*) is a large stocky, partially nocturnal heron which can reach up to a total body length of 75 cm with a wingspan just over 1 m. The species has a long narrow neck, a straight brownish-yellow bill which transitions into a dark brown feathering on the side of its neck and becomes pale at the throat. The mottled brown upper surface of the bittern is supported by a buff dark brown striped under surface and pale green legs (refer Photograph 8.1). Bittern juveniles differ from adults due to their paler feathering and heavier buff flecking on the back. Sexes can be differentiated through size as female bittern weigh about 900 g compared to male bittern, who are significantly heavier weighing up to 1,400 g. The physical appearance of the bittern makes it very well camouflaged within its natural habitat and often go unspotted (Birdlife 2018; SWIFFT 2018; TSSC 2011).



Photograph 8.1 Australasian bittern (*Botaurus poiciloptilus*)

Source: Brown (2014)

8.1.2.2 Known distribution

The Australasian bittern is known to occur in south-eastern Australia, extending from Bundaberg through to northern Tasmania (refer Figure 8.1). In NSW, Australasian bittern is predominantly found in the Murray-Darling basin which once formed a stronghold for the species (Birdlife 2018; Birdlife International 2016).

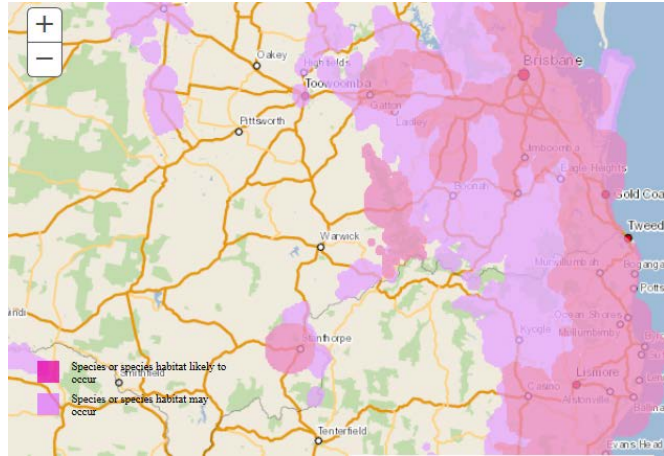


Figure 8.1 Distribution range of the Australasian bittern

Source: ALA (2018), DotEE (2018)

8.1.2.3 Distribution in relation to the Project

Botaurus poiciloptilus has been predicted to occur within the region and associated habitat within the impact assessment area. The closest database records (i.e. AoLA, WildNet) in relation to the Project occur at the Toowoomba Range from within approximately 35 km from the Project footprint although dates to not exist for these records. Several other records exist for this species from within a 50 km buffer of the Project footprint between 1999-2009.

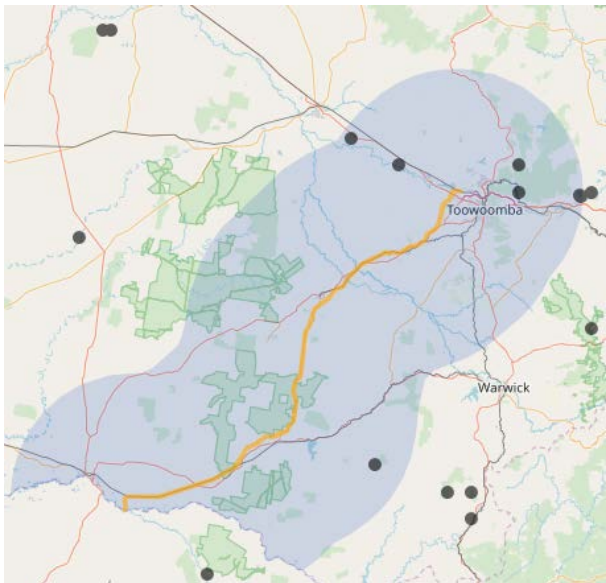


Figure 8.2 Distribution range of the Australasian bittern in relation to the Project

Source: ALA (2020)

8.1.2.4 Biology and reproduction

The Australasian bittern is crepuscular and known to hide during day time and come out after sun down. It feeds mainly on frogs, fish, crayfish, spiders, insects and snails. The species constructs a feeding platform over deeper water using reeds trampled by the bird and uses multiple hunting techniques to capture prey (Birdlife 2018; OEH 2017).

The species breed around summer, between October and January, as solitary pairs and begin building nests in secluded, densely vegetated wetlands on platforms of reeds approximately 30 cm above water level. The female Australasian bittern will lay six eggs of olive to brown colour to a clutch and known to have a short incubation period (Birdlife 2018; O'Donnell 2011; TSSC 2011).

8.1.3 Habitat

Preferred habitat for the Australasian bittern consists of permanent freshwater wetlands with tall dense vegetation including bulrushes (*Typha* spp.), spikerushes (*Eleocharis* spp.) and tall emergent sedges. Rice paddies within the Murray-Darling basin are a known habitat for the species who disperse widely during periods of droughts to coastal wetlands and to ephemeral wetlands (Birdlife International 2016; OEH 2017).

8.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Australasian bittern:

- Wetland drainage for agriculture
- Changes brought on by high levels of grazing, drought and salinisation of swamps
- Long term habitat destruction exposing species to predation
- Abandoning nests due to slight disturbances as a result of their sensitive nature (Birdlife International 2016).

8.1.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2019). Draft National Recovery Plan for the Australasian Bittern *Botaurus poiciloptilus*. Available from: <https://www.environment.gov.au/system/files/consultations/9a03b781-7f67-4874-a919-cf53cd1eee60/files/draft-recovery-plan-australasian-bittern.pdf>.
- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10105>. In effect under the BC Act 2016.

The following threat abatement plans have been identified as being relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox>. In effect under the EPBC Act from 01-Oct-2008.

8.1.6 Summary of threat abatement/recovery plan

Threats identified in the Draft National Recovery Plan for the Australasian Bittern *Botaurus poiciloptilus* include:

- Changes of water flow reducing the availability of wetland habitat
- Loss and alteration of wetland habitat from fire and livestock
- Climate change resulting in variability of environmental conditions, in particular a reduction in rainfall and increase in drought reducing water levels in wetland habitat
- Impacts to water quality from increased salinity, acidification, siltation and pollution
- Increased competition, habitat alteration and predation from hard hooved invasive herbivores and predators
- A lack of genetic diversity due to small population sizes.

Management actions outlined in the Draft National Recovery Plan for the Australasian Bittern *Botaurus poiciloptilus* include:

- Reduce threats to Australasian bittern and the species' habitat through the implementation of management strategies
- Better protect the species and provide improvements in the quality and extend of suitable habitat
- Gain an improved understanding of the species' ecology and biology and identify population trends through ongoing monitoring
- Increase the engagement of stakeholders in the conservation and management of the specie
- Ensure the recovery process is well coordinated, reviewed and reported on.

Threats identified by the *Saving our Species* program include:

- Drainage of wetlands and ponds and alteration of natural flow regimes
- Loss and degradation of wetland habitat, including artificial wetland habitat in rice growing areas, due to changes in water management and cropping practises
- Climate change driven seasonality changes such as amount of rainfall and associated changes in environmental water allocations
- Predation by foxes, pigs and cats.

Management activities in the *Saving our Species* program to protect this species are:

- Apply environmental water quality requirements (timing, depth, duration, frequency) in long-term environmental water plans (including Murrumbidgee, Murray, Lachlan, Macquarie, Gwydir) to maintain and restore habitat
- Develop and/or upgrade infrastructure to support environmental water delivery to priority bittern habitat areas
- Educate and encourage landholders to improve wetland management and awareness of bitterns, and report sightings (target landholders in Hunter, north and south coast, northern basin and Riverina/Murray areas)
- Undertake targeted control of predators at selected priority sites during breeding (summer) using techniques such as trapping and/or baiting
- Educate irrigation corporations in rice-growing areas and encourage sensitive management of canals
- Work with rice growers to develop a "bittern friendly" rice label that promotes best practice rice growing for maintaining bittern habitat
- Conduct targeted research into habitat use during non-breeding season and during drought.

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the Threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

8.1.7 References

Atlas of Living Australia (2018). *Botaurus poiciloptilus*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:47dca80b-ac7c-4130-bef3-4afb4fad35ab> [Accessed 22 August 2018].

Birdlife Australia (2018). Australasian Bittern. Available from: <http://www.birdlife.org.au/bird-profile/australasian-bittern> [Accessed 22 August 2018].

BirdLife International (2016). *Botaurus poiciloptilus*. The IUCN Red List of Threatened. Available from: <http://www.iucnredlist.org/details/22697353/0> [Accessed 22 August 2018].

Brown, C. (2014). Australasian bittern (*Botaurus poiciloptilus*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=540dc629-3998-48c0-848a-18e1514a39c5>. [17 September 2019].

O'Donnell, Colin. (2011). Breeding of the Australasian Bittern (*Botaurus poiciloptilus*) in New Zealand. ResearchGate. Available from: <https://www.researchgate.net/publication/263002340> [Accessed 22 August 2018].

Office of Environment and Heritage (2017). Australasian Bittern – Profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10105> [Accessed 22 August 2018].

State Wide Integrated Flora and Fauna Teams (2018). Australasian Bittern. Available from: http://www.swifft.net.au/cb_pages/australasian_bittern.php [Accessed 22 August 2018].

Threatened Species Scientific Committee (2011). *Botaurus poiciloptilus* in Species Profile and Threats Database. Department of Environment and Energy. Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/1001-listing-advice.pdf> [Accessed 22 August 2018].

8.2 Australian painted snipe (*Rostratula australis*)

8.2.1 Status

EPBC Act – Endangered Marine (CAMBA)

8.2.2 Biology and ecology

8.2.2.1 Characteristic

The Australian painted snipe (*Rostratula australis*) is a stocky wading bird approximately 220 to 250 mm in length. It has a long pinkish bill and chestnut-coloured head, with a white ring around the eye and a crown stripe. The back and wings are metallic green and barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down the individuals upper back (refer Photograph 8.2). The adult female is slightly larger and more brightly coloured than the male (DotEE 2018).



Photograph 8.2 Australian painted snipe male (*Rostratula australis*)

Source: eBird Australia (20015)

8.2.2.2 Known distribution

The Australian painted snipe has been recorded at wetlands in all states and territories of Australia but is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and southeastern South Australia (refer Figure 8.3). Known distribution has likely declined by approximately 50% in Australia since European settlement (DotEE 2018; Garnett & Crowley 2000).

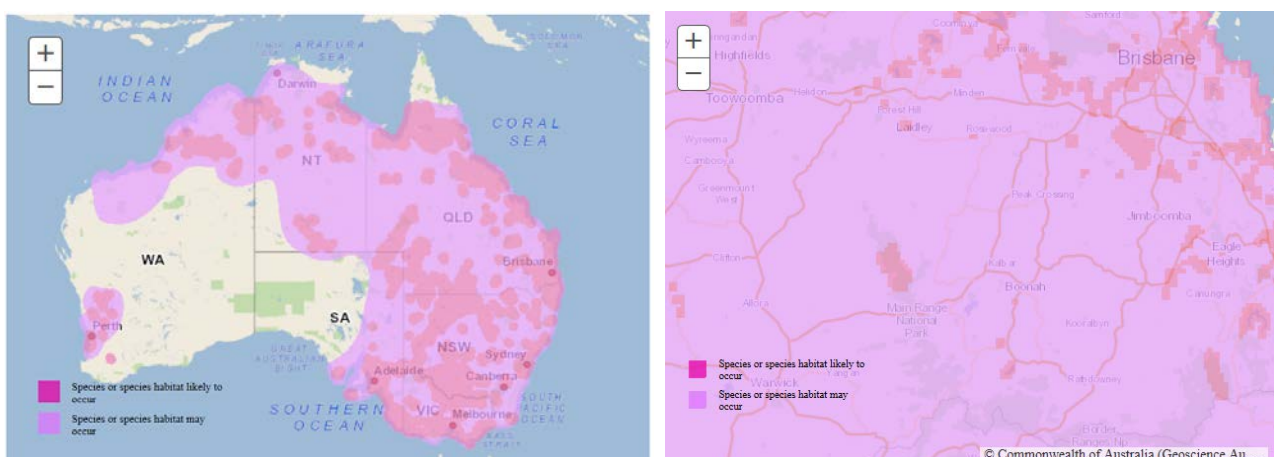


Figure 8.3 Distribution range of the Australian painted snipe

Source: DotEE (2018)

8.2.2.3 Distribution in relation to the Project

Australian painted snipe was not identified during any Project-associated field surveys within the impact assessment area. The closest database record (2017) to the Project is from the north-east of Inglewood at a small farm dam located 6.5 km east of the footprint. There are several records in the wider area surrounding Toowoomba and the Lockyer Valley. The nearest recent records are from Cooby Creek Dam (1995) and several records from the Helidon area (1982 and 2013) located approximately 14 km north-east and 25 km east of the northern extent of the Project respectively (AoLA 2020). Other records occur to the west including near Jondaryan (undated - 26 km north-west) and several records in Dalby (1965) and to the south at Lake Broadwater (four records from 1983 – 2013) which are over 50 km west of the Project footprint (refer Figure 8.4). There are no nearby records to the west of the majority of the Project footprint.

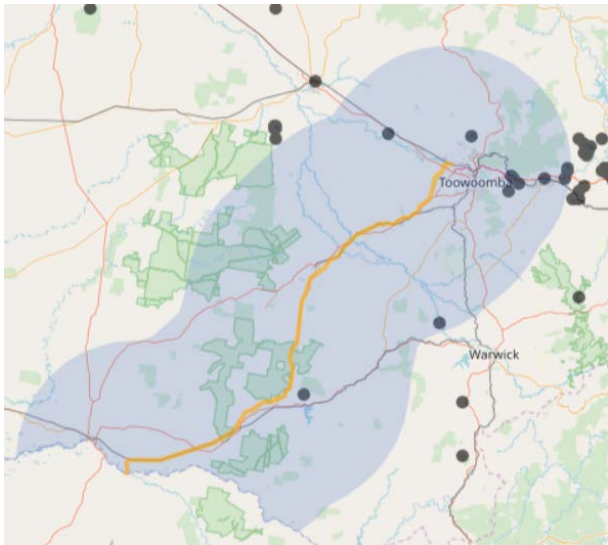


Figure 8.4 Distribution range of the Australian painted snipe in relation to the Project

Source: ALA (2020)

8.2.2.4 Biology and reproduction

The Australian painted snipe eats vegetation, worms, seeds, insects, molluscs, crustaceans and other invertebrates. They are mainly crepuscular and generally remain in dense cover when feeding, although they may forage over nearby mudflats and other open areas such as agricultural land or grassland (DotEE 2018).

The Australian painted snipe may breed in response to wetland conditions rather than during a particular season. The species has been recorded breeding in all months in Australia. Their breeding habitat requires shallow wetlands with areas of bare wet mud and with canopy cover nearby. The species nests usually occur on or near small islands in freshwater habitats. Females are known to lay two to six (typically three or four) eggs and may lay up to four clutches in a year and incubation takes 15 to 21 days. The females usually breed every two years (DotEE 2018).

This species is generally seen alone or in pairs or occasionally in small flocks. Flocking occurs during the breeding season but are also known to form after the breeding season and at some locations where small groups regularly occur (DotEE 2018).

8.2.3 Habitat

The Australian painted snipe generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. The species has also been observed to use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. The Australian painted snipe has been recorded nesting in and near swamps, canegrass swamps, flooded areas, including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch, saltbush (*Halosarcia* sp.) and grass, in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush (DotEE 2018).

The Australian painted snipe requires suitable wetland areas even in drought conditions, but the species can move to suitable habitat if necessary (DotEE 2018).

8.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Australian painted snipe:

- The loss and alteration of wetland habitat, particularly the drainage of wetlands and diversion of water to agriculture and reservoirs therefore reducing flooding and precluding the formation of temporary shallow wetlands (DotEE 2018)
- Grazing and trampling of wetland vegetation by livestock (DotEE 2018)
- The colonisation of invasive, noxious weeds could render habitats less suitable for the snipe and changes to fire regimes might be affecting savannah vegetation around wetlands in northern Australia (Garnett and Crowley 2000; DotEE 2018)
- Australian painted snipe nesting sites may also be vulnerable to introduced terrestrial predators such as the European red fox or feral cat (DotEE 2018).

8.2.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2019) Draft National Recovery Plan for the Australian Painted Snipe. Available from: <https://www.environment.gov.au/system/files/consultations/5e6b3bf-ef4d-4d0a-b9c8-c8e29bb11afc/files/draft-recovery-plan-australian-painted-snipe.pdf>.
- Office of Environment and Heritage (2017). Saving our Species: Help save the Australian Painted Snipe. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=1292&ReportProfileID=10734>.

8.2.6 Summary of threat abatement/recovery plan

Threats identified in the Draft National Recovery Plan for the Australian Painted Snipe include:

- Historical threats include land use changes, particularly in the Murray-Darling Basin resulting in losses of temporary wetlands due to changes in water management
- Current threats include; degradation of wetlands resulting from drainage and water diversion
- Loss of breeding habitat due to reduced frequency of flooding
- Reduced fresh water availability through drainage, losses to irrigation and water diversion
- Increased cropping and fire regimes altering wetland vegetation in floodplains and wetlands
- Drought and changing climatic conditions intensifying impacts of degrading processes
- Dry season grazing in wetlands causing trampling of vegetation and nutrient enrichment
- Changes to the structure of wetland habitat and reduced water quality
- Encroachment from invasive weeds and changes in community structure of native vegetation reducing habitat suitability for the species
- Lack of genetic diversity

Management actions outlined in the Draft National Recovery Plan for the Australian Painted Snipe:

- Approach protection and management of breeding habitat from a landscape scale
- Implement measurement techniques to quantify population growth/decline to determine success of recovery actions
- Mitigate degradation of critical habitat for various life stages of the species

- Increase knowledge on the biology and ecology of the species and better understand habitat requirements
- Increase awareness of the species and conservation efforts being implemented amongst community stakeholders
- Compile and review results of the recovery process through coordinated efforts.

Threats identified in the Saving our Species plan includes:

- Drainage of wetland breeding sites
- Grazing and frequent fires in wetland habitat
- Herbicide, pesticide and other chemical use near wetlands
- Invasive native plants and exotic weeds reducing the health of wetland habitat
- Lack of knowledge on the reproduction of the species.

Management actions outline in the Saving our Species plan includes:

- Set environmental water quality parameters in long-term environmental water plans
- Control invasive vegetation
- Manage grazing and burning in wetlands creating a mosaic of habitat features
- Engage with landholders adjacent to wetlands providing education on the impact of chemical use, discuss non-toxic alternative and implement appropriate drainage management to avoid run-off
- Manage stock and fire regimes near wetlands
- Conduct research into the species to fill knowledge gaps
- Encourage the restoration of wetland habitat in an agricultural landscape
- Manage environmental water to ensure shallow muddy edge habitat during spring and summer.

8.2.7 References

Department of the Environment and Energy (2018). *Rostratula australis* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=77037 [Accessed 22 August 2018].

eBird Australia. (2015). Australian painted snipe male (*Rostratula australis*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=80919ccc-36ac-463a-9bd9-1462b7a05d1d>. [17 September 2019].

Garnett, S.T. and Crowley G.M. (2000). *The Action Plan for Australian Birds 2000*. Canberra, ACT: Environment Australia and Birds Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/action/birds2000/index.html> [Accessed 22 August 2018]

8.3 Black-breasted button-quail (*Turnix melanogaster*)

8.3.1 Status

EPBC Act – Vulnerable

8.3.2 Biology and ecology

8.3.2.1 Characteristic

The Black-breasted button-quail (*Turnix melanogaster*) is a relatively large, plump and pale-eyed quail. The males are about 18 cm long, with a wingspan of 32 to 35 cm, and weighing 65 g. The females tend to be larger weighing 100 g. Females are slightly larger than males and are the dominant sex. Female and male plumage also differs, with females having a black head and breast with white half-moon markings across the upper-breast and a chestnut marbled upper covered in black ladder markings and white streaks. Conversely, males have white markings on the face and neck covered with fine black dots and the upper-breast is a mottled chestnut and black (refer Photograph 8.3). Both sexes have grey bills, white-cream eyes and yellowish legs and feet (DotEE 2018; Pizzey and Knight 2007).



Photograph 8.3 Black-breasted button-quail (*Turnix melanogaster*)

Source: Dunis (2017)

8.3.2.2 Known distribution

Black-breasted button-quails are distributed across south-eastern Queensland from near Byfield in the north to the Border Ranges rainforests in the south, generally east of the Great Dividing Range (refer Figure 8.5); although there are records up to 300 km inland at locations at Palmgrove National Park and Barakula State Forest in Queensland. In north-eastern NSW, they are restricted to the Northern Rivers and Tablelands (DotEE 2018; Marchant and Higgins 1993).

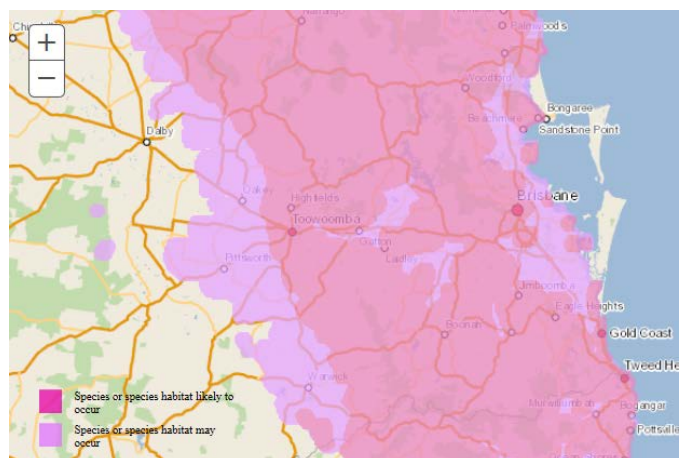


Figure 8.5 Distribution range of the Black-breasted button-quail

Source: ALA (2018f), DotEE (2018)

8.3.2.3 Distribution in relation to the Project

Black-breasted button-quail has not been detected within the Impact assessment area. There are several database records close to the northern extent of the Project footprint around Toowoomba. These records range from 1889 – 2018 with the nearest records from 1999 located 1.5 km north of the footprint from the Kingsthorpe area (ALA 2020) (refer Figure 8.6).

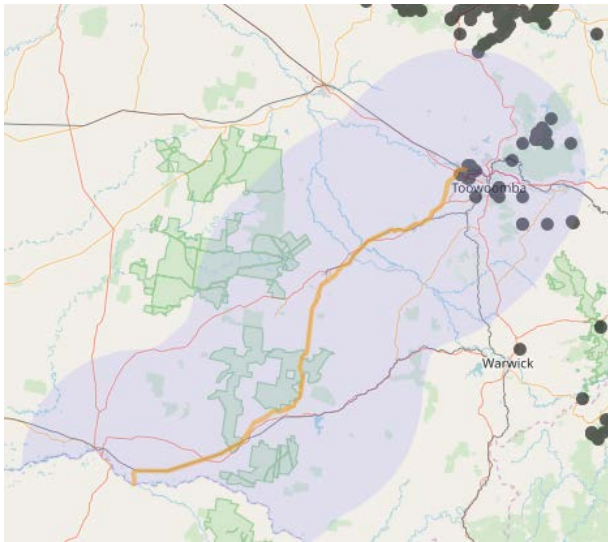


Figure 8.6 Distribution range of the Black-breasted button-quail in relation to the Project

Source: ALA (2020)

8.3.2.4 Biology and reproduction

Their principal food is invertebrates gathered from the leaf litter on the forest floor, however, seeds may also be consumed (DotEE 2018; Hughes and Hughes 1991).

The species is polyandrous (a single female mates with several males who incubate the eggs) and it has been seen in pairs or, more occasionally, in small groups. There is little known on the breeding habits of the Black-breasted button-quail, however they are assumed to breed throughout their range. Although they may exhibit limited migratory movements at night in response to resource availability. The breeding season occurs from September to April/May and between three and five eggs are laid. Nests consist of a scrape in the ground, lined with leaves, grass or moss. Nests are typically well-concealed and placed in the buttress root of a tree or sapling, the base of a fern or under a low bush or grass tussock (DotEE 2018).

8.3.3 Habitat

The Black-breasted button-quail is restricted to rainforests and forests, mostly in areas with 770 to 1,200 mm rainfall per annum in areas characterised by highly fertile soils. They prefer drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest. They may also be found in low, dense Acacia thickets and, in vegetation behind coastal sand dunes. In southeastern Queensland, the Black-breasted button-quail has been recorded on rare occasions in open Eucalypt forest; for example, birds have been recorded in Grey ironbark (*Eucalyptus siderophloia*) with a low sparse shrub layer of Eucalypt and Acacia seedlings, and a sparse ground cover of short tussock grasses and leaf litter. This species also heavily utilises areas infested with *Lantana camara*, particularly where this produces a dense leaf-litter below a thigh woody shrub layer. A dense leaf-litter layer is required for foraging and possibly also roosting (DotEE 2018).

8.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Black-breasted button-quail:

- Massive clearance of forest for agriculture, forestry and urban development continues to be the biggest threat to the species. Sub-populations in the remaining fragmented habitats are affected by excessive grazing and trampling which may reduce the amount of understorey vegetation and deep leaf litter on which the species relies (Bennett 1985; Garnett and Crowley 2000).
- Frequent fire eliminates shrubby understorey in dry rainforest remnants and can also reduce the amount of leaf litter on the ground, rendering habitat unsuitable (Garnett and Crowley 2000)
- Being ground-nesters, they are also affected by predation by cats, foxes and pigs (Bennett 1985; Garnett and Crowley 2000).

8.3.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Mathieson, M.T. & G.C. Smith (2009). National recovery plan for the black-breasted button-quail *Turnix melanogaster*. Report to the Department of the Environment, Water, Heritage and the Arts, Canberra. Department of Environment and Resource Management, Brisbane. Available from: <http://www.environment.gov.au/resource/national-recovery-plan-black-breasted-button-quail-turnix-melanogaster>. In effect under the EPBC Act from 13-Nov-2009.

The following threat abatement plans have been identified as being relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment and Energy (2017). Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (2017). Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017>. In effect under the EPBC Act from 18-Mar-2017.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox>. In effect under the EPBC Act from 01-Oct-2008.

8.3.6 Summary of threat abatement/recovery plans

Threats specific to the Black-breasted button-quail in the strategy include:

- Very specific habitat requirements that are subject to development pressure
- Polyandrous breeding nature could result in genetic bottleneck given there are fewer females than males in the population
- Habitat loss, fragmentation and degradation
- Inappropriate fire regimes
- Predation by feral animals.

Objectives and actions outlined in the threat abatement plan for the Black-breasted button-quail include:

- Consolidate current information and define assessment and monitoring strategies determining where suitable habitat is occupied
- Protect key habitat for the species from human induced processes
- Maintain and improve the extent, condition and connectivity of suitable habitat

- Reduce the impacts of introduced predators and competitors
- Increase ecological knowledge of the species
- Review the operation of the recovery process.

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pigs (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

Threats identified in the Threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

8.3.7 References

- Atlas of Living Australia (2018). *Turnix (Austroturnix) melanogaster*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:03a6ee3f-e227-41e2-b2f3-6f6aea694a83> [Accessed 23 August 2018].
- Bennett, S. (1985). The distribution and status of the Black-breasted Button-quail *Turnix melanogaster*. *Emu*. 85:157-162.
- Department of the Environment and Energy (2018). *Turnix melanogaster* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=923 [Accessed 23 August 2018].
- Dunis, V. (2017). Black-breasted button-quail (*Turnix melanogaster*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=ea3c5de8-f1f6-4c56-8567-f8a8db613669>. [17 September 2019].
- Garnett, S.T. and Crowley G.M. (2000). *The Action Plan for Australian Birds 2000*. Canberra, ACT: Environment Australia and Birds Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/action/birds2000/index.html>.
- Marchant, S. and Higgins, P.J. eds. (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings*. Melbourne, Victoria: Oxford University Press.
- Pizzey, G. and Knight, F. (2007). *The Field Guide to the Birds of Australia*. Harper Collins publishing, Sydney.

8.4 Black-throated finch (*Poephila cincta cincta*)

8.4.1 Status

EPBC Act – Endangered

8.4.2 Biology and ecology

8.4.2.1 Characteristics

The Black-throated finch (southern sub-species) (*Poephila cincta cincta*) is a small stocky finch with a total body length of 12 cm and weighing about 15 g. The physical appearance of the finch is distinguishable by its bluish-grey head which features a short black stripe leading all the way through to the upper breast of the bird. The body of the finch is brown on the back, cinnamon on the breast and white on the rump which attaches to a black tail (refer Photograph 8.4). Plumage of both male and female finches are similar, however, female finches are smaller in size and have a slightly smaller throat patch compared to the male (DES 2018; OEH 2017).



Photograph 8.4 Black-throated finch (*Poephila cincta cincta*)

Source: Sherony (2016)

8.4.2.2 Known distribution

The known distribution of the Black-throated finch (southern sub-species) once extended from Inverell in northeast NSW, through eastern Queensland into the Atherton Tablelands as well as west to central Queensland (refer Figure 8.7). However, the species is considered to be locally extinct within the southern portion of its range. The species can now only be found in Queensland, near Townsville and in the Galilee Basin of Central Queensland, as the finch is likely extirpated in NSW (DES 2018; OEH 2017).

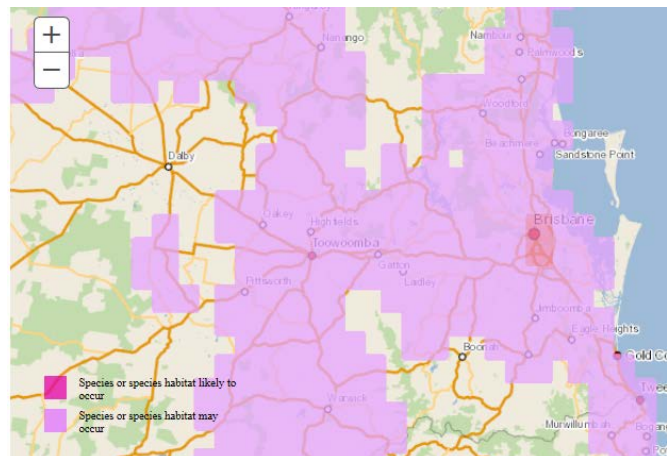


Figure 8.7 Distribution range of the Black-throated finch

Source: ALA (2018), DotEE (2018)

8.4.2.3 Distribution in relation to the Project

Poephila cincta has been identified as potentially occurring within the impact assessment area. Database records (i.e. AoLA, WildNet) indicated that the species is known from within 10 km to the east of the northern section of the Project footprint near Toowoomba. Records from this area do not have dates and no other records occur from within 50 km of the Project footprint.

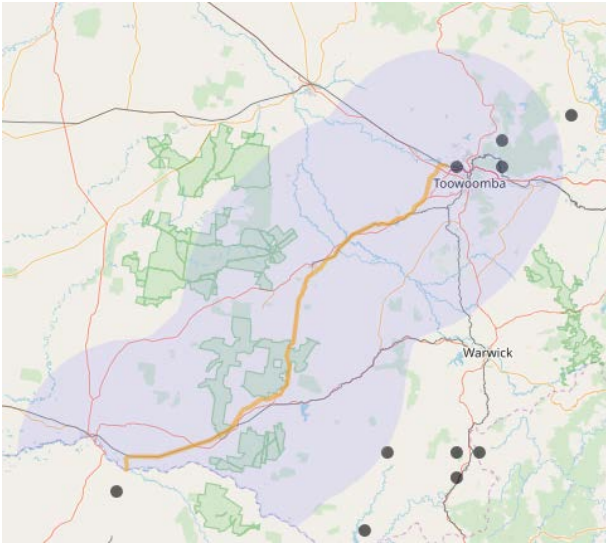


Figure 8.8 Distribution range of the Black-throated finch in relation to the Project

Source: ALA (2020)

8.4.2.4 Biology and reproduction

This finch species forages in small flocks, consuming seeds on the ground of native grasses as well as plucking seeds directly from the seedheads. During the breeding season, the finch is known to consume insects such as flying termites (Birdlife 2018; DES 2018).

Black-throated finches pair for life and separate from the flock during breeding season despite nesting in colonies due to their social nature. The species is known to reuse abandoned nests as well as build fresh dome shaped nests with a side entrance. Built nests are woven from grass stems and lined with soft seedheads, plant down and feathers which are placed in trees or tree hollows between spring into early autumn (Birdlife 2018; DES 2018).

The female will lay between five to nine eggs per brood and up to two broods may be produced per year, with an incubation period of up to 12 days. Fledging has been recorded to occur after 21 days with the young being independent only after 40 days (DES 2018; OEH 2017).

8.4.3 Habitat

This species of finch is a highly social bird, roaming in flocks of 40 or more. Black-throated finch (southern sub-species) require habitats that supply year-round seeds for feeding. Typical areas inhabited by the bird include grassy woodland dominated by eucalypts, paperbarks, tea-tree, Melaleuca or acacias along water courses (riparian habitats) due to their significance in providing shelter, specially within highly fragmented and modified environments. Despite being considered sedentary the species may move in response to droughts (DES 2018; OEH 2017).

8.4.4 Threatening processes

The following have been identified as potentially threatening processes to the Black-throated finch:

- Spread and intensification of pastoralism
- Changes to fire regimes
- Increases in the density of native woody weeds among grassy savannas (Birdlife International 2016; DES 2018).

8.4.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Black-throated Finch Recovery Team, Department of Environment and Climate Change (NSW) and Queensland Parks and Wildlife Service (2007). National recovery plan for the black-throated finch southern subspecies *Poephila cincta cincta*. Report to the Department of the Environment and Water Resources, Canberra. Department of Environment and Climate Change (NSW), Hurstville and Queensland Parks and Wildlife Service, Brisbane. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-black-throated-finch-southern-subspecies-poephila-cincta-cincta>. In effect under the EPBC Act from 08-Jan-2008.

The following threat abatement plans have been identified as being relevant to this species:

- Department of Sustainability, Environment, Water, Population and Communities (2012). Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses. Department of Sustainability, Environment, Water, Population and Communities. Available from: <http://www.environment.gov.au/resource/threat-abatement-plan-reduce-impacts-northern-australias-biodiversity-five-listed-grasses>. In effect under the EPBC Act from 11-Dec-2012.
- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016>. In effect under the EPBC Act from 07-Jan-2017.

8.4.6 Summary of threat abatement/recovery plans

Threats outlined in the National recovery plan for the black-throated finch southern subspecies *Poephila cincta cincta* include:

- Clearing and fragmentation of woodland, riverside, and wattle shrubland habitats
- Grazing impacts from livestock and rabbits
- Alteration of fuel load, vegetation structure and wet season food availability
- Fire causing alteration to habitat
- Invasive weed species including exotic grasses
- Illegal trapping of birds
- Predation by feral vertebrate pest species
- Hybridisation with escapees from sub-species.

Objectives and actions outlined in the National recovery plan for the black-throated finch southern subspecies *Poephila cincta cincta* include:

- Investigate and quantify threats faced by the species
- Determine distribution and abundance
- Protect and enhance habitat
- Investigate the viability of reintroducing captive breed stock
- Increase public awareness.

Threats identified in threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses includes:

- These highly invasive grasses can increase fuel loads
- Alter nitrogen cycling and water availability
- Degrade ecosystems through loss of habitat and biodiversity declines.

Management actions outlined in the threat abatement plan include:

- Determine the extent and spread pathways of infestation by the five listed grasses outlined in the plan
- Support and facilitate coordination management strategies through the design of tools, systems and guidelines
- Identify and prioritise key asset and areas for the implementation of management strategies
- Implement on the ground management strategies that are cost effective in high priority areas
- Monitor, evaluate and report back on the effectiveness of management programs.

Threats identified in the Threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Suppress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

8.4.7 References

Atlas of Living Australia (2017). *Poephila (Poephila) cincta*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:26d93abf-b5bf-43ea-91f3-4187e30619c5> [Accessed 22 August 2018].

Birdlife Australia (2018). Black-throated Finch. Available from: <http://www.birdlife.org.au/bird-profile/black-throated-finch> [Accessed 22 August 2018].

BirdLife International (2016). *Poephila cincta*. The IUCN Red List of Threatened. Available from: <http://www.iucnredlist.org/details/22719692/0> [Accessed 22 August 2018].

Department of Environment and Science (2018). Black-throated finch (southern subspecies). Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/blackthroated_finch_southern_subspecies.html [Accessed 22 August 2018].

Office of Environment and Heritage (2017). Black-throated Finch - Profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10641> [Accessed 22 August 2018].

Sherony, D. (2016). Black-throated finch (*Poephila cincta cincta*). [image] [online] Available from: <https://www.flickr.com/photos/9765210@N03/31293004362/in/photolist-25zw5ov-LufB5o-PFfPXY>. [17 September 2019].

8.5 Grey falcon (*Falco hypoleucos*)

8.5.1 Status

EPBC Act – Vulnerable

8.5.2 Biology and ecology

8.5.2.1 Characteristics

The Grey falcon (*Falco hypoleucos*) is a solitary falcon that grows to a total body length between 33 to 43 cm with an average male weighing around 400 g whilst females are heavier, weighing 550 g. The pale coloured falcon has a heavy, thick-set, deep-chested appearance with a light grey body featuring black shading on the primaries forming dark wing tips. The chin, throat and cheeks are white whilst the tail has narrow blackish bars. The eye-ring, cere and base of the beak are an orange-yellow (refer Photograph 8.5). Juvenile Grey falcons have fine dark streaks and do not have the orange-yellow eye-ring and feet the adults have (AWC 2018; OEH 2017).



Photograph 8.5 Grey falcon (*Falco hypoleucos*)

Source: Nicholas (2018)

8.5.2.2 Known distribution

The known distribution of the Grey falcon is over Australia's arid and semi-arid zones. It is absent from the Cape York Peninsula, south of the Great Diving Range in Queensland and NSW and south of the Great Dividing Range in Victoria (refer Figure 8.9). Throughout the Murray-Darling Basin the species is sparsely found with breeding occurring in the arid parts of the range and extinct in areas of more than 500 mm rainfall in NSW (Birdlife International 2016; OEH 2017).



Figure 8.9 Distribution range of the Grey falcon

Source: ALA (2018)

8.5.2.3 Distribution in relation to the Project

Falco hypoleucos has been predicted to occur within the region and associated habitat within the MNES study area. Database records (i.e. AoLA) indicate this species occurs from 2008 within the Gowrie region of Toowoomba, to the north of the Disturbance footprint. Other records within a 50 km buffer of the Disturbance footprint exist to the east between Toowoomba and Stanthorpe with a western record between Oakey and Dalby (refer Figure 8.10).



Figure 8.10 Distribution range of the Grey falcon in relation to the Project

Source: ALA (2020)

8.5.2.4 Biology and reproduction

The Grey falcon is often undetectable, perching amongst foliage or sitting on branches prior to hunting prey at tree-top height attacking mainly bird species. Targets for the falcon include finches, doves, parrots and pigeon but also know to consume insects and small mammals and carrion (Birdlife International 2016).

Grey falcon are solitary nesters, laying one to four eggs in late winter to early spring. This species, like most falcons, utilise old nests of other birds such as other species of raptor and ravens, usually positioned high in eucalyptus trees close to water. During times of drought the species has been known to not breed (AWC 2018; Johnson 2011).

8.5.3 Habitat

The habitat of the Grey falcon is restricted to shrubland, grassland and wooded watercourses of arid or semi-arid regions, however, wetlands where surface water attracts potential prey is also capitalised on by the falcon. The falcon has a high affinity to habitats with high temperature and low rainfall of less than 500 mm. During periods of drought, this species moves towards the coast regions, where it frequents wooded watercourses (Birdlife International 2016; OEH 2017).

8.5.4 Threatening processes

The following have been identified as potentially threatening processes to the Grey falcon:

- Clearing and grazing of arid and semi-arid zones
- Secondary poisoning through mouse and locust control programs
- Collection of young and eggs for falconry (OEH 2017)

8.5.5 Threat abatement/recovery plans

No threat abatement/recovery plans have been identified as being relevant for this species.

8.5.6 References

Atlas of Living Australia (2018). *Falco* (Hierofalco) *hypoleucos*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:5c4c5947-83a6-4a42-b861-8c408cfed4e7> [Accessed 2 September 2018].

Australian Wildlife Conservancy. (2018). Species Profile – Grey Falcon. Available from: <http://www.australianwildlife.org/wildlife/grey-falcon.aspx> [Accessed 22 August 2018].

BirdLife International (2016). *Falco hypoleucos*. The IUCN Red List of Threatened. Available from: <http://www.iucnredlist.org/details/22696479/0> [Accessed 22 August 2018].

S, Johnson. (2011). Grey Falcon. *Beauty of Birds*. Available from: <https://www.beautyofbirds.com/greyfalcons.html> [Accessed 22 August 2018].

Nicholas, K. (2018). Grey falcon (*Falco hypoleucos*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=569ffdf5-5560-454d-9dd0-f1d9e40a3c04>. [17 September 2019].

Office of Environment and Heritage (2017). Grey Falcon - Profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10330> [Accessed 2 September 2018].

8.6 Painted honeyeater (*Grantiella picta*)

8.6.1 Status

EPBC Act – Vulnerable

8.6.2 Biology and ecology

8.6.2.1 Characteristic

Painted honeyeater (*Grantiella picta*) is a medium honeyeater, growing to a length of 14 to 15 cm in size. The Painted honeyeater weights around 20 to 25 g and has a black head and back, and bright yellow on the wings and upper tail and a bright pink bill (refer Photograph 8.6). The male is distinguished by white underparts with black streaks on flanks (above legs). The females are slightly smaller than the males and identified by brownish-black colouring with white underparts. Juveniles are browner and have a greyish coloured bill. The Painted honeyeater is known to use the same nest sites each season and are generally seen in pairs or singles, rarely in small flocks of up to six birds (DES 2018; DotEE 2018).



Photograph 8.6 Painted honeyeater (*Grantiella picta*)

Source: Knight (2009)

8.6.2.2 Known distribution

The Painted honeyeater is endemic to Australia and its distribution over summer and spring stretches from inland central Victoria through scattered parts of NSW, the ACT and southern Queensland (refer Figure 8.11). During winter the Painted honeyeater is known to migrate further to North Queensland, around Cape York Peninsula, and eastern areas of the Northern Territory. Opportunistic sightings have been recorded in far eastern parts of South Australia (DotEE 2018).

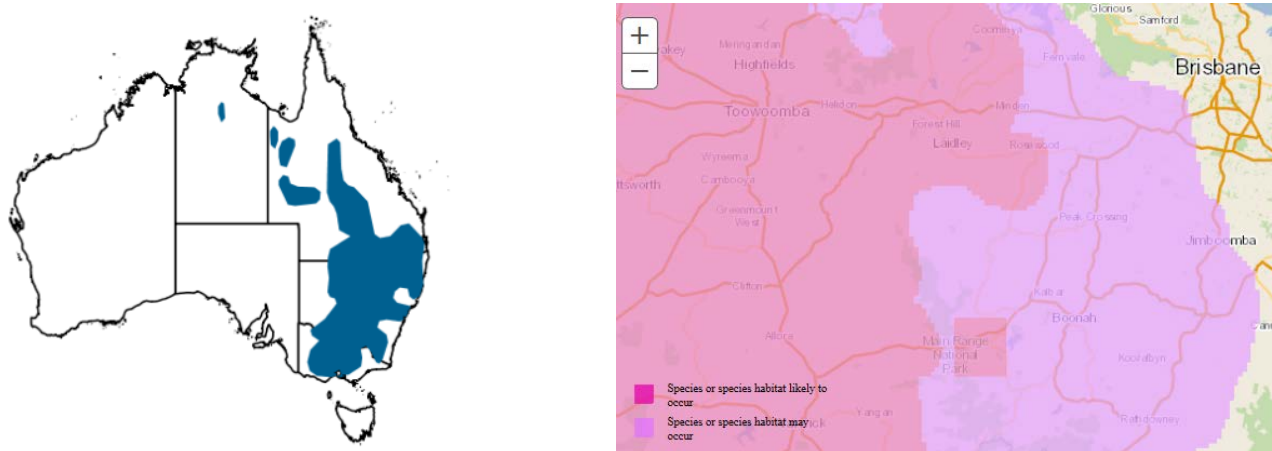


Figure 8.11 Distribution range of the Painted honeyeater

Source: ALA (2018), DotEE (2018)

8.6.2.3 Distribution in relation to the Project

Database records indicate that Painted honeyeater has not been recorded within the Impact assessment area however has occurred within from within 50 km of the Project footprint (ALA 2020). The nearest database record is from 2007 and approximately 2 km south of the Project in Pittsworth. A second record is located approximately 3 km north of the Project footprint from McEwan State Forest (2013) (near Pittsworth). There is a 2006 record located 2.5 km east of the northern extent of the Project (north of Toowoomba). There are two records further south along the alignment in the Inglewood area, one from close to Coolmunda Dam (1995) and another from Whetstone State Forest (1996). Both of these are more than 10 km from the Project footprint. Other database records are scattered in the wider area, largely to the north-west and south of the Project (refer Figure 8.12). Records indicate occurrences of this species in all directions around the Project footprint except for the east where few records exist. The species population is sparsely dispersed across south-east Australia to north-west Queensland and eastern Northern Territory. The Project footprint is not located near the limit of the species' range.

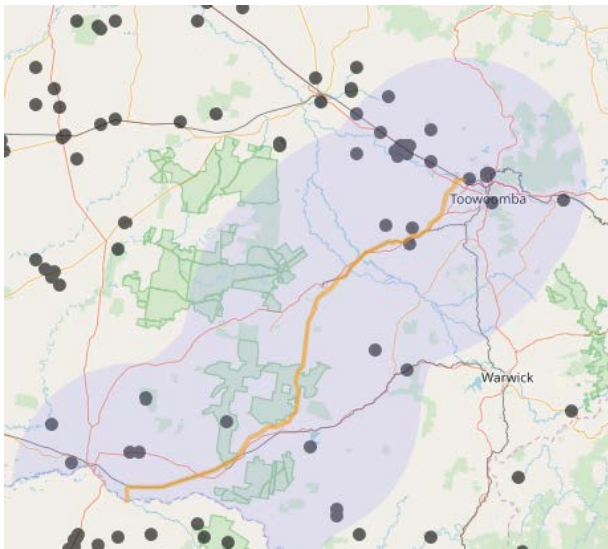


Figure 8.12 Distribution range of the Painted honeyeater in relation to the Project

Source: ALA (2020)

8.6.2.4 Biology and reproduction

The Painted honeyeater is typically seen individually or in pairs, less frequently seen in small flocks of up to six birds. This species is known to consume fruit. The species is predominantly observed in areas where mistletoe is abundant. The species is known to have a mixed diet consisting of nectar, berries and insects, defining them an omnivorous and an obligate nectarivore (DotEE 2018).

The species nests in a variety of trees and have been documented to favour mistletoe as a nesting site. The foliage of mistletoe helps with concealment of the nest to protect from predators and subsequent nest failure (DotEE 2018).

The breeding season generally takes place between October through to March and can be influenced by environmental conditions and the availability of food resources. Generally, the male Painted honeyeater will arrive at a nesting site several weeks before the female.

Both the male and female Painted honeyeaters maintain the nest, incubate the eggs, brood and feed the young. Nests are generally found approximately 15 m from the ground where the typical clutch consists of 2 eggs, but not uncommonly 1 to 3 eggs can be found. The species are known to raise 1 to 2 broods per season, where eggs are incubated for 13 to 15 days, and young fledge in 14 to 20 days. Both the female and male leave the nest at approximately the same time, generally five months after fledglings leave the nest and food resources decline (DES 2018; DotEE 2018).

8.6.3 Habitat

The Painted honeyeater is predominantly found in open forest, box-open woodland, eucalypt forest/woodlands, riparian woodlands and acacia woodlands. The Painted honeyeater inhabits environments that have a high prevalence of mistletoe which provides both nesting and food resources. Favourable species including needle-leaved mistletoe (*Amyema cabagei*) and grey mistletoe (*A. quandang*). An identified key association between the Painted honeyeaters migration south-north is believed to be a result of mistletoe fruit availability and general mistletoe distribution and abundance (DotEE 2018).

8.6.4 Threatening processes

The following have been identified as potentially threatening processes to the Painted honeyeater:

- Habitat loss and fragmentation
- Grazing inhibiting tree recruitment for feed trees (DotEE 2018).

8.6.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/Project.aspx?results=c&ProfileID=10357>. In effect under the BC Act 2016.

8.6.6 Summary of threat abatement/recovery plan

Threats identified in the Saving our Species plan includes:

- Degradation of open forest and woodland remnants along with the thinning of trees that bear mistletoe
- The loss of large, old trees that have heavy mistletoe infestations
- Habitat loss as a result of clearing woodlands and open forest
- Grazing pressure within grassy woodlands causing degradation and simplification of habitat
- Incursion from invasive weeds, particularly African boxthorn and invasive grasses
- Noisy minors causing aggressive exclusion in forest and woodland habitat.

Management actions identified in the Saving our Species plan includes:

- Encourage relevant landholders to enter into agreements that promote the protection, maintenance and recruitment of *Acacia* (*A. pendula* or *A. homalophylla*) woodland with mistletoe
- Incorporate into landholder agreements sensitive grazing regimes allowing suitable woodland habitat to regenerate
- Increase awareness with landholders of the importance of mistletoe as a resource for the Painted honeyeater and education around the fact that it is not harmful to healthy trees
- Revegetation of Brigalow, Boree and Yarran woodlands to provide connectivity between fragments, particularly in Painted honeyeater breeding habitat
- Encourage landholders to protect ground and mid-storey vegetation through the implementation of sensitive grazing techniques along with eliminating slashing or underscrubbing to retain floral and structural diversity
- Target removal of exotic grasses and promote regeneration of native grasses
- Measure the impact and abundance on Noisy miners implementing appropriate management strategies to reduce their impact
- Prioritise site protection in areas that function as drought refuges or source populations in programs that aim to protect, manage and restore habitat

- Implement research to fill knowledge gaps around restoring the structure and function of the ground layer, including soil structure in degraded habitat.

8.6.7 References

Atlas of Living Australia (2018), *Grantiella picta*. Viewed 17 August 2018, Available:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:de126daa-e11d-42e0-ace6-7873abe6c96b#>.

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Canberra: Department of the Environment. Available from:

<http://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conservation-advice.pdf>. In effect under the EPBC Act from 08 July 2015.

Department of Environment and Science (DES), Painted honeyeater – *Grantiella picta*, WetlandInfo, Queensland, viewed 17 August 2018,

<https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?grantiella-picta>.

Knight, R. (2009). Painted honeyeater (*Grantiella picta*). [image] [online] Available from:

<https://www.flickr.com/photos/sussexbirder/8079677675/in/photolist-8Fw6ib-diYsFv-LDPPEM>. [17 September 2019].

8.7 Red goshawk (*Erythrotriorchis radiatus*)

8.7.1 Status

EPBC Act – Vulnerable

8.7.2 Biology and ecology

8.7.2.1 Characteristics

The Red goshawk (*Erythrotriorchis radiatus*) is a large, swift and powerful rufous-brown goshawk. This species of raptor is estimated to be of 45 to 58 cm in total body length with a wingspan of 110 to 135 cm. The Red goshawk is boldly mottled and streaked, with rufous scalloping on the back and upper wings, and massive yellowish legs and feet. The head of the bird is pale and streaked with darker feathers (refer Photograph 8.7). Females are typically larger than males, more powerfully built, paler and more heavily streaked below, showing some white on the under body. Red goshawk juveniles are distinguished from adults due to their rufous head (DES 2017; DotEE 2018).



Photograph 8.7 (*Erythrotriorchis radiatus*)

Source: ALA (2016)

8.7.2.2 Known distribution

The Red goshawk is distributed along the east coast of Queensland, Cape York Peninsula and across into northern regions of Australia (refer Figure 8.13). In Queensland, it is estimated that the species population is limited to the bioregions of the Wet Tropics, Cape York Peninsula and Mount Isa Inlier. However, surveying of the species in another three bioregions has yet to occur. Some adults of Red goshawk in southeast Australia have been known to migrate annually from the ranges down into the lowlands during winter period. The species is thought to be extinct in southeast Queensland as well as being very rare in NSW extending south to about 30°S (DES 2017; OEH 2017).

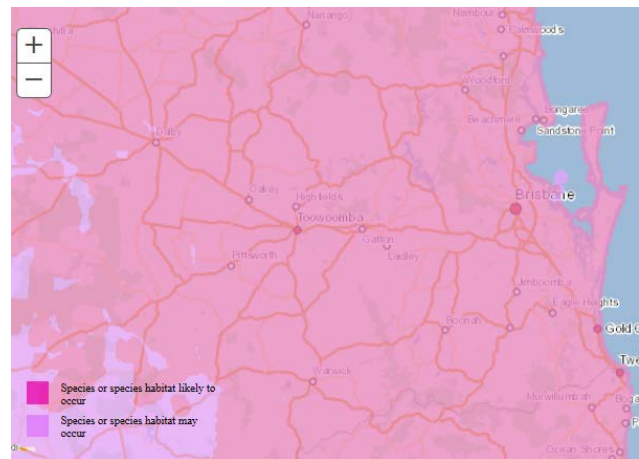


Figure 8.13 Distribution range of Red goshawk

Source: ALA (2016), DotEE (2018)

8.7.2.3 Distribution in relation to the Project

Red goshawk was not identified during any Project-associated field surveys including RE assessments and threatened flora surveys within the alignment where this species occurs (Eco logical 2016; Aurecon 2018). Database records indicate this species has been recorded within 50 km of the Project. It is noted available records (AoLA) have all been generalised in order to protect the species and so accurate locations have not been published. The nearest specimen backed record occur approximately 11 km to the north of the Project east of Kelvinhaugh there was however no date supplied for this record. A relatively recent record occurs to the west of Kelvinhaugh and 17 km north-west of the Project was recorded from 1980. The most recent nearby record occurs at Silver Ridge from 2012 approximately 17 km east of the northern end of the Project. Other records for the species within a 50 km radius of the Project occur in the Lockyer Valley with most records dated between the early 1990s and 2000s (refer Figure 8.14).

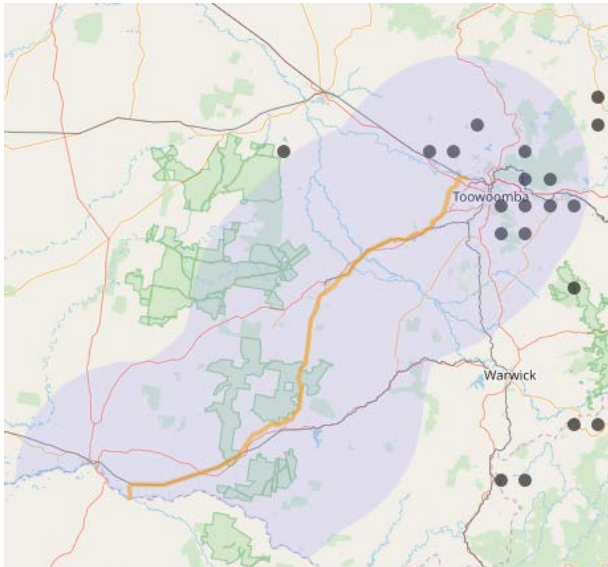


Figure 8.14 Distribution range of Red goshawk in relation to the Project

Source: ALA (2020)

8.7.2.4 Biology and reproduction

The solitary Red goshawk is known to prey on birds such as Australian brush-turkeys, Kookaburras and Rainbow lorikeet as well as small mammals, reptiles and insects. The species is known to attack its prey from the air, gliding straight down or chasing it down. The male of the species will build nests using dead sticks lined with twigs and green leaves within an exposed fork in the upper quarter of a tree between 10 to 20 m above ground and used each year (DES 2017; OEH 2017).

The breeding season for Red goshawk occurs from September to December with one to two eggs being laid by the females between August and October in the southeast regions. Females will incubate eggs for a period of 39 to 43 days with the young being fully fledged after eight weeks despite not being independent for at least another ten weeks (DES 2017).

8.7.3 Habitat

The Red goshawk typically occurs in both coastal and sub-coastal areas, in wooded and forested lands of tropical and warm-temperate Australia. Riverine forests are also used frequently. The Red goshawk nests in large trees, frequently the tallest and largest in a stand, which are typically within one kilometre of a permanent water source. This species typically avoids very dense, and very open habitats (Debus 1991; 1993; OEH 2017; Marchant and Higgins 1993).

In Queensland the species is known to inhabit cleared parts of eastern Queensland associated gorges and escarpment country whilst in NSW the preferred habitat includes mixed subtropical rainforest such as *Melaleuca* swamp forest as well as riparian *Eucalyptus* forest of coastal rivers (DES 2017; OEH 2017).

8.7.4 Threatening processes

The following have been identified as potentially threatening processes to the Red goshawk:

- Heavy habitat fragmentation caused by urban development, agriculture and forestry processes clearing extensive areas of forests
- Vulnerability of nests to storm damage and prey
- Development or noise dispersing food sources (DES 2017).

8.7.5 Threat abatement/recovery plans

No threat abatement plans have been identified as being relevant to this species.

The following recovery plan has been identified as being relevant for this species:

- Department of Environment and Resource Management (2012). National recovery plan for the red goshawk *Erythrotriorchis radiatus*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra. Queensland Department of Environment and Resource Management, Brisbane. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-red-goshawk-erythrotriorchis-radiatus>. In effect under the EPBC Act from 24-Jul-2012 as *Erythrotriorchis radiatus*.

8.7.6 Summary of threat abatement/recovery plan

Threats identified in the recovery plan for this species includes:

- Loss of habitat
- Fragmentation of existing habitat
- Reduction in nest sites through the loss of mature trees
- Reduction to the prey base
- Threats to prey availability
- Knowledge and communication gaps for this species
- Poor management practices.

Recover plan actions for this species include:

- Identify and map important Red goshawk habitat
- Protect and appropriately manage important habitat areas for the species to ensure its long-term survival
- Gain a better understanding regarding the reproductive success and survival for the Red goshawk
- Identify important populations for the species
- Increase community awareness and engagement in the conservation of the species.

8.7.7 References

Atlas of Living Australia (2016). *Erythrotriorchis radiatus*. Available from:

<https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:1405a1d4-557c-40ac-9f44-a6d41e9136cd#overview> [Accessed 22 August 2018].

Debus, S.J.S. (1991). An annotated list of NSW records of the Red goshawk. *Australian Birds*. 24:72- 89

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Office of Environment and Heritage (2017). Red Goshawk – Profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10279> [Accessed 22 August 2018].

8.8 Regent honeyeater (*Anthochaera phrygia*)

8.8.1 Status

EPBC Act – Critically Endangered

8.8.2 Biology and ecology

8.8.2.1 Characteristic

The Regent honeyeater (*Anthochaera phrygia*) is approximately 20 to 23 cm in total length, and weighs between 31 to 50 g. This species is characterised by its striking black and yellow appearance. The head, neck and upper breast of the species features black feathering which transitions into a lemon-yellow back and leads to black wings with conspicuous yellow patches. The tail of the bird is predominantly black with yellow edging (refer Photograph 8.8). Males of the species are distinguished by yellowish warty bare skin surrounding the eye whilst females are noticeably smaller in size with a bare yellowish patch under the eye as well as less black on the throat. Young Regent honeyeaters resemble females, however have a browner and paler bill (Birdlife 2018; Curtis et al. 2012).



Photograph 8.8 Regent honeyeater (*Anthochaera phrygia*)

Source: eBird Australia (2015)

8.8.2.2 Known distribution

The Regent honeyeater is a species endemic to southeast Australia, ranging from southeast Queensland to central Victoria (refer Figure 8.15). Despite historic records indicating that the species ranged widely, from Rockhampton, Queensland to Adelaide, the species is now restricted to the western slopes of the Great Diving Range (Birdlife 2018).

In southeast Queensland, the Regent Honeyeater's distribution ranges from the Cooloola Plains in the north to inland areas such as Dalby, and further south into areas such as Narrabri NSW. Regent honeyeater breeding occurs by a smaller number of the species regularly west of Warwick in Queensland (Curtis et al. 2012; DES 2017).

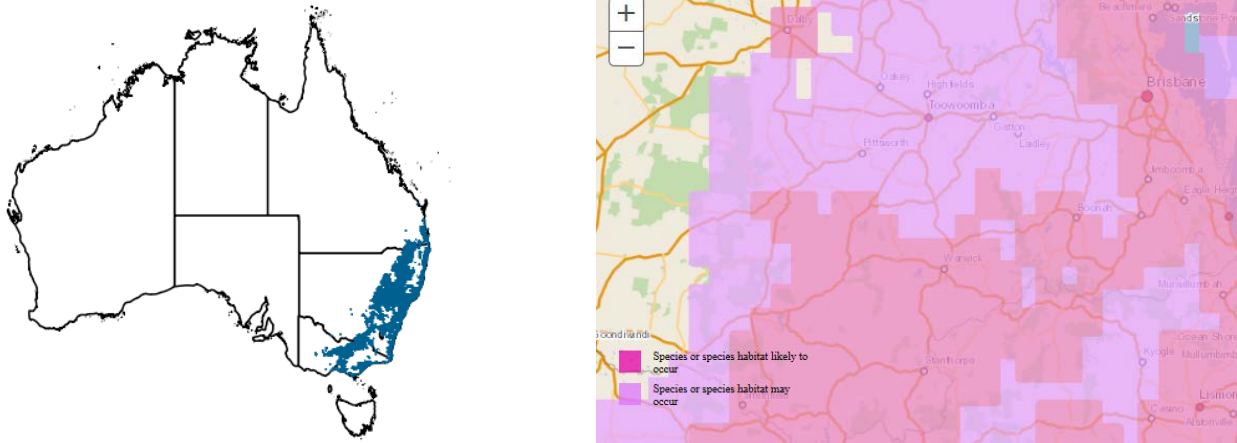


Figure 8.15 Distribution range of the Regent honeyeater

Source: ALA (2018), DotEE (2018)

8.8.2.3 Distribution in relation to the Project

This species was not identified during any Project-associated field surveys within the impact assessment area. Regent honeyeater is not known from within or near the Impact assessment area. It is noted AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. The nearest records to the Project footprint are two records east of Towoomba from the 1980s (24 km and 27 km away from the Project footprint). There are a number of records (including recent sightings) from the Durikai area (considered as 'critical habitat' for the species as noted below) which is located approximately 35 km east of the Project footprint (AoLA 2020). Almost all records are located substantially east of the Project. The only records west of the Project are from Dalby (60 km north-west of the Project), Chinchilla (140 km away) and near Saint George (over 200 km away) (refer Figure 8.16).

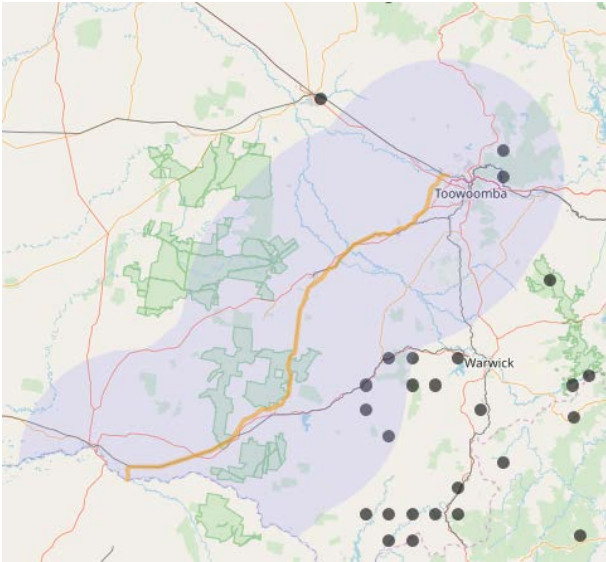


Figure 8.16 Distribution range of the Regent honeyeater in relation to the Project

Source: ALA (2020)

8.8.2.4 Biology and reproduction

The Regent honeyeater's diet consists of nectar from key species such as Yellow Box (*Eucalyptus melliodora*), White Box (*Eucalyptus albens*) and Mugga Ironbark (*Eucalyptus sideroxylon*) as well as sugary exudates. The species is also known to consume insects particularly when breeding (Birdlife International 2016).

The species breeds as individual pairs or sometimes in loose colonies with the female honeyeater incubating eggs whilst both parents feed the young. The eggs are often laid in cup-shaped nest 1 m to 20 m above the ground in tree forks of eucalypts and sometimes among mistletoe. The nests are usually constructed of bark with soft material lining the nest (Birdlife 2018; Birdlife International 2016).

8.8.3 Habitat

The preferred habitat of the Regent honeyeater is wet areas containing fertile soils that provide reliable nectar seasonally in areas of creek flats, river valleys and lower slopes. They are also found in dry eucalypt woodland and open forest in both rural and urban environments with mature eucalypts (DES 2018).

Other habitats of the species include Swamp mahogany (*E. robusta*), Spotted gum (*Corymbia maculata*) and River she-oak (*Casuarina cunninghamiana*) with associated Mistletoe (*Amyena cambagei*) (DES 2018).

8.8.4 Threatening processes

The following have been identified as potentially threatening processes to the Regent honeyeater:

- Habitat loss, fragmentation and degradation as a result of clearing for agriculture and development
- Suppression of natural regeneration of overstorey tree species and shrub species as a result of overgrazing
- Competition from larger, aggressive species such as the Noisy miner, Noisy friarbird and Red wattlebird
- Disturbance to nesting sites leading to abandonment (OEH 2017).

8.8.5 Threat abatement/recovery plans

The following threat abatement plan has been identified as being relevant to this species:

- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016>. In effect under the EPBC Act from 07-Jan-2017.

The following recovery plan has been identified as being relevant for this species:

- Department of the Environment (2016). National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*). Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-regent-honeyeater-anthochaera-phrygia-2016>. In effect under the EPBC Act from 04-May-2016 as *Anthochaera phrygia*.

8.8.6 Summary of threat abatement/recovery plan

Threats identified in the Threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Suppress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

Threats identified in the National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*) include:

- A reduction in population size
- The loss of habitat and further fragmentation
- Degradation of remaining habitat
- Competition with other nectivorous birds and the honeybee (*Apis mellifera*).

Recover plan actions for this species include:

- Improve Regent honeyeater habitat in extent and quality
- Utilise captive-bred birds to bolster wild populations until they become self-sustaining
- Better understand wild Regent honeyeater population parameters including size, structure and population trends
- Increase and maintain existing community awareness, understanding and involvement in the recovery program.

8.8.7 References

- Atlas of Living Australia (2018). *Anthochaera (Xanthomyza) phrygia*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:af9380ee-2f65-4213-bb6f-ea6baf92ad3e#overview> [Accessed 17 August 2018].
- Birdlife Australia (2018). Regent Honeyeater. Available from: <http://www.birdlife.org.au/bird-profile/regent-honeyeater> [Accessed 17 August 2018].
- BirdLife International (2016). *Anthochaera phrygia*. The IUCN Red List of Threatened. Available from: <http://www.iucnredlist.org/details/full/22704415/0> [Accessed 17 August 2018].
- Curtis, Lee K. Dennis, Andrew J. McDonald, Keith R. Kyne, Peter M. Debus, Stephen J.S (2012). Queensland's Threatened Animals. CSIRO.
- Department of Environment and Science (2017). Regent Honeyeater. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/regent_honeyeater.html [Accessed 17 August 2018].
- eBird Australia. (2015). Regent honeyeater (*Anthochaera phrygia*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageId=ad1bf8a3-56b4-4f31-ab23-4e19388eeecac>. [17 September 2019].

8.9 Squatter pigeon (*Geophaps scripta scripta*)

8.9.1 Status

EPBC Act – Vulnerable

8.9.2 Biology and ecology

8.9.2.1 Characteristics

The Squatter pigeon (*Geophaps scripta scripta*) (southern sub-species) is a heavily built, medium sized ground dwelling pigeon, measuring approximately 26 to 32 cm in total length with a wing span of 45 cm. Adults are generally grey-brown in colour, with black and white stripes on the face and throat, blue-grey skin around the eyes, dark brown (with some patches iridescent green or violet) wings, a blue-grey lower breast, and white flanks and lower belly (refer Photograph 8.9). Both sexes are of similar appearance, whilst juveniles are duller in colour, with patchy and less distinctive black and white facial stripes and paler facial skin (DotEE 2018; OEH 2017; NPWS 1999).



Photograph 8.9 Squatter pigeon southern sub-species (*Geophaps scripta scripta*)

Source: ALA (2016)

8.9.2.2 Known distribution

The Squatter pigeon (southern sub-species) was once found widespread nationally extending from southern NSW to the Burdekin River in northern Queensland (refer Figure 8.17). However, the species is now limited to an area from north Queensland to the northwest slopes of NSW, including southeast Queensland, the western slopes of the Great Dividing Range, the Gwydir River region and the Liverpool Plains (Cooper et al. 2014; OEH 2017).

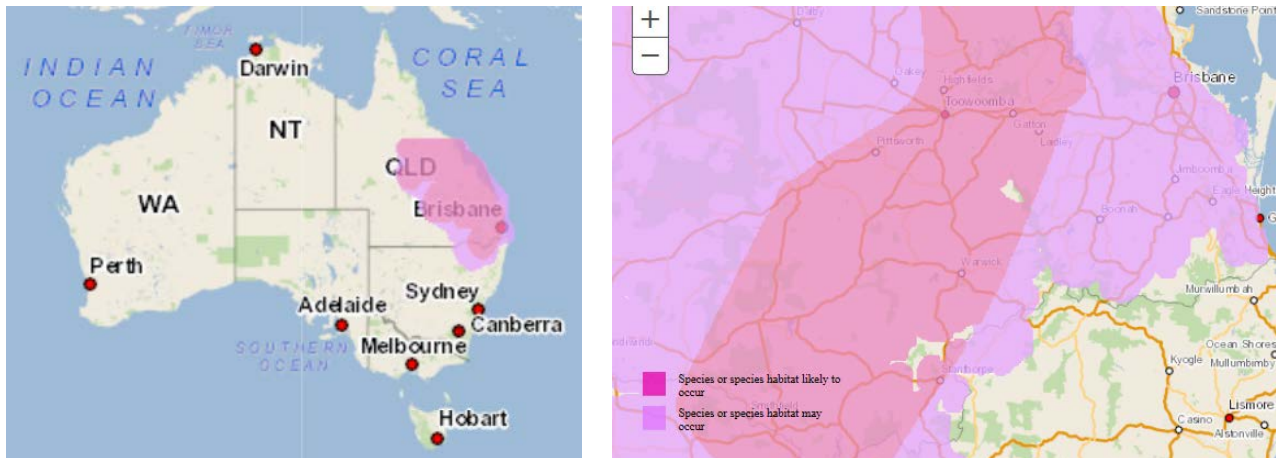


Figure 8.17 Distribution range of the southern Squatter pigeon

Source: DotEE (2018)

8.9.2.3 Distribution in relation to the Project

Squatter pigeon was not identified during any Project-associated field surveys (Ecological 2016; Aurecon 2018). There are a number of database records around the Inglewood area and further north-east in Durikai State Forest. The nearest of these is from 2017 and located 1.2 km west of the Project footprint in Bringalilly State Forest. A second record (2014) is located 5 km east of the alignment in the same area located on the edge of Devine State Forest. The majority of records are to the south and east of the alignment and are generally more than 10 km away from the Project footprint (refer Figure 8.18). These records occur predominantly within forest reserves around the Inglewood area. Records are mostly scattered occurring from Dhinna Dhinawan National Park over the border in northern New South Wales, at Yelarbon State Forest to Texas to the south-east of the Project to Talgai and Bringalilly State Forest. Records throughout this region include many that are from within the last 20 years. There are scattered records to the east of the northern extent of the Project, however these are largely older and located more than 15 km away from the Project footprint.

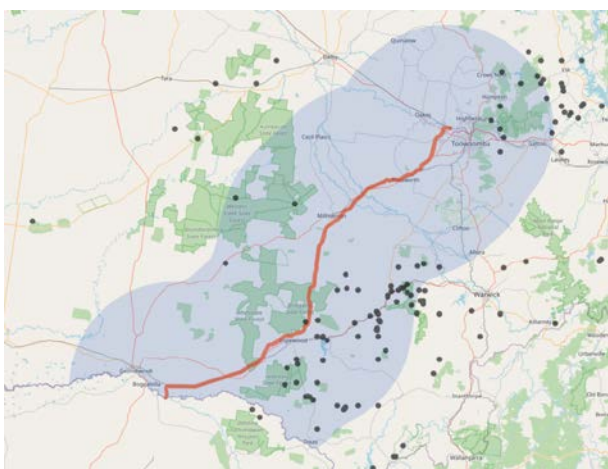


Figure 8.18 Distribution range of the southern Squatter pigeon in relation to the Project

Source: ALA (2020)

8.9.2.4 Biology and reproduction

The Squatter pigeon (southern sub-species) forages on the ground for grass seeds, herbs, shrubs and insects. The Squatter pigeon is typically seen in pairs, or in small groups of up to 20 or more individuals and breed throughout the year. Breeding however is influenced by heavy rainfall which most commonly occurs during the dry season between May and June (DotEE 2018; OEH 2017; Pizzey and Knight 2007).

Squatter pigeon nests are depressions scraped into the ground beneath a tussock of grass, bush, fallen tree or log and sparsely lined with grass. The female lays two eggs which are smooth, lustrous, pale cream and oval with an incubation period of approximately 17 days by both parents. Southern Squatter pigeon chicks will remain in the nest for a further 2 to 3 weeks after hatching (Australian Bush Birds 2018; AWC 2017; DotEE 2018).

8.9.3 Habitat

The Squatter pigeon (southern sub-species) is known to inhabit grassy understorey of open eucalypt woodlands and plains featuring sandy areas within close proximity to water. Areas of semi-arid or arid landscape with sandy, open and short grass cover dissected by gravel ridges is the preferred habitat for the species. The ground cover in foraging and breeding habitat is typically patchy, consisting of native, perennial tussock grasses or a mix of perennial tussock grasses and low shrubs or forbs. This vegetated ground layer rarely exceeds 33% of the ground area. The remaining ground surface typically consists of bare patches of gravelly or dusty soil, and areas lightly covered in leaf litter and coarse, woody debris (e.g. fallen trees, logs and smaller debris). The species is also often found alongside tracks and roadsides (DotEE 2018; OEH 2017).

8.9.4 Threatening processes

The following have been identified as potentially threatening processes to the southern Squatter pigeon:

- Fragmentation and/or clearing of grassy woodland habitats for agriculture and development
- Overgrazing by domestic stock and feral rabbits of habitat
- Predation by feral cats and foxes
- Illegal shooting (OEH 2017).

8.9.5 Threat abatement/recovery plans

8.9.6 Threat abatement/recovery plans

No recovery plan has been identified as being relevant to this species.

The following threat abatement plans has been identified as being relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016>. In effect under the EPBC Act from 07-Jan-2017.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox>. In effect under the EPBC Act from 01-Oct-2008.

8.9.7 Summary of threat abatement/recovery plan

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the Threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Suppress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

Threats identified in the Threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

8.9.8 References

Atlas of Living Australia (2016). *Geophaps (Geophaps) scripta scripta*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:d5c52cd0-6d21-4322-a5c5-bc11a94d8c3a#overview> [Accessed 22 August 2018].

Australian Bush Birds (2018). Squatter Pigeon - *Geophaps scripta*. Available from: <http://www.australianwildlife.org/wildlife/squatter-pigeon.aspx> [Accessed 22 August 2018].

Australian Wildlife Conservancy (2017). Species profile - Squatter Pigeon. Available from: <http://www.australianwildlife.org/wildlife/squatter-pigeon.aspx> [Accessed 22 August 2018].

Department of the Environment and Energy (2018). *Geophaps scripta scripta* (Squatter Pigeon) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64440 [Accessed 22 August 2018].

National Parks and Wildlife Service (1999). Threatened Species Information – Squatter Pigeon. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/resources/nature/tsprofileSquatterPigeon.pdf> [Accessed 22 August 2018].

Office of Environment and Heritage (2017). Squatter Pigeon (southern) - Profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10350#> [Accessed 22 August 2018].

Pizzey, G. and Knight, F. 2007, The Field Guide to the Birds of Australia (8th edition) Harper Collins Publishers, NSW, Australia.

8.10 Swift parrot (*Lathamus discolor*)

8.10.1 Status

EPBC Act – Critically Endangered, Marine

8.10.2 Biology and ecology

8.10.2.1 Characteristics

The Swift parrot (*Lathamus discolor*) is a small lorikeet-like parrot with a long slender tail measuring approximately 25 cm in body length and weighing 77 g. The Swift parrot is predominately bright green in colour, with dark-blue patches on the crown, a prominent red face, and the chin and throat are narrowly bordered with yellow. One of most distinctive features from a distance is its long 12 cm, thin tail, which is dark red (refer Photograph 8.10). The female Swift parrot is distinguishable from the male as it has slightly duller feathering with a creamy underwing bar (Birdlife 2018; DES 2017; OEH 2017).



Photograph 8.10 Swift parrot (*Lathamus discolor*)

Source: eBird Australia (2015)

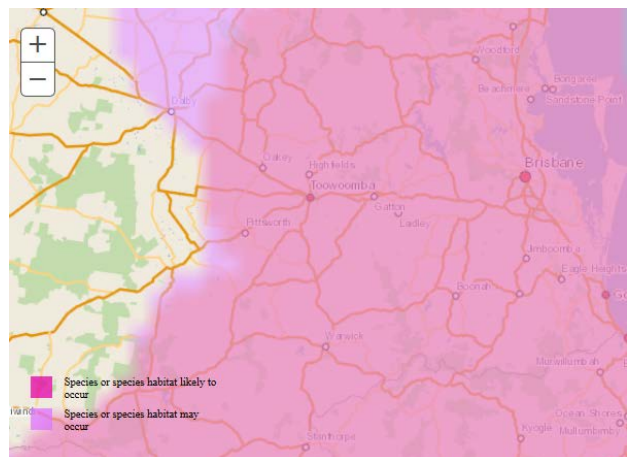
8.10.2.2 Known distribution

The Swift parrot is endemic to southeastern Australia. This species breeds only in Tasmania and migrates during the autumn and winter months to southeast Queensland as well as both coastal and the southwest slopes of NSW (DotEE 2018; OEH 2017) (refer Figure 8.19).



Figure 8.19 Distribution range of Swift parrot

Source: ALA (2018), DotEE (2018)



8.10.2.3 Distribution in relation to the Project

Swift parrot was not identified during any Project-associated field surveys within the impact assessment area. There are several records from the Toowoomba area, the closest of which is 4.5 km east of the northern extent of the Project footprint (no location or date data attached). It is noted most AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. Glen Lomond Park is a 'priority habitat area' (Saunders and Tzaros 2011) and located approximately 17 km east to south-east of the northern extent of the Project footprint. There are two records near this area from 2000. There are a cluster of records around Durikai State Forest (approximately 40 km east of the central portion of the Project footprint). There are two other records scattered to the east of the southern extent of the Project footprint from Texas (1984) and near Wilga Park Nature Refuge (2017) although neither is within 40 km of the Project footprint. The only records west of the Project are three records that are old and over 100 km north-west of the Project (refer Figure 8.20). It is noted the northern section of the Project (where the species may be more likely to occur) passes through heavily modified lands that are largely cleared of woody vegetation.

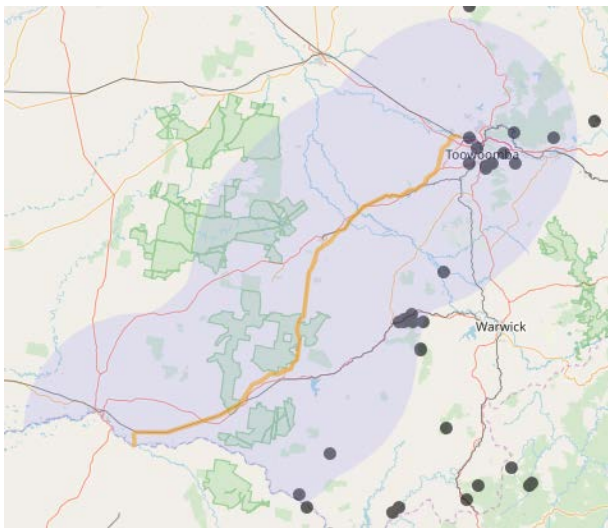


Figure 8.20 Distribution range of Swift parrot in relation to the Project

Source: ALA (2020)

8.10.2.4 Biology and reproduction

The Swift parrot feeds mostly on nectar, mainly from Eucalypts, but also eats psyllid insects and lerps (waxy secretion on Eucalypt leaves produced as a protection by young psyllid insects), seeds and fruit. Swift parrots are mostly arboreal foragers, foraging mainly in Eucalypts, but occasionally coming to the ground to feed on seeds, fallen flowers, fruit and lerp, and to drink (DotEE 2018; Higgins 1999; Mallick et al. 2004; Swift parrot Recovery Team 2011).

Swift parrot's breeding season occurs from mid-September to late-January in Tasmania. Nests are typically constructed in hollows of trunks, a branch or spout of a living or dead gum tree with nests known to be used each year. The typical nesting season begins in late September with females laying 3 to 5 eggs during October and November. The females incubate the eggs and fledging hatch from early December to late January (Birdlife 2018; DotEE 2018).

8.10.3 Habitat

The Swift parrot typically inhabits dry sclerophyll, Eucalypt forests, woodlands, suburban parks and even gardens with flowering fruit trees with records showing it occasionally inhabiting wet sclerophyll forests (Birdlife 2018; Swift parrot Recovery Team 2011).

In northern NSW and southeastern Queensland, Narrow-leaved ironbark (*Eucalyptus crebra*), Forest red gum (*E. tereticornis*) forests and Yellow box (*E. melliodora*) forest are commonly utilised by Swift parrots (OEH 2017). While on the western slopes Mugga ironbark (*E. sideroxylon*) and Grey Box (*E. microcarpa*) woodlands are used (DotEE 2018).

Habitats associated with the inland slopes of the Great Dividing Range, and along the eastern coastal plains, are considered the principal wintering grounds (DotEE 2018).

8.10.4 Threatening processes

The following have been identified as potentially threatening processes to the Swift parrot:

- Habitat loss associated with breeding sites as well as drought refugia habitat
- Habitat alteration through forestry operations, firewood collection and urbanisation in Tasmania
- Competition with noisy miner and aggressive honeyeaters
- Nest predation by gliders (DES 2017; OEH 2017).

8.10.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant to this species:

- Saunders, D.L. & C.L. Tzaros (2011). National Recovery Plan for the Swift Parrot (*Lathamus discolor*). Birds Australia, Melbourne. Available from: <http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-swift-parrot-lathamus-discolor>. In effect under the EPBC Act from 10-Feb-2012.

The following threat abatement plans has been identified as being relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats>. In effect under the EPBC Act from 23-Jul-2015.

8.10.6 Summary of threat abatement/recovery plan

Threats identified in the National Recovery Plan for the Swift parrot include:

- Habitat loss and alteration from forestry activities including fire wood harvesting
- Residential and industrial development
- Agricultural tree senescence and dieback
- Suppression of tree regeneration
- Frequent fires
- Climate change
- Mortality resulting in collision with wire netting or mesh fences
- Competition from large, aggressive honeyeaters
- Psittacine Beak and Feather Disease (PBFD), which can have devastating impacts depending on general conditions and parrot health
- Illegal poaching of wildlife
- The cumulative impact of all threats.

Threat abatement actions for this species include:

- The identification of the quality and extent of suitable habitat
- Managing and protecting suitable Swift parrot habitat at the landscape level
- Monitor and manage the impact of collisions, competition and disease
- Monitor population and habitat

- Increase community awareness and involvement in the recovery program
- Report on and review the recovery process.

Threats identified in the Threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

8.10.7 References

Atlas of Living Australia (2018). *Lathamus discolor*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:3f12e573-a7b7-45e7-a6e4-aeae9bc3a9ed> [Accessed 22 Aug. 2018].

Birdlife Australia (2018). Swift Parrot. Available from: <http://www.birdlife.org.au/bird-profile/swift-parrot> [Accessed 22 August 2018].

Department of Environment and Energy (2018). *Lathamus discolor* (Swift Parrot) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=744 [Accessed 22 August 2018].

Department of Environment and Science (2011). Swift parrot. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/swift_parrot.html [Accessed 22 August 2018].

eBird Australia. (2015). Swift parrot (*Lathamus discolor*). [image] [online] Available from: <https://images.ala.org.au/image/details?imageld=5fdc44e4-6dcf-4a63-955c-c6ae76f938a1>. [17 September 2019].

Office of Environment and Heritage (2017). Swift Parrot - Profile. New South Wales Government. Available from: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10455> [Accessed 22 August 2018].

8.11 Curlew sandpiper (*Calidris ferruginea*)

8.11.1 Status

EPBC Act – Critically Endangered Marine and Migratory (CAMBA)

8.11.2 Biology and ecology

8.11.2.1 Characteristic

The Curlew sandpiper (*Calidris ferruginea*) is a small sandpiper approximately 18 to 23 cm long with a wingspan of 38 to 41 cm and weighing about 57 g. The head is small and round with a black bill that is long and decurved with a slender tip, sometimes with a brown or green tinge at the base (refer Photograph 8.11). The sexes are similar, but females have a slightly larger and longer bill and a slightly paler underbelly in breeding plumage (DotEE 2018).

In breeding plumage, the head, neck and underbody are a rich chestnut-red with narrow black bars on the belly and flanks. There are black streaks on the crown, a dusky loreal stripe, and white around the base of the bill. The feathers on the mantle and scapulars are black with large chestnut spots and grayish-white tips. The back and upper rump are dark brown, with a prominent square white patch across the lower rump and uppertail-covert (DotEE 2018).

During the breeding season the cap, ear-coverts, hindneck and sides of neck are pale brownish-grey with fine dark streaks changing to white on the lower face and throat. There is a narrow dark loreal stripe and white supercilium from the bill to above the rear ear-coverts. The mantle, back, scapulars, tertials and innerwing-covert are pale brownish-grey with fine dark streaks. The underbody is white with a brownish-grey wash and fine dark streaks on the breast (DotEE 2018).



Photograph 8.11 Curlew sandpiper (*Calidris ferruginea*)

Source: Emilio (2014)

8.11.2.2 Known distribution

In Australia, Curlew sandpipers occur around the coasts and are also quite widespread inland (refer Figure 8.21). Records occur in all states and territories during the non-breeding season as well as the breeding season when immature birds remain in Australia rather than migrating north towards Siberia (DotEE 2018).

In Queensland, widespread records occur along the coast south of Cairns with sparsely scattered records inland. In NSW, they are widespread east of the Great Divide, especially in coastal regions. They are occasionally recorded in the Tablelands and are widespread in the Riverina and southwest NSW, with scattered records elsewhere (DotEE 2018).

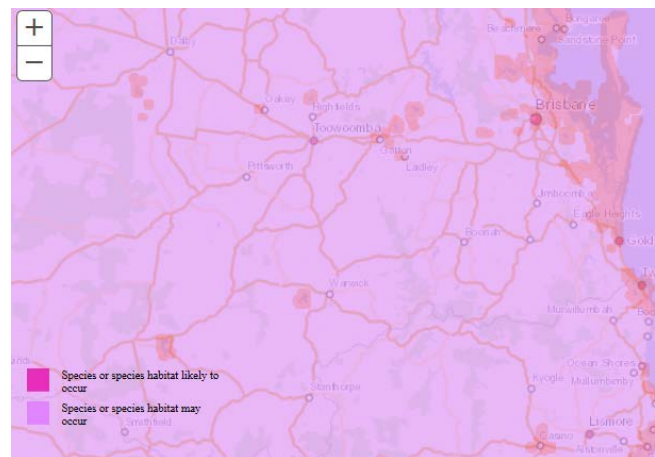


Figure 8.21 Distribution range of the Curlew sandpiper

Source: ALA (2018), DotEE (2018)

8.11.2.3 Distribution in relation to the Project

Curlew sandpiper was not identified during any Project-associated field surveys within the impact assessment area. There are few within 50 km of the Project footprint. The closest database record occurs from at Lake Coolmunda to the east of Inglewood (12 km east of the Project footprint), however this record is not dated. There is a recent record (2018) from Lake Cooby located 14 km north of the northern extent of the Project. Other records occur near Oakey (1980 - 15 km north-west), south of Dalby at dam sites (2007 and 1985 – over 50 km west) (refer Figure 8.2). The vast majority of occurrence records for this species occur along the east coast. Virtually all inland sites are on large waterbodies with shallow edges.

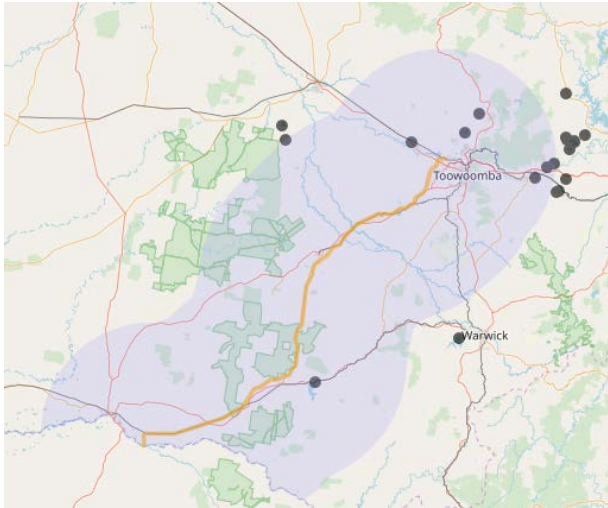


Figure 8.22 Distribution range of the Curlew sandpiper in relation to the Project

Source: ALA (2020)

8.11.2.4 Biology and reproduction

In Australia, the Curlew sandpiper forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Curlew sandpipers usually forage by pecking and probing in water, near the shore or on bare wet mud at the edge of wetlands. They glean from mud, from the surface of water, or in drier areas above the edge of the water. Curlew sandpipers may wade up to the belly, often with their heads submerged while probing. They often forage in mixed flocks, including with Red-necked stints (*Calidris ruficollis*). In tidal waters, the birds move onto the most recently exposed parts of the tidal flats and retreat in stages as the tide comes in. Supratidal feeding mainly occurs during the pre-migratory fattening periods (February to April) (DotEE 2018).

This species does not breed in Australia and they move north to Siberia to breed and nest during June and July (Hayman et al. 1986).

8.11.3 Habitat

Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. Occasionally they are recorded around floodwaters and wet mats of algae or waterweed, or on banks of beachcast seagrass or seaweed (DotEE 2018).

Curlew sandpipers generally roost on bare dry shingle, shell or sand beaches, sandspits and islets around coastal and near-coastal lagoons and other wetlands. They occasionally roost in dunes and saltmarshes (DotEE 2018).

8.11.4 Threatening processes

The following have been identified as potentially threatening processes to the Curlew sandpiper:

- In non-breeding grounds in Australia, this species mostly occurs in highly populated areas and is therefore vulnerable to possible habitat alteration
- Threats to the Curlew sandpiper include the loss and fragmentation of feeding and roosting habitat from human development, human disturbance at roost and feeding sites, disturbance by wild dogs and pollution (DECC 2005; DotEE 2018, DECC 2005).

8.11.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from <https://www.environment.nsw.gov.au/savingourspeciesapp/Project.aspx?results=c&ProfileID=20166>. In effect under the BC Act 2016.

The following marine bioregional plan has been identified as being relevant for this species:

- Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2012). *Marine bioregional plan for the North-west Marine Region*. Prepared under the *Environment Protection and Biodiversity Conservation Act 1999*. Available from: <http://www.environment.gov.au/topics/marine/marine-bioregional-plans/north-west>. In effect under the EPBC Act from 27-Aug-2012.

No threat abatement plan has been identified as being relevant for this species

8.11.6 Summary of threat abatement/recovery plan

Paspalidium grandispiculatum is assigned as a partnership (range-restricted) species under the NSW Saving our Species Program. The conservation strategy identifies five priority management sites:

- Richmond River Estuary in Ballina, Byron, Lismore, Richmond Valley LGA
- Clarence River Estuary in Clarence Valley LGA
- Manning River Estuary in Mid-Coast LGA
- Hunter Estuary and Port Stephens in Lake Macquarie, Maitland,
- Mid-Coast, Newcastle, Port Stephens LGA
- Shoalhaven Estuary in Goulburn Mulwaree, Shoalhaven LGA.

Threats identified at the management sites include:

- Human disturbance at roosting and foraging sites from fishing, baiting, pets, boating, horses, 4WDing, biking and surfing
- Mangrove incursion into saltmarsh habitat
- Habitat loss from development such as major port expansions and transport related development
- Habitat loss from erosion, climate change inundation and sea-level rise.

Management activities to protect this species at the sites are:

- Educate recreational users and land managers on the impact of disturbance on birds to minimise the impact of recreational activity
- Install signage and exclusion fencing at significant foraging and roosting sites
- Protect habitat from degradation using methods such as raising the height of dikes or armouring works around intertidal feeding sites

- Identify and protect opportunities for wader habitat expansion by liaising with relevant agencies and land managers
- Continue monthly population monitoring and liaise with other regions to assess trends in the species across its range
- Monitor habitat usage where management strategies have been implemented to assess their effectiveness.

In terms of the Marine bioregional plan for the North-west Marine Region, the relevant management strategies for the Curlew sandpiper include:

- Increase the support from research organization
- Establish and manage a Commonwealth marine reserve network to provide protection and conservation of biodiversity
- Provide regional advice determining the significance of potential impacts
- Develop targeted collaborative programs to coordinate species recovery and environmental protection efforts
- Improve monitoring, evaluation and reporting on ecosystem health.

8.11.7 References

Atlas of Living Australia (2018). *Calidris (Erolia) ferruginea*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:fa188c0e-68ba-4b3f-8e8f-48734608c7d1> [Accessed 23 August 2018].

Birdlife Australia (2018). Curlew Sandpipers. (Image) [Online] Available from: <http://birdlife.org.au/bird-profile/curlew-sandpiper> [Accessed 22 August 2018].

Department of the Environment and Energy (2018). *Calidris ferruginea* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=856 [Accessed 22 August 2018].

Department of Environment and Climate Change, NSW (DECC) (2005). *Taren Point Shorebirds - profile*. NSW DECC. Available from: <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10800> [Accessed 22 August 2018].

Emilio, J. (2014). Curlew sandpiper (*Calidris ferruginea*). [image] [online] Available from: https://www.flickr.com/photos/juan_e/14189744097/in/photolist-3Dg6vj-XhMbXb-rEiyqF-XnhsNC-rssdoW-AUdiMa-pdsrhP-dhR1NF-XPhgeP-MPQ8zZ-q6ScfT-3fHmMC-PrPzBY-c2Wp1A-qadmL4-dMuRJe-MPQ8s4-224r7hp-YNVDc5-rA499X-dMuRA8-d9oHrS-J5pVor-Dnv4mM-nBU9yi-4nUe3Y-3ZKHWu-rA9TAR-fUJf3r-DAhXUZ-3ZFvdM-21Wxs4h-CCLU2s-Ds1PXx-D2MNA2-6eZssG-4FMQa8-DnvAzZ-6eVizr-vYK8Ps-J5q4k8-2327Qcz-21Fvk46. [18 September 2019].

8.12 White-throated needletail (*Hirundapus caudacutus*)

8.12.1 Status

EPBC Act – Vulnerable, Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

8.12.2 Biology and ecology

8.12.2.1 Characteristic

The White-throated needletail (*Hirundapus caudacutus*) is a large swift with a thickset, cigar-shaped body, a stubby tail and pointed wings (refer Photograph 8.12). This species typically measures 20 cm in length and approximately 115 to 120 g in weight. Adults exhibit a dark-olive head and neck, with an iridescent gloss on the crown, whilst the mantle and the back are paler and greyish. The upperwings are blackish (often with a greenish gloss), with a contrasting white patch at the base of the trailing edge. The face is dark-olive with a narrow, white band across the forehead, and lores and a white patch on the chin and throat. The underparts are generally dark-olive except for a U-shaped band across the rear flanks, the vent and the undertail coverts, and the undertail is black with a greenish gloss (DotEE 2018).



Photograph 8.12 White-throated needletail (*Hirundapus caudacutus*)

Source: Knight (2007)

8.12.2.2 Known distribution

White-throated needletails breed in Asia, from central and southeastern Siberia and Mongolia, east to the Maritime Territories of Russia, Sakhalin and the Kuril Islands and south to northern Japan and northeastern China. Most White-throated needletails spend the non-breeding season in Australia, and occasionally in New Guinea and New Zealand (DotEE 2018).

The White-throated needletail is considered widespread in eastern and southeastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains (DotEE 2018) (refer Figure 8.23).

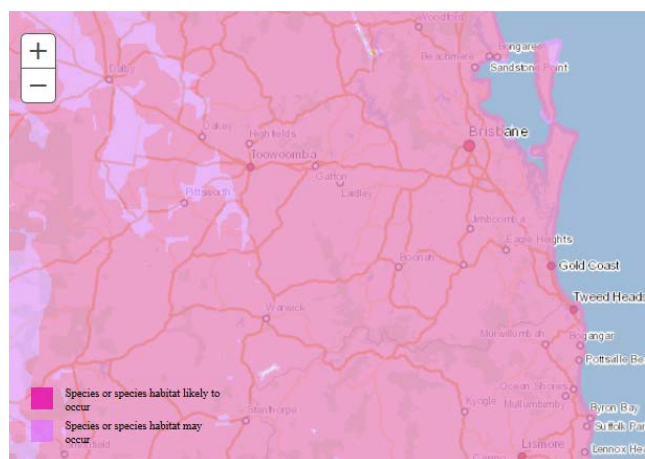


Figure 8.23 Distribution range of the White-throated needletail

Source: ALA (2018), DotEE (2018)

8.12.2.3 Distribution in relation to the Project

Hirundapus caudacutus has been identified as potentially occurring within the impact assessment area. Database records (i.e. AoLA, WildNet) indicate this species occurs within the Project footprint from 2017 at Bringalily State Forest. Records also indicate this species within the impact assessment area at Yelarbon (2018) and the Cunningham Highway (2016) at the southern end of Whetstone State Forest. Records exist from within a 50 km buffer of the Project footprint in all directions.

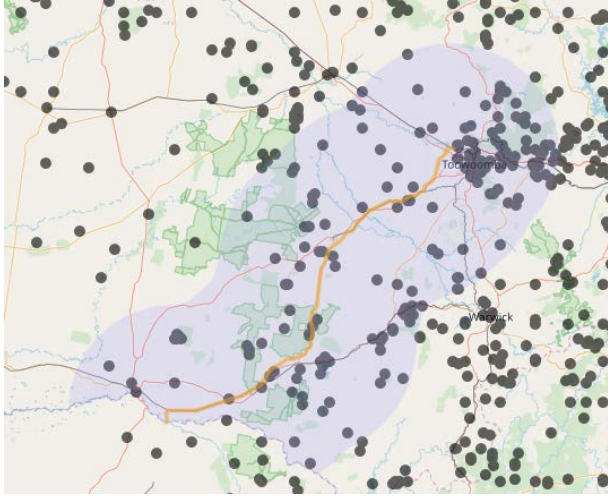


Figure 8.24 Distribution range of the White-throated needletail in relation to the Project

Source: ALA (2020)

8.12.2.4 Biology and reproduction

In Australia the White-throated needletail has been recorded eating a wide variety of insects, including beetles, cicadas, flying ants, bees, etc. (DotEE 2018).

White-throated needletails are non-breeding migrants in Australia. Breeding takes place in northern Asia from April to October (DotEE 2018).

8.12.3 Habitat

In Australia, the White-throated needletail is almost exclusively aerial, flying at heights of less than 1 m up to more than 1,000 m above the ground. White-throated needletails often forage along the edges of low pressure systems, which both lift their food sources, and assist with their flight. The species has been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows (DotEE 2018).

This species is known to occur over most types of habitat, however, they are most often recorded above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy. In coastal areas, they are often seen flying over sandy beaches or mudflats, and often around coastal cliffs and areas with prominent updraughts, such as ridges and sand-dunes (DotEE 2018).

8.12.4 Threatening processes

There appear to be few threats to the populations of White-throated nNeedletails in Australia, but there is always the potential threat of habitat destruction and predation by feral animals (DotEE 2018).

8.12.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

8.12.6 References

Atlas of Living Australia (2018). *Hirundapus caudacutus*. Available from: <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:21205690-54fd-452a-9772-d3e1f8780dff#> [Accessed 24 August 2018].

Department of the Environment and Energy (2018). *Hirundapus caudacutus* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=682 [Accessed 24 August 2018].

Knight, R. (2007). White-throated needletail (*Hirundapus caudacutus*). [image] [online] Available from: <https://www.flickr.com/photos/sussexbirder/8077024804/in/photolist-dCzG2D-diJS5m-diJRGS-s1aH3F>. [17 September 2019].