

APPENDIX

INLAND
RAIL 

J

Terrestrial Ecology Technical Report

Part 1 of 2

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

IR_1534

ARTC

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

Inland Rail Border to Gowrie EIS

Appendix J – Terrestrial Ecology
Technical Report

**Australian Rail Track
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Abbreviations

Abbreviation	Explanation
ALA	Atlas of Living Australia
AquaBAMM	Aquatic Biodiversity Assessment and Mapping Method
ARTC	Australian rail track corporation limited
B2G	Border to Gowrie Project
BAMM	Biodiversity Assessment and Mapping Methodology
BD	Biodiversity
Biosecurity Act	<i>Biosecurity Act 2014</i> (Qld)
BPA	Biodiversity planning assessment
CBD	Central business district
CE	Critically Endangered'
CEMP	Construction Environmental Management Plan
Ch	Chainage
CoC	Chain of Custody
CPESC	Certified Professional in Erosion and Sediment Control
Cr	Critical priority
DAF	Department of Agriculture and Fisheries
DAWE	Department of Agriculture, Water and the Environment
DDMRB	Darling Downs Moreton Rabbit Board
DEHP	Department of Environment and Heritage Protection (former)
DERM	Department of Environment and Resources Management (former)
DES	Department of Environment and Science
DEWHA	Department of the Environment, Water, Heritage and the Arts
DNRME	Department of Natural Resource Management and Energy
DotEE	Department of the Environment and Energy
DPI	Department of Primary Industries
DSDMIP	Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP)
DSITI	Department of Science, Information Technology and Innovation (former)
E	Endangered agenda
EIS	Environmental impact statement
EP Act	<i>Environmental Protection Act 1994</i> (Qld)
EP Reg	<i>Environmental Protection Regulation 20019</i> (Qld)
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth)
ERA	Environmentally relevant activity
Es	Emergent stratum
ESA	Environmentally sensitive area
ESD	Environmentally sustainable development
EVNT	Endangered, 'Vulnerable' and Near-threatened
EX	Extinct
FBW	Flash butt welding
FFJV	Future Freight Joint Venture

Abbreviation	Explanation
FHA	Fish habitat area
Fisheries Act	<i>Fisheries Act 1994 (Qld)</i>
G	Ground stratum
G2H	Gowrie to Helidon
GDE	Groundwater dependent ecosystem
GIS	Geographic information system
GRC	Goondiwindi Regional Council
H	High priority
H2C	Helidon to Calvert
ha	Hectare
HES	High ecological significance
HVR	High value regrowth
IAS	Impact assessment study
ICBN	International Code of Botanical Nomenclature
ID	Identification
Inland Rail	Melbourne to Brisbane Inland Rail Program
kg/m	Kilogram/metre
km	Kilometre
Koala Plan	The Nature Conservation (Koala) Conservation Plan 2017
Land Act	<i>Land Act 1994 (Qld)</i>
LC	Least Concern
LOR	Limit of Reporting
m	Metre
M	Migratory
MCA	Multi-criteria analyses
Me	Medium priority
MLES	Matters of local environmental significance
mm	Millimetre
MNES	Matters of national environmental significance
MSES	Matters of State environmental significance
NC Act	<i>Nature Conservation Act 1992 (Qld)</i>
NRM	Natural resource management
NS2B	North Star to Border
NSW	New South Wales
NT	Near-threatened
OC	Of Concern
OEH	Office of Environment and Heritage (NSW)
Offsets Act	<i>Environmental Offsets Act 2014 (Qld)</i>
PAH	Polycyclic aromatic hydrocarbons
PDA	Planning development area
Planning Act	<i>Planning Act 2016 (Qld)</i>
PMST	Protected matters search tool

Abbreviation	Explanation
PRG	Project reference group
Project	Border to Gowrie Project
Public Health Act	<i>Public Health Act 2005</i>
QEOP	Queensland environmental offsets policy (Qld)
QLD	Queensland
QR	Queensland rail
RE	Regional ecosystem
S	Shrub stratum
SDA	State development area
SDPWO Act	<i>State Development and Public Works Organisation Act 1971 (Qld)</i>
SFRC	Southern freight rail corridor
SLC	Special least concern
sp.	Species
SPP	State Planning Policy 2017
spp.	Multiple species
T	Tree (canopy) stratum
TEC	Threatened ecological community
ToR	Terms of reference
TSSC	Threatened species scientific committee
V	Vulnerable
VM Act	<i>Vegetation Management Act 1999 (Qld)</i>
Water Act	<i>Water Act 2000 (Qld)</i>
Watercourse	Is a river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flows
WIM	Watercourse identification mapping
WoNS	Weeds of national significance
WPSQ	Wildlife Preservation Society Queensland

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.
Back on Track species prioritisation framework (Qld)	An initiative of the Department of Environment and Science (DES), the Back on Track species prioritisation program ranks species as Critical, High, Medium or Low priority for the State and for the Natural Resource Management (NRM) region (irrespective of their <i>Nature Conservation Act 1992</i> (Qld) (NC Act) or <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth) (EPBC Act) classification). There is also a data deficient category according to three sets of criteria: probability of extinction, consequences of extinction and potential for successful recovery. While not legislated, Back on Track provides a useful framework for biodiversity assessment and species prioritisation when determining ecological values. Priority Back on Track species have been identified for each of the 14 NRM regions across Queensland. The Border to Gowrie Project is located in the and Border Rivers Maranoa-Balonne NRM region.
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) (Department of Environment and Heritage Protection 2014). The BPAs draw upon the Department of Environment and Heritage Protection (former) (DEHP) 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.
Biodiversity status	For biodiversity planning purposes and in relation to Environmentally Sensitive areas (ESAs) the DES classifies an RE as 'Endangered' if: - Less than 10% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss, or 10 to 30% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 ha; or it is a uncommon RE subject to a threatening process. For biodiversity planning purposes and in relation to ESAs, DES classifies an RE as 'Of Concern' if: 10 to 30% of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss For biodiversity planning purposes and in relation to ESAs an RE is listed as 'Least Concern' at present if: - The degradation criteria listed above for 'Endangered' or 'Of Concern' REs are not met.
Bioregion	A bioregion as defined in An Interim Biographic Regionalisation of Australia (Thackway and Cresswell 1995). The bioregion subject to this report is the Brigalow Belt bioregion.

Term	Explanation
<i>Biosecurity Act 2014</i> (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', 'Vulnerable' or 'Near Threatened' under the provisions of the NC Act and migratory species listed under the EPBC Act (refer NC Act conservation significance and 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
Critical priority	Rating associated with the Back on Track species prioritisation framework. Constitutes the highest total score/priority.
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 impact assessment area	The cumulative impact assessment area encompasses the Project and extends 50 km beyond the temporary Project footprint
Cumulative impact Project footprint	The cumulative impact Project footprint encompasses the Projects that are identified within Table 6.1 of this technical report
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.
Direct impacts	Impacts that result from a direct interaction between integral Project activities and the Sensitive environmental receptor (e.g. land clearing resulting in vegetation and habitat loss)
Disturbance footprint	The disturbance footprint is the surface area subject to direct disturbance (both temporary and permanent) associated with the Project
Ecological community	An assemblage of species occupying a particular area
Impact assessment area	This includes a nominal 1 km buffer area either side of the centreline, wider in some areas where multiple design options required an increase investigation area. Where temporary disturbance exceeds the nominal 1 km buffer from the centreline, a 100m buffer was placed around these footprints to account for potential indirect impacts.
Ecological receptor	A receptor is a feature, area or structure or grouping of the aforementioned that may be affected by direct or indirect changes to the environment.
Endangered	Designated as 'Endangered' under the EPBC Act, NC Act, <i>Vegetation Management Act 1999</i> (Qld) (VM Act). Refer to definitions of EPBC Act conservation status, NC Act conservation status, VM Act and <i>Environmental Protection Act 1994</i> (Qld) (EP Act) conservation status for meaning of 'Endangered' under each Act. 'Endangered' refers to a species of community that: - Is not 'Critically Endangered' - Is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria

Term	Explanation
Environmentally Sensitive Area (ESA)	■ As defined under the <i>Environmental Protection Regulation 2019</i>, a Category A ESA is any of the following: – National Parks – Conservation Parks – Forest Reserves – Wet Tropics World Heritage Area – Great Barrier Reef Marine Park Area – Marine Parks other than General Use Zones. ■ A Category B ESA includes the following: – World Heritage Areas – Queensland Heritage Register Places – Ramsar Sites – Cultural Heritage Registered Areas and DLAs other than the area known as Stanbroke Pastoral Development Holding – Special Forestry Areas – Fish Habitat Areas – Coordinated Conservation Areas – Endangered Regional Ecosystems (remnant and mature regrowth (biodiversity status)) – Marine Parks other than General Use Zones – Marine Plants. ■ A Category C ESA includes any of the following: – Essential Habitat – Referable Wetlands – Declared Catchment Areas – Nature Refuges – Resources Reserves – State Forests – Timber Reserves. Of Concern REs (remnant and mature regrowth (biodiversity status)).
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

Term	Explanation
	Migratory Migratory species are those animals that migrate to Australia and its external territories or pass through or over Australian waters during their annual migrations. Examples of migratory species are species of birds (e.g. albatrosses and petrels), mammals (e.g. whales) or reptiles. Listed migratory species are those listed in the: - Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) - China-Australia Migratory Bird Agreement (CAMBA) - Japan-Australia Migratory Bird Agreement (JAMBA) - Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
Essential habitat	As defined by DES, essential habitat is vegetation in which a species that is listed under the NC Act as 'Endangered', 'Vulnerable' or 'Near Threatened' has been known to occur. Essential habitat is identified on the approved DES RE mapping
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 Sensitive environmental receptor is at risk from the Project activity. The activity will only be allowed with a specific set of stringent mitigation measures.
High Value Regrowth	Described as Category C regulated vegetation under the VM Act In accordance with the VM Act, vegetation located – - on freehold land, indigenous land, or land subject of a lease issued under the <i>Land Act 1994</i> for agriculture or grazing purposes or an occupation licence under that Act; and - in an area that has not been cleared (other than for relevant clearing activities) for at least 15 years, if the area is – - an endangered regional ecosystem; or - an 'Of Concern' regional ecosystem; or - a 'Least Concern' regional ecosystem.
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, including impact on wetlands or ocean reefs from sediment, fertilisers or chemical which are washed or discharged into river systems - Upstream impacts including 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.
K-selected species	Those species with low fecundity and longer lifespans.
Least Concern	Designated as 'Least Concern' under the VM Act. Refer to definition of VM Act conservation status for meaning of 'Least Concern' under the Act
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. Refer to definitions of EPBC Act conservation status, for meaning of migratory under the Act

Term	Explanation
MSES wildlife habitat mapping (Queensland Government 2019)	As defined by DES, MSES Wildlife habitat is vegetation in which a species that is listed under the NC Act as 'Endangered', 'Vulnerable' or 'Near Threatened' has been known to occur. MSES wildlife habitat is identified on the approved DES RE mapping.
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, including diurnal systems.
NC Act conservation status	Under the NC Act, protected species are assigned a conservation status of 'Extinct in the wild', 'Endangered', 'Vulnerable', 'Near Threatened', or 'Least Concern'. Definitions of these terms under the NC Act are as follows: 'Extinct in the wild' - There have been thorough searches conducted for the wildlife, and - It has not been seen in the wild over a period that is appropriate for the lifecycle or form of the wildlife Endangered - There have not been thorough searches conducted for the wildlife and the wildlife has not been seen in the wild over a period that is appropriate for the lifecycle or form of the wildlife, or - The habitat or distribution of the wildlife has been reduced to an extent that the wildlife may be in danger of extinction, or - The population size of the wildlife has declined, or is likely to decline, to an extent that the wildlife may be in danger of extinction, or - The survival of the wildlife in the wild is unlikely if a threatening process continues Vulnerable - Its population is decreasing because of threatening processes, or - Its population has been seriously depleted, and its protection is not secured, or - Its population, while abundant, is at risk because of threatening processes, or - Its population is low or localised or depends on limited habitat that is at risk because of threatening processes Near Threatened - The population size or distribution of the wildlife is small and may become smaller, or - The population size of the wildlife has declined, or is likely to decline, at a rate higher than the usual rate for population changes for the wildlife, or - The survival of the wildlife in the wild is affected to an extent that the wildlife is in danger of becoming 'Vulnerable' Least Concern - The wildlife is common or abundant and is likely to survive in the wild - Native wildlife may be prescribed as 'Least Concern' wildlife even if: - The wildlife is the subject of a threatening process, or - The population size or distribution of the wildlife has declined, or - there is insufficient information about the wildlife to conclude whether the wildlife is common or abundant or likely to survive in the wild.
Near Threatened	Designated as 'Near Threatened' under the NC Act. Refer to definition of NC Act conservation status for meaning of 'Near Threatened' under the NC Act. Capitalisation of the term 'Near Threatened' in this report refers to those species listed as such under the NC Act
Negative impact	An impact that is considered to result in an unfavourable or adverse change to the receptor.

Term	Explanation
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> 2012)
Of Concern	Designated as 'Of Concern' under the VM Act or 'Of Concern' under the EP Act. 'Of Concern' refers to a community in which 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.
Permanent impact	The impact will last more than 21 years.
Project footprint	The Project footprint is the area subject to direct disturbance (both temporary and permanent) associated with the Project.
Project cumulative impact area	The Inland Rail Program cumulative impact area encompasses the Inland Rail disturbance footprint and extends 50 km beyond the Project footprint boundary.
R-selected species	those species with high fecundity and shorter lifespans
Red-boarded	Rail term: A line with a stop board attached to the rail preventing traffic entering the section
Region	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.
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 may be 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 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. Areas identified as Category C on a regulated vegetation management Map.
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 <i>et al.</i> 2012).
Significant impact	In accordance with 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 Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) (refer EPBC Act conservation significance for more details). Under the NC Act (Qld) a threatened species is any plant or animal species that is at risk of extinction and is allocated a conservation class of either extinct in the wild, endangered or 'Vulnerable'.
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 (see 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

Term	Explanation
	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, the Department of Environment and Science 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 and/or NC Act. Refer to definitions of EPBC Act conservation status and NC Act conservation status for meaning of 'Vulnerable' under these Acts.
Weeds of National Environmental Significance (WoNS)	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.
Wetland	- Areas shown on the <i>Map of Referable Wetlands</i> which is a document approved by the chief executive on 4 November 2011 and published by the department, as amended from time to time by the chief executive under section 144D of the <i>Environmental Protection Regulation 2008</i> (Qld); and - Are wetlands as defined under the Queensland Wetlands Program as areas of permanent or periodic/intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed 6 m, and possess one or more of the following attributes: - At least periodically, the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their lifecycle; or - The substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers; or - The substratum is not soil and is saturated with water or covered by water at some time.
Wetland of high ecological significance	Otherwise known as a high conservation value wetland, is a wetland that meets the definition of a wetland (above) and that is shown as a wetland of high ecological significance or high conservation value wetland on the <i>Map of Referable Wetlands</i>

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 technical report has been prepared in accordance with Sections 11.92 to 11.104 of the ToR. This document has been prepared to accompany EIS Appendix L: Matters of National Environmental Significance Technical Report of the Border to Gowrie Project EIS (the EIS), which specifically addresses the EPBC Act controlling provisions of the Project (i.e. threatened species and communities listed under the EPBC Act) and EIS Appendix K: Aquatic Ecology Technical Report. Therefore, in order to avoid repetition, the EPBC Act controlling provisions and issues associated with aquatic ecology have been excluded from this document.

The impact assessment area is mapped as providing suitable habitat for six non- MNES, *Nature Conservation Act 1992* (Qld) (NC Act) listed conservation significant species (i.e. three plants and three animals) as well as potential habitat for 11 non-threatened, migratory species as listed under the EPBC Act (not controlling provisions under the Minister of Environment's determination for the Project). In addition, a number of 'Endangered', 'Of Concern' and 'Least Concern' Regional Ecosystems (REs) are also present within the impact assessment area that are protected under the *Vegetation Management Act 1999* (Qld) (VM Act). The impact assessment area is mapped as containing a suite of Sensitive environmental receptors, including protected areas, High Value Regrowth vegetation, conservation significant flora and fauna species regionally significant species as well as bioregional corridors (local, regional and State significant).

Forty-two (42) Sensitive environmental receptors were identified from predictive habitat mapping within the impact assessment area. These varied from broad scale Sensitive environmental receptors such as protected areas and bioregional corridors, down to finer species-scale Sensitive environmental receptors, including conservation significant and migratory species.

An assessment of potential impacts from Project activities upon the identified Sensitive environmental receptors 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 ecology Sensitive environmental receptors including but not necessarily limited to:

- 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
- Contamination
- Flooding.

To determine the significance of potential impacts of the Project upon the identified Sensitive environmental receptors, sensitivity categories were applied to each of the Sensitive environmental receptors. The sensitivity of the Sensitive environmental receptors 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 Sensitive environmental receptors. 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 Sensitive environmental receptors 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 additional 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 Sensitive environmental receptors were generally reduced following the implementation of an additional mitigation measures and management plans. A key reason for disturbance to Sensitive environmental receptors 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 Sensitive environmental receptors 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.

In accordance with the outcomes of the Sensitive environmental receptors significant impact guideline, there are **no significant impacts expected**, based on predictive habitat mapping, for the following non-threatened EPBC Act listed migratory species:

- Common sandpiper (*Actitis hypoleucos*)
- Fork-tailed swift (*Apus pacificus*)
- Sharp-tailed sandpiper (*Calidris acuminata*)
- Pectoral sandpiper (*Calidris melanotos*)
- Red-necked stint (*Calidris ruficollis*)
- Oriental cuckoo (*Cuculus optatus*)
- Latham's snipe (*Gallinago hardwickii*)
- Black-faced monarch (*Monarcha melanopsis*)
- Yellow wagtail (*Motacilla flava*)
- Satin flycatcher (*Myiagra cyanoleuca*)
- Osprey (*Pandion haliaetus*)
- Glossy ibis (*Plegadis falcinellus*)
- Rufous fantail (*Rhipidura rufifrons*)
- Spectacled monarch (*Symposiachrus trivirgatus*)
- Common greenshank (*Tringa nebularia*).

Assessment of prescribed matters of State environmental significance (MSES) has been undertaken in accordance with the MSES significant impact criteria (refer Section 5.3.4). Analysis, based on predictive habitat mapping, indicates that the Project is likely to result in significant residual impacts to following Sensitive environmental receptors:

- Endangered or 'Of Concern' REs: 214.24 hectares (ha)
- Regulated vegetation (Category B (other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature): 43.88 ha
- Essential Habitat (EH): 117.31 ha
- Connectivity areas:
 - Regional Terrestrial corridors: 235.37 ha
 - State Riparian corridors: 37.42 ha
 - State Terrestrial corridors :161.39 ha
- Protected wildlife habitat for the following species:
 - A sedge (*Cyperus clarus*): 106.00 ha
 - Finger panic (*Digitaria porrecta*): 455.61 ha
 - Tall hawkweed (*Picris barbarorum*): 567.49 ha
 - Common death adder (*Acanthopis antarcticus*): 540.87 ha
 - Glossy black-cockatoo (*Calyptorhynchus lathami lathami*): 480.86 ha
 - *Nature Conservation (Koala) Conservation Plan 2017* mapping (Koala Habitat Areas): 81.73 ha.

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 Sensitive ecological receptors.

Potential predicted cumulative impacts within 50 km of the Project were assessed incorporating the footprints projects identified in Table 3.10. Impacts 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 added to the other similar projects that occur within 50 km of the Project boundary are likely to be higher on the following Sensitive environmental receptors:

- EPBC Act listed, non-threatened migratory species:
 - Common sandpiper (*Actitis hypoleucos*), Sharp-tailed sandpiper (*Calidris acuminata*), Pectoral sandpiper (*Calidris melanotos*), Red-necked stint (*Calidris ruficollis*), Yellow wagtail (*Motacilla flava*), Glossy ibis (*Plegadis falcinellus*), Common greenshank (*Tringa nebularia*) – Project impact makes a 0.17 per cent contribution to the clearing of approximately 77,993.16 ha (sum of cumulative impact) which constitutes 42.9 per cent of the available habitat within the cumulative impact assessment area
- NC Act listed flora and species habitat:
 - Finger panic (*Digitaria porrecta*) – Project impact makes a 9.89 per cent contribution to the clearing of approximately 4,608.69 ha (sum of cumulative impact) which constitutes 7.44 per cent of the available habitat within the cumulative impact assessment area

- Common death adder (*Acanthophs antarcticus*) – Project impact makes a 3.54 per cent contribution to the clearing of approximately 15258.00 ha (sum of cumulative impact) which constitutes 2.14 per cent of the available habitat within the cumulative impact assessment area
- Category B regulated vegetation 'Of Concern' - Project impact makes a 4.12 per cent contribution to the clearing of approximately 3,681.57 ha (sum of cumulative impact) which constitutes 1.82 per cent of the available habitat within the cumulative impact assessment area
- MSES Wildlife habitat - Project impact makes an 8.79 per cent contribution to the clearing of approximately 1,385.80 ha (sum of cumulative impact) which constitutes 1.64 per cent of the available habitat within the cumulative impact assessment area.

However, the proposed project mitigation measures (including the provision of offsets) will minimise the Project's overall contribution to cumulative impact within the broader region.

This assessment has concluded that the Project will result in significant residual adverse impact on Sensitive environmental receptors, 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.

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 confirm offset requirements for the Project. Additional species, communities and habitats may be identified through this process.

ARTC's Environmental Offset Delivery Strategy – Qld (refer EIS Appendix N: Draft Offset Strategy) will inform 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.

1 Introduction

1.1 Project overview and objectives

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 kilometres (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 use 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 Scope and purpose

1.2.1 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).

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.

1.2.2 This report

This technical report has been prepared to specifically address sections 11.94 to 11.106 of the ToR. These sections of the ToR refer to flora and fauna, and biosecurity requirements.

Sections 11.94 to 11.101 of the ToR outline matters relating to flora and fauna that must be included in the EIS for assessment against the objective of:

Matters of environmental significance are identified and appropriately safeguarded to support healthy and resilient ecosystems and ensure the sustainable, long-term conservation of biodiversity and the social, economic, cultural and environmental benefits it provides.

Sections 11.102 to 11.106 of the ToR outline matters relating to biosecurity that must be included in the EIS for assessment against the objectives of:

The construction and operation of the project should aim to ensure:

- (a) the spread of weeds and pest animals is avoided or minimised*
- (b) existing weeds and pests are controlled*
- (c) comply with relevant provisions of the Biosecurity Act 2014 (Qld).*

Specific conditions of the ToR and the sections of this report where those conditions are addressed are presented in Section 1.3.

In addressing sections 11.94 to 11.106 of the ToR, this technical report has extended to providing coverage of matters of State environmental significance (MSES) and migratory species listed under the EPBC Act, as migratory species are not a controlling provision for the Project. MSES are a component of the biodiversity state interest that is defined under the State Planning Policy (SPP) and defined under the *Environmental Offsets Regulation 2014* (Offset Regulation). MSES includes certain environmental values that are protected under Queensland legislation including the:

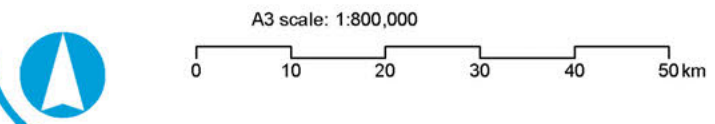
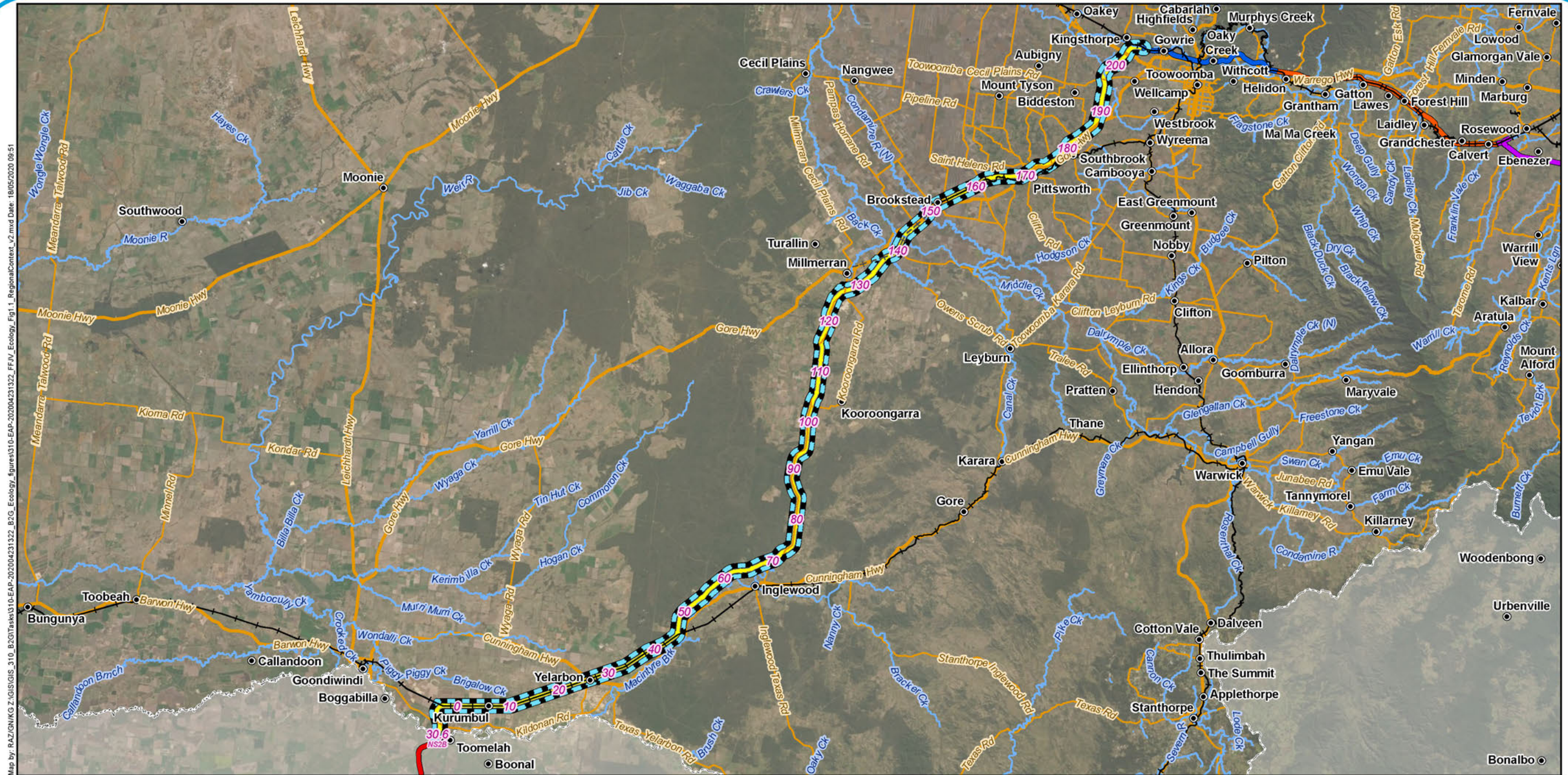
- *Nature Conservation Act 1992* (NC Act)
- *Marine Parks Act 2004* (MP Act)
- *Fisheries Act 1994* (Fisheries Act)
- EP Act
- *Regional Interests Planning Act 2014* (RIP Act)
- *Vegetation Management Act 1999* (VM Act)
- *Environmental Offsets Act 2014* (EO Act).

Threatened species and communities under the EPBC Act, as a controlling provision for the Project, have been assessed and documented separately in EIS Appendix L: Matters of National Environmental Significance Technical Report.

For the purposes of this technical report, the investigations and assessment were focussed on the rail alignment and the impact assessment area presented in Figure 1.1.

This technical report describes the terrestrial ecological values of the impact assessment area (refer Section 1.2.3), providing a summary of MSES and migratory species listed under the EPBC Act, vegetation communities, habitats as well as weed and pest presence. Where relevant, desktop searches beyond the impact assessment area have been conducted (e.g. natural resource management region) to give an understanding of Sensitive environmental receptors across the broader landscape.

Potential impacts to Sensitive environmental receptors resulting from construction, operation and decommissioning of the Project are also identified, with mitigation measures developed to minimise environmental impacts resulting from the Project. An assessment of the impacts of the Project following the application of mitigation measures is provided, along with the significance of the anticipated impacts to each Sensitive environmental receptor (refer Sections 5.3.2, 5.3.3 and 5.3.4).



Border to Gowrie

Figure 1.1: Location of Project and regional extent and impact assessment area

1.2.3 Impact assessment area

The impact assessment area for this technical report was 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 land required on a temporary basis to enable construction of the Project, including for construction laydown, stockpile and storage areas, temporary erosion control structures, concrete batching and movement of construction traffic parallel to the rail alignment. The Project footprint also encompasses land required to accommodate permanent infrastructure 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.

Sensitive ecological receptors were identified within the impact assessment area and used to inform the assessment of potential impacts from the Project. The impact assessment area and sensitive ecological receptors within that area informed the impact assessment in accordance with the Commonwealth *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (MNES Guidelines) (DoE 2013) for EPBC Act listed, non-threatened migratory species, and the *Queensland Environmental Offsets Policy Significant Residual Impact Guidelines* (DEHP 2014b).

1.3 Terms of reference requirements

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.

Matters associated with the EPBC Act controlling provisions (i.e. EPBC Act listed threatened species and communities) as identified by the ToR (i.e. sections 11.1 to 11.35) are addressed in EIS Appendix L: Matters of National Environmental Significance Technical Report and as such are not included in Table 1.1. However, MNES that have not been identified as a controlling provision of the Project (e.g. non-threatened migratory species listed under the EPBC Act) have been included within this technical document in accordance with item 11.94 of the ToR.

Table 1.1 Compliance against relevant sections of the terms of reference

Terms of reference requirement		Report section
Flora and fauna		
Existing environment		
11.94	Identify and describe matters of state environmental significance (MSES), state, ecological areas, regionally significant biodiversity and natural environmental values of the terrestrial and aquatic ecology likely to be impacted by the project which have not been addressed in the section on MNES	Section 4.5, Section 4.6 and Section 4.7
Impact assessment		
11.95	Describe the likely impacts on the biodiversity and natural Sensitive environmental receptors of affected areas arising from the construction and operation of the project. Provide information based on relevant DES information guidelines that cover flora and fauna, aquatic ecology, and groundwater dependent ecosystems. The assessment should include, but not be limited to, the following key elements: (a) MSES, matters of local environmental significance (MLES), and designated State and regional biodiversity values and conservation corridors of conservation significance. Reference should be made to the Biodiversity Planning Assessment and BioCondition assessment tools where appropriate. (b) terrestrial and aquatic ecosystems (including groundwater-dependent ecosystems) and their interaction and areas surrounding watercourses and wetlands. (c) biological diversity including listed flora and fauna species and regional ecosystems, connectivity and essential habitat.	a) Sections 4.4, 4.5, 4.6, 5.1.2, 5.2.2 b) Sections 4.4, 4.5, 4.6, 5.1.2.13 and EIS Appendix K: Aquatic Ecology Technical Report c) Sections 4.6.1, 4.6.2, 4.5.1, 4.5.2 and 5.1.2.5 d) Sections 4.4, 4.5, 4.6, 5.1.2 e) Sections 4.2, 4.3, 5.1.2 f) Sections 5.1.2.13 and 5.2.2, EIS Chapter 3: Legislation and project approvals process and EIS Appendix K: Aquatic Ecology Technical Report g) Sections 5.1.2.12, 5.1.2.13 and 5.1.2.15 h) Sections 5.1.2.8, 5.1.2.9, 5.1.2.10, 5.1.2.11, 5.1.2.12

Terms of reference requirement		Report section
	(d) the existing integrity of ecological processes, and habitats of threatened, near-threatened or special least-concern species. (e) the integrity of landscapes and places, including wilderness and similar natural places. (f) actions of the project that may require an authority under the NC Act and Water Act (for example, riverine protection permits) and/or could be assessable development for the purposes of the VM Act, Fisheries Act and Planning Act. (g) any exposure to contaminants or the bio-accumulation of contaminants. (h) impacts on native fauna due to proximity to the site and site impacts (e.g. lighting, noise, waste and fencing). (i) impacts to movement of native fauna due to barrier effect of linear infrastructure. (j) impacts on vegetation category areas identified on the regulated vegetation management maps under Queensland's vegetation management framework.	i) Section 5.1.2.8 j) Sections 4.6.2, 5.1.2, 5.3, 5.3.1, 5.3.2, and 5.3.4
Mitigation measures		
11.96	Describe any proposed measures to avoid, minimise or mitigate potential impacts on natural values, and enhance these values. Assess how the nominated quantitative indicators and standards may be achieved for nature conservation management. In particular, address measures to protect or preserve any threatened or near-threatened species.	Design considerations - Section 5.2.1 Proposed mitigation measures - Section 5.2.2.
11.97	Assess the need for buffer zones and the retention, rehabilitation or construction of fauna movement corridors across the railway. Propose measures that would avoid the need for waterway barriers or mitigate the impacts of their construction and operation. With respect to the Macintyre River, reference should be made to the New South Wales Department of Primary Industries policy and guidelines for fish habitat conservation and management and the Queensland Department of Agriculture and Fisheries (DAF) policy and factsheets on waterways and waterway barrier works.	Proposed mitigation measures - Section 5.2.2. EIS Appendix K: Aquatic Ecology Technical Report and EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy
11.98	Describe how the achievement of the objectives would be monitored and audited, and how corrective actions would be managed.	Proposed mitigation measures - Section 5.2.2. EIS Chapter 22: Outline environmental management plan
11.99	Where a significant residual impact will occur on a prescribed environmental matter as outlined in the Environmental Offsets Regulation 2014, the offset proposal(s) must be consistent with the requirements of Queensland's EO Act and the latest version of the Queensland Environmental Offsets Policy.	Biodiversity offsets - Section 5.4 EIS Appendix N: Draft offset strategy
11.100	Assess the need and suitability and provide objective commitments to the provision of fauna passage between habitat fragmented by the rail corridor, of suitable design and location for affected species and their habitat.	Design considerations - Section 5.2.1 Proposed mitigation measures - Section 5.2.2 EIS Appendix M: Preliminary Fauna Movement Provision and Fencing Strategy
11.101	Demonstrate that actions of the project avoid and minimise impacts of clearing of vegetation regulated through the VM Act/Planning Act and how any clearing maintains connectivity of the remaining mapped category B area in the landscape. Provide details on the exemptions/assessment pathway for any clearing of vegetation regulated through the VM Act/Planning Act.	Legislative, policies, standards and guidelines - Section 2 Design considerations - Section 5.2.1 Proposed mitigation measures - Section 5.2.2 EIS Chapter 3: Legislation and project approvals process

Terms of reference requirement		Report section
Biosecurity		
Existing environment		
11.102	Provide information on the current distribution of animal pests and weeds on the preferred alignment.	Invasive species biosecurity areas - Section 4.5.4.
11.103	Surveys of animal pests and weeds should be undertaken in those areas identified during the desktop assessment as containing listed flora, fauna or ecological communities of national or State environmental significance (MNES or MSES defined by the EPBC and NC Acts respectively).	Weed species - Section 4.6.1.3 Invasive animals - Section 4.6.2.1
Impact assessment		
11.104	Describe the impact the project's construction and operation will have on the spread of pest animals and weed species and disease along the preferred alignment and into adjoining properties.	Displacement of flora and fauna species by invasion of weed and pest species - Section 5.1.2.4
Mitigation measures		
11.105	Propose detailed measures to control and limit the spread of pests, weeds and disease surrounding the proposed alignment and adjacent areas. Detail any relevant local government area Biosecurity Plans. This includes restricted matters listed in the Biosecurity Act 2014 and Biosecurity Regulation 2016 and designated pests under the Public Health Act 2005.	Proposed mitigation measures - Section 5.2.2 EIS Chapter 22: Outline environmental management plan
11.106	All proposed measures must be in accordance with any relevant biosecurity surveillance or prevention program authorised under the Biosecurity Act and any requirements of the VM Act/Planning Act. Mitigation measures should be developed in consultation with the relevant Queensland and New South Wales government agencies and local governments (e.g. baiting programs) to ensure cross border impacts are minimised.	

1.4 Project location and existing land use

The Project is located within the Goondiwindi and Toowoomba Regional Council local government areas in the Brigalow-belt (BB) and Southeast Queensland (SEQ) bioregions. The Project is the western and southern most package of the Inland Rail Program within the State of Queensland. The location of the Project and its regional context is shown in Figure 1.1.

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 QR's 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 which have been subject to regular clearing, grazing and other land management practices. 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 historically cleared for pasture, agricultural production and for rural and urban residential settlements. Tracts of remnant vegetation are also present, limited to the steep, isolated mountains and hills (typically associated with granite and basaltic outcrops and sandstone hills) and State forest reserves.

The largest town in the impact assessment area is Oakey, situated 29.0 km west of Toowoomba with a population of 4,529 (ABS 2016). It is noted that Oakey is located on the periphery of the impact assessment area, approximately 10.0 km from the Project. Pittsworth is the second largest town in the impact assessment area, located 41.0 km southwest of Toowoomba, with a population of 3,294 (ABS 2016). Further information on landscape values of the Project are reported in EIS Chapter 9: Landscape and visual amenity.

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. Further information on land use is reported in EIS Chapter 7: Land use and tenure.

1.5 Project description

The Project consists of the key permanent and temporary features listed in Table 1.2. 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 1.2 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.
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.

Aspect	Description
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-resident workforce accommodation	■ 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 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 scheduled to be completed by the beginning of 2026. Inland Rail, and the Project, are scheduled to be operational in 2026.

2 Legislation, policies, standards and guidelines

This section describes the legislative, policy and management framework which applies to the assessment of ecology applicable to the Project at the Commonwealth and State levels, and provides the statutory context for which the ecological assessment has been undertaken.

An overview of the Commonwealth and State legislation that is relevant to ecological aspects of the Project, is presented in Table 2.1.

Table 2.1 Legislative approvals. Licences, permits and authorities relevant to the Project

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
Commonwealth			
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth) (EPBC Act)	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 to rely on specified environmental impact assessment processes of Queensland in assessing actions under the EPBC Act.	ARTC submitted an EPBC Act referral to the DotEE, now the Department of Agriculture, Water and Environment (DAWE), in February 2018 (EPBC 2018/8165). The Minister for the Environment determined that the Project is a 'controlled action' on 9 April 2018. 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 between the Australian Government and the Queensland Government. Note that EPBC Act controlling provisions have been assessed within EIS Appendix L: Matters of National Environmental Significance Technical Report. To avoid repetition between technical reports, this document discusses MNES that have not been identified as controlling provisions (i.e. EPBC Act listed migratory species only)
EPBC Act Environmental Offsets Policy (2012) (Cth) (EPBC Act Offsets Policy)	Actions subject to the EPBC Act	The EPBC Act Offset Policy was 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 DAWE. 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: ■ 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 ■ Be built around direct offsets but may include other compensatory measures ■ Be in proportion to the level of statutory protection that applies to the protected matter	The Project will implement a range of mitigation measures to avoid and minimise Significant residual impacts on the MNES. 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 identified separately in EIS Appendix L: Matters of National Environmental Significance Technical Report. ARTC's Environmental Offset Delivery Strategy - Qld (EIS Appendix N: Draft Offset Strategy) has been prepared in consultation with the relevant State and Commonwealth departments, to ensure compliance with relevant offsets policies and guidelines.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
		- Be of a size and scale proportionate to the residual impacts on the protected matter - 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 residual adverse impacts of an action on the environment (Australian Government 2012).	
Matters of National Environmental Significance: <i>Significant impact guidelines 1.1 – Environmental Protection and Biodiversity Conservation Act 1999</i> (Cth)	MNES	The purpose of the guideline is to assist any person who proposes to take an action to decide whether or not they should submit a referral to the DAWE for a decision by the Australian Government Minister for Environment (the Minister) on whether assessment and approval is required under the EPBC Act. These guidelines outline 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 guidelines will facilitate the determination of a Significant residual impact to MNES. This has been undertaken in EIS Appendix L: Matters of National Environmental Significance Technical Report (for the EPBC Act controlling provisions)
Draft <i>Referral guidelines for 14 birds listed as migratory species under the EPBC Act</i> (Cth) (DotE 2015)	MNES	The purpose of the guideline is to assist any person who proposes to take an action to decide whether or not they should submit a referral to the DAWE for a decision by the Australian Government Environment Minister (the minister) on whether assessment and approval is required under the EPBC Act in relation to the 14 migratory birds. These guidelines outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether referral may be required. Important terms and phrases are explained.	Assessment of MNES (non-threatened migratory species) against the guidelines will facilitate the determination of a significant residual impact to migratory birds relevant to this guideline. Assessment been undertaken in Section 5.3.3 for EPBC Act migratory species.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
State			
<i>Planning Act 2016</i> (Qld) (Planning Act)	Queensland	The purpose of the Planning Act is to provide an efficient, effective, transparent, integrated, coordinated and accountable system of land use planning, development assessment and dispute resolution to facilitate the achievement of ecological sustainability. Together with a development assessment system, Chapter 1 of the Planning Act establishes a hierarchy of planning instruments which comprises: - State planning policies (including temporary policies); - Regional plans; - Planning schemes; - Temporary local planning instruments; and - Planning scheme policies.	The Project may trigger the requirement to obtain approval for aspects of development that are assessable under Schedule 10 of the <i>Planning Regulation 2017</i> (and integrated through other legislation as part of the Development Assessment Rules process) following completion of the EIS process. Modification of the existing Yelarbon levee may be the preferred design solution to avoid worsening of hydrological conditions in the Yelarbon area. Levees built across tributaries connecting floodplain wetlands to streams are waterway barriers. If this solution is confirmed as preferred through detail design, the design requirements for modifying the existing Yelarbon levee will be confirmed through further consultation with GRC. It is anticipated that the modified levee would be considered a Category 2 levee (Schedule 10 of the Water Regulation 2016) requiring a development approval under the Planning Act.
Regional plans (Qld)	Queensland. Specifically, activities that are regulated through the Planning Act.	Regional plans are State planning instruments made under the Planning Act. Regional plans seek to provide strategic direction to achieve regional outcomes that align with the State interests in planning and development.	The Project is located within the Darling Downs Regional Plan area that incorporates six LGAs including: - Balonne; - Goondiwindi; - Maranoa; - Southern Downs; - Toowoomba; and - Western Down. The Darling Downs Regional Plan provides the regional framework for local government to manage growth, planning directions, economic competitiveness and high-quality living. The regional plan identifies the need to plan strategically for the protection and enhancement of biodiversity values and landscape function and processes.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
State Planning Policy 2017 (Qld) (SPP)	Queensland	The SPP is a key component of the Queensland land use planning system which articulates the Queensland Government's 17 State interests in land use planning and development. The SPP is a statutory instrument and requires that the State interests be integrated into local government planning schemes. Some State interests in the SPP include assessment benchmarks that apply to certain types of development where a local government planning scheme does not appropriately integrate the relevant State interest. A number of the State interests set out in the SPP apply to the Project and to the Project impact assessment area.	The SPP is applicable to the Project across various aspects, including terrestrial and aquatic ecology which is represented by the <i>State interest guideline – biodiversity</i> (DILGP, 2016). The biodiversity State interest requires development to be located in areas to avoid significant impacts to MNES, avoid and minimise impacts to MSES and matters of local environmental significance (MLES), maintaining or enhancing ecological processes and connectivity by avoiding fragmentation and conserve and enhance koala habitat extent and condition (refer to glossary for definitions of MNES, MSES and MLES).
<i>Environmental Protection Act 1994</i> (Qld) (EP Act)	Queensland	The EP Act is the key legislative framework for environmental management and protection in Queensland. It regulates activities that will, or have the potential to, release contaminants into the environment which may cause environmental harm. These activities are defined as Environmentally Relevant Activities (ERAs). ERAs include both prescribed ERAs and resource activities. The EP Act regulates the application of Environmental Authorities (EAs) for ERAs and employs a number of mechanisms to achieve its objectives relating to biodiversity, including the <i>Environmental Protection Regulation 2008</i> (Qld) (EP Reg). The EP Reg identifies prescribed ERAs that require an approval and provides the mechanism for levels of protection for Environmentally Sensitive Areas, which are defined in Schedule 12 of the EP Reg. The EP Act also regulates wetlands in wetland management areas under the subordinate Environmental Protection Policy (EPPs) including the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP (Water)). The EPP (Water and Wetland Biodiversity) establishes a process for identifying Sensitive environmental receptors to be protected and states standards for water quality in support of those values.	The identification of any prescribed ERAs that will require an EA has been identified in EIS Chapter 3: Legislation and project approvals process. Confirmation of these ERAs will be undertaken as part of the post-EIS approvals process. The EP Act also lists obligations and duties to prevent environmental harm, nuisances and contamination. The two primary duties that apply to everyone in Queensland are: ■ General environmental duty – which means a person must not carry out any activity that causes or is likely to cause environmental harm, unless all reasonable and practicable measures to prevent or minimise the harm have been taken by that person (Section 319(1) of the EP Act). Environmental harm is defined in Section 14 of the EP Act as “<i>any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an Sensitive environmental receptor, and includes environmental nuisance</i>”; and ■ Duty to notify of environmental harm – to inform the administering authority and landowner or occupier when an incident has occurred that may have caused or threatens serious or material environmental harm that is not authorised.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
			Mitigation strategies (refer Section 5.2) and a Draft Environmental Offset Delivery Strategy - Qld (EIS Appendix N: Draft Offset Strategy) has been prepared in consultation with the relevant State and Commonwealth departments, to ensure compliance with relevant offsets policies and guidelines to mitigate potential environmental harm.
<i>Nature Conservation Act 1992 (Qld) (NC Act)</i>	Queensland	The NC Act provides for the conservation of nature through protection of all native plants, birds, reptiles, mammals and amphibians in Queensland (along with a limited range of invertebrates and freshwater fish). The NC Act is based on principles aimed at conserving biological diversity, ecologically sustainable use of wildlife, ecologically sustainable development and international criteria developed by the International Union for the Conservation of Nature for establishing and managing protected areas. The NC Act has 14 subordinate regulatory instruments in the form of regulations, conservation plans and notices. Of relevance to the Project are three instruments that regulate disturbance to flora, fauna and habitat, including: ■ <i>Nature Conservation (Protected Plants) Conservation Plan 2000</i> which provides protection for protected flora species. Currently all species of native Australian flora are listed as protected plants, including those species that are considered of 'Least Concern' ■ <i>Nature Conservation (Animals) Regulation 2020</i>, which prohibits the taking or destruction, without authorisation, of protected animals and lists all fauna species that are considered to be extinct in the wild, endangered, vulnerable, near threatened, least concern and special least concern wildlife (refer Glossary and Abbreviations for definitions of these terms). Also listed is international wildlife and prohibited wildlife.	The following permits and management plans may be required for the Project: ■ Wildlife Movement Permits (Sections 88 and 97 of the NC Act) - for wildlife protected under the NC Act, and those found in certain areas covered by conservation plans created and implemented under the NC Act ■ Clearing Permit (Protected Plants) (Section 89 of the NC Act) – for the clearing of vegetation contained within High risk areas identified on the Department of Environment and Science (DES) flora survey trigger map, or where protected plants have been identified in a Project survey within a proposed clearing area ■ Rehabilitation Permit (spotter catcher endorsement) (Part 14 of the <i>Nature Conservation (Animals) Regulation 2020</i>) ■ Damage Mitigation Permit (removal and relocation) ((Part 10 of the <i>Nature Conservation (Animals) Regulation 2020S</i>) ■ Species management plan must be submitted to the DES for approval for tampering with some animal breeding places (Section 33 of the <i>Nature Conservation (Animals) Regulation 2020</i>). For the purposes of this document only species listed solely under the NC Act (i.e. MSES) have been included. In instances where an NC Act listed species is also listed under the EPBC Act (i.e. identified as a controlling provision under the EPBC Act), this species has been included within EIS Appendix L: Matters of National Environmental Significance Technical Report and has subsequently been excluded from this document to avoid repetition.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
		■ <i>Nature Conservation (Plants) Regulation 2020</i>, which prohibits the taking or destruction, without authorisation, of protected plants and lists all flora species that are considered to be extinct in the wild, endangered, vulnerable, near threatened, least concern and special least concern wildlife (refer Glossary and Abbreviations for definitions of these terms). Also listed is international wildlife and prohibited wildlife. The NC Act also includes provisions for protected areas such as national parks, nature refuges, and world heritage management areas.	
<i>Biosecurity Act 2014</i> (Qld)	Queensland	The <i>Biosecurity Act 2014</i> seeks to provide a framework for an effective biosecurity system for Queensland that helps to manage and minimise State biosecurity risks, as well as facilitate the response to biosecurity issues and events in a timely and effective way, so as to align with national and international obligations. The Act introduces the general biosecurity obligation upon all persons to take all reasonable and practical measures to prevent or minimise biosecurity risks. Additionally, the Act holds power to repeal the provisions of various former Acts with respect to the management and impacts of animals and plant diseases and pests, including the <i>Plant Protection Act 1989</i>, <i>Land Protection (Pest and Stock Route Management) Act 2002</i> and <i>Fisheries Act 1994</i> to provide a single cohesive legislative framework for biosecurity for Queensland. The Biosecurity Act identifies requirements for invasive animal barrier fencing including authority for building and maintaining the wild dog check fence, Rabbit fence and agreements that are required in order to make an opening in the barrier fences.	The Project will potentially involve interaction with restricted matters and prohibited matters (potentially including pests, diseases or contaminants) and will therefore require compliance with the Biosecurity Act. A Biosecurity management sub-plan will ensure that the potential spread of invasive species as a result of Project activities are minimised and managed appropriately. The pest and weed managements plans will consider operational impacts associated with movement of stock and produce on trains as a vector for spread of pest animals, plants and pathogens. The Project will require openings to be created in the wild dog check fence for the purposes of construction, therefore approvals under the <i>Biosecurity Act 2014</i> will be required.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
<i>Vegetation Management Act 1999</i> (Qld)	Queensland. Specifically, activities that are regulated through the Planning Act	The VM Act regulates the conservation and management of vegetation communities and clearing of vegetation identified as "Regulated vegetation" identified as Category A, B, C and R. The VM Act provides a framework for identification, description, and mapping of remnant Regional Ecosystems (REs) certified by DES as 'Endangered', 'Of Concern' or 'Least Concern' (refer Glossary for definitions of these terms). It also provides a framework for the identification, description and mapping of High Value Regrowth (HVR) vegetation as 'Endangered', 'Of Concern' or 'Least Concern'.	The clearing of vegetation regulated under the VM Act (e.g. Category B and C regulated vegetation) will occur as a result of the Project. Regulated regrowth vegetation (in this instance, Category C areas only) can be undertaken as exempt clearing, or in accordance with an accepted development vegetation clearing code - please refer to section 3.4.32 (Vegetation Management Act 1999) of Chapter 3: "Clearing of any relevant remnant or regulated regrowth vegetation will constitute operational works under Schedule 10 of the Planning Regulation that will require development approval, unless an exemption applies. Under Schedule 21, Part 1, Item 14 of the Planning Regulation, the following clearing work is exempt clearing work for which a development permit is not required: <i>Clearing vegetation for the construction or maintenance of infrastructure stated in Schedule 5, if:</i> - the clearing is on a designated premises, or - the infrastructure is government supported transport infrastructure. The Project is Government Supported Infrastructure as per requirements of the Planning regulation and therefore is exempt from requirements of the VM Act.
<i>Environmental Offsets Act 2014</i> (Qld) (Offsets Act)	Queensland	The Offsets Act and associated <i>Environmental Offsets Regulation 2014</i> (Qld) seeks to 'counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets'. Introduced on 1 July 2014, the Act is administered by DES, and establishes a new framework to regulate the delivery of offsets in Queensland, integrating the previous multiple sets of policies in a manner which provides an outcome-based approach and reducing duplication. Under the Offsets Act, an environmental offset is defined as 'an activity undertaken to counterbalance a Significant residual impact of a prescribed activity on a prescribed environmental matter'. The Act defines the type of activities for which offsets may be imposed (i.e. 'prescribed activities') where these activities are determined to result in a 'Significant residual impact'.	The Project will be required to deliver environmental offsets consistent with the Offsets Act. Environmental offsets for Significant residual impacts to a prescribed matter may be delivered through a proponent-driven offset (e.g. land-based offset), a financial offset calculated in accordance with the Financial Settlement Offset Calculation Methodology, or a combination of proponent driven and financial offsets. Information related to the provisions of offsets are provided in Section 5.4. ARTC's Environmental Offset Delivery Strategy – Qld (EIS Appendix N: Draft Offset Strategy) has been prepared in consultation with the relevant State and Commonwealth departments, to ensure compliance with relevant offsets policies and guidelines.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
		To achieve the purpose of the Offsets Act, the Queensland Environmental Offsets Policy (Version 1.9, 2020) has been developed to provide further guidance on the requirements for the assessment of 'Significant residual impacts', and accepted methods for the delivery of offsets, where required.	
Queensland Environmental Offsets Policy Significant Residual Impact Guideline (<i>Nature Conservation Act 1992 Environmental Protection Act 1994 Marine Parks Act 2004</i>)	Queensland	The purpose of this guideline is to assist in deciding whether or not a prescribed activity will or is likely to have a significant residual impact on a matter of State environmental significance (MSES). This guideline applies to any activity prescribed in the Environmental Offsets Regulation 2014 that requires an approval in relation to MSES, under any of the following: ■ <i>Nature Conservation Act 1992</i> ■ <i>Marine Parks Act 2004</i>, or ■ <i>Environment Protection Act 1994</i>.	The Project involves disturbance to features protected under one or more of the of the following: ■ <i>Nature Conservation Act 1992</i> ■ <i>Marine Parks Act 2004</i>, or ■ <i>Environment Protection Act 1994</i>. As such, assessment against the MSES guidelines is required to determine if a Significant residual impact upon an MSES occurs. Assessment against the MSES guidelines is undertaken in Section 5.3.4.1.
Queensland Environmental Offsets Policy (Qld) (QEOP)	Queensland	The QEOP (DES 2020) aims to provide a framework for environmental offsets in Queensland, including principles and guidelines for using environmental offsets and guidance on when offsets should be used. The QEOP outlines seven principles that direct the way offsets must be used to contribute to environmentally sustainable development (ESD) as follows: ■ Offsets will not replace or undermine existing environmental standards or regulatory requirements, or be used to allow development in areas otherwise prohibited through legislation or policy ■ Impacts must first be avoided, then minimised, before considering the use of offsets for any remaining impact ■ Offsets must achieve a conservation outcome that achieves an equivalent environmental outcome ■ Offsets must provide Sensitive environmental receptors as similar as possible to those being lost ■ Offset provision must minimise the time-lag between the impact and delivery of the offset ■ Offsets must provide additional protection to Sensitive environmental receptors at risk, or additional management actions to improve Sensitive environmental receptors. Where legal security is required, offsets must be legally secured for the duration of the impact on the prescribed environmental matter.	The Project will deliver environmental offsets consistent with the QEOP.. Information related to the provisions of offsets are provided in Section 5.4. ARTC's Environmental Offset Delivery Strategy – Qld (Strategy) (EIS Appendix N: Draft Offset Strategy) informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
<i>Water Act 2000</i> (Qld) (Water Act)	Queensland	The Water Act provides for the sustainable management of non-tidal waters and other resources, together with the establishment and operation of water authorities, and for other purposes. The Queensland Government maintains Watercourse Identification Mapping (WIM), which identifies defined watercourses under the Water Act, as well as drainage features (not regulated under the Water Act). Through the Planning Act, certain water related development under the Water Act is assessable. In addition to the approvals triggered under Planning Act, the Water Act regulates the undertaking of works that involve the excavating or placing fill in a watercourse, lake or spring. Under the Water Act, a proponent must obtain a Riverine Protection Permit in order to lawfully undertake these works unless the works can be undertaken in accordance with Riverine Protection Permit Exemption Requirements (DNMRE, 2018)	The Project involves works within defined mapped watercourses and as such the provisions of the Water Act may apply. Other unmapped waterways will be required to be verified during the detail design phase to determine their status under the Water Act. Further the Project involves the removal of vegetation, excavation or placing fill in a waterway, lake or spring. This will require a Riverine Protection Permit to authorise excavation and the Project will apply for licencing under the Riverine Protection Permit as necessary (if exemption is not granted as a Government-owned corporation). Watercourse diversions required by Project activities will require approval under a diversion for resource activities under works that take or interfere with watercourse, lake or spring (for interference with overland flow). ARTC have an exemption under the Water Act. However, Activities falling outside this exemption may trigger requirements for approval.
<i>Fisheries Act 1994</i> (Qld) (Fisheries Act)	Queensland	The Fisheries Act provides for the management, use, development and protection of fish habitats and resources, together with the management of aquaculture activities. Administered by the Department of Agriculture and Fisheries (DAF), the Fisheries Act applies to: - Works in a declared Fish Habitat Area (FHA) - Waterway barrier works resulting in the construction of instream structures inhibiting the free movement of fish along waterways. Waterway Barrier Works: A waterway includes a river, creek, stream, watercourse or inlet of the sea as defined in the Schedule under the Fisheries Act 1994 and mapped according to the spatial data layer, Queensland waterways for waterway barrier works. Waterways providing for fish passage are a Matter of State Environmental Significance (MSES). A waterway barrier is defined under the Fisheries Act as a dam, weir, or other barrier across a waterway if the barrier limits fish stock access and movement along a waterway.	The Project transverses mapped waterways for waterway barrier works and therefore will likely trigger the requirement to obtain a Development Permit for Operational Works that is constructing or raising waterway barrier works, unless an exemption applies, or where works can be shown to comply with the accepted development requirements. The Project does not require: - The removal, destruction or damage of marine plants - Works involving aquaculture - Work that is completely or partly within a declared FHA. If dewatering of existing storages is required, fish salvage should occur in accordance with the Department of Agriculture and Fisheries' Guidelines for fish salvage.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
		Under the provisions of the Fisheries Act and Planning Act, a Development Permit for Operational Works involving Waterway Barrier Works is required for works which pose a barrier to fish passage (including permanent, partial and temporary barriers) within a waterway which is mapped by DAF on the spatial data layer 'Queensland waterways for waterway barrier works' unless: ■ The works have a low impact to fisheries productivity and comply with DAF's requirements for 'works which are not waterway barrier works' which include (subject to specific design and construction requirements): ■ New single or multi-span bridges ■ Maintenance of existing bridge structures not subject to an existing permit ■ Bank revetment ■ Road resurfacing at waterway crossings ■ Stormwater outlet construction, ■ Works that occur within these waterways will be defined as waterway barrier works, unless the works comply with the <i>Accepted development requirements for operational work that is constructing or raising waterway barrier works (1 October 2018)</i>.	
Back on Track species prioritisation framework (2010)	-	The Back on Track species prioritisation framework is an initiative of the DES, based on the method of Marsh <i>et al</i> (2007), that ranks species (regardless of their NC Act or EPBC Act classification) as Critical, High, Medium, or Low priority for the State and for the Natural Resource Management (NRM) region. There is also a data deficient category according to three sets of criteria: probability of extinction, consequences of extinction and potential for successful recovery. Although it is not legislated, the Back on Track priority species provides a framework for biodiversity assessment and species prioritisation when determining ecological values.	Priority Back on Track species have been identified for each of the 14 NRM regions across Queensland. The Project is located across the Condamine and the Border Rivers Maranoa-Balonne NRM regions. A total of 36 priority Back on Track species (12 flora species and 24 fauna species) are known to occur within the Condamine NRM region through the prioritisation framework (DERM 2010). The Border Rivers Maranoa-Balonne NRM region identifies 42 priority Back on Track species, including 20 flora and 22 fauna species. Sections 4.5.1.2 and 4.5.2.2 list the NRM State Back on Track species and their rank for the NRM.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
Biodiversity Planning Assessments (BPAs)	-	BPAs for each of Queensland's bioregions have been prepared based on the methodology outlined in the Biodiversity Assessment and Mapping Methodology (BAMM) (DEHP 2014a). The BPAs draw upon the Department of Environment and Heritage Protection (DEHP) certified 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. The BPA assigns areas to one of three biodiversity significance levels, including: ■ 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. Although it is not legislated, the BPA provides a framework for biodiversity assessment when determining ecological values. In addition to terrestrial BPAs, aquatic BPAs utilises and assesses the conservation and ecological value of wetland systems based on a series of national and international criteria, including naturalness (aquatic and catchment), diversity and richness, threatened species/ecosystems, priority species/ecosystem, special features, connectivity and representativeness to provide aquatic conservation assessments for SEQ (DEHP 2015).	The Project is located within the Brigalow Belt BPA area, (DEHP 2018). The following report outlines the BPAs conducted within the impact assessment area: ■ <i>Biodiversity Planning Assessment for the Brigalow Belt Bioregion: Expert Panel Report v2.1</i> (2018). Further information related to the BPA is provided in Section 4.5.15.
<i>Nature Conservation (Koala) Conservation Plan 2017</i>	Queensland	The <i>Nature Conservation (Koala) Conservation Plan 2017</i> (Koala Plan) requires any clearing in certain areas to be undertaken sequentially, and in the presence of a suitably qualified koala spotter. The Koala Plan also prescribes three mapped koala districts (A, B and C) and includes requirements relating to the release of rehabilitation, sick or injured koalas.	The Project will require clearing within District A as identified in the Koala Plan. Clearing works in Koala habitat within District A require 'sequential clearing' and the presence of Koala spotters. Refer to EIS Appendix L: Matters of National Environmental Significance Technical Report.

3 Methodology

3.1 Overview

An overview of the stages involved in the assessment of Sensitive environmental receptors for the scope and intent of this Terrestrial Ecology Technical Report (i.e. MNES (restricted to migratory species) and MSES) is provided in Table 3.1. Further information regarding the development predictive habitat mapping to support the assessment process provided in Appendix A.

The initial step of the assessment was to identify the Sensitive environmental receptors (e.g. EPBC Act listed migratory species and MSES) 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 3.3.1). Ecological site investigations associated with pre-clearance work for geotechnical investigations (EPBC Referral 2018/8263) were also incorporated into the findings (refer Section 3.2.2).

Detailed onsite surveys for threatened fauna have not necessarily been carried out as per the relevant Commonwealth survey guidelines for each species. For example, there are no Commonwealth guidelines regarding threatened flora and surveys for protected flora have been carried out following State guidelines (e.g. 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 detecting the potential presence of Sensitive environmental receptors along a 216.2 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 Sensitive environmental receptors. Section 3.2.2 outlines the methods used during Project-associated surveys as they apply to species that are the subject of this technical report.

Predictive habitat modelling for each flora and flora species that constituted a Sensitive environmental receptor (refer Sections 3.2.4.1 and 3.2.4.2) and associated constraints mapping, was developed based on the desktop and field survey results. The predictive modelling was based upon 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 Guidelines (migratory species) or MSES Guideline – refer Sections 5.3.3 and 5.3.4 respectively. Assumptions that were adopted in developing the predictive habitat models are discussed in Section 3.2.4.3

The predictive habitat modelling and constraints mapping, 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 Sensitive environmental receptor.

The interaction of each stage of the assessment process is represented schematically in Figure 3.1.

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 Sensitive environmental receptors. 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 and State threatened species survey guidelines). As such the significance of the impacts on Sensitive environmental receptors will also change. All of which will be done in consultation with relevant stakeholders (Commonwealth and State government) 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.

Further information regarding the development predictive habitat mapping to support the assessment process provided in Appendix A.

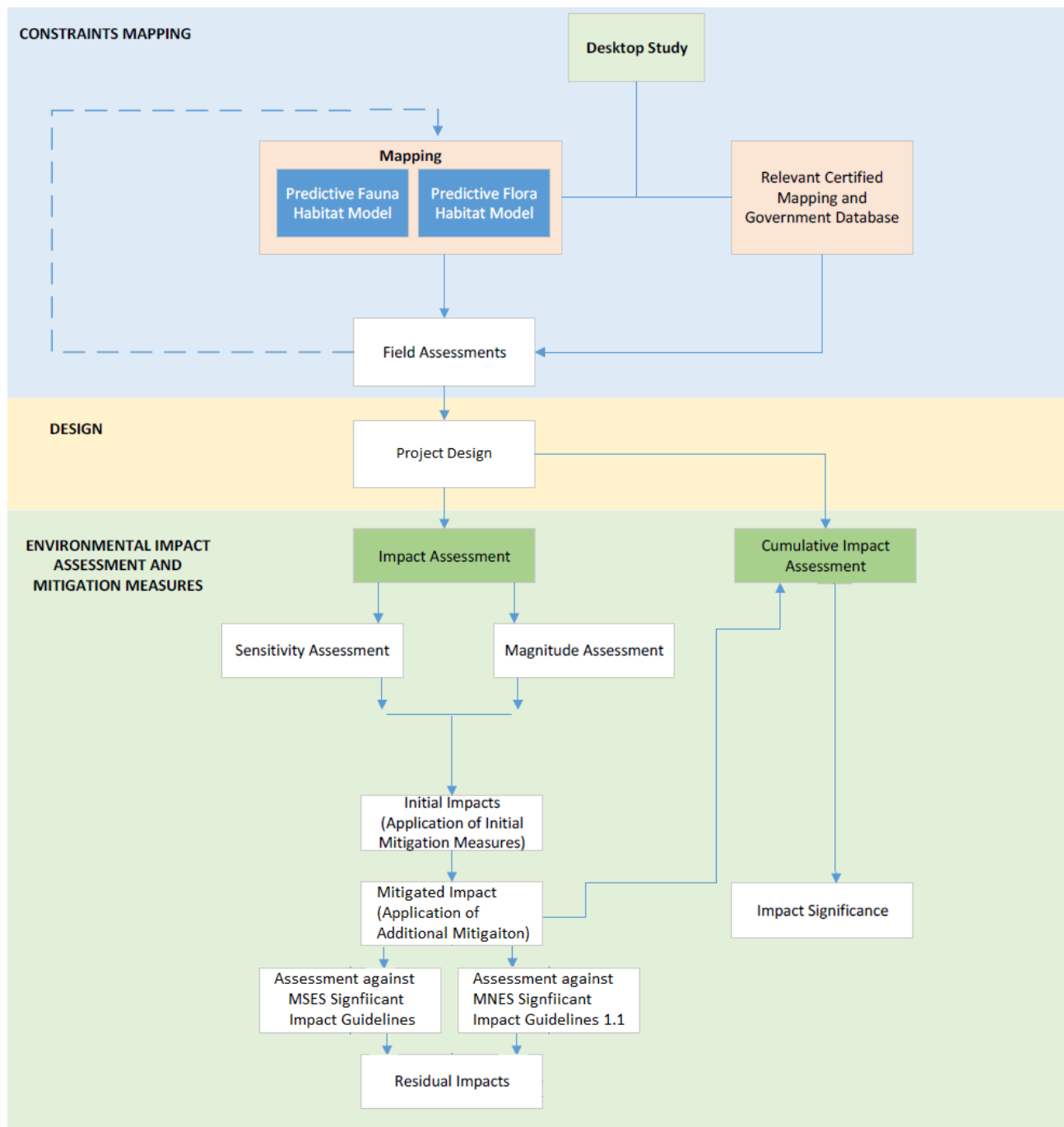


Figure 3.1 Assessment methodology

3.2 Desktop study

This section details the desktop analysis undertaken to identify existing Sensitive environmental receptors located in the impact assessment area. The analysis included a review of existing field data collected prior to the commencement of the Project EIS and field data collected during the EIS data collection phase. In addition, this section provides details related to the creation of predictive GIS models which specifically identify areas of habitat capable of supporting Sensitive environmental receptors within the impact assessment area. In accordance with the EIS ToR, the impact assessment area was used to identify significant environmental receptors that are located in proximity to the Project.

3.2.1 Database review

A database review was undertaken in 2017 prior to field investigations to identify Sensitive environmental receptors that were known or likely to be present within the impact assessment area. To ensure that the most recent data was obtained, searches were re-run in 2019 to ensure that any relevant updates, 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. It is acknowledged that the resolution currency of database information has limitations. These limitations were minimised wherever possible by ensuring that the most recent datasets were used, datapoints with ambiguous metadata or of very low precision were excluded from analysis, and that any ground-truthed was prioritised over that of desktop-based datasets. In addition, specimen backed records in excess of 30 years were excluded from analysis due to concerns related to currency and recent human induced disturbance to the broader area.

The databases incorporate multi-seasonal datasets that span multiple years and adequately account for seasonal variation and detectability related to conservation significant species.

Table 3.1 Summary of database searches

Database/data source name	Database search date	Database search areas	Data type
Atlas of Living Australia (ALA)	11/05/2020	Impact assessment area	Records of flora and vertebrate fauna, including conservation significant species listed under the EPBC Act and/or NC Act (i.e. MNES and MSSES)
Birds Australia	29/03/2019	Impact assessment area	Records of avian fauna, including threatened and migratory species listed under the EPBC Act
Biodiversity Planning Assessment (BPA) mapping (Queensland Government 21/2/2018)	26/02/2020	Impact assessment area	State, regional and locally significant biodiversity matters mapping. This mapping has been used to indicate the location of bioregional corridors (i.e. in the State, regional and local context). This mapping has also been used in the predictive modelling to identify core habitat areas (refer Section 3.2.4)
Back on Track species prioritisation framework (DERM 2010; DERM 2010)	26/02/2020	Condamine and the Border Rivers Maranoa-Balonne NRM regions	The Back on Track species are categorised as Critical, High, Medium, or Low priority for the State and for the NRM regions. There is also a data deficient category according to three sets of criteria: probability of extinction, consequences of extinction and potential for successful recovery. Data is presented as a list of species (refer Section 4.5.1.2 (flora) and Section 4.5.2 (fauna)).
EPBC Act Protected Matters Search Tool (PMST) (Australian Government)	26/02/2020	Impact assessment area	MNES listed under the EPBC Act, incorporating world heritage properties, national heritage places or wetlands of international importance

Database/data source name	Database search date	Database search areas	Data type
MSES Wildlife habitat mapping (Queensland Government 2019)	26/02/2020	Impact assessment area	Essential habitat under the VM Act for a conservation significant species listed under the EPBC Act and/or the NC Act (i.e. MNES and MSES)
Regulated Vegetation Management Map (Queensland Government 2018)	26/02/2020	Impact assessment area	Mapping of REs and HVR that provide habitat for TECs and conservation significant species under the EPBC Act and/or NC Act
Register of critical habitat (Australian Government)	26/02/2020	Australian extent	Critical habitat listed under the EPBC Act
Map of Referable Wetlands (Queensland Government 2018)	26/02/2020	Regional extent	Includes State significant, referable wetlands, important wetlands in the Great Barrier Reef catchments and wetland REs
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 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 and/or NC Act
Queensland waterways for waterway barrier works (Queensland Government 2018)	26/02/2020	Impact assessment area	Waterways where proposed waterway barrier works require assessment and approval under the Fisheries Act
Watercourse Identification Mapping (Queensland Government 2018)	26/02/2020	Impact assessment area	Known extent of watercourses and drainage features that are managed under the Water Act
Fish Habitat Areas (Queensland Government 2018)	26/02/2020	Impact assessment area	Boundaries of gazetted, declared fish habitat areas
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 groundwater dependent ecosystems (GDEs).
Matters of State environmental significance (Queensland Government)	26/02/2020	Impact assessment area	Location of MSES, including: - Protected areas - Marine parks - Management A and Management B declared fish habitat areas - Threatened and Special Least Concern wildlife listed under the NC Act - Regulated vegetation under the VM Act - Wetlands in a wetland protection area or wetlands of high ecological significance - Wetlands and watercourses in high ecological value waters as defined in the <i>Environmental Protection (Water) Policy 2009, Schedule 2</i> - Legally secured offset areas.

Database/data source name	Database search date	Database search areas	Data type
Aquatic Biodiversity Assessment Mapping Method (AquaBAMM)/Aquatic Conservation Assessments (ACA)	26/02/2020	Impact assessment area	Conservation values of aquatic ecosystems for: ■ Biodiversity and species richness ■ Presence of threatened species or community ■ Presence of priority species or ecosystem ■ Ecosystem complexity (e.g. uniqueness of geomorphology) ■ Landscape connectivity A summary score (Aquascore) is produced and classified into one of five rankings: ■ Very High ■ High ■ Medium ■ Low ■ Very Low

3.2.2 Review of existing literature and previous studies

Two environmental assessment reports were identified that presented information on the ecology of the impact assessment area. Information included species diversity, abundance and seasonal distribution (refer Table 3.2).

In addition to the material identified in Table 3.2, site specific database queries as identified in Section 3.2.1 have been accessed to produce the predictive habitat mapping related to conservation significant flora, fauna (refer Sections 3.2.4.1 and 3.2.4.2). Whilst it is acknowledged that each of the previous investigations were undertaken over a single season, the analysis of existing database records, additional survey work (refer Section 3.3.1.1) and the formulation of the predictive habitat models which are considered to adequately account for seasonal variation and detectability related to conservation significant species.

Seasonal variation was also captured in the modelling approach (refer Sections 3.2.4.1 and 3.2.4.2) which utilised government datasets and historic records that were developed across multiple seasons/years. The results of the modelling provided a measure of the amount of suitable habitat present regardless of season as it included essential components required by the species (e.g. vegetation structure, geological feature, presence of specific hydrology regimes).

The findings of each of the existing background studies were used to inform this terrestrial ecology assessment, particularly the likely extent of ecological communities and habitat for conservation significant species listed under the NC Act in the impact assessment area. The reports reviewed include impact footprints that largely match that of the Project (refer Table 3.2).

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 2018) ¹	Nil	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 and location (Canning Creek)

Document/investigation title	Timing of supporting surveys	Summary of significant findings related to MNES used to verify inputs to this assessment
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>Rhaphonticum australe</i>) - Tall hawkweed (<i>Picris barbarorum</i>) - Finger panic (<i>Digitaria porrecta</i>)
Initial Advice Statement: Inland Rail – Border to Gowrie (ARTC 2018a) ²	26-29 April 2016	- Survey of alignment and corridor options - Identification of REs and TECs - Opportunistic searches for threatened flora species - Fauna habitat assessments - Anabat deployment at three sites
	12-15 September 2016	- Survey of further corridor options - Identification of REs and TECs - Opportunistic searches for threatened flora species - Fauna habitat assessments - Anabat deployment at two sites
	25-28 October 2016	- Survey of further corridor options - Identification of REs and TECs - Opportunistic searches for threatened flora species - Fauna habitat assessments

Table notes:

- 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#>
- Available from: <http://eisdocs.dsdp.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 Sensitive environmental receptors 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), specifically for informing assessment of the likelihood of occurrence of Sensitive environmental receptors within the impact assessment area.

3.2.3 Assessment of the likelihood of occurrence of conservation significant species

The likelihood of Sensitive environmental receptors listed under the provisions of the NC Act and the EPBC Act to occur within the impact assessment area was determined based on the results of the desktop study and review of existing reports. Likelihood of occurrence was supplemented with data derived from field surveys (refer Section 3.3) and used to refine the predictive habitat mapping (refer Section 3.2.4).

The likelihood of occurrence assessment is central to determining which Sensitive environmental receptors were identified for the Project and were subject to predictive habitat modelling (refer Section 3.2.4, and Appendix A).

Threatened species considered possibly or likely to occur, or which were identified in the impact assessment area during the field assessment, were assessed as Sensitive environmental receptors applicable to the Project. Threatened species, which were considered unlikely to occur within the Impact assessment area, were not considered further as part of this 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 Project 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. altitudinal limits and intertidal saltmarshes and estuarine wetlands)
- Are considered locally extinct based on expert knowledge and/or literature.

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.

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

- Have been recently recorded in the impact assessment area (i.e. sightings within the last 10 years within 20 km of the impact assessment area)
- Use habitat types or resources that are present in the impact assessment area, that are in good condition
- Are likely to maintain sedentary populations within the impact assessment area.

Information related to ecology, habitat requirements, distribution, threatening processes and applicable threat abatement/recovery plans for each of the conservation significant species and communities identified from the desktop component is provided in Sections 5.3.3, 5.3.4.1 and Appendix B.

3.2.4 Predictive habitat modelling for conservation significant flora and fauna species

Predictive habitat modelling was undertaken to identify and map areas that were identified as having the potential to provide habitat for conservation significant species in accordance with Section 11.94 of the EIS ToR.

In addition to RE associations, a number of environmental GIS base layers were incorporated into the predictive habitat model where applicable for each species (refer Appendix A). The model was designed to recognise specific requirements of each conservation significant species, which were identified through the broader desktop analysis.

Databases and other information that were used to inform the predictive GIS based model are identified in Table 3.1 (refer Sections 3.2.1 and 3.2.2) and Table 3.2. In addition to database information, data collected during field-based assessments (refer Section 3.3) was used to verify and “refine model outputs (refer Section 3.2.4 and Appendix G).

3.2.4.1 Habitat mapping for species listed under the NC Act

The habitat in the predictive threatened species habitat model for NC Act listed species was categorised as core, essential, general and unlikely using current scientific knowledge and pre-existing data derived from historic surveys, State based mapping, scientific publications and advice from industry recognised experts. The specific habitat assumptions for each species are provided in Appendix A.

As part of the predictive habitat modelling for NC Act listed species, species-specific assumptions allowed the following areas to be identified for each conservation significant species:

- Core habitat
- Essential habitat
- General habitat
- Unlikely habitat.

An overview of each of these categories is provided in the sections below.

Core habitat

Core habitat consists of essential habitat in which the species is known, and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Where essential habitat intersects with areas identified as important within the relevant bioregion specific BPA, these areas have been elevated to the core habitat category. Species specific assumptions associated with the mapping of core habitat areas are detailed in Appendix A.

Aquatic fauna values were excluded from predictive core habitat modelling, with the highest tier of habitat modelling capped at essential habitat (as per Appendix A). There are currently no GIS datasets that are tractable to facilitate analysis of habitat to elevate essential habitat (i.e. known to support a species) to core habitat (i.e. areas of essential habitat contained within a protected area (e.g. BPA)). However, any core terrestrial habitat in proximity to the aquatic ecosystem (i.e. watercourse), will flag significance of the aquatic values (as associated core habitat) due to the scaling of core terrestrial habitat mapping. As such, standalone aquatic core habitat is not possible (in the absence of any observation of species) in regard to core habitat predictive modelling.

Essential habitat

Essential habitat consists of areas containing resources that are considered essential for the maintenance of populations of the species (e.g. potential habitat for breeding, roosting, foraging, shelter) or areas that have been confirmed as containing suitable habitat as identified by a specimen backed record or indirect evidence of the species (i.e. scat, trace, track, fur/feather, distinctive vocalisation or other site based evidence). Essential habitat has been defined from known location-specific records (i.e. low location error information and from within the last 30 years), with a 1 km buffer or site-based observation of the species during site investigations. In addition, if the 1 km buffer from the known record intersects an area identified as general habitat, the general habitat rating was elevated to essential habitat. Species specific assumptions associated with the mapping of essential habitat, and instances that deviate from the above criteria are detailed in Appendix A.

General habitat

General habitat consisted 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 essential/core habitat (i.e. records of the species are considered anomalies as general microhabitat features are not considered to be present from a desktop perspective). General habitat also includes habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. General habitat may include areas of suboptimal habitat for a species. Species specific assumptions that define the general habitat category are identified in Appendix A.

Unlikely habitat

Unlikely habitat consisted 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.

3.2.4.2 Habitat mapping for EPBC Act listed migratory species

The habitat in the predictive species habitat model for EPBC Act listed migratory species was categorised as important habitat, potential habitat and unlikely 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 migratory species habitat occurring with the impact assessment area, when compared to limited and or sporadic field investigations.

The species-specific assumptions allowed the following areas to be identified for each migratory species:

- Unlikely habitat
- Potential habitat
- Important habitat

The use of these habitat categories aligns with DAWE's habitat definitions for species protected under the EPBC Act as identified in the *Draft Referral guideline for 14 birds listed as migratory species under the EPBC Act* (DotE 2015).

An overview of each of these categories is provided in the sections below.

Important habitat

In line with the DAWE guidelines, 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).

Species specific assumptions that define the Important habitat category for the abovementioned species is provided in Appendix A.

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. Potential habitat may include areas of suboptimal habitat for species. As Potential habitat for many species may include most of the mature vegetation communities of the specific bioregion, the potential habitat category restricts the habitat to a more limited and realistic set of environmental parameters which are supported by literature and field-based observation. Species specific assumptions that define the Potential habitat category are identified in Appendix A.

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 Modelling assumptions

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 as follows:

- The full Project footprint (temporary footprint, plus permanent footprint) has been used to determine the extent of impact of the Project. In doing so, the assumption has been made that the full Project footprint will be cleared to enable to safe and efficient construction of the Project. The Project footprint is conservative in that not all of the nominated area may be required to construct and operate the Project. The Project footprint will be refined through the detail design process and the finalised footprint is expected to be smaller than what has been nominated in the EIS. Additionally, in practice not all of the temporary footprint will need to be cleared to enable construction of the Project. There will be opportunities for habitat to be retained and preserved.
- Heterogeneous RE polygons – Mapping has been developed to identify maximum areas of disturbance based on a precautionary approach. In the case of heterogeneous RE polygons (i.e. a mapped polygon that has more than one vegetation or RE code occurring in it), if an RE code is contained within the heterogeneous polygon, then the entire polygon is included in the model for that RE code. This is of particular importance to species such as those that rely on limited areas of habitat, which would otherwise be missed by the model.
- Buffers – Buffers have been applied when integrating a specimen backed record into the predicted mapping. Generally, a 1 km buffer from a recorded species data point has been applied, in line with the methodology adopted by the VM Act when identifying 'critical habitat' derived from a specimen backed record. Where a recorded species data point (including buffer) intersects with areas of predicted potential habitat, the area of overlap has been elevated to the category of 'Habitat critical to the survival of the species category'.
- 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 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 formula for the particular species. 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 'Important habitat' (e.g. for brigalow belt reptiles) or 'Habitat critical to the survival of the species', in line with the information contained within the relevant species advice/guideline or policy.

In combination, these assumptions mean that the significance and extent of impacts that have been predicted using the habitat modelling approach are, if anything, an overestimation of what actual impacts will be incurred as a consequence of the Project.

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).

This section outlines the field assessment methodologies adopted in recognition of relevant departmental guidelines or policies (i.e. survey guidelines, species recovery plans and the EPBC Act Significant Impact Guidelines). Field surveys were undertaken with due consideration of the following survey guidelines:

- Commonwealth published guidelines for threatened species where applicable (refer: <http://www.environment.gov.au/epbc/policy-statements>)
- Methodology for survey and mapping of REs and vegetation communities in Queensland (Neldner *et al* 2019)
- 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 Sensitive environmental receptors 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 (refer Section 3.3.1). 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 Project 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 Disturbance 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 reduce the areas that were accessible to ecological investigations. The extent of fieldwork and predictive modelling, when used in conjunction with existing information, are considered appropriate to provide confidence in predictions of potential impacts to terrestrial ecology receptors 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.

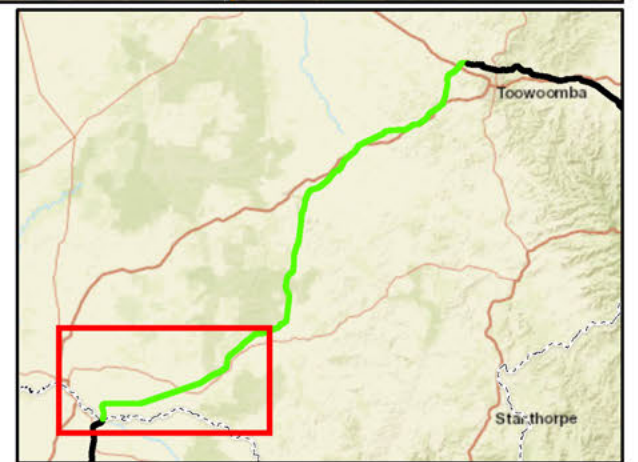
Whilst not specifically detailed within this document, results of previous and concurrent surveys (refer Section 3.3.1.1), have been incorporated within this technical report and the EIS reporting where relevant. Refer to Figure 3.2 for the locations of areas undertaken as part of these surveys. Surveys undertaken to support the geotechnical program were undertaken in accordance with the Flora survey guidelines - protected plants, *Nature Conservation Act 1992* (DEHP 2016) and in addition, habitat assessments (including breeding and foraging habitat for threatened species), focussing on those listed as threatened (e.g. Glossy-black cockatoo). This data has been used to assist in the predictive habitat mapping within the impact assessment area.

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 confirm the calculation of offset requirements for the Project.



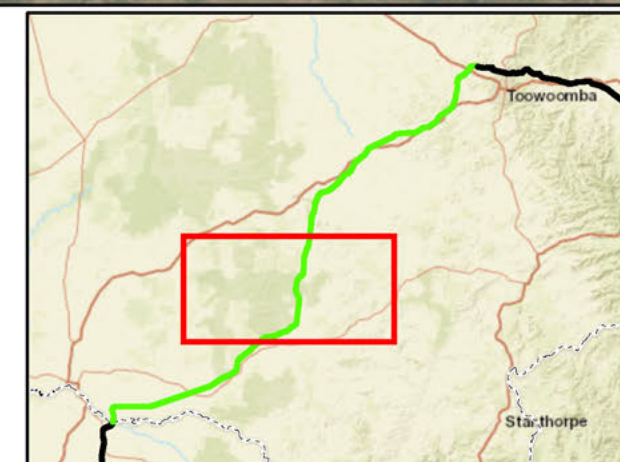
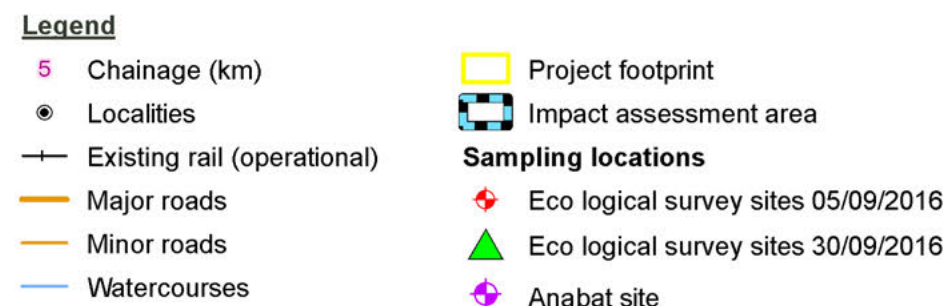
Legend

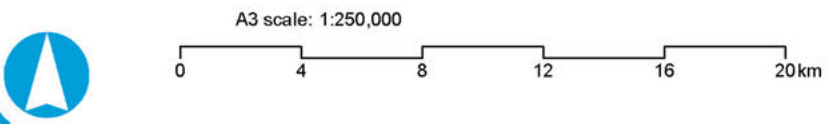
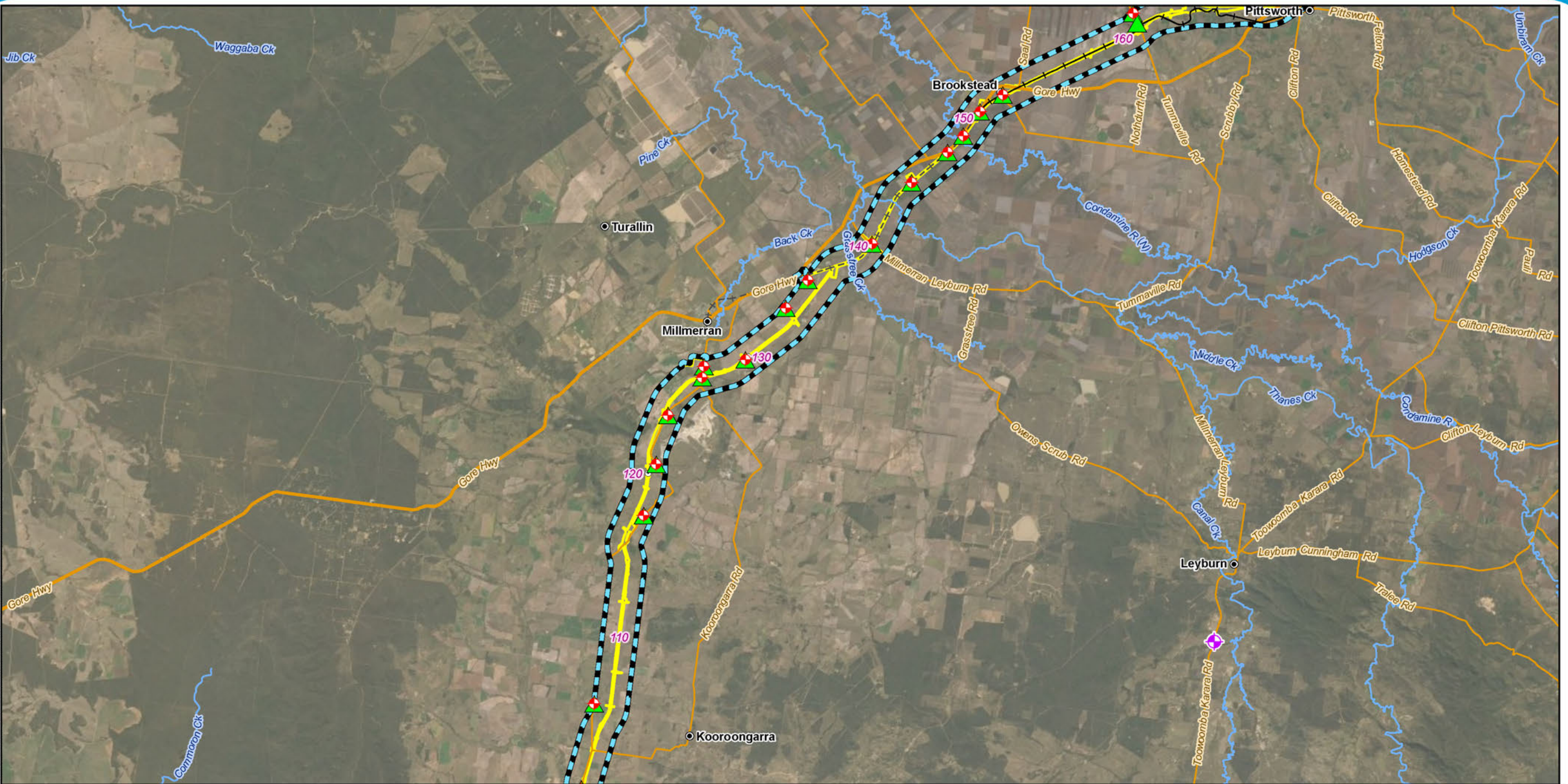
- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area
- Sampling locations**
- ◆ Eco logical survey sites 05/09/2016
- ▲ Eco logical survey sites 30/09/2016



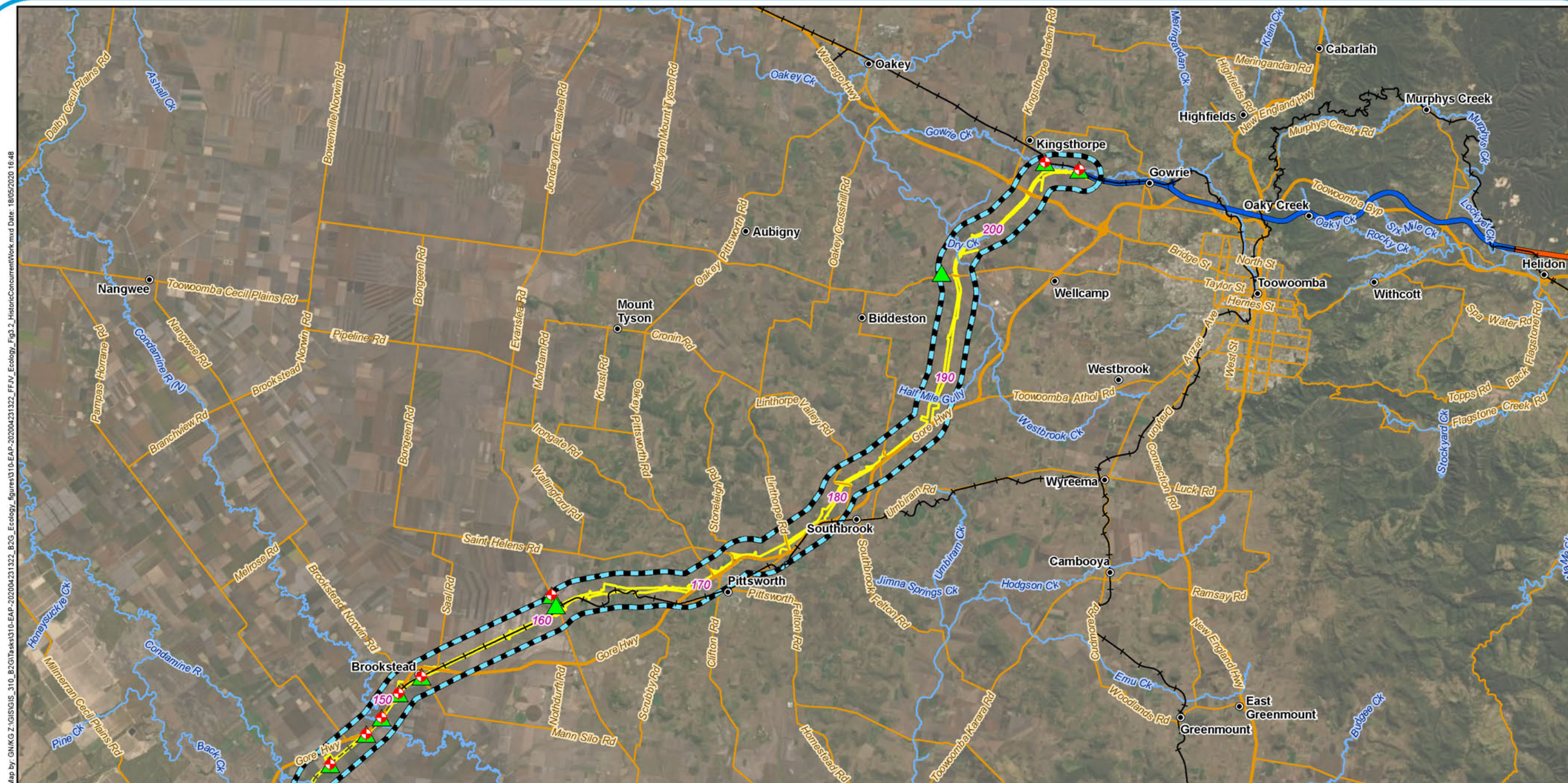
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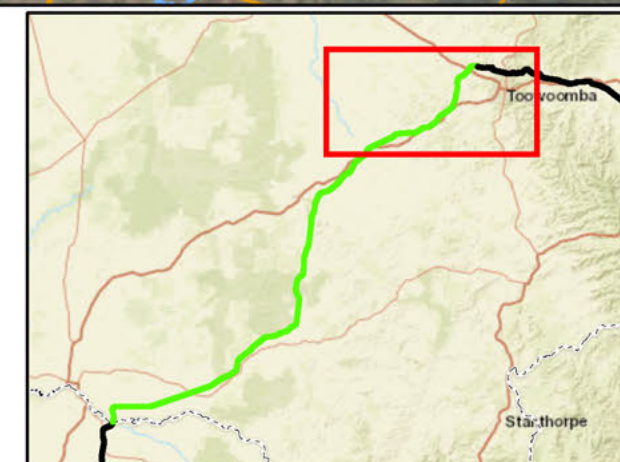


Border to Gowrie
Figure 3.2c: Location of areas sampled as part of historic and concurrent works



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



Specific timing and methods utilised in assessing terrestrial attributes are specified in the following sections.

3.3.1 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.

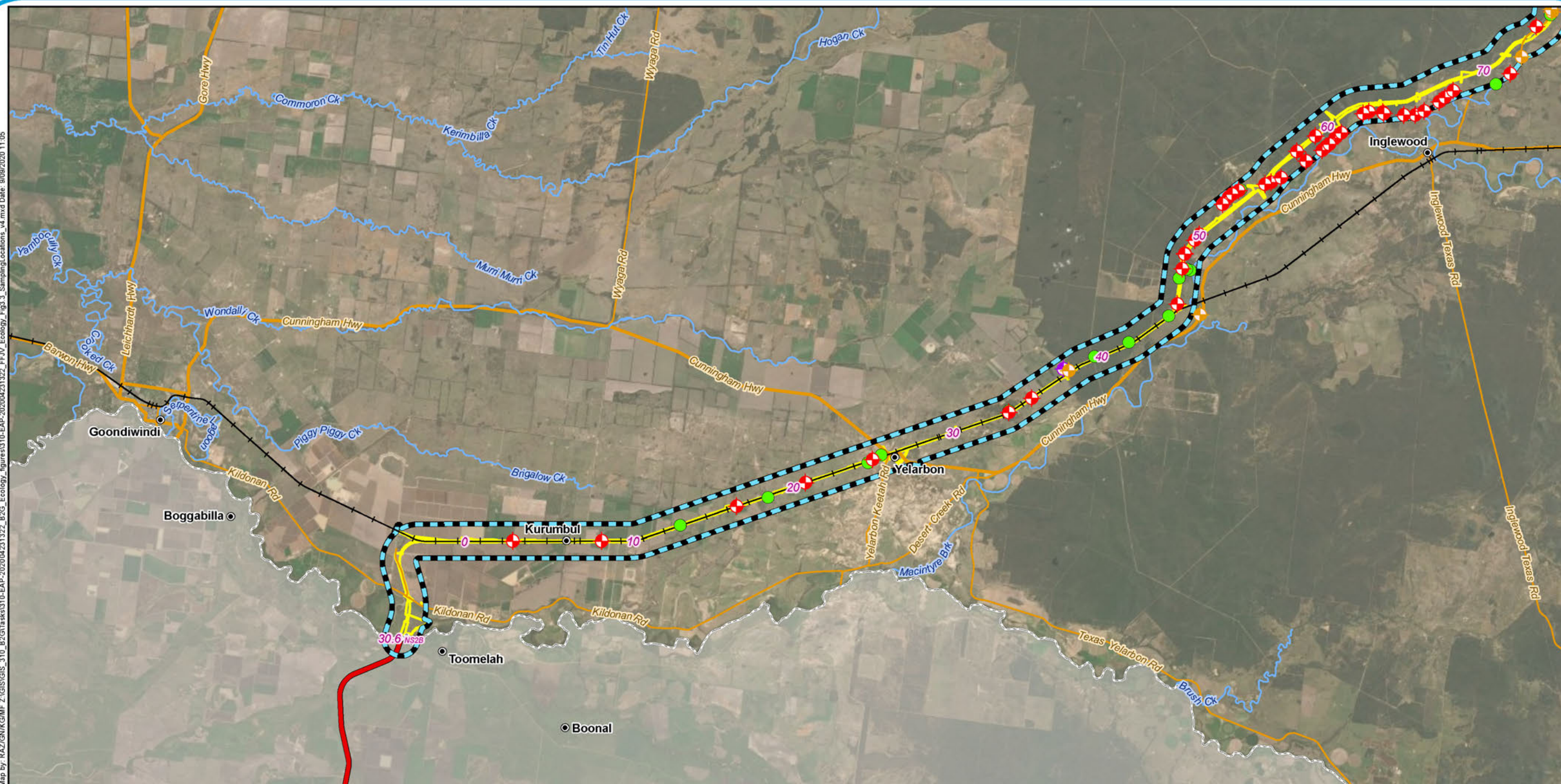
3.3.1.1 Previous and concurrent ecological surveys for Project

Previous ecological investigations undertaken within the impact investigation area have been undertaken by Eco Logical Australia in 2016. This work was used to inform the final advice statement for the EIS process and has been considered for the Project. Table 3.3 presents the survey timing and survey activities associated with previous the Project associated ecological investigations. It is noted that the Project footprint has changed somewhat since the surveys carried out by Eco Logical Australia in 2016. Note, there is some overlap in the location of surveys undertaken during programs presented Table 3.3 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 3.3 Timing of field investigations undertaken associated with the Project used to supplement the results of the current study

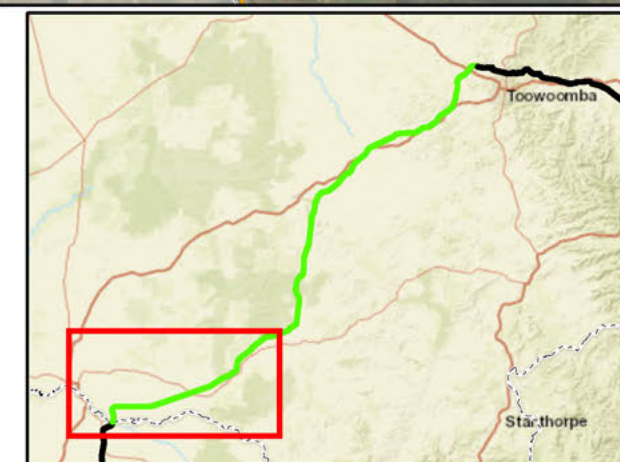
Study/investigation	Consultant/year	Timing of investigations	Season	Methodologies and notes
Border to Gowrie summary of ecological constraints to inform the EIS (total of 134 sites across the impact assessment area over three surveys)	Eco Logical Australia (2016)	26-29 April 2016	Autumn	- Survey of alignment and corridor options - Identification of 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 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 Australia (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
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.
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: - Tall hawkweed (<i>Picris barbarorum</i>) - Finger panic (<i>Digitaria porrecta</i>).

Map by: RAZ/GN/GIMF Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-2020\4231322_B2G_Ecology_figures\310-EAP-2020\4231322_FFJV_Ecology_Fig3.3_SamplingLocations_v4.mxd Date: 9/09/2020 11:05

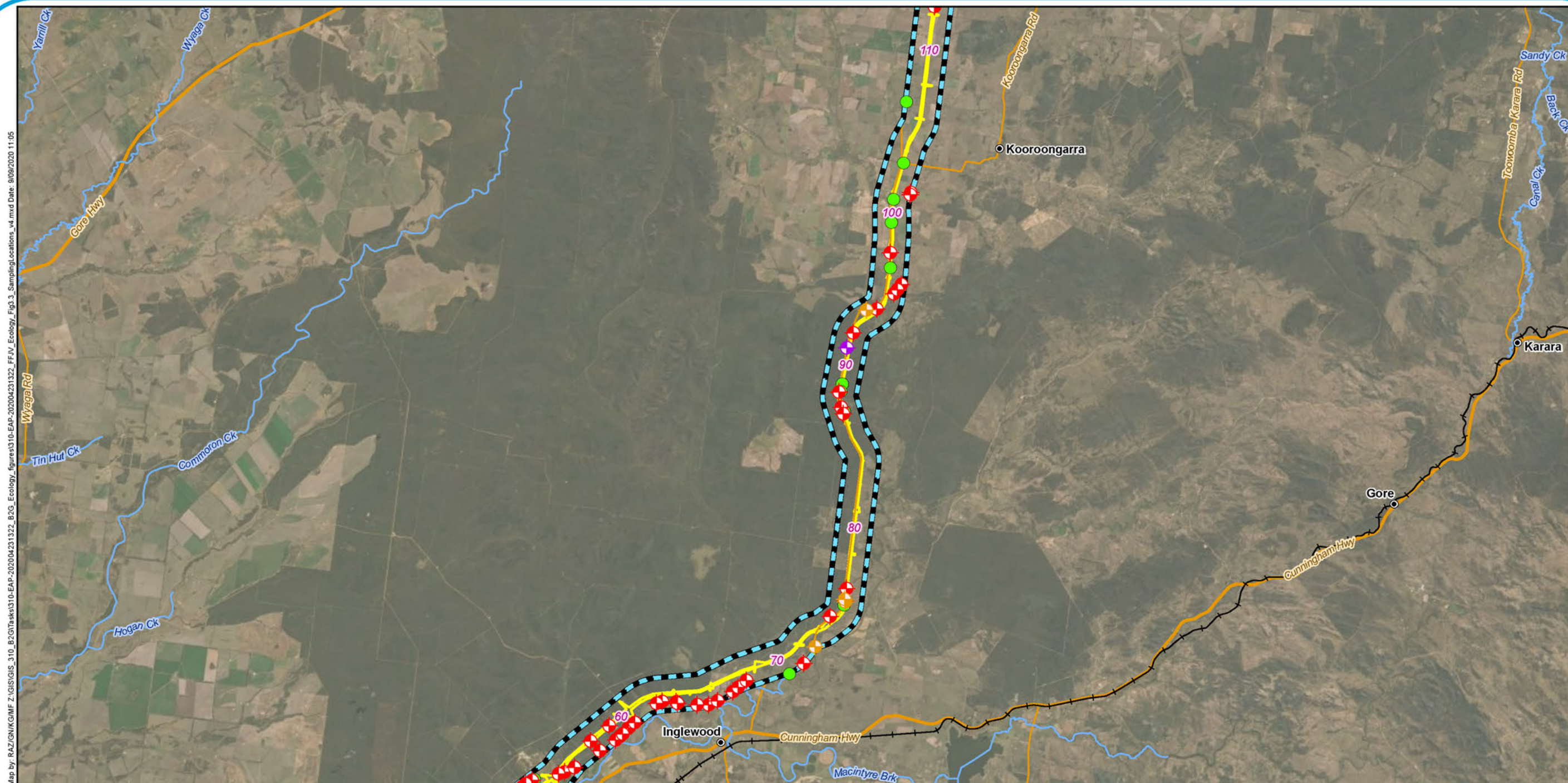


Legend

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

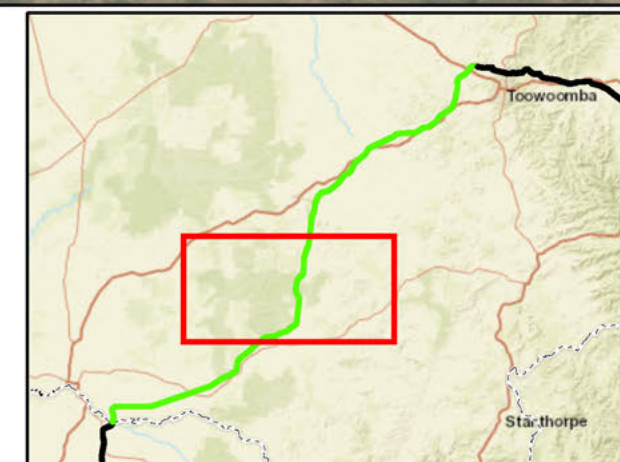


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 0 5 10 15 km

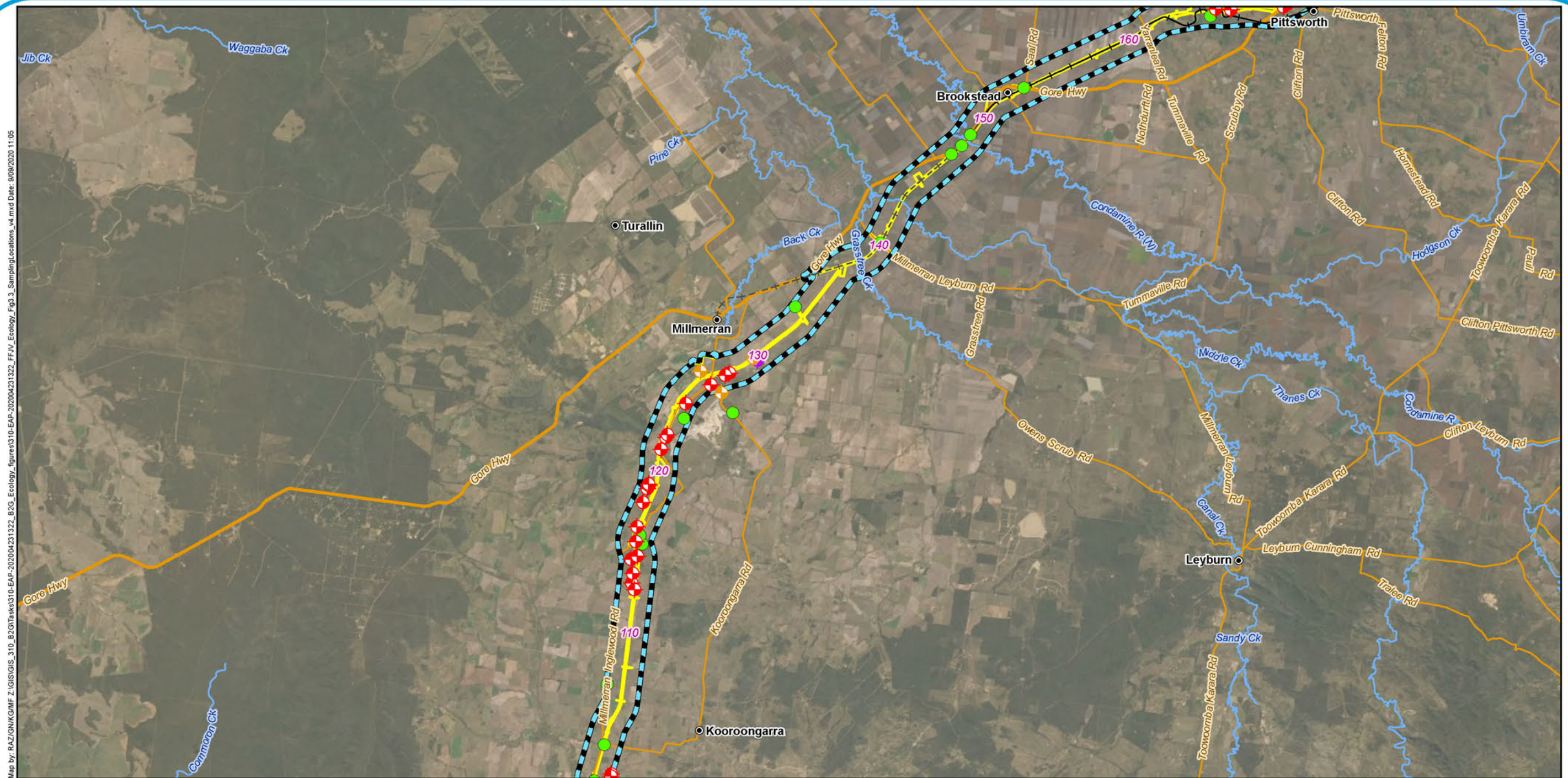


Legend

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



A3 scale: 1:250,000
 0 5 10 15 km



Legend

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



A3 scale: 1:250,000
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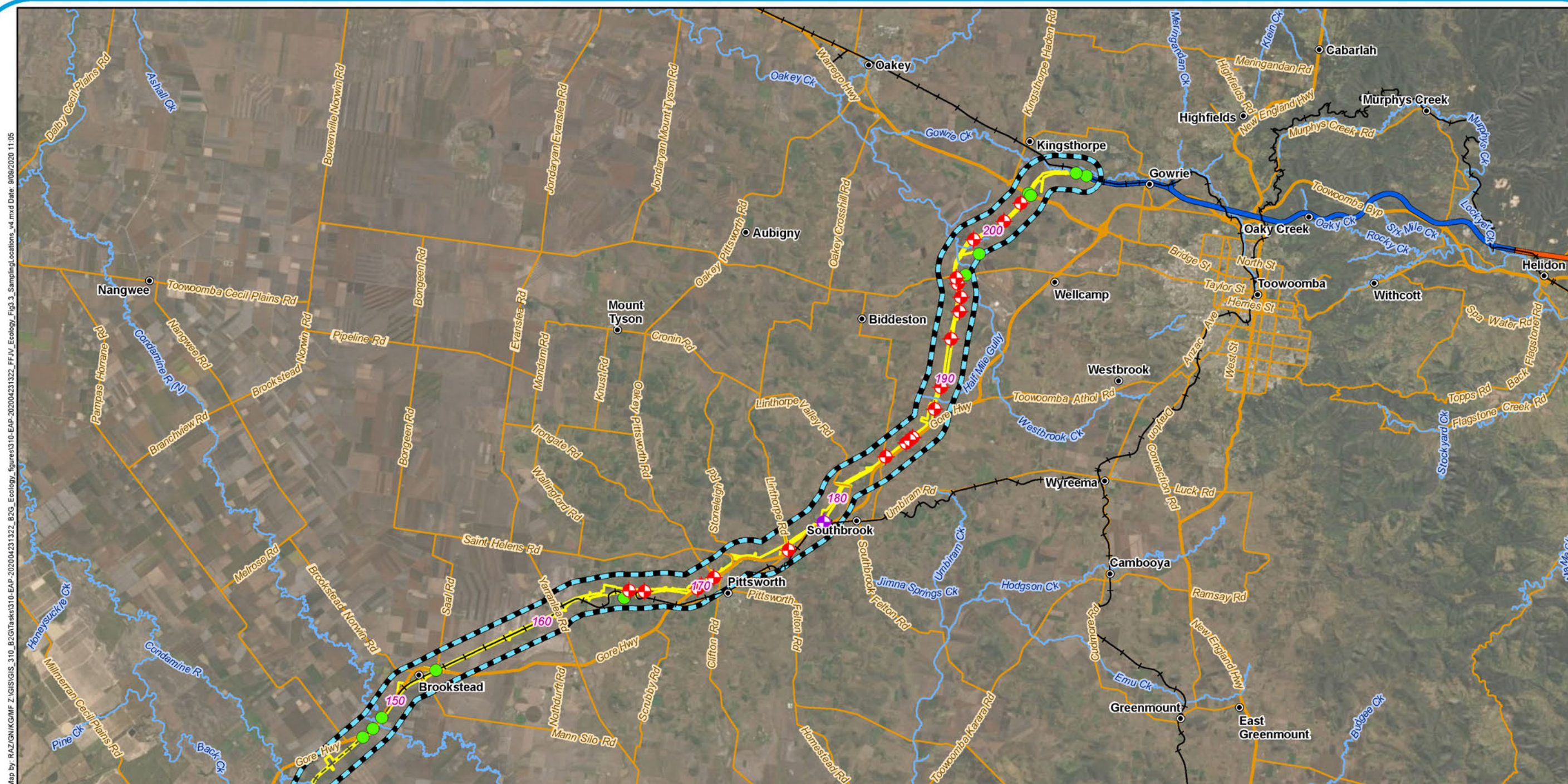


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 Coordinate System: GDA 1994 MGA Zone 56

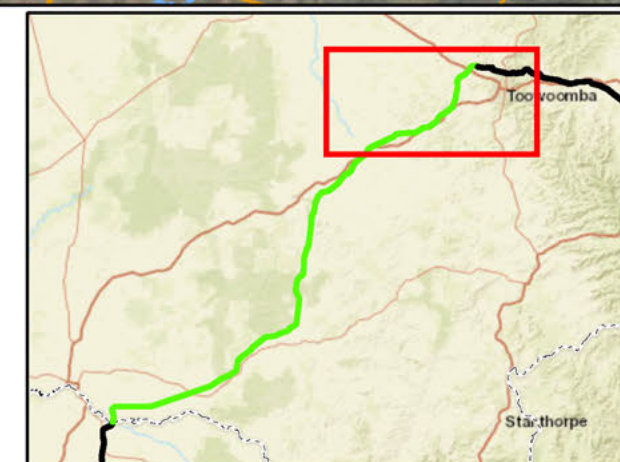
Border to Gowrie

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



Legend

- Localities
- 5 Chainage (km)
- ★ Anabat survey location
- ✦ Camera trap survey location
- ◆ Opportunistic survey locations
- Terrestrial sampling sites
- Major roads
- Minor roads
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Watercourses
- Project footprint
- ▤ Impact assessment area



A3 scale: 1:250,000

0 5 10 15 km



Future Freight
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Issue date: 09/09/2020 Version: 2
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

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

3.3.2 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 3.4 and shown in in Figure 3.3.

Table 3.4 Targeted field survey sites and date of assessment

Site ID	Site location			Date assessed	Survey techniques
	Zone	Easting (m E)	Northing (m S)		
T1	56J	267600	6833087	16 April 2018	■ Active searches for cryptic species ■ Opportunistic fauna observations ■ Census of flora species ■ Habitat assessment
T2	56J	272818	6834722	16 April 2018	■ Active searches for cryptic species ■ Opportunistic fauna observations ■ Census of flora species ■ Habitat assessment
T3	56J	279535	6837249	16 April 2018	■ Active searches for cryptic species ■ Opportunistic fauna observations ■ Census of flora species ■ Habitat assessment
T4	56J	278742	6836780	17 April 2018	■ Active searches for cryptic species ■ Opportunistic fauna observations ■ Census of flora species ■ Habitat assessment
T9	56J	287093	6839863	17 April 2018	■ Active searches for cryptic species ■ Opportunistic fauna observations ■ Census of flora species ■ Habitat assessment
T10	56J	290392	6842292	4 September 2018	■ Active searches for cryptic species ■ Opportunistic fauna observations ■ Census of flora species ■ Habitat assessment

Site ID	Site location			Date assessed	Survey techniques
	Zone	Easting (m E)	Northing (m S)		
T11	56J	290667	6842246	5 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T12	56J	294210	6843939	5 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T13	56J	292177	6843089	5 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T14	56J	296588	6845507	17 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T15	56J	297206	6847737	18 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T16	56J	297857	6848212	18 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T17	56J	297647	6848269	18 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T18	56J	300835	6852989	18 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T19	56J	315986	6859251	19 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T20	56J	319229	6863353	19 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T24	56J	319244	6874797	6 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T25	56J	319119	6876446	7 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment

Site ID	Site location			Date assessed	Survey techniques
	Zone	Easting (m E)	Northing (m S)		
T26	56J	319034	6876002	7 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T27	56J	320574	6880824	19 April 2018, 8 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T28	56J	321988	6883344	8 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T29	56J	322048	6886042	19 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T30	56J	322163	6887416	20 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T31	56J	322758	6889565	20 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T32	56J	322945	6893212	20 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T35	56J	325031	6901588	10 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T36	56J	324895	6902122	21 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T37	56J	327539	6909079	9 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T38	56J	330457	6909418	9 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T39	56J	331835	6912739	22 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment

Site ID	Site location			Date assessed	Survey techniques
	Zone	Easting (m E)	Northing (m S)		
T40	56J	334208	6915773	22 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T41	56J	339306	6919607	22 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T42	56J	343559	6924919	22 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T43	56J	344169	6925429	22 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T44	56J	344693	6926087	22 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T45	56J	347904	6928906	22 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T47	56J	359083	6933186	10 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T50	56J	379353	6952354	7 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T51	56J	386534	6958232	6 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T52	56J	385925	6958407	23 April 2018, 6 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T53	56J	383102	6957203	23 April 2018, 8 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
T54	56J	383239	6957062	23 April 2018, 1 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment

Site ID	Site location			Date assessed	Survey techniques
	Zone	Easting (m E)	Northing (m S)		
T55	56J	380159	6953590	23 April 2018, 9 September 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment
Site X	56J	331980	6912679	21 April 2018	- Active searches for cryptic species - Opportunistic fauna observations - Census of flora species - Habitat assessment

3.3.3 Terrestrial 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. Significant 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 conservation significant species was observed, these areas were elevated in status to either general habitat (for areas that were not currently mapped as general habitat for the species), or essential habitat (for locations that were already included within the general habitat mapping layer) (refer Section 3.2.4 for further detailed information).

3.3.3.1 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 carried out 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 threatened 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.

3.3.4 Terrestrial 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.

3.3.4.1 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 Eco Logical Australia (2016) (a total of 134 sites). Fauna habitat features recorded included, but was not limited to:

- Level of disturbance (scale of 0 – ‘no disturbance’ and 3 – ‘severe disturbance’) 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)
- Number 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.
- Amount of fallen logs (>10 cm diameter)
- Amount of coarse woody debris (<10 cm diameter)
- Quantity 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 fauna observed were identified to the species level where possible (refer Appendix H for site fauna habitat assessment datasheets).

3.3.4.2 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 ha survey area. These used the Birds Australia census technique described by Loyn (1986) for the EIS studies (refer 'terrestrial sampling site' in Figure 3.3a-d 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 3.3a-d 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 3.3a-d 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.

3.3.4.3 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 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.

3.3.5 Survey effort

In addition to the targeted EIS study survey locations identified in Table 3.4 (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.

3.3.6 Permits to conduct works

The 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). These permits were issued by the Queensland Government.

3.3.7 Quality assurance/quality control

Quality control and 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 Flora Survey Guidelines (DES 2019) was present within each survey team
- A portion of any threatened flora species (as listed under the NC Act) encountered, or species that could not be confidently identified during field recognisance, was submitted to the Queensland Herbarium for verification/identification
- 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 9 days of collection
- Scats/pellets that were collected in the field were taken to the Queensland Museum for species confirmation
- Any conservation significant fauna species had to be sighted/confirmed by both members of the field team to produce a confirmed record. Where applicable/possible, proof (e.g. photograph, scat or other evidence) was collected.

3.3.8 Nomenclature

3.3.8.1 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 (McNeill *et al.* 2006) and the International Code of Nomenclature for Cultivated Plants (Bricknell *et al.* 2004). Author abbreviations follow Brummitt and Powell (1992).

3.3.8.2 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.

3.4 Impact assessment method

The terrestrial assessment of the Project uses a significance-based impact assessment framework to identify and assess project related impacts in relation to Sensitive environmental receptors (MNES migratory and MSES receptors).

Terrestrial ecology has been assessed both quantitatively (e.g. quantity measurements) and qualitatively (e.g. via categorisation). A significant impact depends upon the magnitude of the potential impact, sensitivity of an environmental receptor, the quality of the environment that is impacted, and the likelihood that impact may occur.

Determination of the sensitivity of the environmental receptor and the magnitude of the potential impacts facilitate the assessment of the initial significance of potential ecological impacts. Avoidance or mitigation of impact actions are then applied to the Sensitive environmental receptor at specific locations. A residual impact assessment is then calculated with those avoidance or mitigation measures in place.

The following sections discuss and define impact magnitudes, sensitivity of Sensitive environmental receptors and the subsequent initial and residual impact significance.

3.4.1 Magnitude of impacts

The magnitude of a potential impact is essential to the determination of its level of significance on sensitive environmental receptors. A Sensitive environmental receptor is defined as a feature, area or structure (man-made or natural) that may be affected by direct or indirect changes to the environment.

Impact magnitude is defined from the nature and extent of the potential impact, including direct and indirect impacts. The impact magnitude is divided into five categories (refer Table 3.5). The magnitude of impacts is determined using techniques and tools that facilitate an estimation of the **extent, duration and frequency** of the impacts. Definitions for the duration of impact are provided in Table 3.6.

Table 3.5 Criteria for magnitude

Magnitude	Description
Major	An impact that is widespread, permanent and results in substantial irreversible change to the Sensitive environmental receptor. 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 Sensitive environmental receptor. 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)

Table 3.6 Timeframes for duration terms

Duration term	Timeframe – to be defined for each receptor 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 10 to 20 years ²
Permanent or irreversible	More than 20 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 Sensitive environmental receptors

Sensitivity categories are applied to each of the Sensitive environmental receptors to assess the significance of potential impacts on that receptor. The sensitivity categories are split into five discrete groups as described in Table 3.7. These groupings are based on qualitative assessments utilising information related to the sensitivity of the receptor, in addition to the potential of a Sensitive environmental receptor's occurrence within the receiving environment.

The significance of impacts (refer Section 3.4.3) for each Sensitive environmental receptor is calculated by comparing the magnitude of impact rating for the potential project impact type against the sensitivity criteria for the environmental receptor. This comparison is done via the matrix provided in Section 3.4.3.

Sensitive environmental receptors are treated individually even where there may be overlap of more than one feature in the same location. In the case where there are conflicting classes, the "worst-case" is selected.

Table 3.7 Sensitivity criteria for Sensitive environmental receptors within the impact assessment area

Sensitivity	Description
Major	■ The Sensitive environmental receptor is listed on a recognised or statutory State, national or international register as being of conservation significance ■ The Sensitive environmental receptor is entirely intact and wholly retains all intrinsic value ■ The Sensitive environmental receptor 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 Sensitive environmental receptor ■ Project activities would have an adverse effect on the Sensitive environmental receptor.
High	■ The Sensitive environmental receptor is listed on a recognised or statutory State, national or international register as being of conservation significance ■ The Sensitive environmental receptor is in good condition and retains most of its intrinsic value ■ The Sensitive environmental receptor 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 Sensitive environmental receptor has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the Sensitive environmental receptor ■ Project activities would have an adverse effect on the Sensitive environmental receptor.
Moderate	■ The Sensitive environmental receptor is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers ■ The Sensitive environmental receptor 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 Sensitive environmental receptor 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 receptor'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.
Low	■ The Sensitive environmental receptor is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations e.g. historical societies ■ The Sensitive environmental receptor is in a poor to moderate condition as a result of threatening processes, which have degraded its intrinsic value ■ It is not unique or rare and numerous representative examples exist throughout the system/area; ■ It is abundant and widely distributed throughout the host systems/areas ■ There is no detectable response to change or change does not result in further degradation of the Sensitive environmental receptor ■ The abundance and wide distribution of the Sensitive environmental receptor ensures replacement of unavoidable losses is achievable.
Negligible	■ The Sensitive environmental receptor is not listed on any recognised or statutory register and is not recognised locally by relevant suitably qualified experts or organisations; ■ The Sensitive environmental receptor is not unique or rare and numerous representative examples exist throughout the system/area; and ■ There is no detectable response to change or change does not result in further degradation of the Sensitive environmental receptor.

3.4.3 Significance of impact

The initial significance of a potential impact is a function of an impacted Sensitive environmental receptor's sensitivity and the magnitude of the potential impact. Although the sensitivity of the Sensitive environmental receptor will not change (i.e. is generally determined qualitatively by the interaction of the Sensitive environmental receptor'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 environmental receptor has been identified, and the sensitivity of the Sensitive environmental receptor 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 3.8). Significance categories as identified in Table 3.8 are defined Table 3.9.

Table 3.8 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 3.9 Significance classifications

Significance rating	Description
Major	Arises when an impact will potentially cause irreversible or widespread harm to an Sensitive environmental receptor 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 Sensitive environmental receptor. 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 Sensitive environmental receptor 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 Sensitive environmental receptor ensures it is adequately represented in the region, and that replacement, if required, is achievable.
Low	Occurs where an Sensitive environmental receptor 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 Sensitive environmental receptors. 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 (migratory species) or MSES. These were subsequently assessed against the MNES significant impact guidelines (for migratory species) or MSES significant impact to confirm the initial impact assessment results (refer Section 5.3.2).

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 impact assessment.

3.4.4 Assessment of the significance of impact against the matters of national environmental significance (migratory species) and matters of State environmental significance significant impact guidelines

Assessment of residual significant impacts was undertaken after avoidance or mitigation of those impacts to each Sensitive environmental receptor (MNES migratory, and MSES receptors) (Sections 5.3.3 and 5.3.4). Only those Sensitive environmental receptors 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.

Significant residual impacts for relevant MNES/MSES 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)
- *Queensland Environmental Offsets Policy Significant Residual Impact Guideline (Nature Conservation Act 1992 Environmental Protection Act 1994 Marine Parks Act 2004)* (State of Queensland 2014).

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

- EPBC Act Migratory species – Section 5.3.3
- MSES – Section 5.3.4.

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. Assessment of significant residual impacts to MNES (migratory species) and MSES was undertaken using the MNES and MSES significant impact guidelines respectively.

3.5 Cumulative impact assessment

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 overlap of project location, size and timing.

The areas of assessment vary between State listed matters (i.e. MSES) and those that are MNES (i.e. non-threatened Migratory species). For MNES, assessment of areas contained within NSW as well as Queensland is required, considering projects within both states. However, for MSES, the cumulative impact assessment area only considers projects and areas within Queensland as MSES are bound by State borders.

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 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 3.10 indicates the projects that have been included in the cumulative impact assessment, 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 3.10 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 cumulative impact assessment:

- 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 3.10).

Table 3.10 Projects to be considered in cumulative impact 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 waste water to the New Acland coal mine	EIS approved with conditions in 2008 The Wetalla Water Pipeline is completed and operational	2010 to 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, but currently subject to legal challenge	The mine is operational. Stage 3 expansion works will proceed if legal proceeding end favourably for New Acland Coal.
Australia Pacific LNG Project	Walloons gas fields (approximately 20 km west of Millmerran) 13 km west of the Project footprint	Integrated 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	Project started operation in 2015, but subject to continual gas field development
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 to 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 to unknown Assumed to continue development until Inland Rail is operational
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 to 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 to 2014

Projects	Location	Description	Status	Construction dates
Witmack Industry Park and Charlton Logistics Park	Wellcamp, QLD 3 km southeast 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 to 2018
Asterion Medicinal Cannabis Facility	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.	Under construction	2020 to 2021
Commodore Mine and Millmerran Power Station	Domville, QLD Intersects the Project footprint, located primarily to the east	The Commodore Mine is an open cut coal mine which provides coal for the 850 MW Millmerran Power Station. The Millmerran Power Station is a coal-fired power station that supplies enough electricity to power approximately 1.1 million homes.	Operational	2001 to 2003 Subject to annual maintenance shutdown and continual pit expansion. Also potential for coal reserves to be accessed beyond the current footprint
Pittsworth Industrial Precinct and Enabling Project	Pittsworth, QLD 500 m to the south of the Project footprint	Road and sewerage upgrades at the Pittsworth Industrial Precinct to allow for industrial land for industries servicing agriculture and the wider region	Operational	2017 to 2019
Doug Hall Poultry	Millmerran, QLD Intersects the Project footprint, located primarily to northwest	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 the 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

Projects	Location	Description	Status	Construction dates
Wyemo Piggery	Glenarbon, QLD 8 km south of the Project footprint	Piggery with approval for 55,000 pig units	Approved with conditions by GRC	Unknown
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	Operational	2018 to 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 GRC	Unknown
North Star to NSW/QLD Border (Inland Rail)	Rail alignment from North Star, NSW to the NSW/QLD border Adjoins the Project footprint to the south	New 37 km rail corridor to connect North Star (NSW) to the QR South West Rail Line just north of the NSW/QLD border	Reference design and draft EIS	2021 to 2024
Gowrie to Helidon Project (Inland Rail)	Rail alignment from Gowrie to Helidon, QLD Adjoins the Project footprint to the north	New 26 km dual gauge track between Gowrie (north-west of Toowoomba) and Helidon (east of Toowoomba), extending through the LGAs 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 draft EIS	2021 to 2025
Helidon to Calvert (Inland Rail)	Rail alignment from Helidon to Calvert, QLD 26 km to the 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 LGAs 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 draft EIS	2021 to 2025

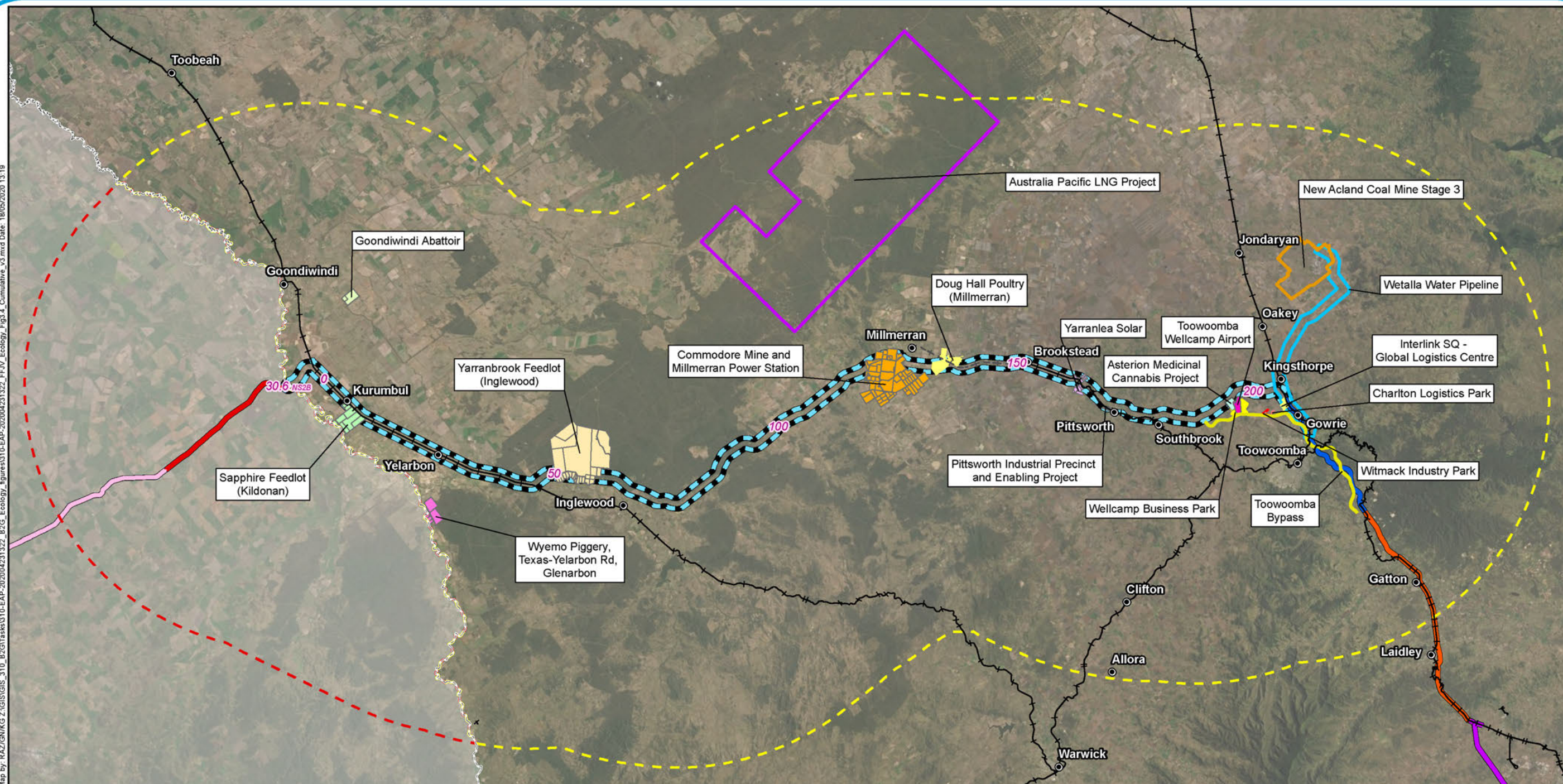
Table notes:

* Project located more than 50 km from the Project footprint. These projects have not been considered as part of the cumulative impact assessment for the Sensitive environmental receptors identified in this report

Selection criteria based on the criteria outlined in the EIS Chapter 21: Cumulative impacts:

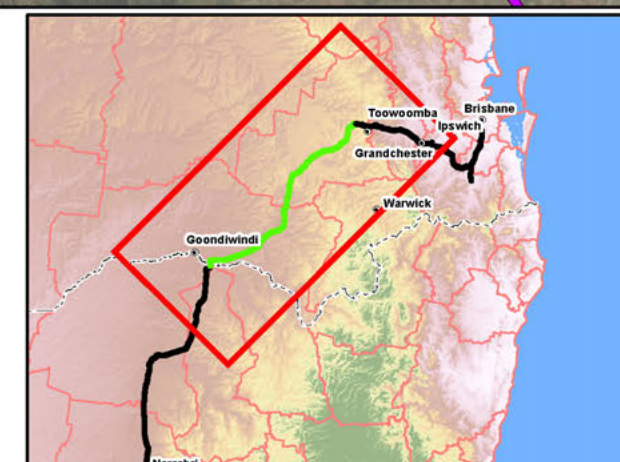
- b) Have been declared a 'coordinated project' by the Coordinator-General under the SDPWO Act and an EIS is currently being prepared or is complete, or an Initial Advice Statement is available on the DSDMIP website.
- c) May use resources located within the region (including materials, groundwater, road networks or workforces) that are the same as those to be used by the ARTC Inland Rail Project.
- d) Could potentially compound residual impacts that the Inland Rail Program may have on environmental or social values

Map by: RAZ/GN/KG 21/01/2020 13:19
 310_0201Tasks\310-EAP-202004231322_B2G_Ecology_Figures\310-EAP-202004231322_FFIV_Ecology_Fig_4_Cumulative_v3.mxd Date: 18/05/2020 13:19



Legend

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



A3 scale: 1:800,000

0 10 20 30 40 50 km

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 detailed in 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 specific matter assessments.

3.5.3 Assessment matrix

Following the identification of each potential cumulative impact, a relevance factor score of Low, Medium and High has been determined in consideration of the impacts, in accordance with the assessment matrix given in Table 3.11.

The significance of the impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 3.11 and summing the relevance factors. The sum of the relevance factors determines the impact significance and consequence which are summarised in Table 3.12. 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 $(2+3+1+1 = 7)$ = Medium.

Table 3.11 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 3.12 **Impact significance**

Impact significance	Sum of relevance 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 program.
Medium	7 to 9	Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate.
High	10 to 12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program required, where appropriate.

4 Description of environmental values

4.1 Content of this section

This section describes the ecological 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 receptors of the impact assessment area which are the scope of the impact assessment presented in Section 5.

4.2 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. Project footprint has been subject to historical disturbance/clearing and approximately one third of its length is located within brownfield (areas already subject to development). The remaining greenfield portions of the Project extend largely through areas subject to agricultural land uses (refer Photograph 4.3, Photograph 4.4, Photograph 4.5 and Photograph 4.6) and 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, Wellcamp airport and Charlton 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 have are used extensively for cropping (FFJV 2019)

There are five State forests within the vicinity of the impact assessment area, but are not traversed by the Project:

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

There are state forests that are traversed by the Project:

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

One conservation park, the Irongate Conservation Park (29 ha), and the Mount Basalt Environmental Park are also located in the impact assessment area. Of these, the Project footprint intersects Whetstone State Forest and Bringalily State Forest located to the west and north of Inglewood respectively. 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 dunmali*), Greater glider (*Petauroides Volans*) and Spotted-tail quoll (*Dasyurus maculatus maculatus*) (DES 2018).

The impact assessment area traverses two catchment areas of 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).

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.

4.3 Environmental values of Whetstone and Bringalily State Forests

Bringalily State Forest covers an area of approximately 35,695 ha and is located to the north of Inglewood. Bringalily State Forest is located approximately 350 km to the west of Brisbane. Approximately 101.73 ha of Bringalily State Forest is contained within the Project impact area. Whetstone State Forest covers an area of approximately 41,282 ha and is located to the west of Inglewood and Bringalily State Forest, and to the north of Yelarbon. Approximately 22.99 ha of Whetstone State Forest is contained within the Project impact area.

Bringalily State Forest and Whetstone State Forest contain open eucalypt woodlands on either shallow soils (in areas of higher elevation) or sandy plains dominate in areas of higher elevation. Diversity of terrestrial vertebrate taxa is very high with approximately 350 species recorded within the area. Among the threatened taxa known are Dunmall's snake (*Furina dunmalli*), Major Mitchell's cockatoo (*Lophochroa leadbeateri*), Regent honeyeater (*Anthochaera phrygia*), Painted honeyeater (*Grantiella picta*), Spotted-tailed quoll (*Dasyurus maculatus*) and Greater glider (*Petauroides volans*) (refer to EIS Appendix L: Matters of National Environmental Significance Technical Report for further details related to MNES). State-listed Priority taxa, under the BPA, include both endemics such as Brigalow scaly foot (*Paradelma orientalis*), and declining taxa, e.g. Brown tree-creeper (*Climacteris picumnus*), Speckled warbler (*Chthonicola sagittate*) and hooded robin (*Melanodryas cucullata*). Bringalily State forest also forms part of the Herries Range Terrestrial Corridor, which provides an east-west linkage between the major eastern escarpment corridor in the New England Tableland bioregion through to the Wondul Range National Park (DES, 2019f). Further details related to environmental values contained within Whetstone and Bringalily State Forests are described in Section 4.5.13).

4.4 Catchment area overview

The impact assessment area traverses two catchment areas of 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). Further information on geology, surface water and groundwater are reported in EIS Chapter 8 Land resources.

4.5 Results of desktop study

The following subsections provide a comprehensive description of the desktop study results within the impact assessment area and broader landscape.

The results of the database searches are presented in full in Appendix D. Results associated with previous surveys and surveys conducted concurrently with the EIS 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 EIS and has informed the impact assessment section of this document where appropriate.

4.5.1 Flora

4.5.1.1 Conservation significant flora species

A total of three conservation significant flora species listed under the provisions of the NC Act (excluding all species listed under the EPBC Act) have been identified from databases searches associated with the impact assessment area (refer Table 4.1). All of these species have been identified from specimen backed sources (i.e. ALA or WildNet) and are considered either known to occur or possible to occur within the impact assessment area. The location of desktop-derived species records in relation to the impact assessment area is provided in Figure 4.1.

Table 4.1 Conservation significant flora species identified from database searches

Family	Species name ¹	Common name	NC Act status	Data source		Likelihood of occurrence
				Wildlife online	Atlas	
Asteraceae	<i>Picris barbarorum</i>	A hawkweed	V	✓	✓	Known
Cyperaceae	<i>Cyperus clarus</i>	A sedge	V	✓	✓	Possible
Poaceae	<i>Digitaria porrecta</i>	Finger Panic Grass	NT	✓	✓	Known

Table notes:

V = 'Vulnerable' NT = 'Near Threatened'

1 Species present within database record within the impact assessment area

4.5.1.2 Priority Back on Track flora species

There are total of 14 Non-MNES Back on Track priority flora species for the Condamine NRM region and Border Rivers Maranoa-Balonne NRM region (DEHP 2015) (refer Table 4.2).

Of the Non-MNES Back on Track priority flora taxa identified as part of the database review and Project EIS field assessments, four species have potential to occur within the impact assessment area (refer Table 4.2). The remaining 10 non-MNES Back on Track flora species are not considered to have potential to occur within the impact assessment area. It must be noted that many of the species listed in Table 4.2 are not geographically located within proximity to the impact assessment area.

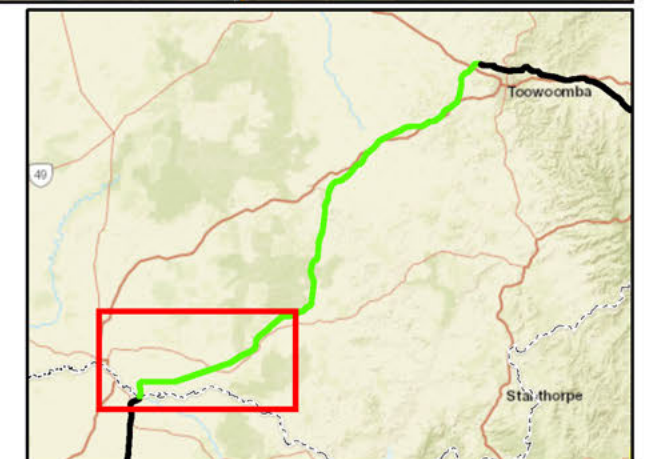
Where those Back on Track species are identified as potentially present within the Project footprint, but are not listed under either the NC Act (i.e. Sedge (*Cyperus clarus*), Reed (*Eleocharis blakeana*), Native liquorice (*Glycyrrhiza acanthocarpa*) and Dalton weed (*Senecio daltonii*)), they have been included as a Sensitive environmental receptors (i.e. 'Least Concern' species under the NC Act) for the purposes of impact assessment (refer Section 4.7.2).



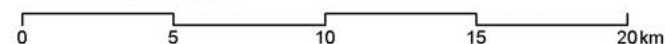
Legend

- 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

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



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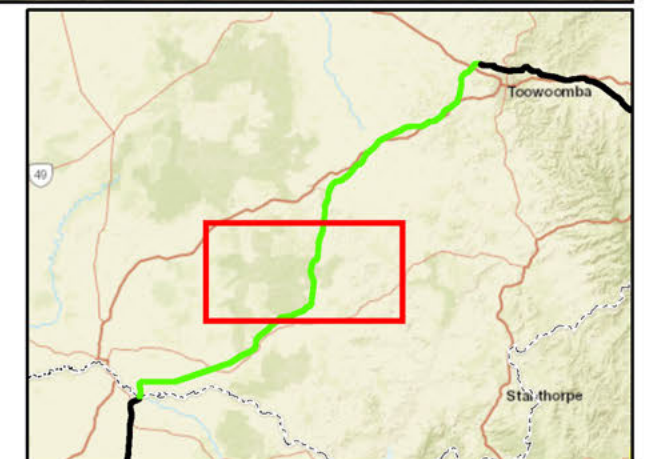
Border to Gowrie

Figure 4.1a: Location of specimen backed records of conservation significant flora species derived from desktop assessments (excluding MNES species)

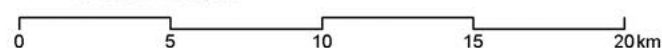


Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Finger panic grass (*Digitaria porrecta*)



A3 scale: 1:250,000

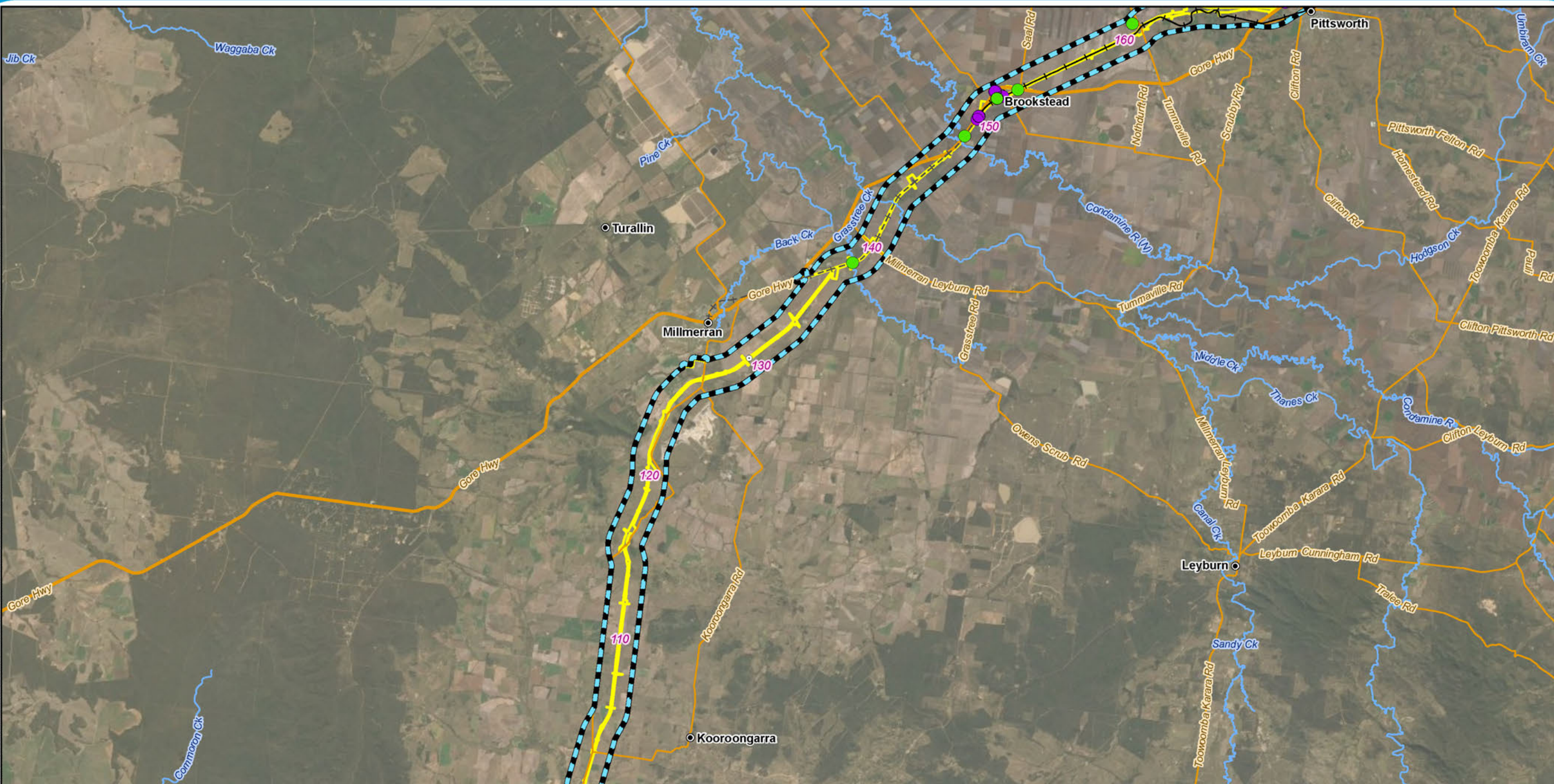


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Border to Gowrie

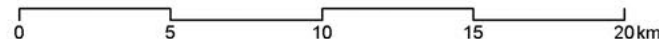
Figure 4.1b: Location of specimen backed records of conservation significant flora species derived from desktop assessments (excluding MNES species)



Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Finger panic grass (*Digitaria porrecta*)
- A hawkweed (*Picris barbarorum*)

A3 scale: 1:250,000

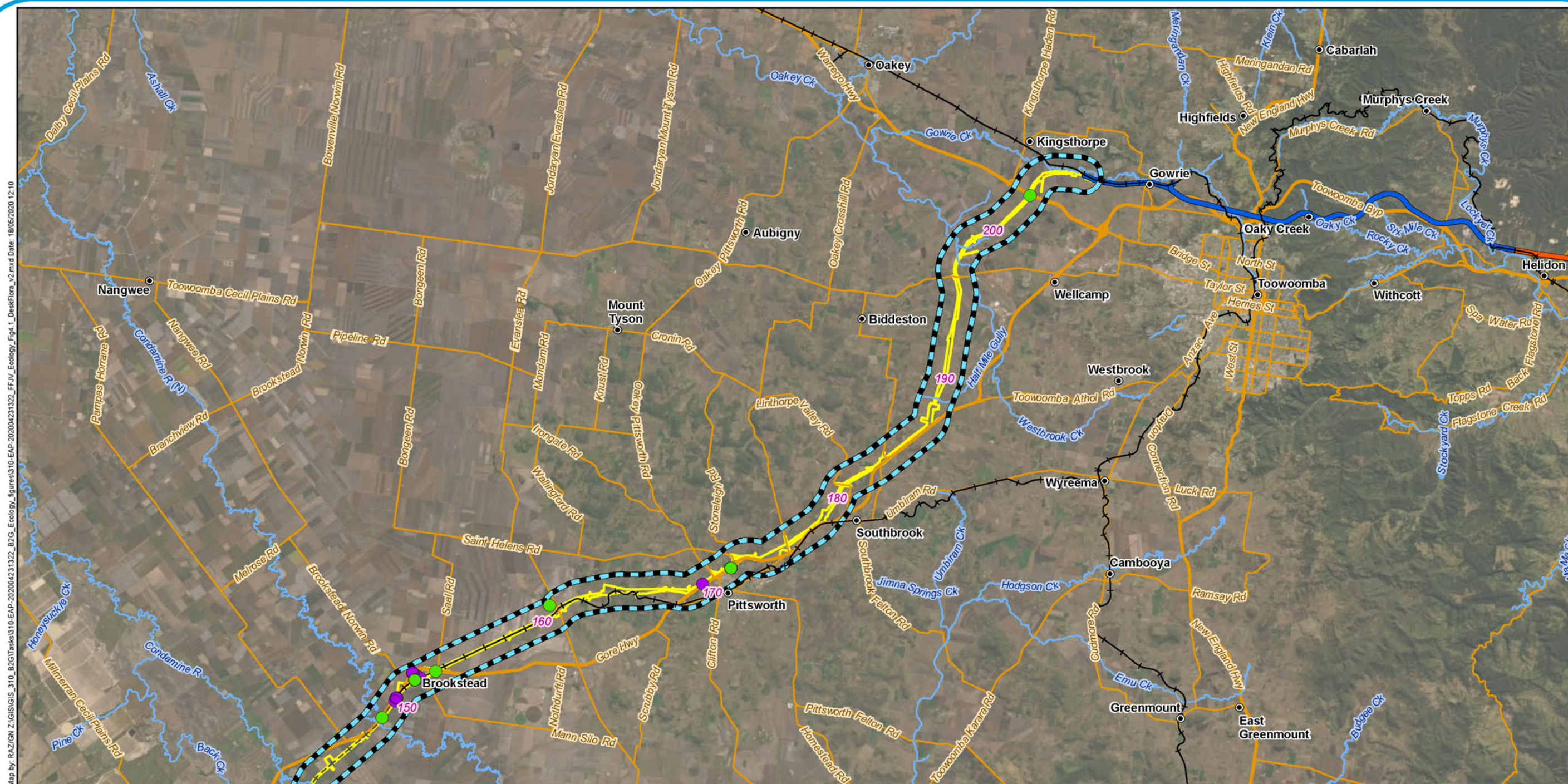


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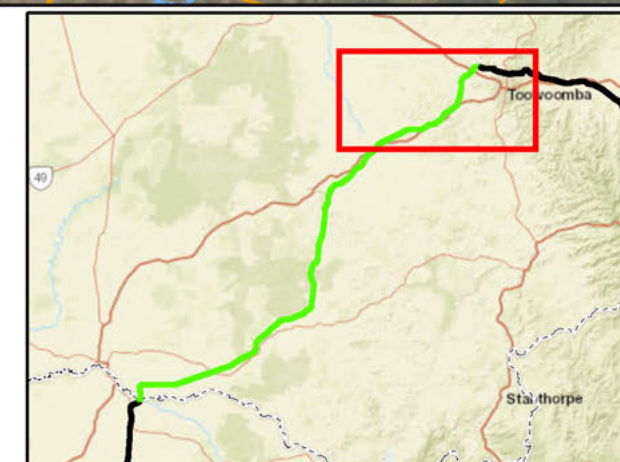
Border to Gowrie

Figure 4.1c: Location of specimen backed records of conservation significant flora species derived from desktop assessments (excluding MNES species)

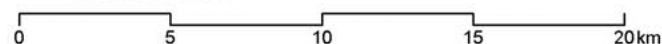


Legend

- | | | |
|-------------------------------------|------------------------|--|
| 5 Chainage (km) | Major roads | ● Finger panic grass (<i>Digitaria porrecta</i>) |
| ● Localities | Minor roads | ● A hawkweed (<i>Picris barbarorum</i>) |
| — Gowrie to Helidon alignment | Watercourses | |
| — Helidon to Calvert alignment | Project footprint | |
| — Existing rail (operational) | Impact assessment area | |
| --- Existing rail (non-operational) | | |



A3 scale: 1:250,000



Future Freight
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Issue date: 18/05/2020 Version: 2
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

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

Table 4.2 Non-matters of national environmental significance Back on Track priority flora species for the Condamine Natural Resource Management region and Border Rivers Maranoa-Balonne Natural Resource Management region

Species name	Common name	Condamine NRM region	Border Rivers Maranoa-Balonne NRM region	State rank	NC Act	Habitat association	Likelihood of occurrence within the impact assessment area
<i>Acacia maranoensis</i>	Womel	-	High	High	LC	Occurs on very flat terrain, where some areas are inundated for various periods after rain. Soils are dark brown, heavy clay loams that become boggy when wet. It usually occurs in woodlands dominated by <i>Eucalyptus populnea</i> (Wetland Info 2018).	Unlikely, outside of known distribution
<i>Callitris baileyi</i>	Bailey's cypress	High	High	High	NT	Grows on rocky slopes, hilly or mountainous areas, in shallow and often clay soils. It is found in eucalypt woodland, commonly associated with ironbark, blue gum and spotted gum (Wetland Info 2018)	Unlikely
<i>Commersonia ingelewoodensis</i>	-	-	Critical	High	E	Occurs in low heathland and shrubland communities on flat-topped rises. It grows on deeply weathered sedimentary rocks and shallow red sandy loam. It may also be a component of adjacent woodland and open forest (Wetland Info 2018).	Unlikely, species not returned on any of the database searches
<i>Cymbonotus maidenii</i>	-	-	High	Medium	E	Occurs on open grassland, along roadsides or beside watercourses. It grows on black, brown or grey heavy, cracking clay soils (Wetland Info 2018).	Unlikely
<i>Cyperus clarus</i>	-	-	High	Medium	V	<i>Cyperus clarus</i> grows in grassland or open woodland, in heavy soils derived from basalt. (Wilson 1991; Wilson, 2008). The species is associated with grasslands where <i>Aristida leptopoda</i> and <i>Panicum queenslandicum</i> occur on deep alluvial black clay; in <i>Eucalyptus melanophloia</i> woodland with mid-dense ground stratum of <i>Chrysopogon fallax</i> ; growing with <i>Stemmacantha australis</i> in mountain coolibah woodland on basalt ridges; and in <i>Dichanthium</i> grassland with <i>Cyperus bifax</i> and <i>Fimbristylis</i> spp. (Wetland Info 2018).	Possible
<i>Diuris parvipetala</i>	Slender donkey purple orchid	High	High	High	V	Grows among grass in open forests, on ridges and gentle to steep slopes, among basalt boulders and on granite pavements. It grows in shallow, brown, basalt loam soils (Wetland Info 2018).	Unlikely, outside of known distribution
<i>Eleocharis blakeana</i>	-	High	High	Medium	C	Occurs on plains and low undulating country on poorly drained, clayey soils. It commonly grows in ephemeral wet habitats in melon hole country in brigalow and belah woodlands, and in small depressions along drainage lines in open forest and woodland communities (Wetland Info 2018).	Likely
<i>Eucalyptus pachycalyx</i> subsp. <i>waajensis</i>	Shiny-barked gum	-	Critical	High	E	Grows in woodland communities, on hillsides and ridge tops on shallow, sandy soils derived from sandstone and granite (Department of Environmental 2018).	Unlikely, outside of known distribution

Species name	Common name	Condamine NRM region	Border Rivers Maranoa-Balonne NRM region	State rank	NC Act	Habitat association	Likelihood of occurrence within the impact assessment area
<i>Glycyrrhiza acanthocarpa</i>	Native liquorice	-	High	Medium	C	Grows in various habitats, especially on heavy soils prone to flooding (PlantNet 2018).	Possible
<i>Homalanthus vagans</i>	-	-	Critical	High	C	No data available. Known from a single property near Inglewood (ALA 2018).	Unlikely
<i>Macrozamia viridis</i>	-	-	Critical	Critical	E	Occurs in moderately wet eucalypt woodlands with a scrubby understorey. It grows on granitic sandy soils with granite outcrops (Wetland Info 2018).	Unlikely, outside of known distribution
<i>Senecio daltonii</i>	Dalton weed	-	High	Medium	C	Widespread on heavy soils, often a weed of cultivation (PlantNet 2018).	Possible
<i>Solanum papaverifolium</i>	-	-	High	Medium	E	Grows in heavy clay soils, frequently as a weed of cereal crop (PlantNet 2018).	Unlikely, outside of known distribution
<i>Solanum stenopterum</i>	-	High	Critical	High	V	Inhabits grassland or woodlands of belah and <i>Eucalyptus populnea</i> (poplar box) on black, brown or red clay loam soils. It also grows on loamy ridges, along roadsides and in paddocks (Department of Environment 2018).	Unlikely, outside of known distribution

Table notes:

- = No common name or conservation listing CE = Critically Endangered' E = 'Endangered' LC = 'Least Concern' NT = 'Near Threatened' V = 'Vulnerable'

4.5.2 Fauna

4.5.2.1 Conservation significant fauna species

A total of three threatened and two Special Least Concern (SLC) fauna species listed under the provisions of the NC Act (excluding all species listed under the EPBC Act) have been identified from databases searches associated with the impact assessment area (refer Table 4.3). The location of historic specimen backed records for non-MNES conservation significant species is provided in Figure 4.2.

Table 4.3 Conservation significant fauna species identified from database searches

Family	Species name	Common name	NC Act status	Data source		Likelihood of occurrence
				Wildlife online	Atlas	
Cacatuidae	<i>Calyptrorhynchus lathamii lathamii</i>	Glossy black-cockatoo (eastern)	V	✓	✓	Possible
Cacatuidae	<i>Lophochroa leadbeateri</i>	Major Mitchell's cockatoo	V	✓		Possible
Ornithorhynchidae	<i>Ornithorhynchus anatinus</i>	Platypus	SLC	✓		Possible
Tachyglossidae	<i>Tachyglossus aculeatus</i>	short-beaked echidna	SLC	✓	✓	Known
Elapidae	<i>Acanthophis antarcticus</i>	Common death adder	V	✓		Known

Table notes:

- = Species not listed or no common name EX = Extinct E = 'Endangered' V = 'Vulnerable'
M = Migratory CE = Critically Endangered' SLC = Special Least Concern' LC = 'Least Concern'
^ = Further details regarding likelihood of occurrence within the impact assessment area and habitat descriptions are provided in Appendix A
✓ = species present within database record within the impact assessment area
= Aquatic fauna i.e. fish and turtles and not considered further as part of this report, further discussion of aquatic fauna is included in the Aquatic Ecology Technical Report (Eco Logical Australia, 2019)

In addition to those species listed in Table 4.3, 15 migratory species as listed under the EPBC Act (also listed as SLC under the NC Act) that have not been identified as a controlling provision of the Project under the EPBC Act, are predicted to occur within the impact assessment area (refer Table 4.4).

Migratory marine birds (e.g. Pelagic species and those specifically associated with marine and estuarine mudflats such as the Eastern Curlew (*Numenius madagascariensis*)) were excluded from this list due to the absence of marine environments within the impact assessment area.

The location of historic specimen backed records for non-marine, non-threatened migratory species listed under the EPBC Act is provided in Figure 4.2.

Table 4.4 Migratory fauna species identified from database searches

Family	Scientific name	Common name	EPBC Act status*	NC Act status
Accipitridae	<i>Pandion haliaetus</i>	Osprey	M	SLC
Apodidae	<i>Apus pacificus</i>	Fork-tailed swift	M	SLC
Cuculidae	<i>Cuculus optatus</i>	Oriental cuckoo	M	SLC
Dicruridae	<i>Monarcha melanopsis</i>	Black-faced monarch	M	SLC
Dicruridae	<i>Rhipidura rufifrons</i>	Rufous fantail	M	SLC
Dicruridae	<i>Myiagra cyanoleuca</i>	Satin flycatcher	M	SLC
Dicruridae	<i>Symposiachrus trivirgatus</i>	Spectacled monarch	M	SLC
Motacillidae	<i>Motacilla flava</i>	Yellow wagtail	M	SLC
Scolopacidae	<i>Actitis hypoleucos</i>	Common sandpiper	M	SLC
Scolopacidae	<i>Calidris acuminata</i>	Sharp-tailed sandpiper	M	SLC
Scolopacidae	<i>Calidris melanotos</i>	Pectoral sandpiper	M	SLC
Scolopacidae	<i>Calidris ruficollis</i>	Red-necked stint	M	SLC
Scolopacidae	<i>Gallinago hardwickii</i>	Latham's snipe	M	SLC
Threskiornithidae	<i>Plegadis falcinellus</i>	Glossy ibis	M	SLC
Scolopacidae	<i>Tringa nebularia</i>	Common greenshank	M	SLC

Table notes:

M = Migratory V = 'Vulnerable' E = 'Endangered' CE = Critically Endangered SLC = Special least concern

4.5.2.2 Priority Back on Track fauna species

There are 12 non-MNES Back on Track priority fauna species for the Condamine NRM region and Border Rivers Maranoa-Balonne NRM region (DEHP 2015) (refer Table 4.5).

Seven of the non-MNES Back on Track priority fauna taxa were identified as having a potential (i.e. possible occurrence) to occur within the impact assessment area. The remaining five species were considered unlikely to occur within the impact assessment area based on distributional limitations or the absence of habitat of suitable type/size/quality. It must be noted that many of the species listed in Table 4.5 are not geographically located within proximity to the impact assessment area.

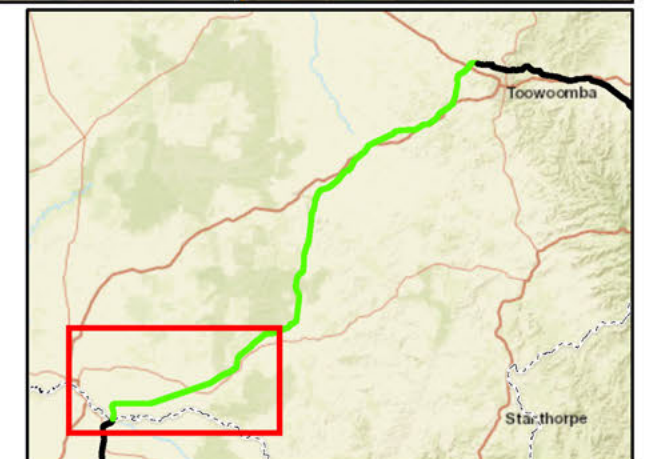
Where those non-MNES Back on Track species are identified as potentially present within the Project footprint, but are not listed under either the NC, they have been included as a Sensitive environmental receptor (i.e. 'Least Concern' species under the NC Act) for the purposes of impact assessment (refer Section 4.7.2).



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
- Fork-tailed swift (*Apus pacificus*)
- Latham's snipe (*Gallinago hardwickii*)
- Glossy ibis (*Plegadis falcinellus*)

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.



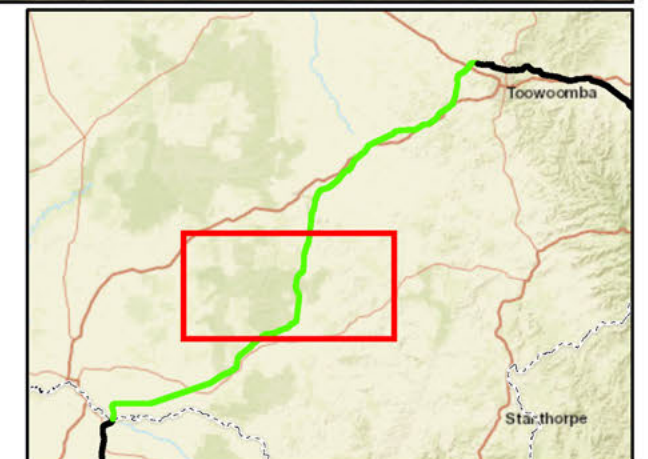
A3 scale: 1:250,000

0 5 10 15 20 km

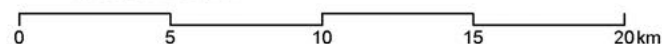


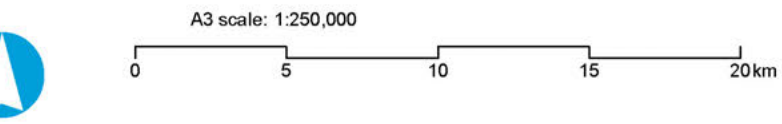
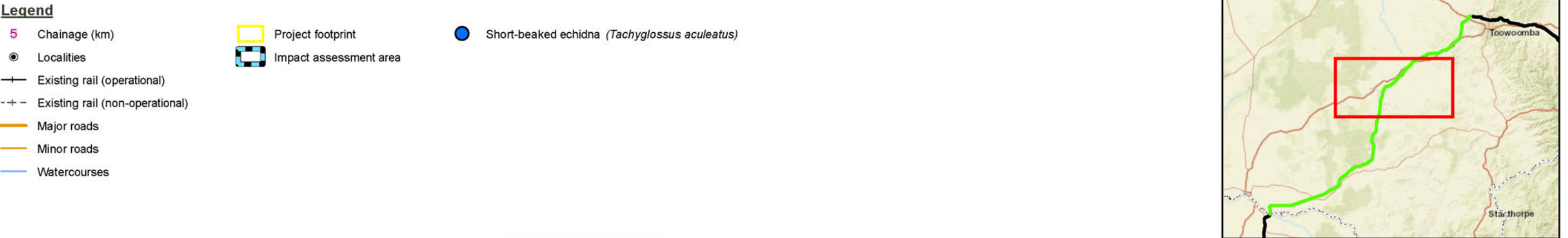
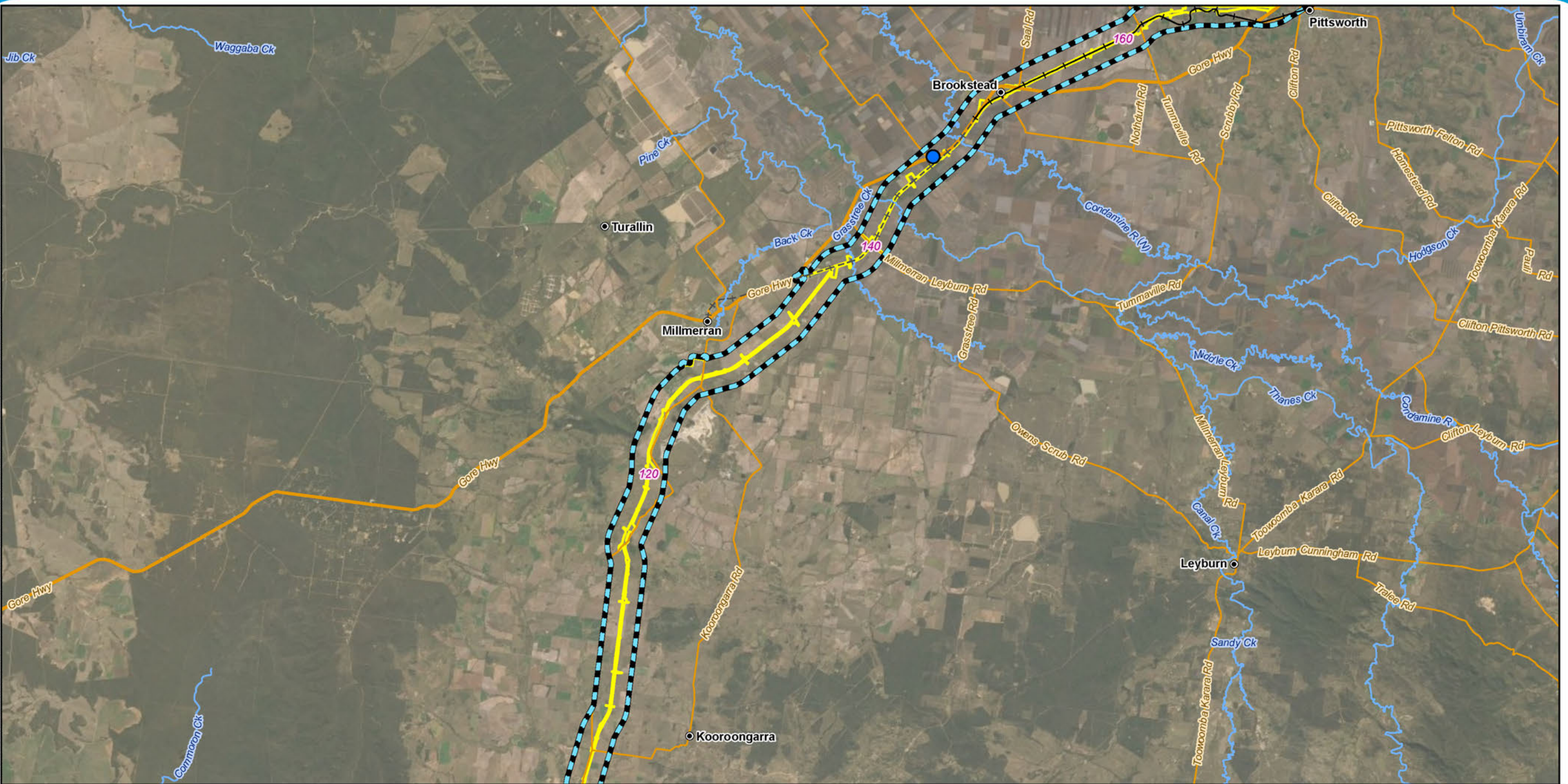
Legend

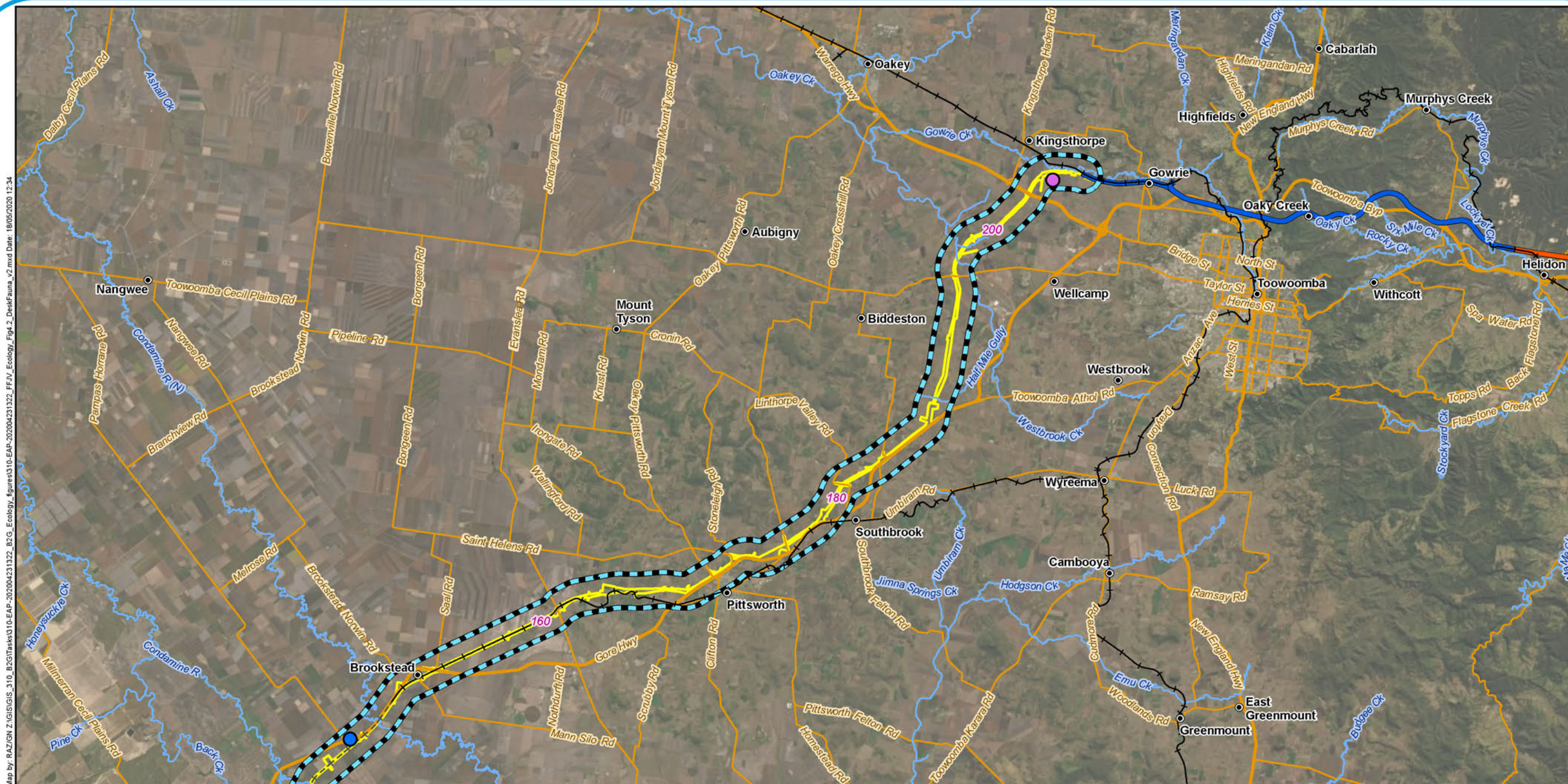
- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Common death adder (*Acanthophis antarcticus*)
- Glossy black-cockatoo (eastern) (*Calyptorhynchus lathami lathami*)



A3 scale: 1:250,000

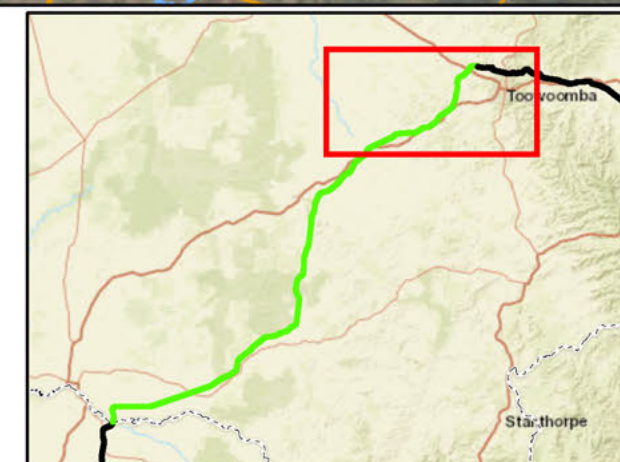






Legend

- 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
- Black-faced monarch (*Monarcha melanopsis*)
- Short-beaked echidna (*Tachyglossus aculeatus*)



A3 scale: 1:250,000

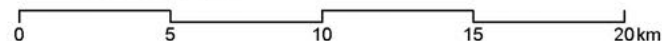


Table 4.5 Non-matters of national environmental significance Back on Track priority fauna priority species for the Condamine NRM region and Border Rivers Maranoa-Balonne NRM region and likelihood of occurrence in the impact assessment area

Species name	Common name	Condamine NRM region	Border Rivers Maranoa-Balonne NRM region	NC Act	Habitat association	Likelihood of occurrence within the impact assessment area
<i>Acanthopis antarcticus</i>	Common death adder	-	High	V	Found in a wide variety of habitats in association with deep leaf litter, including rainforests, wet sclerophyll forests, woodland, grasslands, chenopod dominated shrublands, and coastal heathlands (DES 2018)	Possible
<i>Aspidites ramsayi</i>	Woma	-	High	NT	Occurs on black soils and in stony ridge country in brigalow <i>Acacia harpophylla</i> woodland and grasslands (DES 2018)	Unlikely
<i>Calyptrorhynchus lathamii lathamii</i>	Glossy black-cockatoo (eastern)	High	High	V	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of she oak occur. Black She oak (<i>Allocasuarina littoralis</i>) and Forest She oak (<i>A. torulosa</i>) are important foods. Inland populations feed on a wide range of she oaks, including Drooping She oak, <i>Allocasuarina diminuta</i> , and <i>A. gymnathera</i> . Belah is also utilised and may be a critical food source for some populations (OEH 2018).	Possible
<i>Delma inornata</i>		High	High	LC	Open forests and grasslands with good ground cover (Queensland Museum 2018)	Possible
<i>Hoplocephalus stephensii</i>	Stephens' banded snake	High	High	LC	Rainforest and eucalypt forests and rocky areas up to 950 m in altitude (OEH)	Unlikely, the impact assessment areas are located to the west of the species current distribution
<i>Hypochrysops piceata</i>	Bulloak jewel butterfly	High	High	E	Habitat requirements of the bulloak jewel are complex. It requires a single species of tree, bull oak <i>Allocasuarina luehmannii</i> , an undescribed ant, <i>Anonychomyrma sp.</i> , and possibly also the presence of eriococcid scale insects <i>Rhyzococcus sp.</i> Only older trees appear to be used by the bulloak jewel as these are riddled with the xyloryctid moth tunnels which encourage nesting colonies of the ant and provide shelter sites for the nocturnal butterfly larvae (DES 2018)	Unlikely, large old-growth stands of bulloak are not contained within the impact assessment area
<i>Jimbouria rodhobsoni</i>	Jimbour black soil snail	High	-	LC	Restricted to black soil in the Jimbour area (ALA 2018)	Unlikely

Species name	Common name	Condamine NRM region	Border Rivers Maranoa-Balonne NRM region	NC Act	Habitat association	Likelihood of occurrence within the impact assessment area
<i>Melanodryas cucullata</i>	Hooded robin (south-eastern)	High	-	LC	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses (OEH 2018)	Possible
<i>Pallidelix bennetti</i>	A snail	High	-	LC	Eucalypt woodland in south-east Queensland (Queensland Museum 2015)	Possible
<i>Pallidelix chinchilla</i>	A snail	-	High	LC	Brigalow scrub of the Dalby-Miles area of southern Queensland (Queensland Museum 2015)	Possible
<i>Petaurus australis australis</i>	Yellow-bellied glider (southern subspecies)	High	High	LC	Tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils (OEH 2018)	Unlikely
<i>Stagonopleura guttata</i>	Diamond firetail	High	High	LC	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum <i>Eucalyptus pauciflora</i> Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities (OEH 2018)	Possible

Table notes:

C = Critical priority
E = 'Endangered'

H = High priority
NT = 'Near Threatened'

M = Medium priority
LC = 'Least Concern'

V = 'Vulnerable'
- = Not listed

CE = Critically Endangered'

4.5.3 Matters of State environmental significance wildlife and essential habitat

Habitat for threatened flora and fauna (including some SLC animals) as listed under the NC Act and the *Nature Conservation (Wildlife) Regulation 2006* are defined as MSES under the Queensland SPP 2017. This includes areas listed as 'essential habitat' for threatened species as mapped under the VM Act. This mapping layer includes modelled or known habitat for species that meet the following criteria:

- Threatened wildlife under the NC Act, including:
 - Endangered species
 - Vulnerable species.
- Special least concern animals under the NC Act, including:
 - Echidna
 - Platypus
 - Migratory birds (JAMBA, CAMBA, ROKAMBA, Bonn).

Mapped MSES wildlife habitat (incorporating essential habitat) occurring within the impact assessment area is presented in Table 4.6 and illustrated in Figure 4.3.

Table 4.6 Matters of State environmental significance wildlife habitat mapped as occurring within the impact assessment area

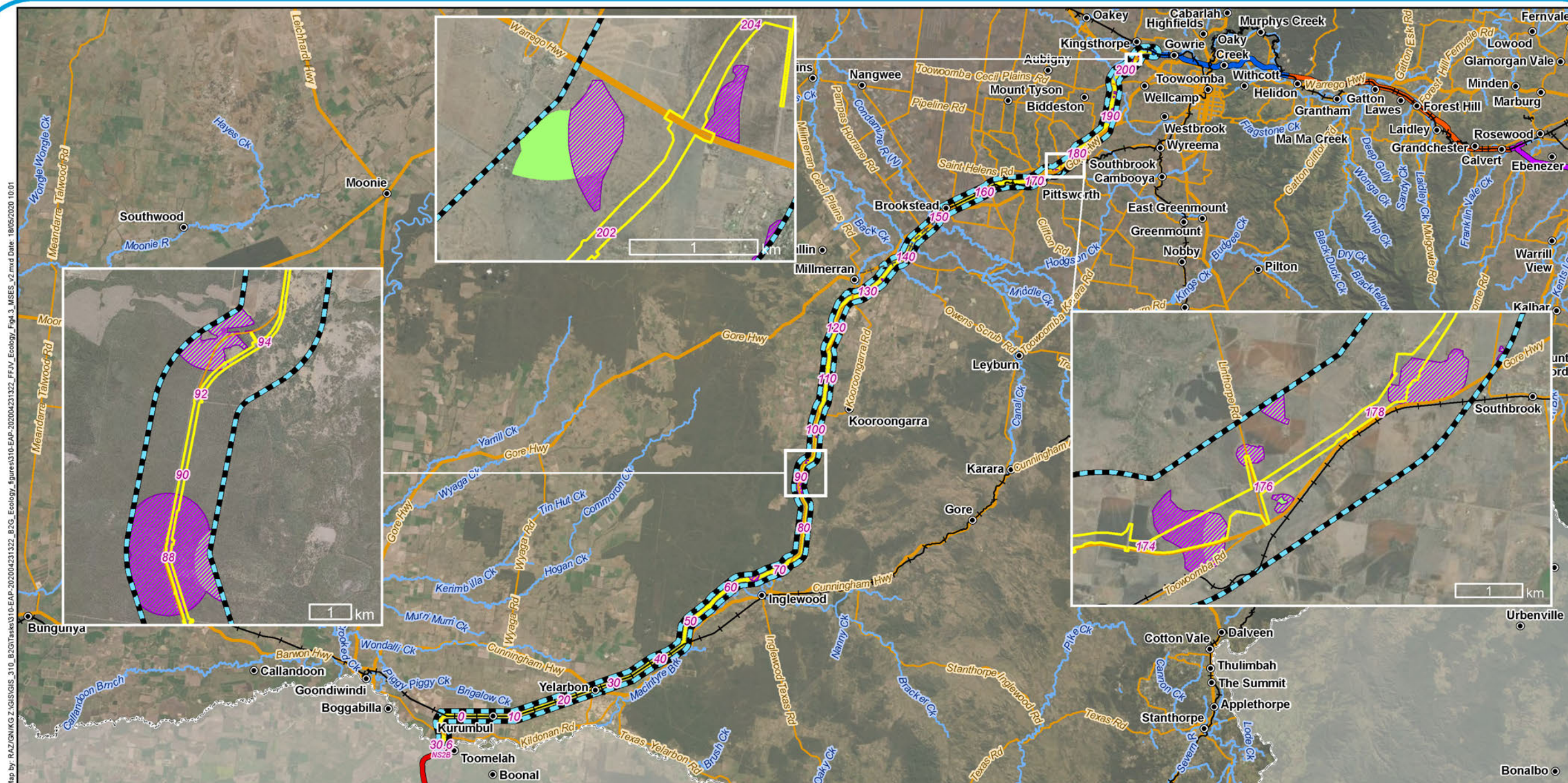
Feature	Extent contained within the impact assessment area (ha)	Extent contained within the Project footprint (ha)
MSES wildlife habitat	1,125.67	121.83
Essential habitat	1,299.96	117.31

4.5.4 Invasive species biosecurity areas

The wild dog check fence is located north of the existing rail corridor at Yelarbon, running adjacent to the impact assessment area from approximate chainages Ch 27.5 km to Ch 44 km. The Project intersects the wild dog check fence at four locations between Yelarbon and Millmerran within the Goondiwindi Regional Council, located at approximate chainages Ch 50.0 km, Ch 51.0 km, Ch 54.5 km and Ch 56.0 km. The Goondiwindi Regional Council is responsible for the ongoing maintenance of approximately 283 km of the wild dog check fence.

In addition, the Project intersects the 555 km long Darling Downs Moreton Rabbit Board (DDMRB) rabbit-proof fence when traversing through the locality of Clontarf, at approximate chainage Ch 120.2 km. Management and maintenance of the fence is provided by the DDMRB. The fence stretches from Lamington National Park in the east, to Goombi in the southwest, where it connects to the wild dog barrier fence.

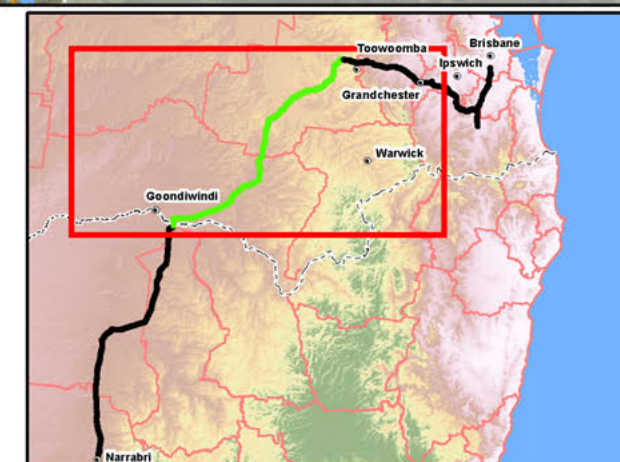
The impact assessment area does not traverse any fire ant biosecurity zones. Fire ant biosecurity zones are in place in areas of Queensland to restrict the movement of materials that could spread the red imported fire ant (*Solenopsis invicta*).



Legend

- | | | |
|--|---------------------------------------|------------------------|
| 5 Chainage (km) | — Existing rail (operational) | Project footprint |
| ● Localities | - - - Existing rail (non-operational) | Impact assessment area |
| North Star to NSW/QLD border alignment | Major roads | MSES wildlife habitat |
| Gowrie to Helidon alignment | Minor roads | Essential habitat |
| Helidon to Calvert alignment | Watercourses | |
| Calvert to Kagaru alignment | NSW/QLD border | |

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: 1:800,000



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Issue date: 18/05/2020 Version: 2
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie
Figure 4.3: Matters of state
environmental significance wildlife habitat

4.5.5 Defined watercourses

Under the Water Act, a watercourse is defined as a river, creek or other stream, which includes a stream in the form of an anabranch or a tributary, where water flows either permanently or intermittently regardless of flow frequency. A watercourse however does not include any section of a feature that has a tidal influence or is downstream of a defined limit (DNRM 2014).

A number of defined watercourses under the Water Act (refer Figure 4.4) and unmapped waterways and waterbodies occur within the impact assessment area. Defined watercourses crossed by the Project include:

- Grasstree Creek – at Ch 13.5 km
- Pariagara Creek – at Ch 67.2 km
- Cattle Creek - at Ch 88.2 km
- Back Creek – at Ch 97.4 km
- Bringalily Creek – at Ch 100.1 km
- Nicol Creek – at Ch 104.3 km
- Back Creek drainage feature – at Ch 126.7 km and Ch 127.9 km
- Condamine River (Main Branch) – at Ch 142.9 km
- Condamine River (North Branch) – at Ch 148.7 km
- Umbiram Creek drainage feature - at Ch 185.9 km
- One Mile Creek drainage feature – at Ch 191.8 km
- Westbrook Creek – at Ch 188.7 km and Ch 197.2 km
- Dry Creek – at Ch 197.8 km.

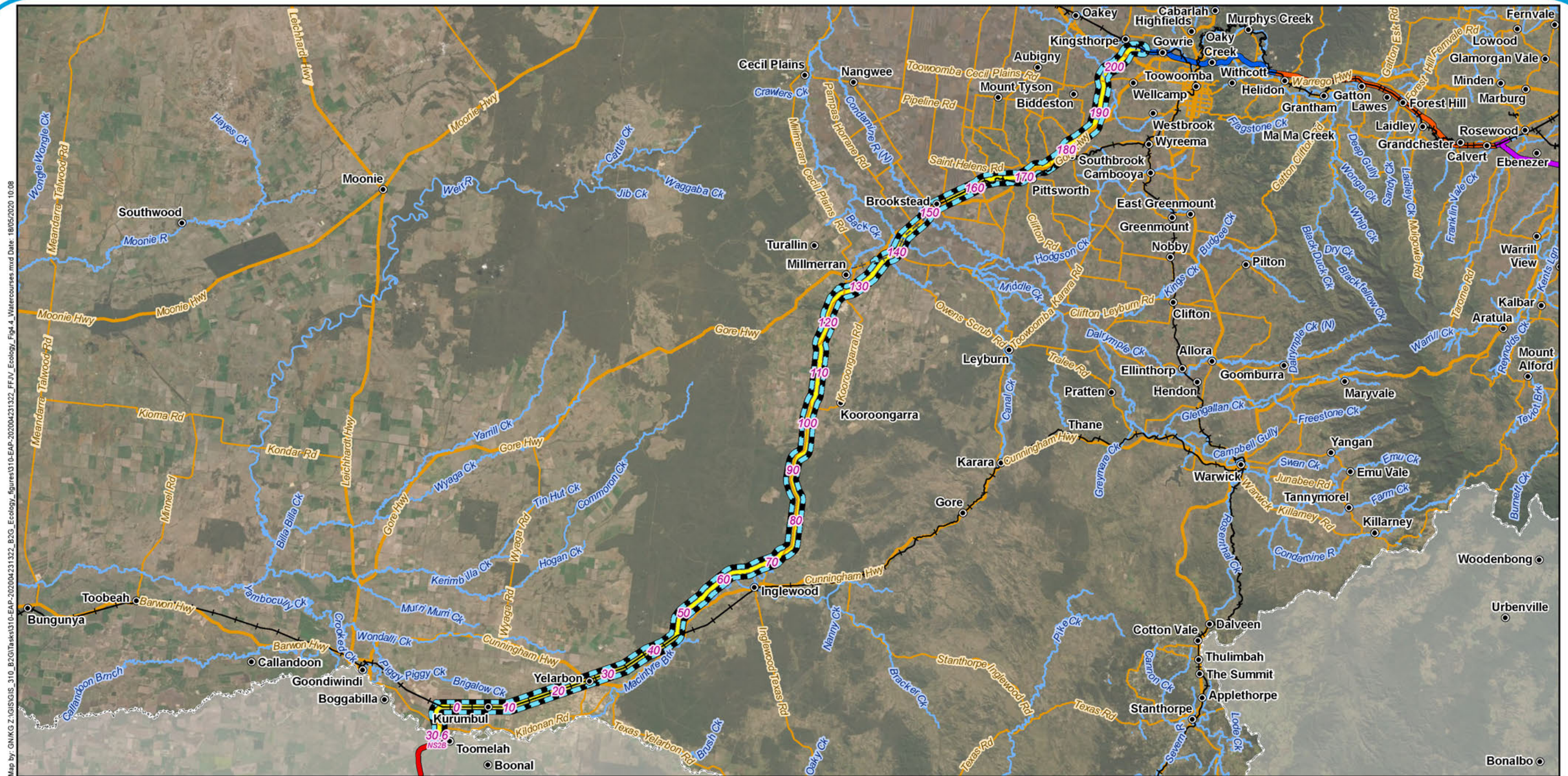
In total, the Project crosses 16 major waterways (stream order ≥ 3) and 66 minor waterways (stream order < 3) defined as watercourses under the Water Act and as mapped waterways (drainage lines and unmapped watercourses).

4.5.6 Stream order mapping

Stream order mapping provides a simplified assessment of stream size via hierarchical status of tributaries feeding into the watercourse of interest. Adopted from Strahler (1952), this system is used to provide an indication on waterway complexity and therefore the potential aquatic habitat present.

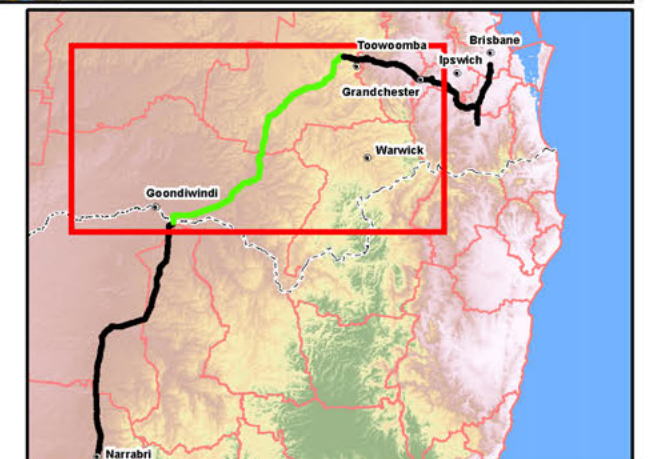
Headwaters or 'new' flow paths are given a stream order of one (or 'first order'), where two first order flow paths converge, the new stream is referred to as a second order stream. Where two second order streams join, a third order stream is formed. Third order streams and above are considered likely to reflect valuable fish habitat, capable of supporting viable populations.

The stream orders for waterways contained within the impact assessment area are outlined in Table 4.7 and indicated in Figure 4.4. Note that the majority of the first-order waterways within the impact assessment area are anticipated to flow only during periods of high seasonal rainfall and as such are not expected to provide high-value fish habitat except during periods of high rainfall or unless semi-permanent or permanent pool habitat is present.



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Defined watercourses
- NSW/QLD border
- Project footprint
- ▨ Impact assessment area



A3 scale: 1:800,000



Table 4.7 Stream orders present within the water quality impact assessment area

Stream order (DNRME)	Waterway (approximate chainage)
9	Macintyre River
6	Condamine River (Ch 142.9)
5	- Bringalily Creek (Ch 100.5) - Un-named tributary of Leonard (Black Creek) Gully (Ch 128.0)
4	- Un-named tributary of Macintyre Brook (Ch 55.5) - Pariagara Creek (Ch 67.2) - Cattle Creek (Ch 88.2) - Back Creek drainage feature (Ch 127.1) - Condamine River (North Branch) (Ch 148.7) - Westbrook Creek drainage feature (Ch 197.2)
3	- Un-named tributary of Macintyre Brook (Ch 52.6) - Un-named tributary of Canning Creek (Ch 87.3) - Native Dog Creek (Ch 93.9) - Nicol Creek (Ch 104.4) - Un-named tributary of Leonard (Black Creek) Gully (Ch 117.3) - Un-named tributary of Leonard (Black Creek) Gully (Ch 119.4) - Dry Creek drainage feature (Ch 197.9)
2	- Un-named tributary of Macintyre Brook (Ch 48.3, Ch 43.2) - Un-named tributary of Canning Creek (Ch 66.2, Ch 61.9) - Un-named tributary of Canning Creek (Ch 92.0, Ch 90.9) - Un-named tributary of Canning Creek (Ch 95.4) - Back Creek (Ch 97.6) - Un-named tributary of Canning Creek (Ch 107.2) - Un-named tributary of Canning Creek (Ch 109.4) - Un-named tributary of Canning Creek (Ch 114.4) - Un-named tributary of Leonard (Black Creek) Gully (Ch 118.4, Ch 117.7, Ch 117.6) - Un-named tributary of Leonard (Black Creek) Gully (Ch 120.4) - Un-named tributary of Leonard (Black Creek) Gully (Ch 124.5) - Grasstree Creek (Ch 138.5) - Un-named tributary of Umbiram Creek (Ch 183.6) - Half Mile Creek drainage feature (Ch 188.7) - One Mile Creek drainage feature (Ch 193.4, Ch 191.8) - Un-named tributary of Westbrook Creek (Ch 196.0)
1	- Un-named tributary of Macintyre Brook (Ch 63.1, Ch 62.8, Ch 61.5, Ch 60.4, Ch 34.7, Ch 32.6) - Un-named tributary of Canning Creek (Ch 86.6, Ch 85.3, Ch 84.4, Ch 83.4, Ch 82.3, Ch 81.0, Ch 80.6, Ch 78.9, Ch 77.7, Ch 73.6) - Un-named tributary of Canning Creek (Ch 88.5) - Un-named tributary of Canning Creek (Ch 93.4) - Un-named tributary of Canning Creek (Ch 96.9, Ch 96.4, Ch 96.2) - Un-named tributary of Canning Creek (Ch 108.5) - Un-named tributary of Canning Creek (Ch 113.1, Ch 110.9) - Un-named tributary of Canning Creek (Ch 116.2, Ch 115.6, Ch 115.5, Ch 114.9) - Un-named tributary of Leonard (Black Creek) Gully (Ch 119.0) - Un-named tributary of Leonard (Black Creek) Gully (Ch 124.0, Ch 123.3, Ch 121.5, Ch 121.1, Ch 120.8) - Un-named tributary of Leonard (Black Creek) Gully (Ch 125.5) - Un-named tributary of Grasstree Creek (Ch 139.7) - Un-named tributary of Condamine River (North Branch) (Ch 170.9, Ch 170.6, Ch 169.7, Ch 169.3, Ch 168.6)

Stream order (DNRME)	Waterway (approximate chainage)
	- Un-named tributary of Umbiram Creek (Ch 181.75) - Un-named tributary of Umbiram Creek (Ch 185.9, Ch 184.8) - Un-named tributary of Westbrook Creek (Ch 190.7) - Un-named tributary of Westbrook Creek (Ch 195.7) - Un-named tributary of Dry Creek (Ch 201.5) - Un-named tributary off Gowrie Creek (Ch 205.8, Ch 205)

Source: DNMRE (2020)

4.5.7 Waterways for waterway barrier works mapping

Fish passage requirements are dictated by the hierarchy of waterways and the risk of impact determined by the Queensland Government. The level of risk is based on stream order, stream slope, flow regime, number of fish species and fish swimming ability.

Under the Fisheries Act a waterway is defined as a river, creek, stream, waterway or inlet of the sea. Waterways for waterway barrier works are regulated under the Fisheries Act and development approvals under the Planning Act when barriers to fish movement including partial barriers, are installed across waterways. Barrier works include construction, raising, replacement and some maintenance works on structures such as culverts, crossings, bed level and low-level crossings, weirs and dams, both permanent and temporary.

A review of the *DAF Queensland Waterways for Waterway Barrier Works* mapping was undertaken, identifying a total of 88 waterways for waterway barrier works (including bridge and culvert infrastructure) which cross the Project alignment. Of the 88 waterways, several of the waterways are crossed by the alignment several times (refer Table 4.8). These waterways are classified as follows:

- Low risk of impact (category 1) – forty-three (43) waterways mapped as ‘Low’ intercept the alignment
- Moderate risk of impact (category 2) – twenty seven (27) waterways mapped as ‘Moderate’ intercept the alignment
- High risk of impact (category 3) – seven (7) waterways mapped as ‘High’ intercept the alignment
- Major risk of impact (category 4) – ten (10) waterways mapped as ‘Major’ intercept the alignment.

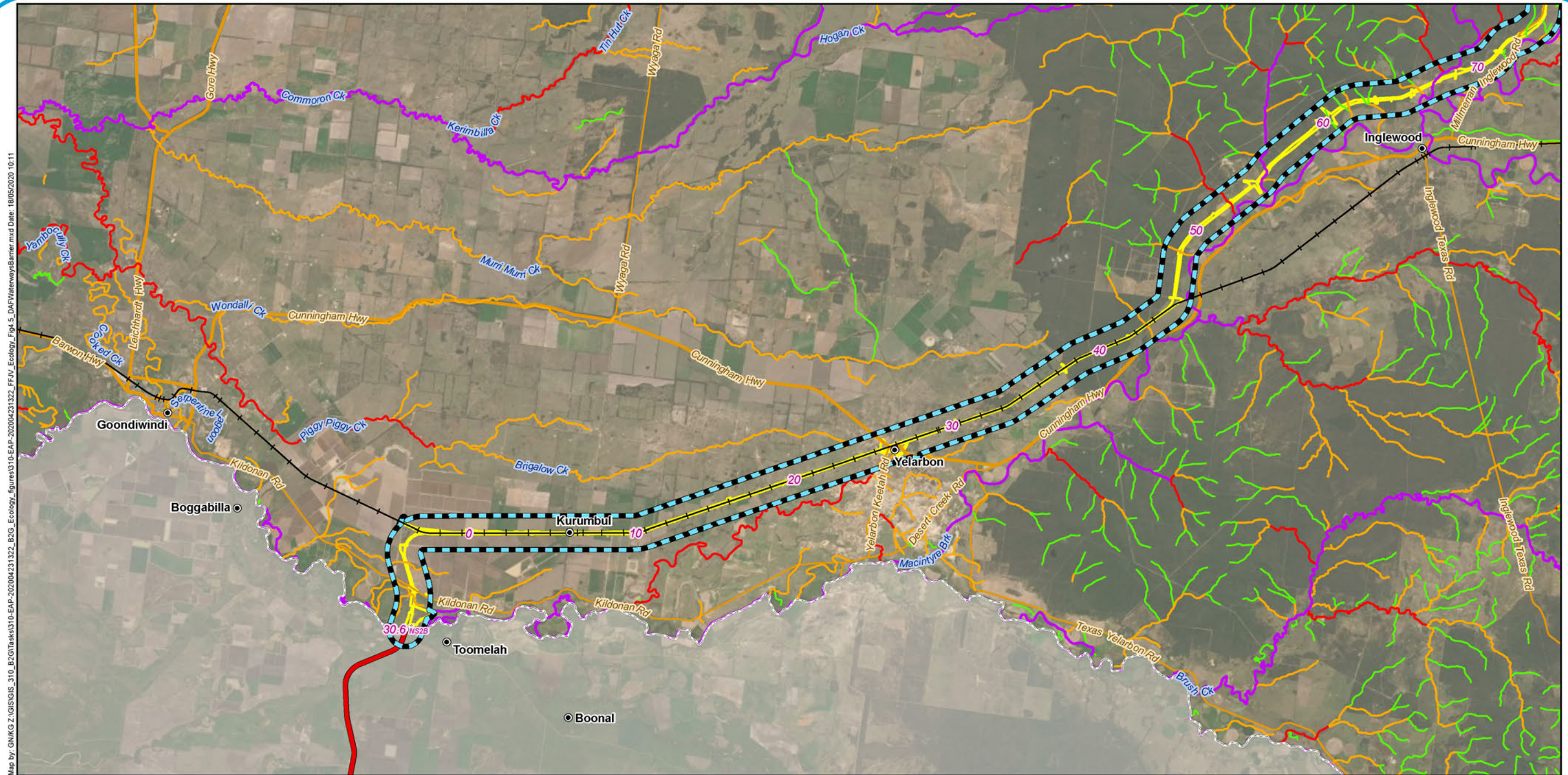
The level of risk relating to each waterway will be considered by the detail design team responsible for the design of infrastructure such as culverts, bridges and other potential barriers. At this stage of Project design, access roads are considered to be proximal to currently identified waterways intersecting the alignment. Designs will need to be in accordance with the DAF factsheet ‘What is not a waterway barrier work?’, or accepted development requirements for operational work that is constructing or raising waterway barrier works, or under a relevant development approval.

Of the 88 waterway barrier works, eight of the barriers are likely to require development approval, as they are exceeding the risk of impact of self-assessable works. However as all of the eight waterway barrier works are associated with bridge infrastructure crossings of major waterways (refer Table 4.8), assessment of the disruption to fish passage would be assessed as part of approval of infrastructure.

Table 4.8 identifies the waterways which cross the alignment and the relevant stream order whilst Figure 4.5 identifies the location of the DAF mapped waterways for waterway barrier works.

Table 4.8 Waterways for waterway barrier works that cross the proposed Project alignment

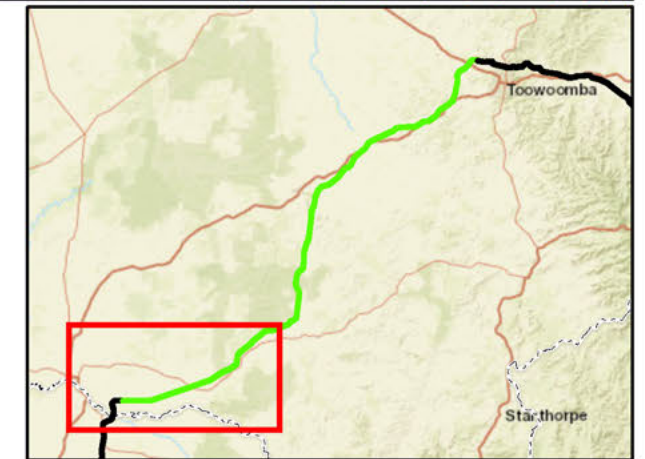
Waterway impact risk (DAF)	Waterway (approximate chainage)
Major (Category 4)	- Un-named tributary of Macintyre Brook (Ch 55.6) - Pariagara Creek (Ch 67.3) - Cattle Creek (Ch 88.3) - Bringalilly Creek (Ch 100.5) - Back Creek drainage feature (Ch 127, Ch 128) - Condamine River (Ch 142.9) - Condamine River (Northern Branch) (Ch 148.7) - Westbrook Creek drainage feature (Ch 197.2)
High (Category 3)	- Un-named tributary of Macintyre Brook (Ch 52.6) - Un-named tributary of Canning Creek (Ch 87.4) - Native Dog Creek (Ch 93.9) - Nicol Creek (Ch 104.4) - Un-named tributary of Leonard (Back Creek) Gully (Ch 117.3) - Un-named tributary of Leonard (Back Creek) Gully (Ch 119.4) - Dry Creek drainage feature (Ch 197.9 km)
Moderate (Category 2)	- Un-named tributary of Macintyre Brook (Ch 32.6, Ch 34.7, Ch 48.4, Ch 43.2) - Un-named tributary of Macintyre Brook (Ch 61.9) - Un-named tributary of Canning Creek (Ch 66.2) - Un-named tributary of Canning Creek (Ch 92.0, Ch 90.9) - Back Creek (Ch 97.6, Ch 96.9, Ch 96.4, Ch 96.2, Ch 95.4) - Un-named tributary of Canning Creek (Ch 107.2) - Un-named tributary of Canning Creek (Ch 109.5) - Un-named tributary of Canning Creek (Ch 114.4) - Un-named tributary of Leonard (Back Creek) Gully (Ch 118.5, Ch 117.7, Ch 117.6) - Un-named tributary of Leonard (Back Creek) Gully (Ch 124.5, Ch 120.3) - Grasstree Creek (Ch 138.6, Ch 139.7) - Half Mile Creek – drainage feature (Ch 188.7, Ch 183.6) - Un-named tributary of Westbrook Creek (Ch 193.4, Ch 191.8) - Un-named tributary of Westbrook Creek (Ch 196.0)
Low (Category 1)	- Un-named tributary of Macintyre Brook (Ch 61.5, Ch 60.4) Un-named tributary of Macintyre Brook (Ch 63.1, Ch 62.8) Un-named tributary of Canning Creek (Ch 86.6, Ch 85.2, Ch 84.4, Ch 83.4, Ch 82.3, Ch 80.6, Ch 80.6, Ch 78.9, Ch 77.7, Ch 73.7) - Un-named tributary of Canning Creek (Ch 88.5) - Un-named tributary of Canning Creek (Ch 93.4) - Un-named tributary of Canning Creek (Ch 108.5) - Un-named tributary of Canning Creek (Ch 113.1, Ch 110.9) - Un-named tributary of Leonard (Back Creek) Gully (Ch 116.2, 115.6, 115.5, Ch 114.9) - Un-named tributary of Leonard (Back Creek) Gully (Ch 119.0) - Un-named tributary of Leonard (Back Creek) Gully (Ch 121.5, Ch 121.4, Ch 120.8) - Un-named tributary of Leonard (Back Creek) Gully (Ch 124, Ch 123.4) - Un-named tributary of Leonard (Back Creek) Gully (Ch 125.5) - Un-named tributary of Condamine River (North Branch) (Ch 168.6, Ch 169.7, Ch 169.3 Ch 170.9, Ch 170.6) - Un-named tributary of Upper Tributary Umbiram Creek (Ch 181.7) - Un-named tributary of Upper Tributary Umbiram Creek (Ch 185.9, Ch 184.8) - Un-named tributary of Westbrook Creek (Ch 190.7) - Un-named tributary of Westbrook Creek (Ch 195.7) - Un-named tributary of Dry Creek (Ch 201.4 km) - Un-named tributary of Gowrie Creek (Ch 205.8 km, Ch 205 km)



Legend

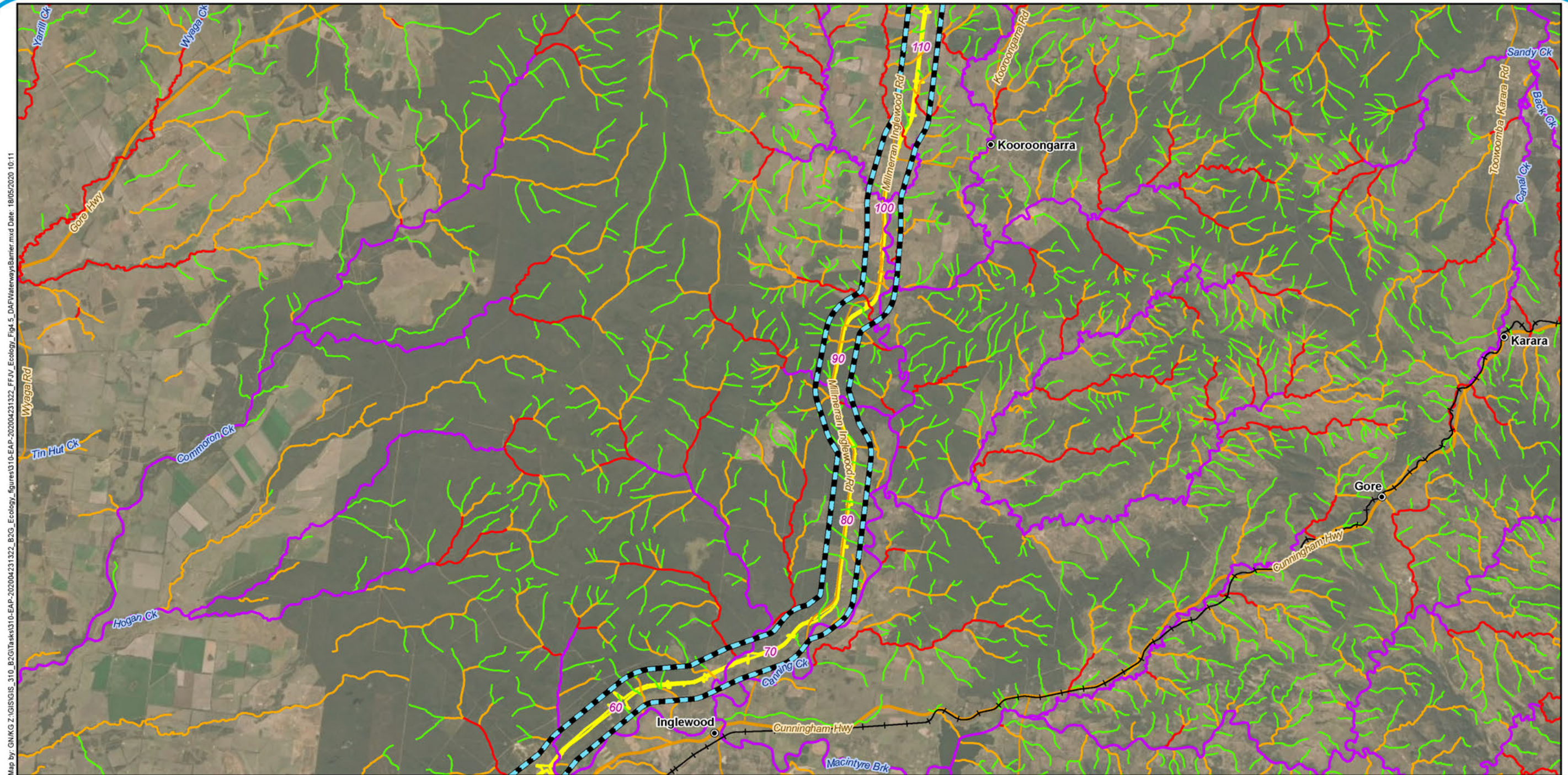
- | | | |
|--|------------------------|---|
| 5 Chainage (km) | Major roads | Risk of Impact
1 - Low
2 - Moderate
3 - High
4 - Major |
| Localities | Minor roads | |
| North Star to NSW/QLD border alignment | NSW/QLD border | |
| Existing rail (operational) | Project footprint | |
| | Impact assessment area | |

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

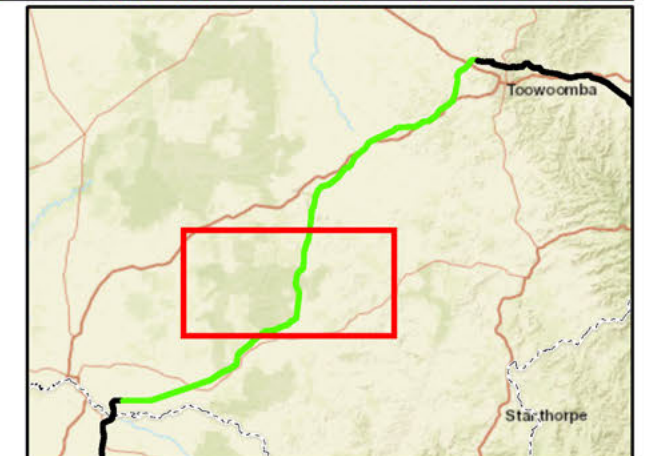




Legend

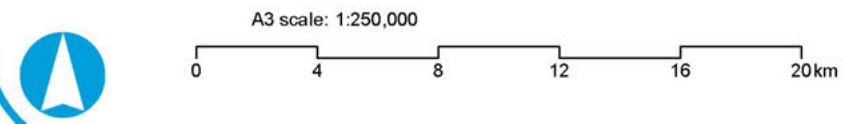
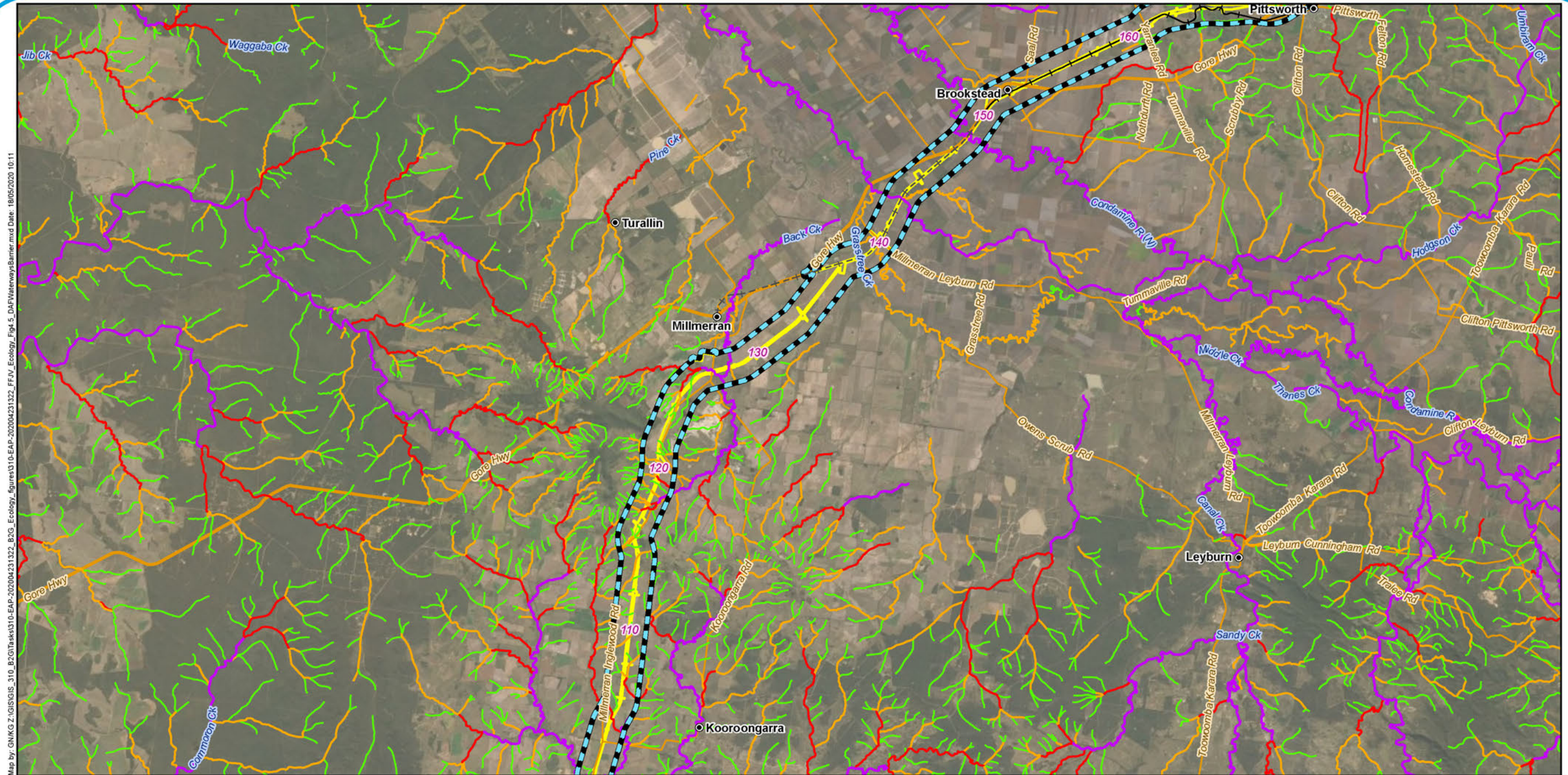
- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Project footprint
- Impact assessment area

- Risk of Impact**
- 1 - Low
 - 2 - Moderate
 - 3 - High
 - 4 - Major

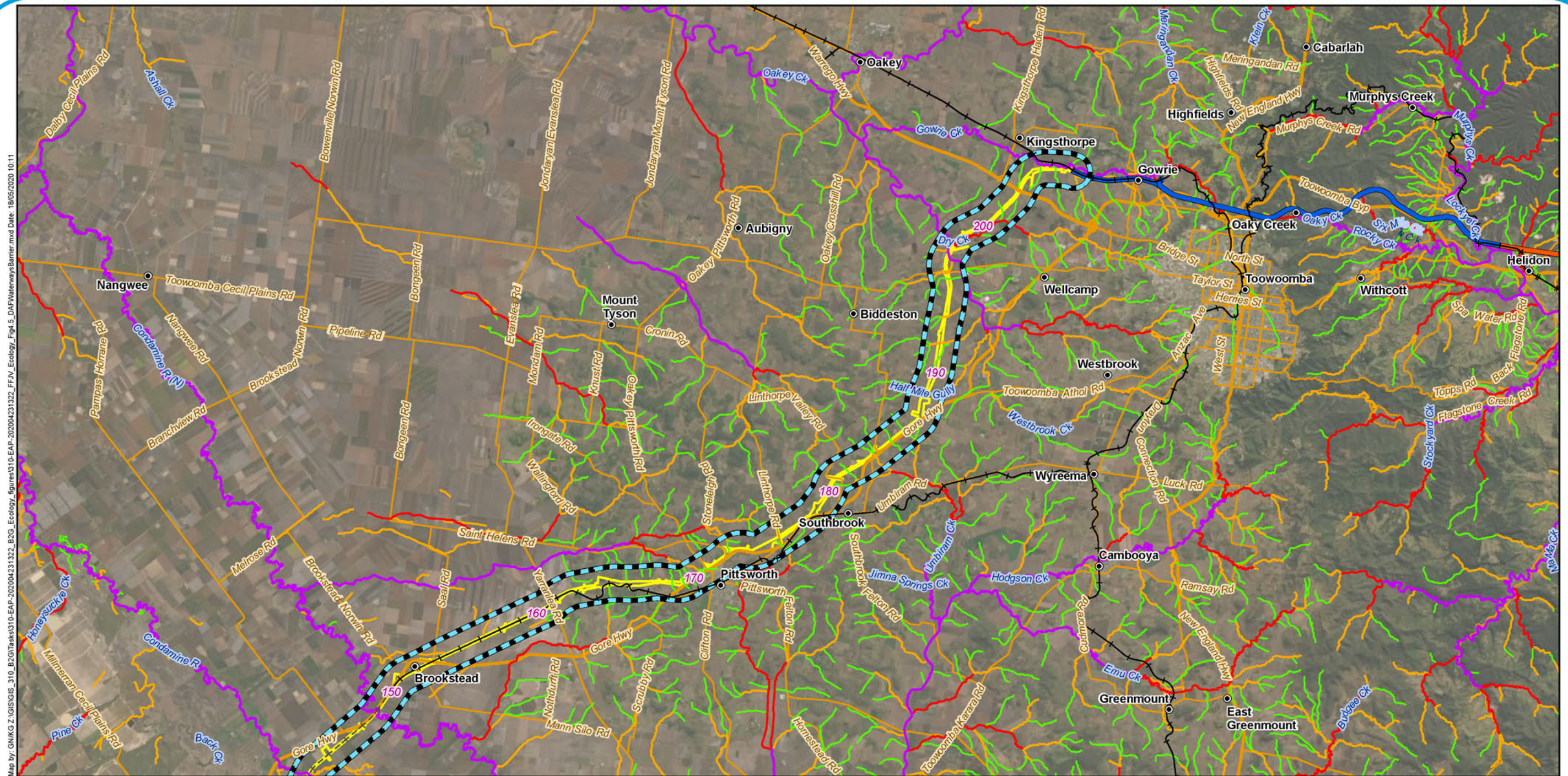


A3 scale: 1:250,000





Border to Gowrie
Figure 4.5c: Department of Agriculture and Fisheries waterway barrier works



Legend

- 5 Chainage (km)
- Localities
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Existing rail (operational)
- Existing rail (non-operational)

- Major roads
- Minor roads
- Project footprint
- Impact assessment area

- #### Risk of Impact
- 1 - Low
 - 2 - Moderate
 - 3 - High
 - 4 - Major



A3 scale: 1:250,000

0 4 8 12 16 20km



Future Freight
Integrating Community, Environment and Engineering

Issue date: 18/05/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.5d: Department of Agriculture and Fisheries waterway barrier works

4.5.8 Wetlands

Detailed discussion of the location, value and potential impacts to waterways in the impact assessment area is provided in EIS Appendix K: Aquatic Ecology Technical Report.

There are no Wetlands of International Importance (Ramsar wetlands) located in, or within 10 km of the impact assessment area. No high ecological value (HEV) wetlands are mapped as occurring within the impact assessment area. Two discrete wetlands of high ecological significance (HES), which are considered MSES under the *Environmental Protection Regulation 2019* (EP Reg), are located within the impact assessment area within the vicinity of Kurumbul (refer Table 4.9). The area that these encompass in the impact assessment area is presented in Figure 4.6.

Table 4.9 High ecological significance wetlands present within the impact assessment area

Habitat values	Extent contained within the impact assessment area (ha)	Extent contained within the Project footprint (ha)
HEV Wetlands	0.00	0.00
HES Wetlands	9.85	0.00

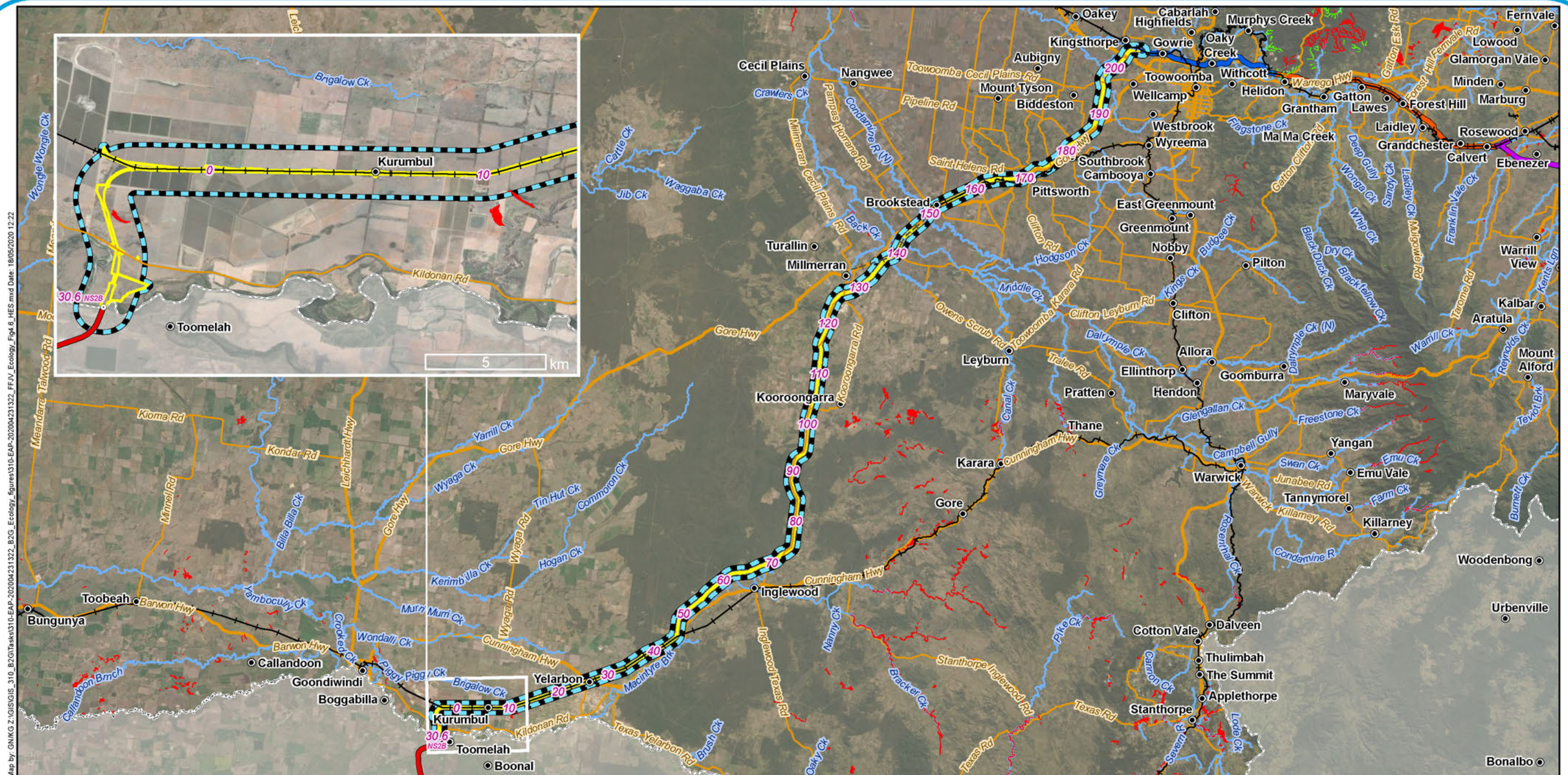
4.5.9 AquaBAMM

The aquatic conservation assessment using AquaBAMM assesses the conservation and ecological value of wetland systems based on a series of national and international criteria, including naturalness (aquatic and catchment), diversity and richness, threatened species/ecosystems, priority species/ecosystem, special features, connectivity and representativeness (DEHP 2015).

The AquaBAMM scores for each monitoring site are detailed in the Appendix P: Surface Water Technical Report and EIS Appendix K: Aquatic Ecology Technical Report. The details of each monitoring site can be found in those reports. The resulting modelled score (as a categorical, standardised score of overall ecological value) gives an indicative representation of expected wetland ecological value (refer Table 4.10).

Table 4.10 Specific Riverine AquaBAMM Aquascore for all water quality monitoring sites

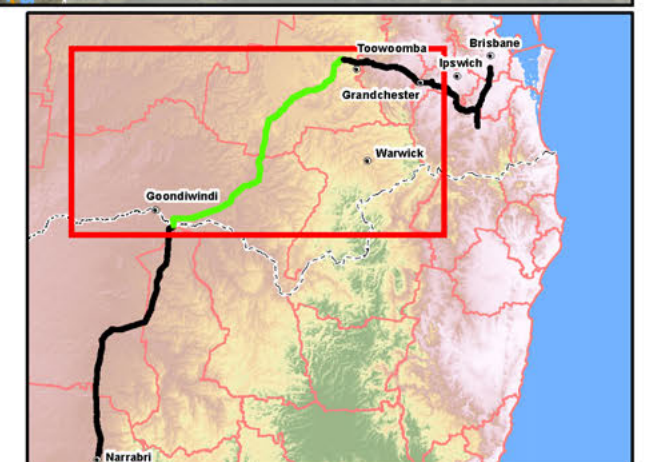
Aquascore	Monitoring site
Very Low	-
Low	16, 27
Medium	18, 20R, 23, 24, 32, 33, 39, 40, 42
High	14
Very High	2, 2R, 3, 6, 7, 11, 29, 30



Legend

- | | | |
|--|---------------------------------------|---|
| 5 Chainage (km) | — Existing rail (operational) | Project footprint |
| ● Localities | - - - Existing rail (non-operational) | Impact assessment area |
| North Star to NSW/QLD border alignment | Major roads | High ecological significance wetlands |
| Gowrie to Helidon alignment | Minor roads | High ecological value waters - wetlands |
| Helidon to Calvert alignment | Watercourses | |
| Calvert to Kagaru alignment | NSW/QLD border | |

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: 1:800,000

0 10 20 30 40 50 km

4.5.10 Springs and groundwater dependent ecosystems

Groundwater dependent ecosystems (GDE) are ecosystems that require access to groundwater on a permanent or periodic basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.

The Groundwater Dependent Ecosystems (GDE) Atlas (BoM 2018) identifies three types of ecosystems:

- Aquatic ecosystems that rely on the surface expression of groundwater – this includes surface water ecosystems which may have a groundwater component (i.e. rivers, wetlands, springs)
- Terrestrial ecosystems that rely on the subsurface presence of groundwater – this includes all vegetation ecosystems
- Subterranean ecosystems – this includes cave and aquifer ecosystems.

As the assessment using the BoM atlas is modelled at a large scale, the identification of potential GDEs in the Atlas therefore does not confirm that a particular ecosystem is groundwater dependent. Noting this, the atlas has identified several potential aquatic and terrestrial groundwater dependant systems including wetland systems and watercourses (refer Figure 4.7).

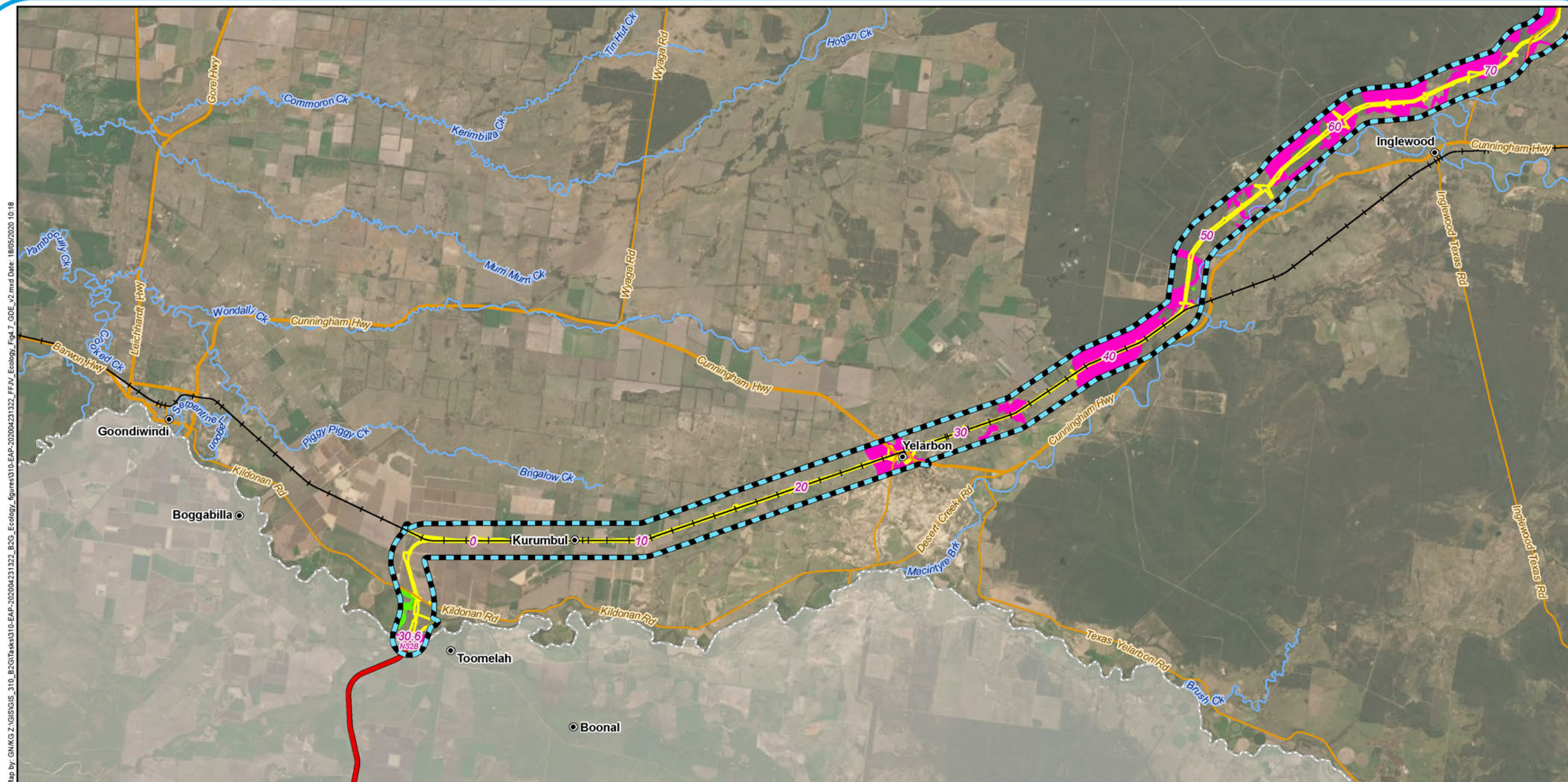
A review of refined scale potential GDE mapping (DES 2018) has been undertaken and the following GDEs aquifer categories have the potential to occur within the impact assessment area:

- Unconsolidated sedimentary aquifers
- Consolidated sedimentary aquifers
- Metamorphic rock aquifers.
- The extent of aquifers was used as a proxy for the location of potential GDEs. GDEs were assumed to be present in line with the precautionary approach taken for the assessment.

There are no springs known to occur within the impact assessment area. However, terrestrial groundwater dependant ecosystems and surface areas are present within the impact assessment area. The location of GDEs and surface areas is provided in Figure 4.7 and quantified in Table 4.11. Further discussion of GDEs is provided in the EIS Appendix K: Aquatic Ecology Technical Report and EIS Appendix R: Groundwater Technical Report.

Table 4.11 **Extent of mapped springs, groundwater dependant ecosystems and surface areas within the impact assessment area and Project footprint**

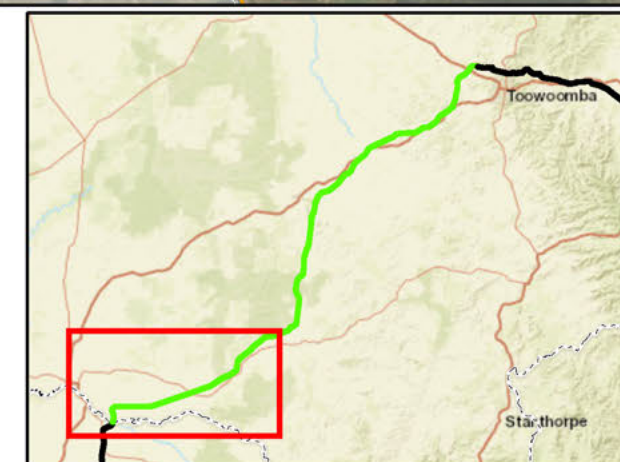
Feature	Extent contained within the impact assessment area (ha)	Extent contained within the Project footprint (ha)
Springs	0.00	0.00
GDEs	7,237.98	447.40
Surface areas	94.13	0.00
Total	7,332.11	447.40



Legend

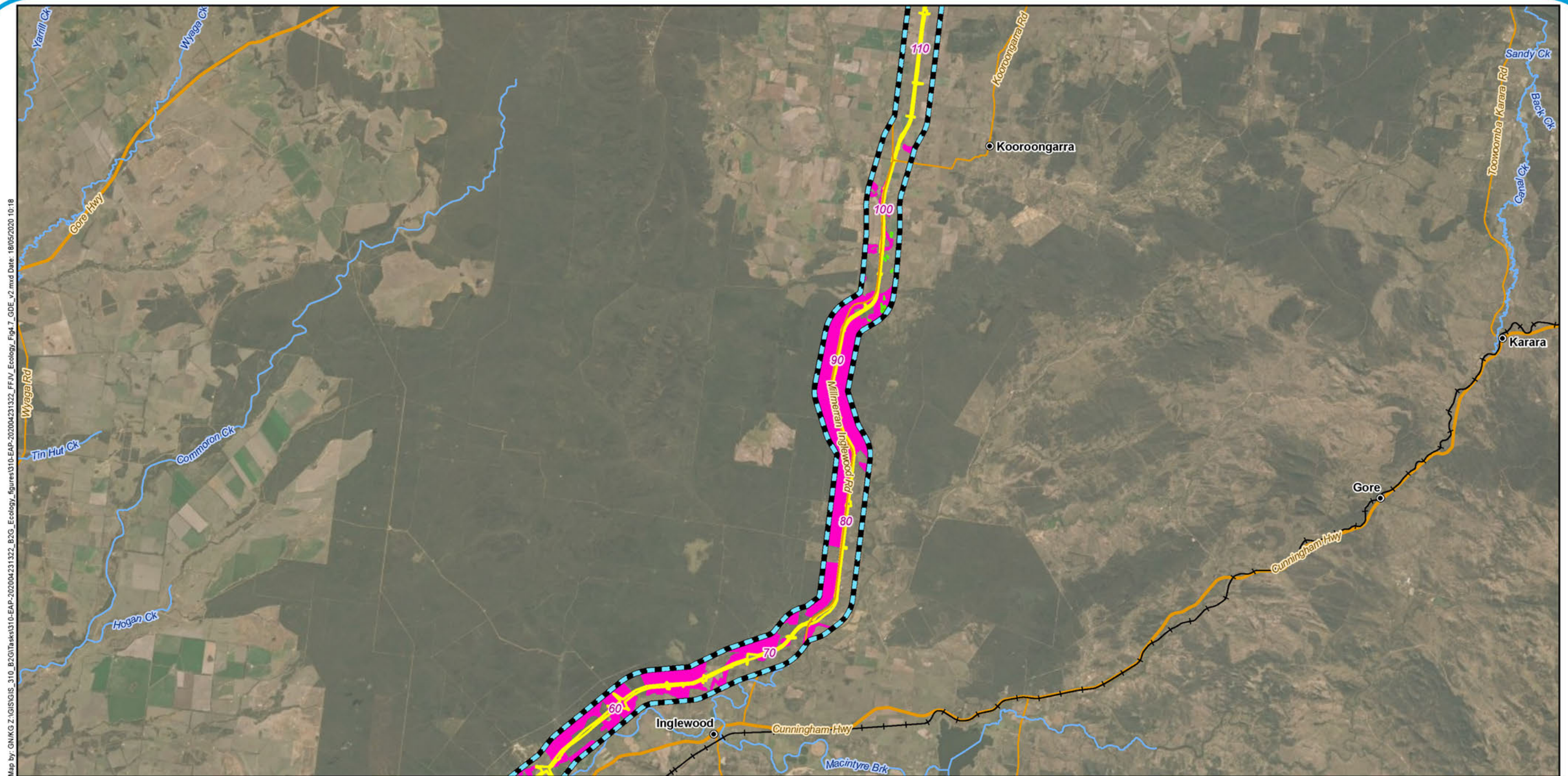
- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area
- Groundwater Dependant Ecosystems - Surface areas
- Groundwater Dependant Ecosystems - Terrestrial

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 4 8 12 16 20km

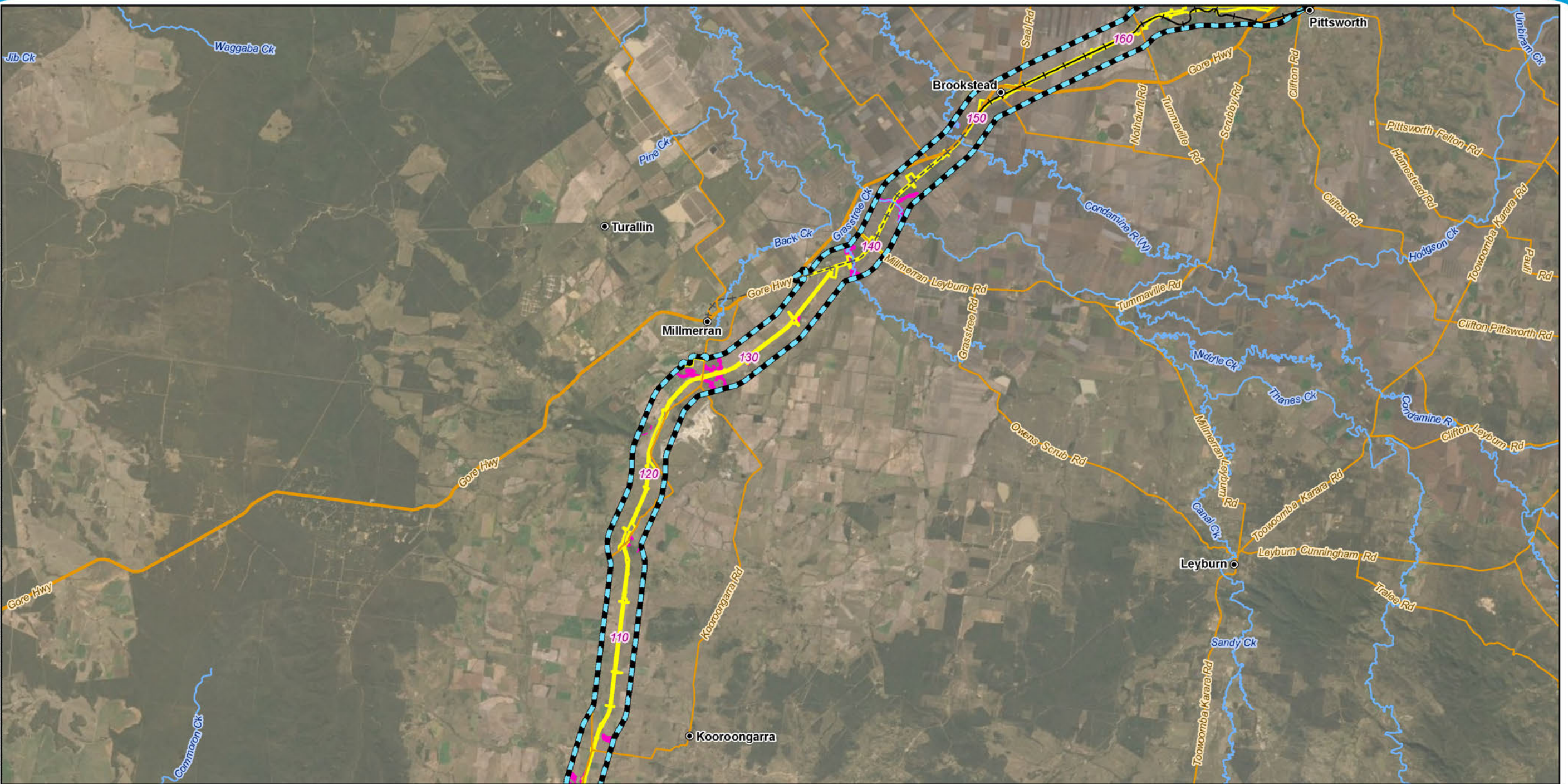


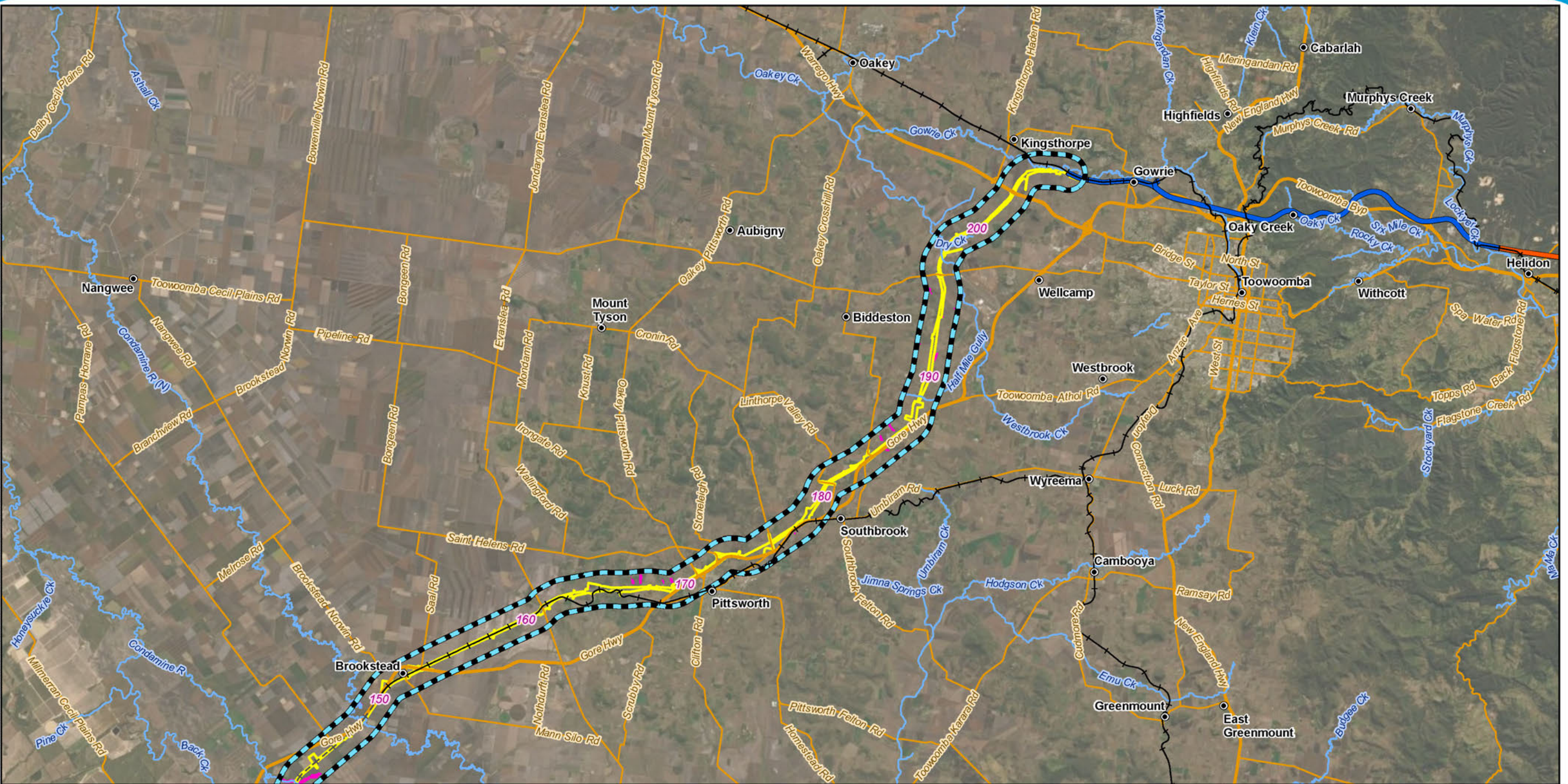
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Groundwater Dependant Ecosystems - Surface areas
- Groundwater Dependant Ecosystems - Terrestrial

A3 scale: 1:250,000







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
- Groundwater Dependant Ecosystems - Terrestrial



A3 scale: 1:250,000



4.5.11 Declared fish habitat areas

A declared fish habitat area is an area protected against physical disturbance from coastal development, while still allowing legal fishing.

There are no declared fish habitat areas mapped within the impact assessment area.

4.5.12 Local fisheries, fishing clubs and impoundments

The Fisheries Act provides provisions for ecological sustainable development principles to be applied to developments which may have an impact on fishing clubs and stocking organisations which utilise water resources on an ongoing basis.

There are no fishing clubs within the impact assessment area or within a 5 km radius of the impact assessment area. However, there is the potential that smaller unofficial clubs exist in the area. Stocking of fish into impoundments and dams may have been undertaken by local landholders or the DAF within and adjacent to the impact assessment area. Stocking of species outside of their natural range/drainage system (e.g. Mary River cod, Silver perch, Australian lungfish) may have historically occurred and may account for any records of such species within the local area.

4.5.13 Protected areas (Bringalily and Whetstone State Forests)

Two protected areas (as defined under the Forestry Act 1959) exist within the impact assessment area. These protected areas, including the extent contained within the impact assessment area, are presented in Figure 4.8.

Table 4.12 Protected areas identified as occurring within the impact assessment area and Project footprint

Habitat values	Extent contained within the impact assessment area (ha)	Extent contained within the Project footprint (ha)
Bringalily State Forest	2,761.74	101.73
Whetstone State Forest	990.77	22.99

4.5.13.1 Ecological values contained within Bringalily and Whetstone State Forests

GIS analysis of habitat modelling (refer Section 3.2.4) and publicly available datasets (refer Section 3.2.1) indicates that potential impacts to a number of different MNES and MSES are likely to occur. The quantum of these features contained within each state forest is presented in Table 4.13, Table 4.14 and Table 4.15.

Table 4.13 Commonwealth values (non-controlling provisions), listed under the EPBC Act contained within Bringalily and Whetstone State Forests

Species name	Common name	NC Act status	EPBC Act status	Total combined habitat types (Bringalily State forest) (ha)	Total combined habitat types (Whetstone State forest) (ha)
Migratory fauna					
<i>Actitis hypoleucos</i>	Common sandpiper	SLC	M	2.96	0.00
<i>Apus pacificus</i>	Fork-tailed swift	SLC	M	101.73	22.99
<i>Calidris acuminata</i>	Sharp-tailed sandpiper	SLC	M	2.96	0.00
<i>Calidris melanotos</i>	Pectoral sandpiper	SLC	M	2.96	0.00
<i>Calidris ruficollis</i>	Red-necked stint	SLC	M	2.96	0.00
<i>Cuculus optatus</i>	Oriental cuckoo	SLC	M	5.77	0.00
<i>Gallinago hardwickii</i>	Latham's snipe	SLC	M	2.96	0.00

Species name	Common name	NC Act status	EPBC Act status	Total combined habitat types (Brigalily State forest) (ha)	Total combined habitat types (Whetstone State forest) (ha)
<i>Monarcha melanopsis</i>	Black-faced monarch	SLC	M	5.77	0.00
<i>Motacilla flava</i>	Yellow wagtail	SLC	M	2.96	0.00
<i>Myiagra cyanoleuca</i>	Satin flycatcher	SLC	M	5.77	0.00
<i>Pandion haliaetus</i>	Osprey	SLC	M	2.19	0.00
<i>Plegadis falcinellus</i>	Glossy ibis	SLC	M	2.96	0.00
<i>Rhipidura rufifrons</i>	Rufous fantail	SLC	M	5.77	0.00
<i>Symposiachrus trivirgatus</i>	Spectacled monarch	SLC	M	5.77	0.00
<i>Tringa nebularia</i>	Common greenshank	SLC	M	2.96	0.00

Table notes:

SLC = Special Least Concern

M = Migratory

Table 4.14 State Flora and Fauna values, listed under the NC Act values contained within Brigalily and Whetstone State Forests

Species name	Common name	NC Act status	Total combined habitat (Brigalily State forest) (ha)	Total combined habitat (Whetstone State forest) (ha)
<i>Digitaria porrecta</i>	Finger panic	NT	1.12	0.00
<i>Picris barbarorum</i>	Tall hawkweed	V	96.65	2.43
<i>Acanthophis antarcticus</i>	Common death adder	V	98.92	22.99
<i>Calyptorhynchus lathami lathami</i>	Glossy black-cockatoo	V	98.87	22.99
<i>Lophochroa leadbeateri</i>	Major Mitchell's cockatoo	V	98.92	22.99
<i>Ornithorhynchus anatinus</i>	Platypus	SLC	7.93	0.00
<i>Tachyglossus aculeatus</i>	Echidna	SLC	99.93	22.99

Table notes:

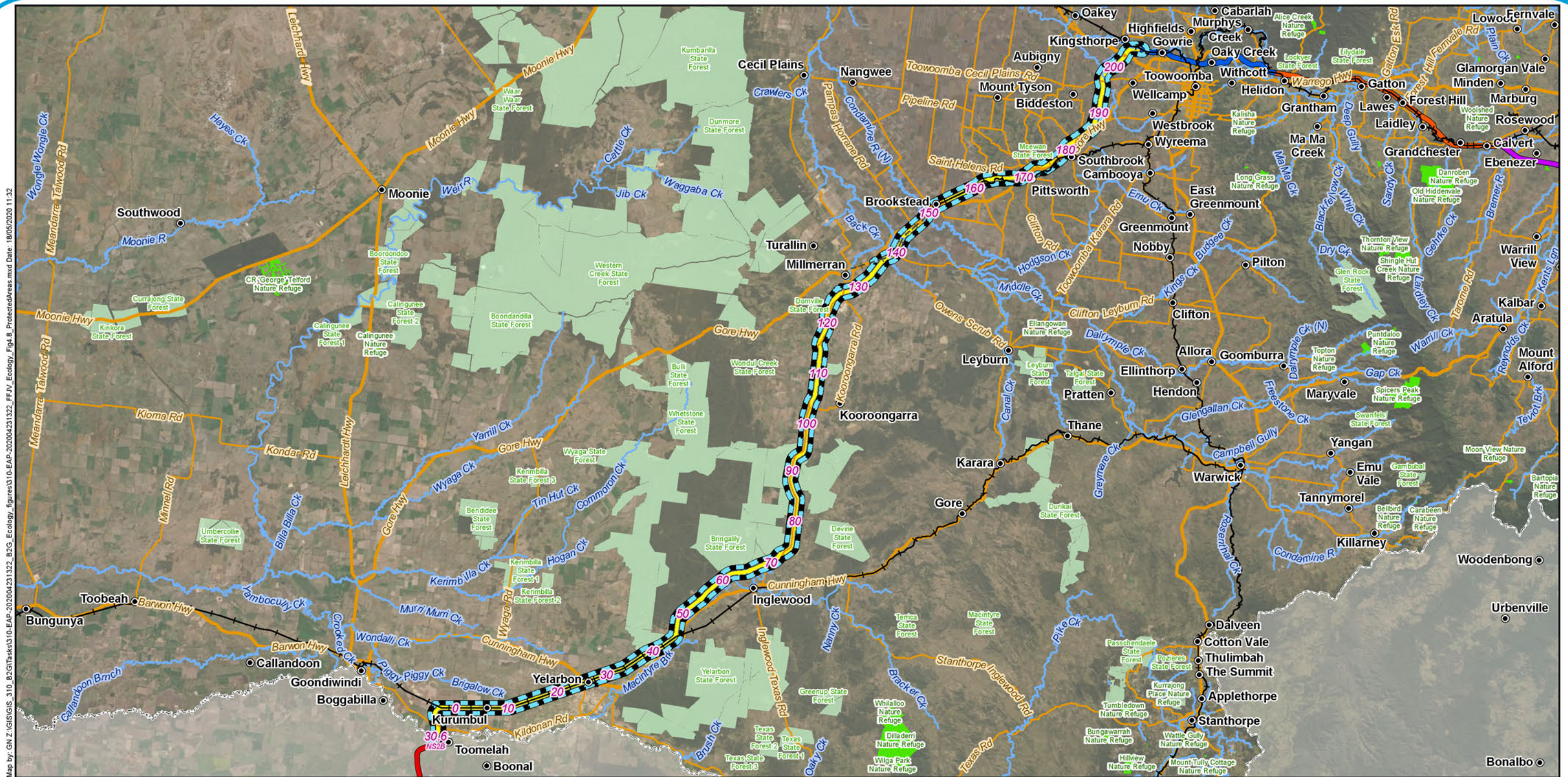
V = Vulnerable

NT = Near Threatened

SLC = Special Least Concern

Table 4.15 State-Based Environmental features contained within Brigalily and Whetstone State Forests

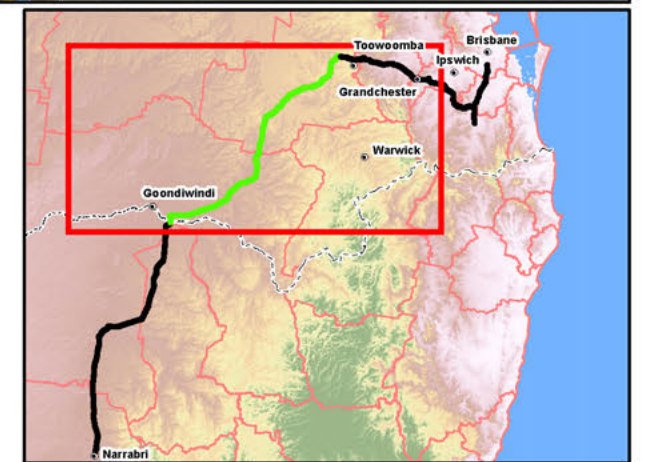
Sensitive environmental receptor	Brigalily State forest (ha)	Whetstone State forest (ha)
Endangered remnant vegetation (REs) (Category B)	2.25	2.55
Of concern remnant vegetation (REs) (Category B)	9.47	20.43
Least concern remnant vegetation (REs) (Category B)	87.20	0.00
MSES wildlife habitat	30.41	0.00
Essential habitat	47.04	0.00
BPA habitat values for EVNT taxa (State)	21.58	0.00
BPA State riparian corridors	3.20	0.00
BPA State terrestrial corridors	53.37	22.99



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area
- Nature refuge
- State forest

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: 1:800,000



4.5.14 Nature Conservation (Koala) Conservation Plan 2017

The impact assessment area is wholly contained within Koala district A which is defined as South-east Queensland under the *Planning Regulation 2017*.

As defined by the *Nature Conservation (Koala) Conservation Plan 2017*, the following areas may occur within and/or adjacent to the Project footprint:

- Koala Priority Areas
- Koala Habitat Areas
- Koala Habitat Restoration Areas
- Locally Refined Koala Habitat Areas.

The extent of these areas is shown in Figure 4.9 and defined in Table 4.16.

Table 4.16 The extent of Koala mapping within the impact assessment area

Habitat category	Extent (ha)	
	Impact assessment area	Project footprint
Koala Priority Areas	0	0
Koala Habitat Areas	81.73	7.44
Koala Habitat Restoration Area - Koala Priority Area	0	0
Koala Habitat Restoration Areas	0	0
Locally Refined Koala Habitat Areas	0	0

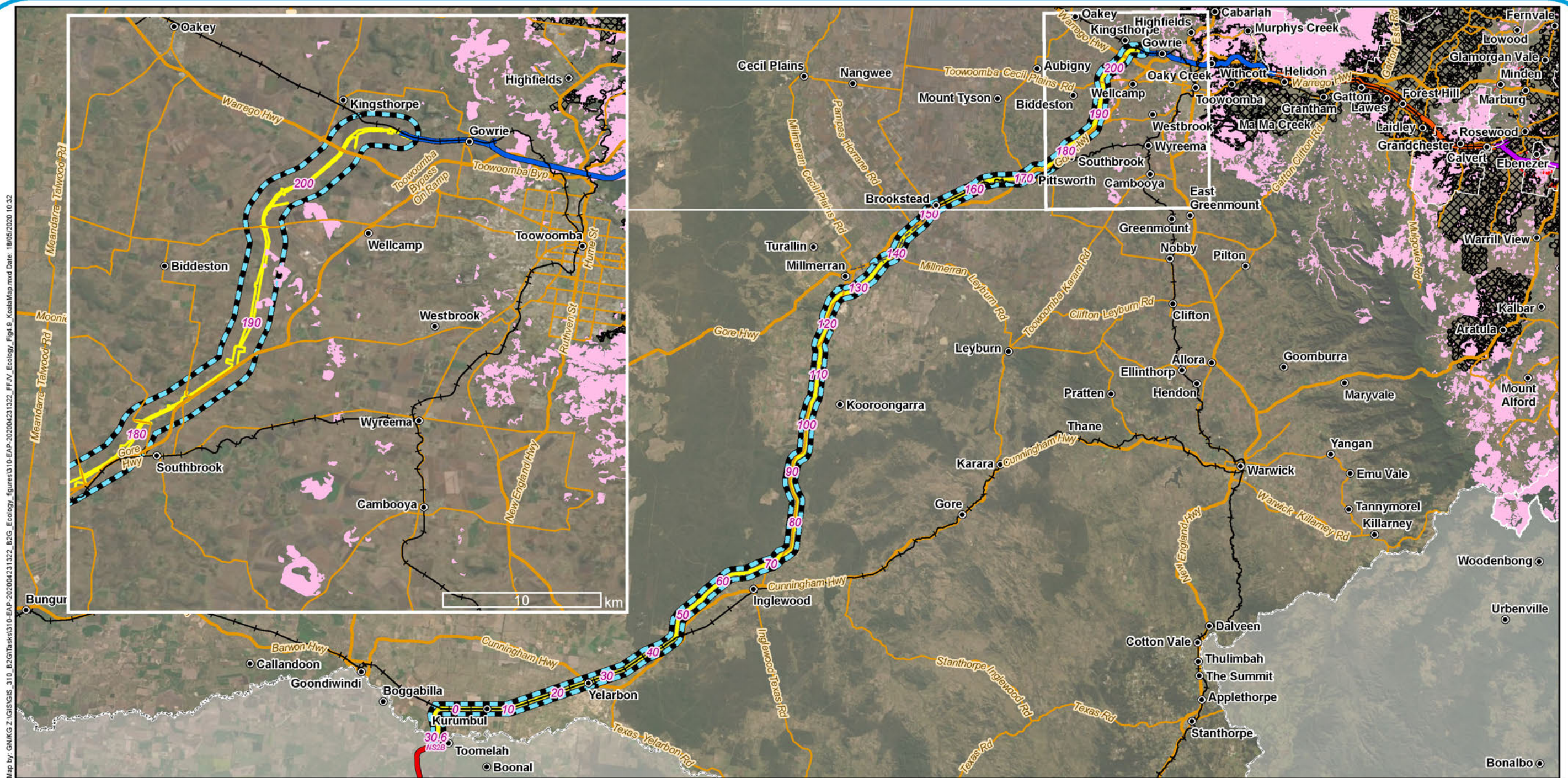
4.5.15 Biodiversity Planning Assessment

The DES attributes biodiversity significance on a bioregional scale through a BPA. A BPA involves the integration of ecological criteria using the BAMM.

BPAs assign three levels of overall biodiversity significance as identified below:

- **State significance** - areas assessed as being significant for biodiversity at the bioregional or State scales. They also include areas assessed by other studies/processes as being significant at national or international scales. In addition, areas flagged as being of State significance due to the presence of 'Endangered', 'Vulnerable' and/or 'Near Threatened' taxa, are identified as "State Habitat for EVNT taxa".
- **Regional significance** - areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.
- **Local significance and/or other values** - areas assessed as not being significant for biodiversity at State or regional scales. Local values are of significance at the local government scale.

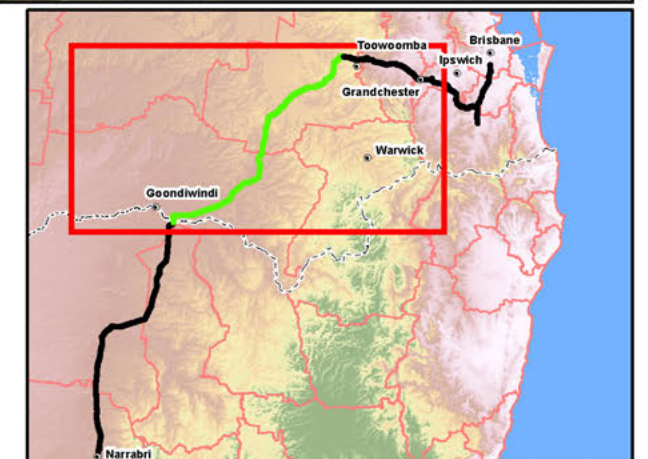
The results of the BPA assessment for habitat values and corridors are provided in Sections 4.5.15.1 and 4.5.15.2 respectively.



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area
- Koala priority areas
- Koala habitat areas
- Locally refined koala habitat areas
- Koala habitat restoration areas

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: 1:800,000



4.5.15.1 Special area decisions

The BPA Expert panel derived "Special Area Decisions" are used to assign values to Other Essential Criteria. The specific decisions to the impact assessment area include the following:

- **Yelarbon and Bringalily State Forest Tracts** (State significance) – Open eucalypt woodlands on either shallow soils (in areas of higher elevation) or sandy plains dominate. Diversity of terrestrial vertebrate taxa is very high with approximately 350 recorded. Among the threatened taxa known are Dunmall's snake (*Furina dunmali*), Major Mitchell's cockatoo (*Lophochroa leadbeateri*), Regent honeyeater (*Anthochaera phrygia*), Painted honeyeater (*Grantiella picta*), Spotted-tail quoll (*Dasyurus m. maculatus*) and Greater glider (*Petauroides Volans*). Priority taxa include both endemics such as Brigalow scaly-foot (*Paradelma orientalis*), and declining taxa, e.g. Brown treecreeper (*Climacteris picumnus*), Speckled warbler (*Chthonicola sagittate*) and Hooded robin (*Melanodryas cucullata*)
- **Core areas** (State significance) – Tracts are defined as patches of continuous remnant vegetation. The size of any tract is a major indicator of ecological significance and is strongly correlated with the long-term viability of biodiversity values. Larger tracts are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller tracts. These areas can be considered core nodes/refugia in which a large proportion of the bioregions biodiversity is represented. A modified tract size analysis (Criterion C) (EHP 2014) was used to identify and delineate discrete tracts of remnant vegetation at a bioregion scale. For the purpose of the assessment, a core area was identified as a relatively contiguous area of remnant vegetation (disregarding small perforations, or linear breaks) and which was generally greater than 5 km in width (based upon the minimum width of the terrestrial corridor network). Tracts of greater than 10,000 ha were included.
- **Locally significant natural palustrine & lacustrine wetlands** (Local significance) – The panel considered that relatively natural palustrine and lacustrine wetlands and waterbodies within the Brigalow Belt bioregion act as important refugia, especially during periods of drought. In addition, all relatively natural wetland complexes of less than 5ha in size be classed as being of at least local significance.
- **Regionally significant natural palustrine & lacustrine wetlands** (Regional significance) – The panel considered that relatively natural palustrine and lacustrine wetlands and waterbodies within the Brigalow Belt bioregion act as important refugia, especially during periods of drought. In addition, all natural wetland complexes with a combined area of greater than or equal to 5ha in size should be classed as being of at least Regional significance
- **Wondul Range and Inglewood Sandstone subregion remnants** (Regional significance) – Part of a large tract of remnant vegetation (11.7.5 and adjacent polygons of 11.9.5) containing perched heaths on sandstone with high species richness of Heath (*Ericaceae*) (11) and concentrations of endemic or isolated taxa such as Wire grass (*Aristida forsteri*) ('Endangered' and endemic to Wondul Range), Cycad (*Macrozamia machinii*), as well as disjunct populations of species or species considered close to or at their distributional range limits. This includes Thick twig-rush (*Caustis pentandra*), Devils rice (*Conospermum taxifolium*), Five corners (*Styphelia viridis* subsp. *Breviflora*), Tall raspwort (*Gonocarpus elatus*) and Micromyrtus (*Micromyrtus striata*), which is at the northern limit of its range). *Commersonia ingelewoodensis* an 'Endangered' and locally endemic species also occurs directly to the east
- **Relictual subregions (less than 30 per cent remnant vegetation) – remnant vegetation** (Regional significance) – A summary of research on landscape thresholds for remnant vegetation is provided by James Saunders (2001). The evidence suggests that once remnant vegetation falls below 30 per cent, there are significant declines in biodiversity. The following subregions have less than 30 per cent remnant vegetation in the southern Brigalow Belt: Relictual subregions (less than 30 per cent remnant vegetation remaining) for the Brigalow Belt include; Upper Belyando Flood out (11.8), Isaac – Comet Downs (11.11), Callide Creek Downs (11.19), Dawson River Downs (11.21), Taroom Downs (11.25), Dulacca Downs (11.28), Weribone High (11.29), Tara Downs (11.30), Eastern Darling Downs (11.31), Moonie R. - Commoron Creek Floodout (11.33), Moonie - Barwon Interfluvium (11.34), Warrambool - Moonie (11.35), Macintyre - Weir Fan (11.36), Narrandool (11.38). Remnant vegetation provides a refuge from clearing in fragmented subregions and should be retained to maintain biodiversity.

- **Relictual subregions - largest remaining examples of each regional ecosystem in a subregion** (State significance) - A summary of research on landscape thresholds for remnant vegetation is provided by James Saunders (2001). The evidence suggests that once remnant vegetation falls below 30 per cent, there are significant declines in biodiversity. Relictual subregions (less than 30 per cent remnant vegetation remaining) for the Brigalow Belt include the Upper Belyando Flood out (11.8), Isaac - Comet Downs (11.11), Callide Creek Downs (11.19), Dawson River Downs (11.21), Taroom Downs (11.25), Dulacca Downs (11.28), Weribone High (11.29), Tara Downs (11.30), Eastern Darling Downs (11.31), Moonie R. - Commoroon Creek Floodout (11.33), Moonie - Barwon Interfluve (11.34), Warrambool - Moonie (11.35), Macintyre - Weir Fan (11.36), Narrandool (11.38). The largest remaining examples of each regional ecosystem in a subregion represent important refuges from clearing in these fragmented landscapes.
- **Poplar box *Eucalyptus populnea* open woodland on alluvium, Eastern Darling Downs** (State significance) – Within the Eastern Darling Downs subregion, the regional ecosystem "*Eucalyptus populnea* woodland on alluvial plains" (11.3.2) exhibits a distinct variation in terms of structure and presents a more open woodland community when compared to other examples of this ecosystem. Due to clearing, less than 10 per cent of the preclear extent of this regional ecosystem remains within the subregion. Endemic taxa present within the area include Ma Ma Creek wattle (*Acacia loroloba*), Kardomia (*Kardomia jucunda*), Oakey bottlebrush (*Melaleuca quercina*) and Woolly wrinklewort (*Rutidosia lanata*), whilst species such as Mulga (*Acacia aneura* var. *major*), Miles mulga (*Acacia aprepta*), Homoranthus (*Homoranthus melanostictus*) and Miles dogwood (*Jacksonia rhadinoclona*) occur at or close to their known limit of range. In addition to the flora values, some areas of Poplar box (*Eucalyptus populnea*) may also provide important faunal habitat through fostering high densities of hollows in a heavily modified landscape.
- **Mountain coolibah remnants, Eastern Darling Downs** (Regional significance) – The Eastern Darling Downs subregion contains the southern limits of Mountain coolibah (*Eucalyptus orgadophila*) woodlands on basalt hills (11.8.5). The community is considered to provide important habitat for several threatened plant species including: Finger panic grass (*Digitaria porrecta*), and Hairy anchor plant (*Discaria pubescens*).
- **Remnant grasslands, Eastern Darling Downs** (State significance) – Remnants of once more extensive grasslands (less than 2 per cent remains) dominated by Blue grass (*Dichanthium spp.*) or Mitchell grass (*Astrebla spp.*) within the Eastern Darling Downs subregion provide a refuge for a variety of threatened flora, e.g. Finger panic grass (*Digitaria porrecta*) and *Solanum papaverifolium*, many of which occur as disjunct populations or at the limit of their geographic range. These areas are also recognised as being of important for reptile fauna including Southern rainbow-skink (*Carlia tetradactyla*), shingle-back (*Tiliqua rugosa*), Spotted black snake (*Pseudechis guttatus*), *Delma inornate*, and Common delma (*Delma plebeian*). Another notable fauna endemic is the only grassland snail found in Queensland, Jimbour black soil snail (*Jimbouria rodhobsoni*). Note: In future panel reviews, the significance of all Brigalow Belt remnant natural grasslands should be reviewed

4.5.15.2 State and regional habitat values

State and regional habitat values are classified according to their significance based on the presence of EVNT taxa. The classification excludes highly mobile fauna taxa.

The impact assessment area includes areas of State significant habitat areas, regionally significant habitat areas, and local and other values (refer Figure 4.10). No non-bioregion ecosystem areas are mapped.

Table 4.17 summarises these habitat values across the impact assessment area.

Table 4.17 The extent of Biodiversity Planning Assessment habitat values within the impact assessment area and Project footprint

Habitat values	Extent contained within the impact assessment area (ha)	Extent contained within the Project footprint (ha)
Local or other values	111.32	5.19
Regional	1,245.98	95.23
State	6,567.49	419.82
State habitat for EVNT taxa	414.42	48.96

4.5.15.3 State and regionally significant corridors

Areas identified under the BPA as corridors qualify either because they are existing vegetated corridors important for contiguity including regrowth or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and 'stepping stones'. The function of Terrestrial and Riparian corridors is outlined below:

- **Terrestrial Bioregional corridors**, in conjunction with large tracts of remnant vegetation, maintain ecological and evolutionary processes at a landscape scale, by:
 - Maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations of species over long periods of time
 - Maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change
 - Maintaining large scale seasonal/migratory species processes and movement of fauna
 - Maximising connectivity between large tracts/patches of remnant vegetation
 - Identifying key areas for rehabilitation and offsets
- **Riparian Bioregional Corridors** also maintain and encourage connectivity of riparian and associated ecosystems.



Legend

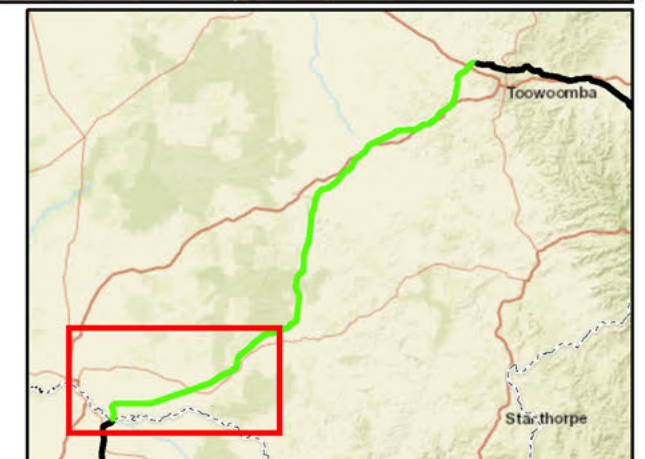
- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border

- Project footprint
- Impact assessment area

Biodiversity Significance

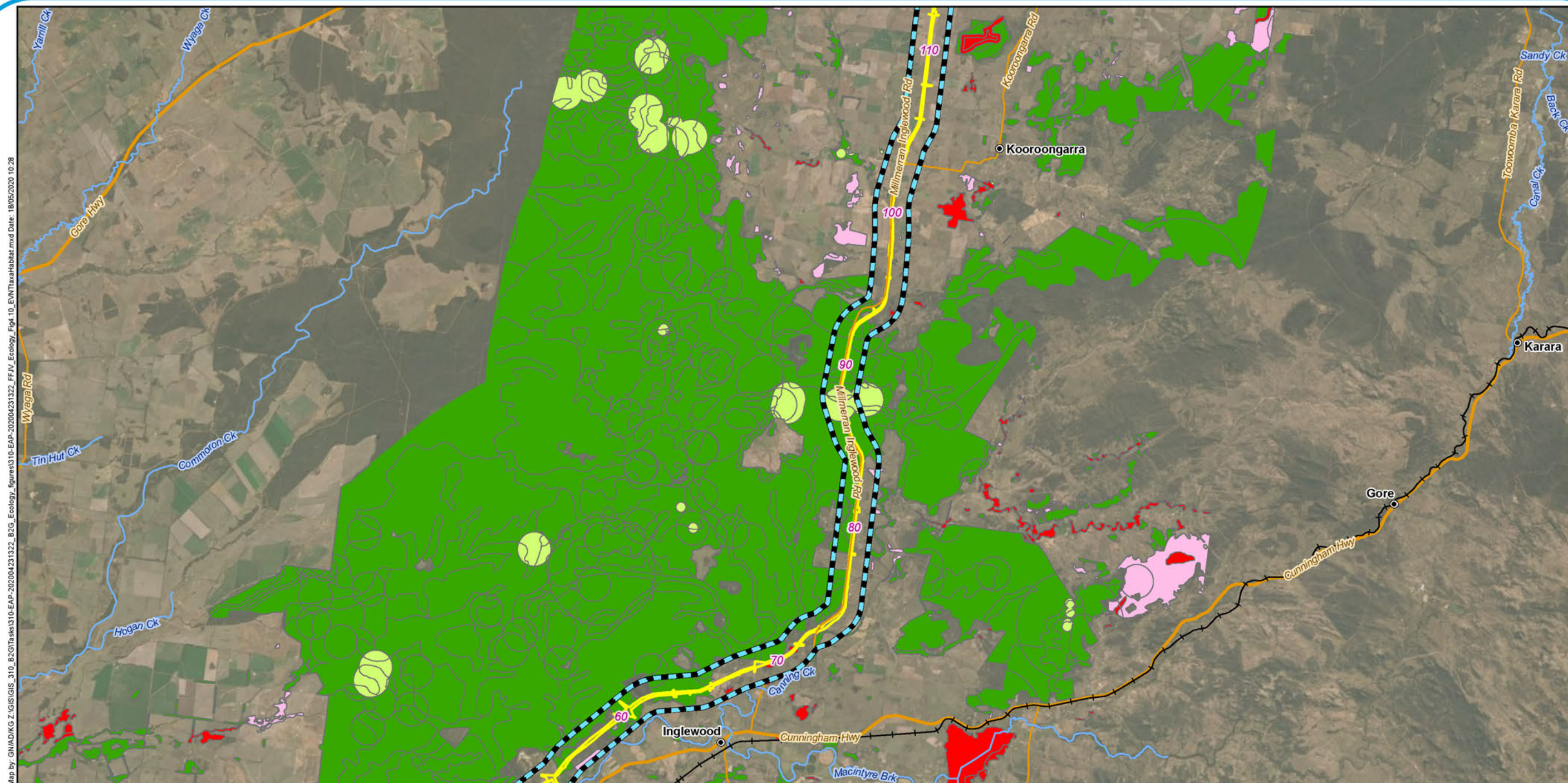
- State Habitat for EVNT taxa
- State
- Regional
- Local or Other Values

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.



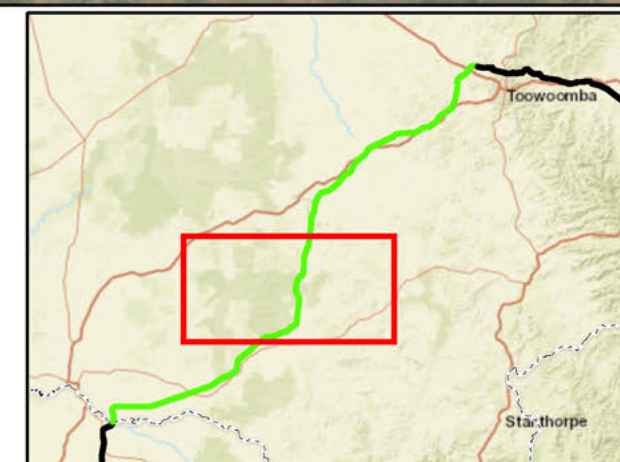
A3 scale: 1:250,000





Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Biodiversity Significance**
- State Habitat for EVNT taxa
- State
- Regional
- Local or Other Values



A3 scale: 1:250,000



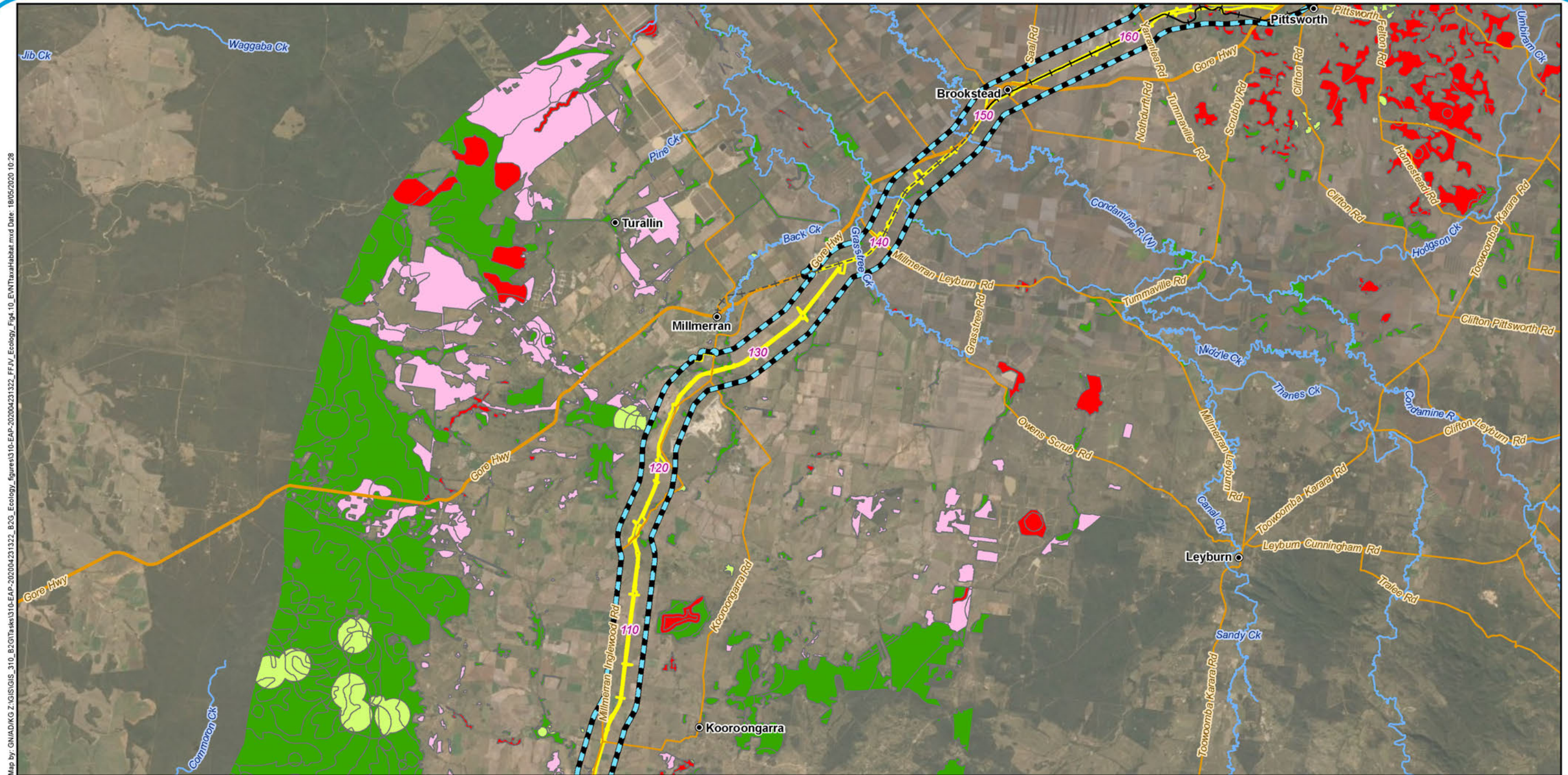
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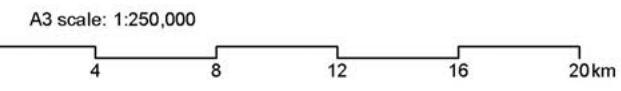
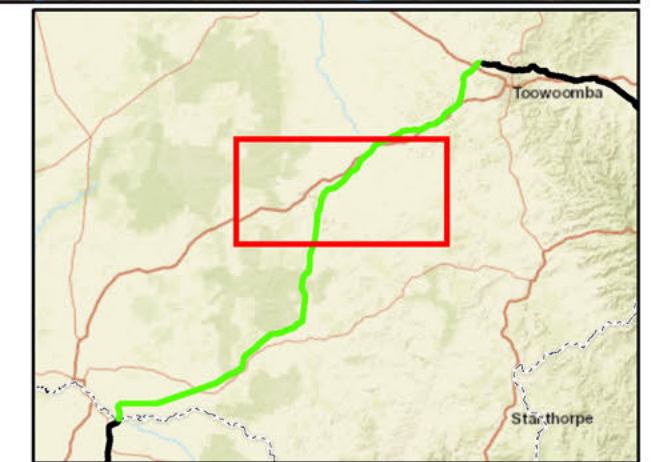
Border to Gowrie

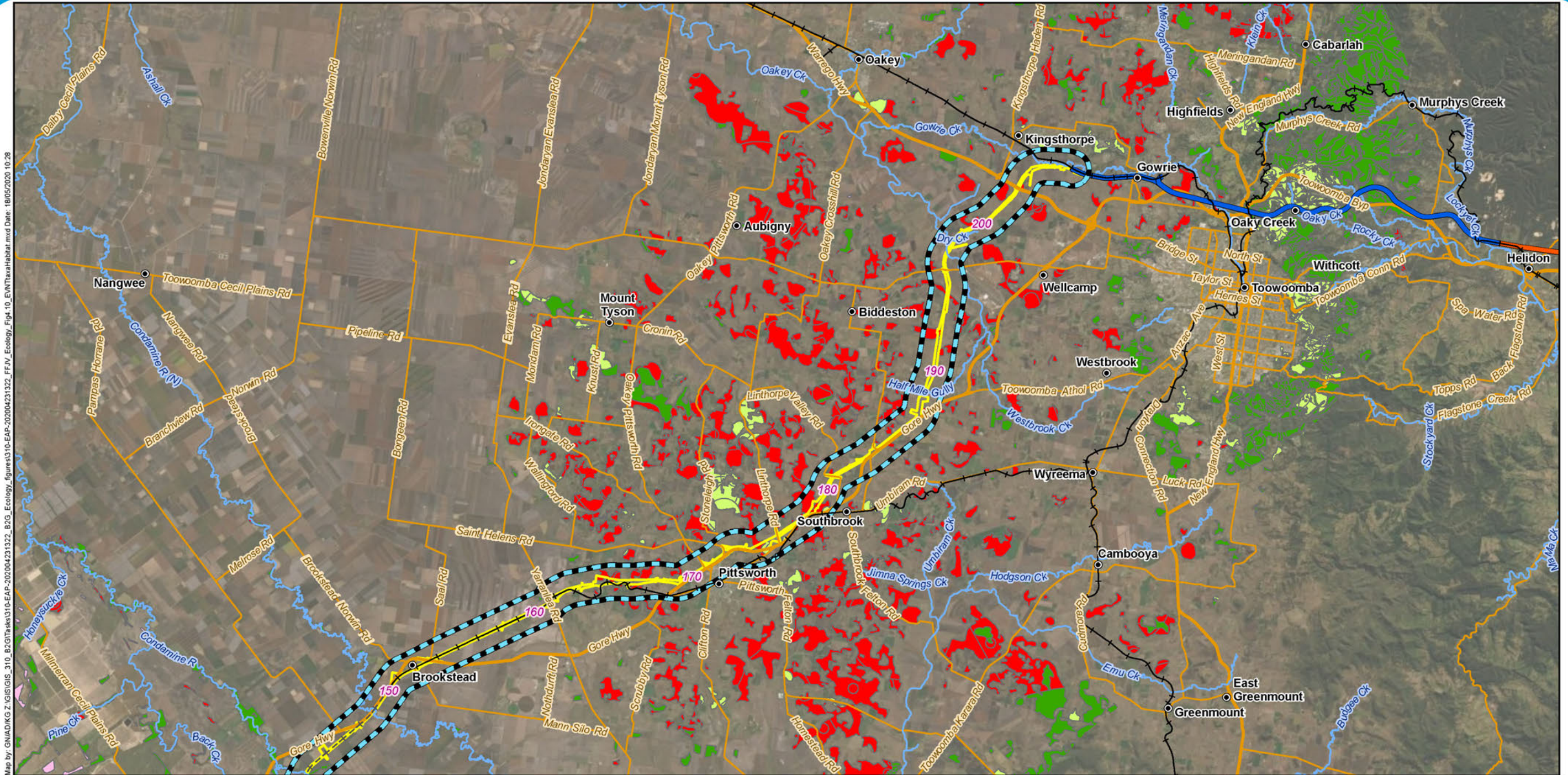
Figure 4.10b:

State and regional EVNT taxa and habitats



- Legend**
- 5 Chainage (km)
 - Localities
 - Existing rail (operational)
 - - - Existing rail (non-operational)
 - Major roads
 - Minor roads
 - Watercourses
 - Project footprint
 - Impact assessment area
 - Biodiversity Significance**
 - State Habitat for EVNT taxa
 - State
 - Regional
 - Local or Other Values





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
- Biodiversity Significance**
- State Habitat for EVNT taxa
- State
- Regional
- Local or Other Values



A3 scale: 1:250,000



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Figure 4.10d:

State and regional EVNT taxa and habitats

The location of the corridors is determined by the following principles:

- **Terrestrial**
 - Complement riparian landscape corridors (i.e. minimise overlap and maximise connectivity)
 - Follow major watershed/catchment and/or coastal boundaries
 - Incorporate major altitudinal/geological/climatic gradients
 - Include and maximise connectivity between large tracts/patches of remnant vegetation
 - Include and maximise connectivity between remnant vegetation in good condition
- **Riparian**
 - Located on the major river or creek systems within the bioregion in question.

The impact assessment area is traversed by riparian corridors of State significance, and terrestrial corridors of State and regional significance. These corridors are quantified in Table 4.18 and shown in Figure 4.11.

Potential impacts of the Project on reduction in the connectivity of biodiversity corridors is addressed in Section 5.1.2.7.

Table 4.18 The extent of BPA terrestrial and riparian ecological corridors within the ecology impact assessment area

Corridor type	Extent contained within the impact assessment area (ha)	Extent contained within the Project footprint (ha)
Regional Riparian	694.24	41.15
Regional Riparian/Terrestrial	2.07	0.00
Regional Terrestrial	2267.09	235.37
State Riparian	936.46	37.42
State Riparian/Terrestrial	84.31	3.27
State Terrestrial	3314.80	161.39

4.5.16 Register of critical habitats

No critical habitats, included in the Register of Critical Habitat, occur within the impact assessment area.

4.5.17 Regional Planning Interests Regulation 2014

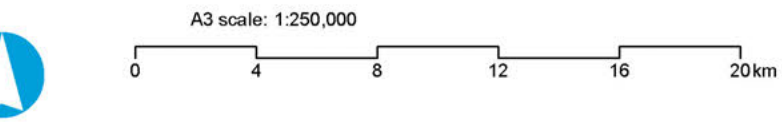
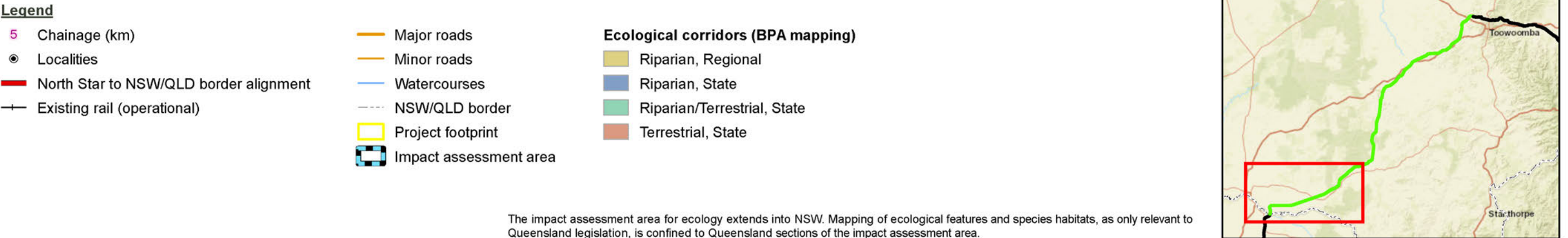
No designated precincts, in a strategic environmental area under the Regional Planning Interests Regulation 2014, Schedule 2, Part 5, Section 15(3), are located within the impact assessment area.

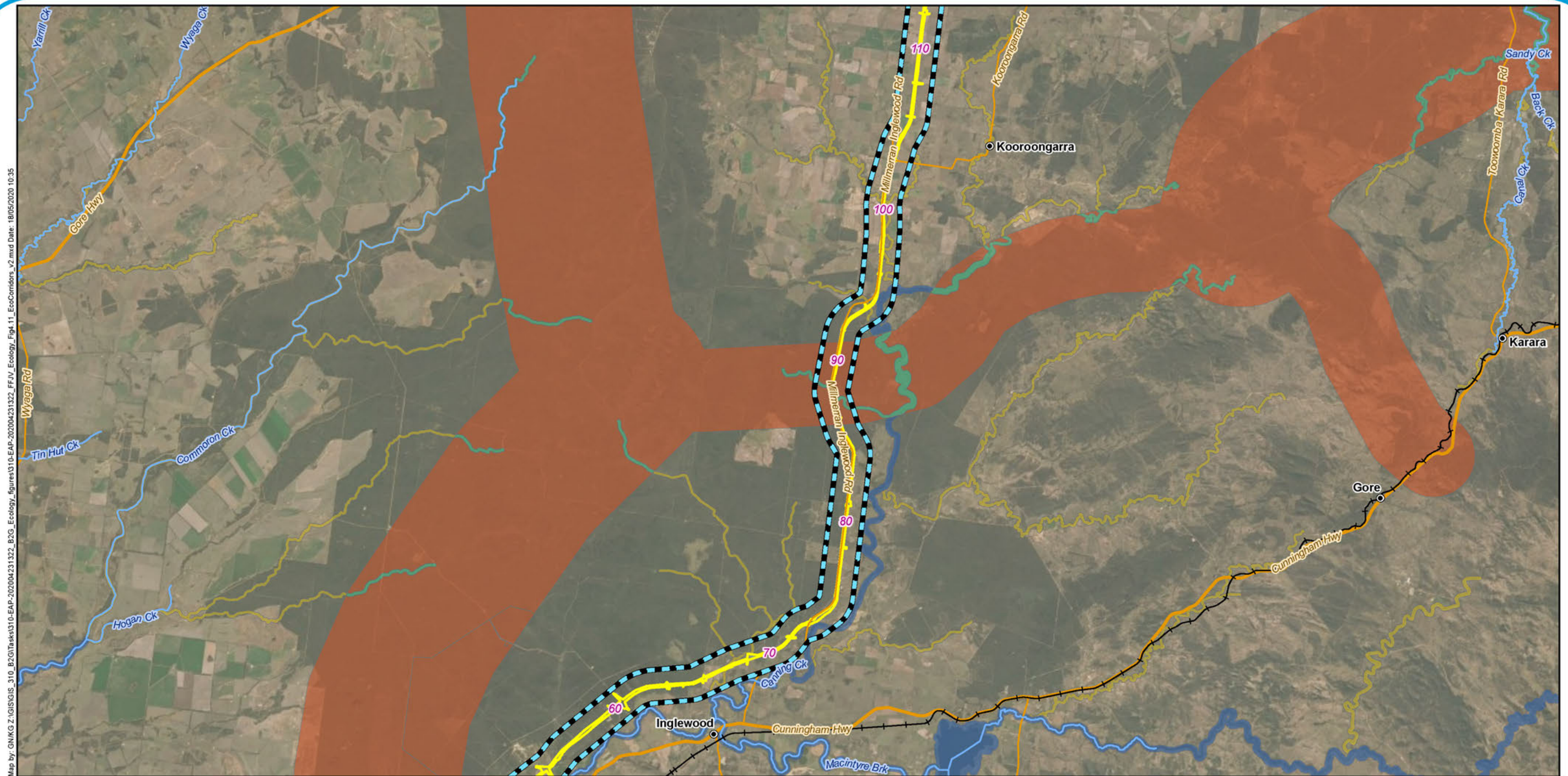
4.5.18 Regulated vegetation mapping

Vegetation regulated under the VM Act is categorised into five separate categories as follows:

- **Category A:** vegetation that is subject to compliance notices, offsets and voluntary declarations
- **Category B:** remnant vegetation shown on RE or remnant map as an 'Endangered' RE, an 'Of Concern' RE or a 'Least Concern' RE
- **Category C:** high-value regrowth vegetation
- **Category R:** regrowth watercourse area
- **Category X:** vegetation that is generally exempt from requirements under vegetation management laws.

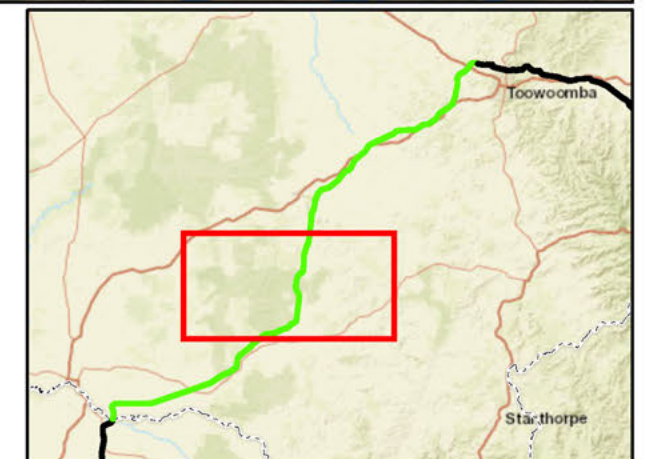
In addition to the five categories presented above, vegetation associated with Categories A, B, C and R have been assigned a specific three-digit RE code.





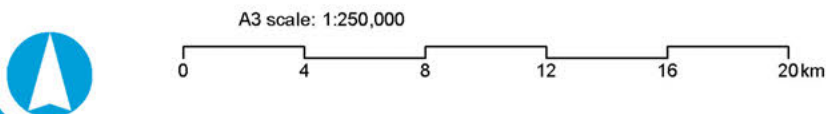
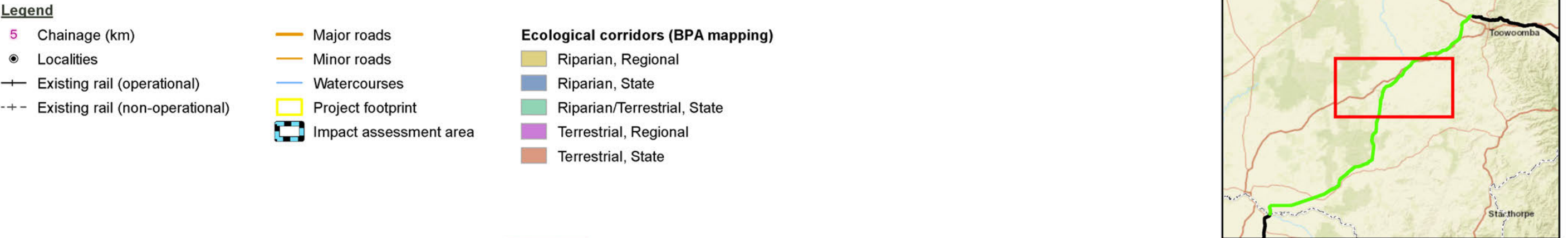
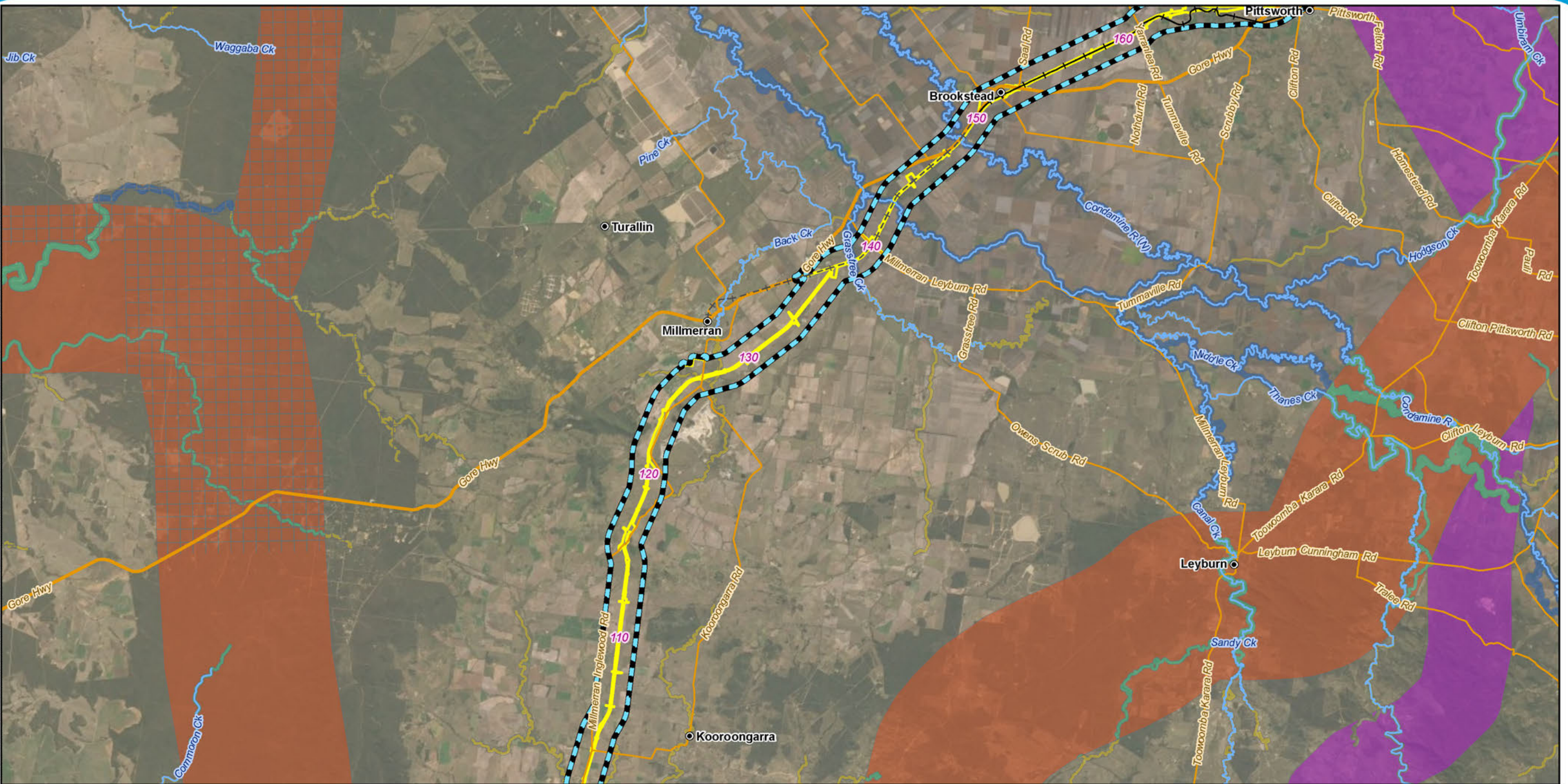
Legend

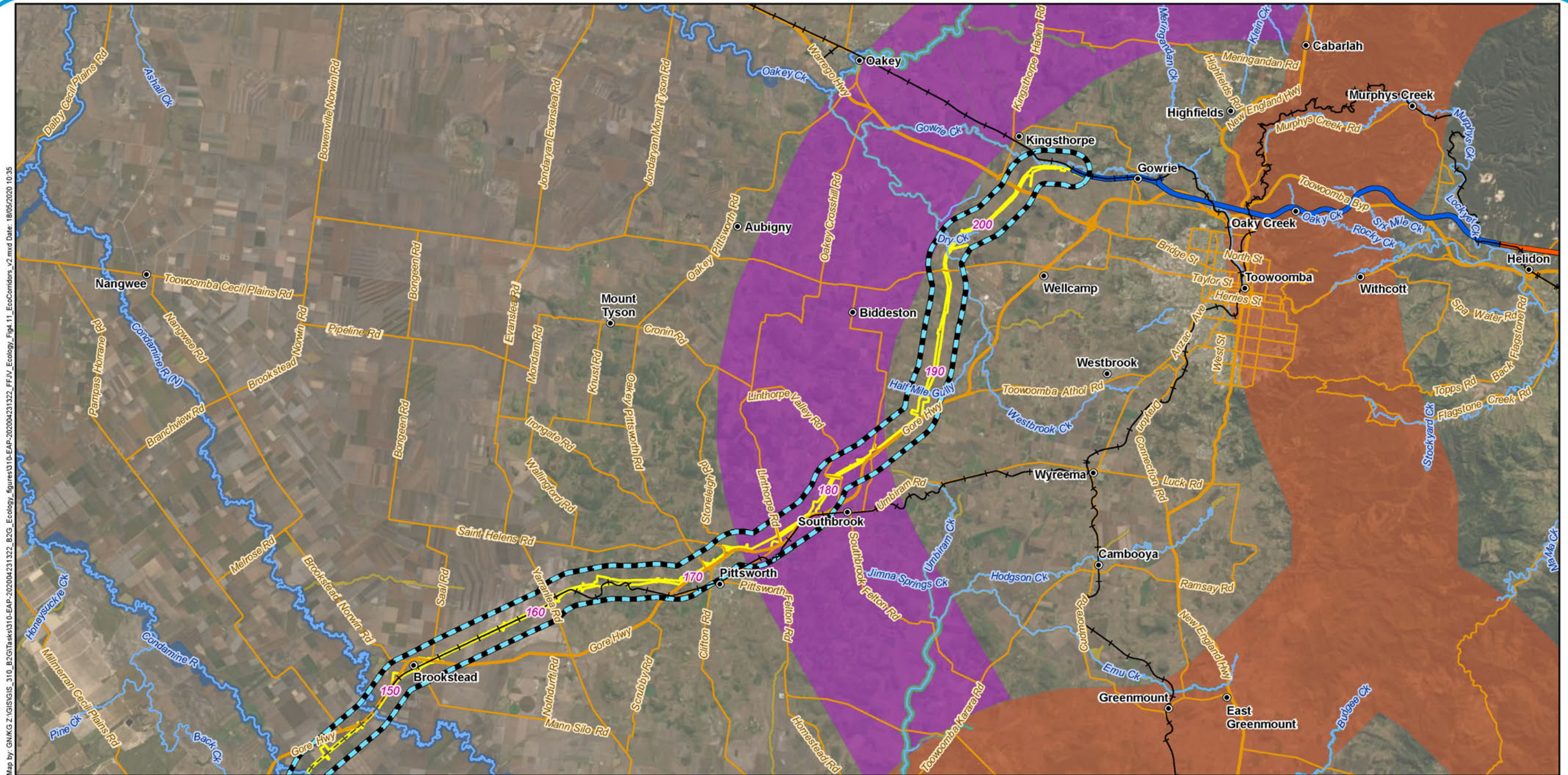
- | | | |
|-----------------------------|------------------------|---|
| 5 Chainage (km) | Major roads | Ecological corridors (BPA mapping) |
| Localities | Minor roads | |
| Existing rail (operational) | Watercourses | |
| | Project footprint | |
| | Impact assessment area | |
| | | |



A3 scale: 1:250,000





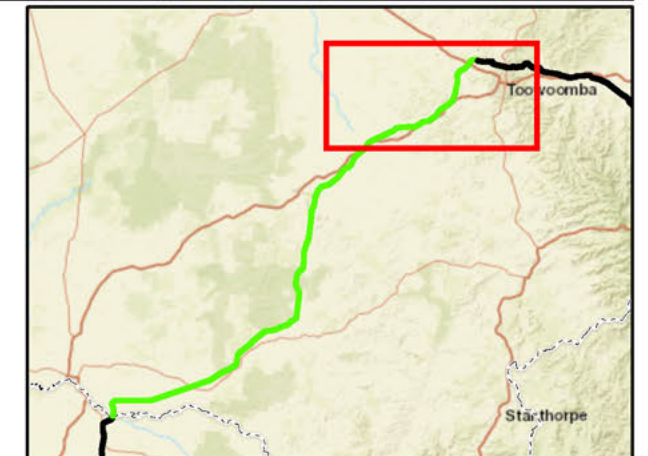


Legend

- 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

Ecological corridors (BPA mapping)

- Riparian, Regional
- Riparian, State
- Riparian/Terrestrial, State
- Terrestrial, Regional
- Terrestrial, State



A3 scale: 1:250,000



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Figure 4.11d:

Terrestrial and riparian ecological corridors

REs are vegetation communities that are consistently associated with a particular combination of geology, landform and soil in a bioregion. REs are shown on the vegetation management supporting map. Each RE has been assigned a vegetation management status based on its current remnant extent—that is, how much of it remains in a bioregion. The three vegetation management codes are as follows:

- **Endangered** status: the area of remnant vegetation is less than 10 per cent of the pre-clearing extent of the RE or the area of remnant vegetation is 10–30 per cent of the pre-clearing extent of the RE, and less than 10,000 ha remains
- **Of Concern** status: the area of remnant vegetation is 10–30 per cent of the pre-clearing extent of the RE or the area of remnant vegetation is more than 30 per cent of the pre-clearing extent of the RE, and less than 10,000 ha remains
- **Least Concern** status: the area of remnant vegetation is more than 30 per cent of the pre-clearing extent of the RE and more than 10,000 ha remains.

Analysis of the State based Regulated vegetation mapping (DNRME 2019), indicates that the impact assessment area contains Category B and C regulated vegetation. This vegetation is listed as 'Endangered', 'Of Concern' and 'Least Concern'. The impact assessment area does not contain vegetation mapped as Category R (refer Table 4.19 and Figure 4.12).

The impact assessment area contains Categories B and C regulated vegetation as indicated on the regulated vegetation map (VMA 1999). This vegetation is listed as 'Endangered' or 'Of Concern' REs. However, the impact assessment area does not contain vegetation mapped as category R (refer Table 4.19 and Figure 4.12). The extent of Category B vegetation analysed by VM Act status is presented in Table 4.20

Table 4.19 Extent of category B, C, R areas of regulated vegetation within the impact assessment area and Project footprint

Regulated vegetation category	Extent (ha)	
	Impact assessment area	Project footprint
Category A – Constrained remnant vegetation	0.00	0.00
Category B – Remnant vegetation	8,254.08	563.25
Category C – High value regrowth	797.00	34.64
Category R – Regrowth watercourse	0	0

Regulated vegetation identified as an MSES includes that mapped as categories B, C, R areas of 'Endangered' RE or 'Of Concern' RE, and category A, B, C, R¹ areas intersecting a watercourse or wetland when they meet the following criteria:

- Category A, B, C and R areas that are located within a defined distance from the defining banks of a relevant watercourse identified on the vegetation management watercourse and drainage feature map
- Category A, B, C and R areas that are located within 100 m from the defining bank of a wetland identified on the vegetation management wetlands map.

¹ Category A: an area which is either a declared area, an offset area, an exchange area, an area that has been subject to unlawful clearing or an enforcement notice, an area subject to clearing as a result of a clearing offence OR an area that the chief executive determines to be Category A

Category B: an area which is remnant vegetation or an area the chief executive determines to be Category B

Category C: an area which is high-value regrowth vegetation on freehold land, Indigenous land or land the subject of a lease issued under the Land Act 1994 for agriculture or grazing purposes or an occupation licence under that Act in an area that has not been cleared in the last 15 years which is also an 'Endangered', 'Of Concern', or 'Least Concern' regional ecosystem Category C areas may also be vegetation which the chief executive decides to show as Category C.

Table 4.20 **Extent of Category B regulated vegetation (i.e. 'Endangered', 'Of Concern' and 'Least Concern' Regional Ecosystems) contained within the impact assessment area**

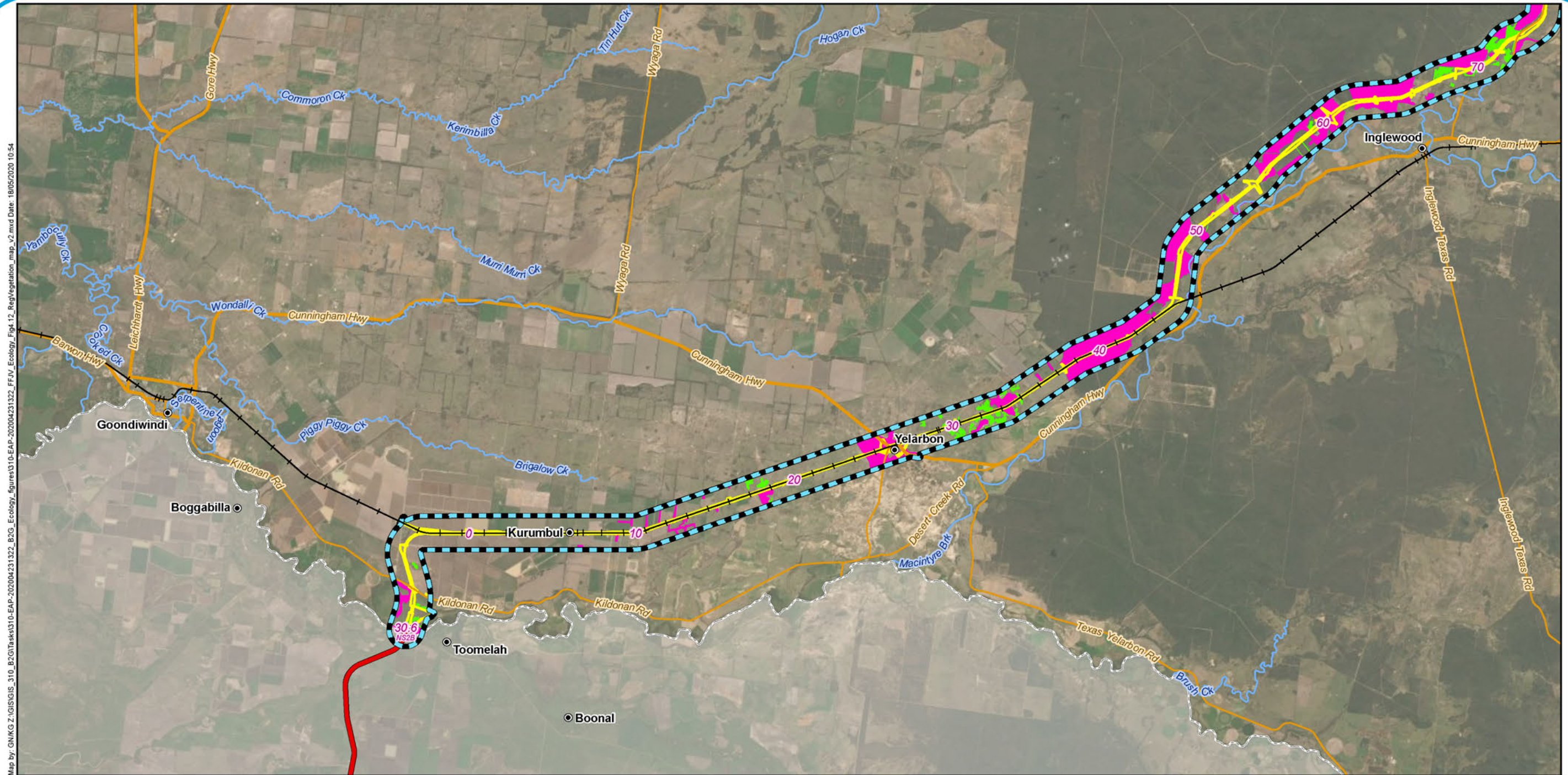
Category B regulated vegetation (VM Act status)	Extent (ha)	
	Impact assessment area	Disturbance footprint
Endangered	506.70	62.74
Of Concern	2,583.23	151.50
Least Concern	5,164.15	349.00

Categories B and C regulated vegetation intersecting a watercourse/wetland occur within the impact assessment area. Category R regulated vegetation intersecting a watercourse/wetland does not occur within the impact assessment area. The extent of regulated vegetation intersecting watercourses and wetlands is summarised in Table 4.19 and shown in Figure 4.12

Table 4.21 **The extent of regulated vegetation intersecting watercourses and wetlands within the impact assessment area and Project footprint**

Regulated vegetation category	Extent (ha)	
	Impact assessment area	Project footprint
Category A – Constrained remnant vegetation	0.00	0.00
Category B – Remnant vegetation	733.23	43.88
Category C – High value regrowth	35.66	2.87
Category R – Remnant vegetation	0.00	0.00
Category X – Exempt vegetation	1,632.15	94.39

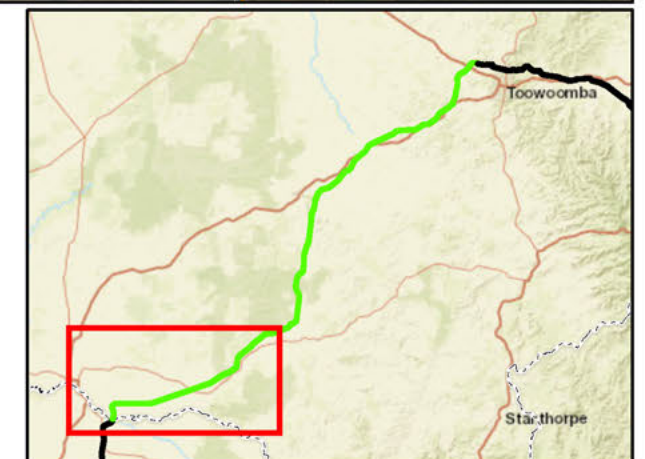
Table 4.22 provides a breakdown of the remnant vegetation (i.e. REs) that constitute category B regulated vegetation. Figure 4.14 shows the distribution of these REs within the impact assessment area. The extent (ha) of 'Endangered', 'Of Concern', and 'Least Concern' regulated vegetation contained within the impact assessment area is provided in Table 4.23.



Legend

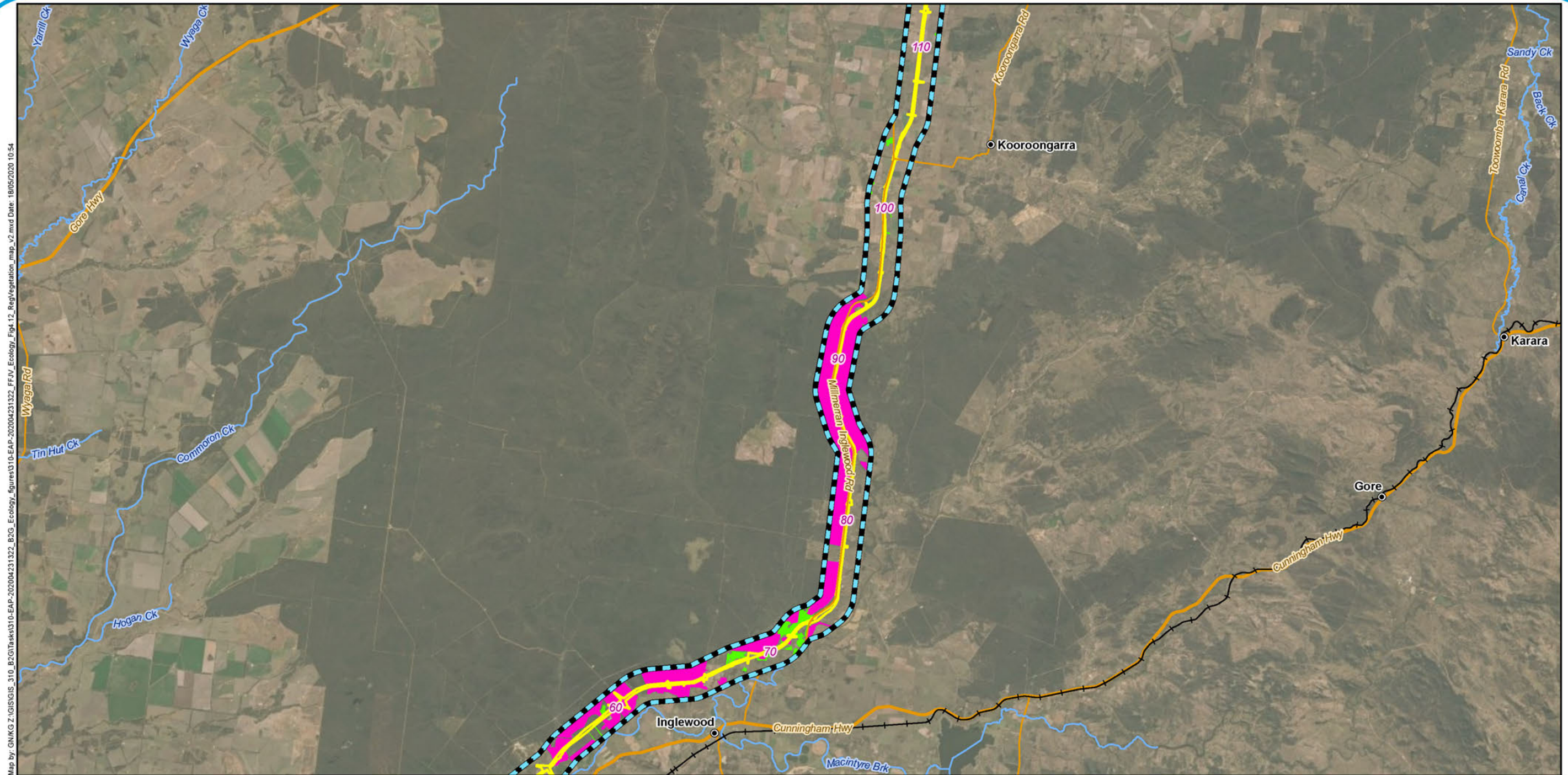
- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area
- Regulated vegetation management**
 - Category B - Remnant vegetation
 - Category C - High value regrowth

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.



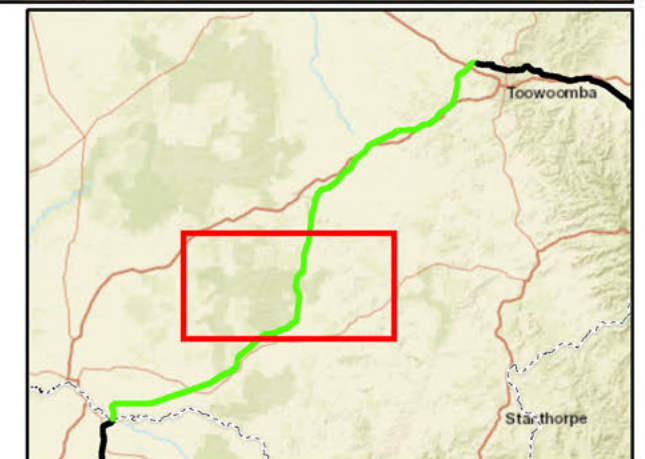
A3 scale: 1:250,000

0 4 8 12 16 20 km



Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Regulated vegetation management**
 - Category B - Remnant vegetation
 - Category C - High value regrowth



A3 scale: 1:250,000

0 4 8 12 16 20 km



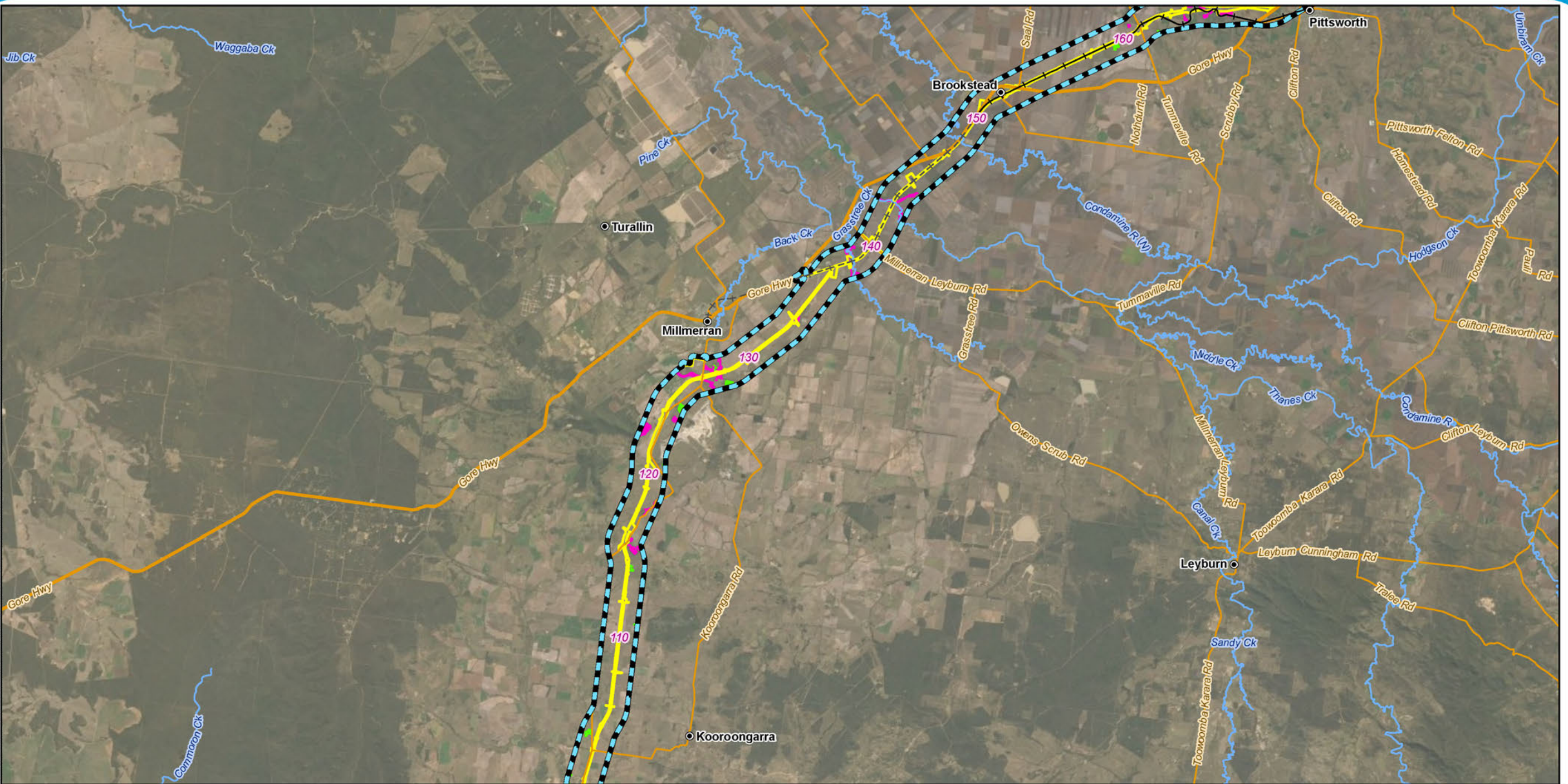
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Border to Gowrie

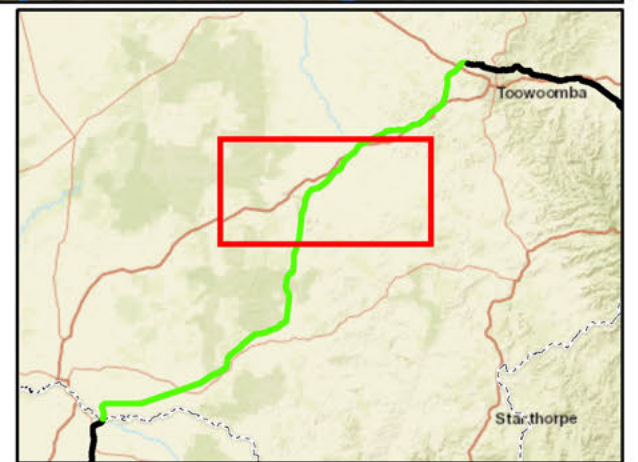
Figure 4.12b:

Regulated vegetation management mapping



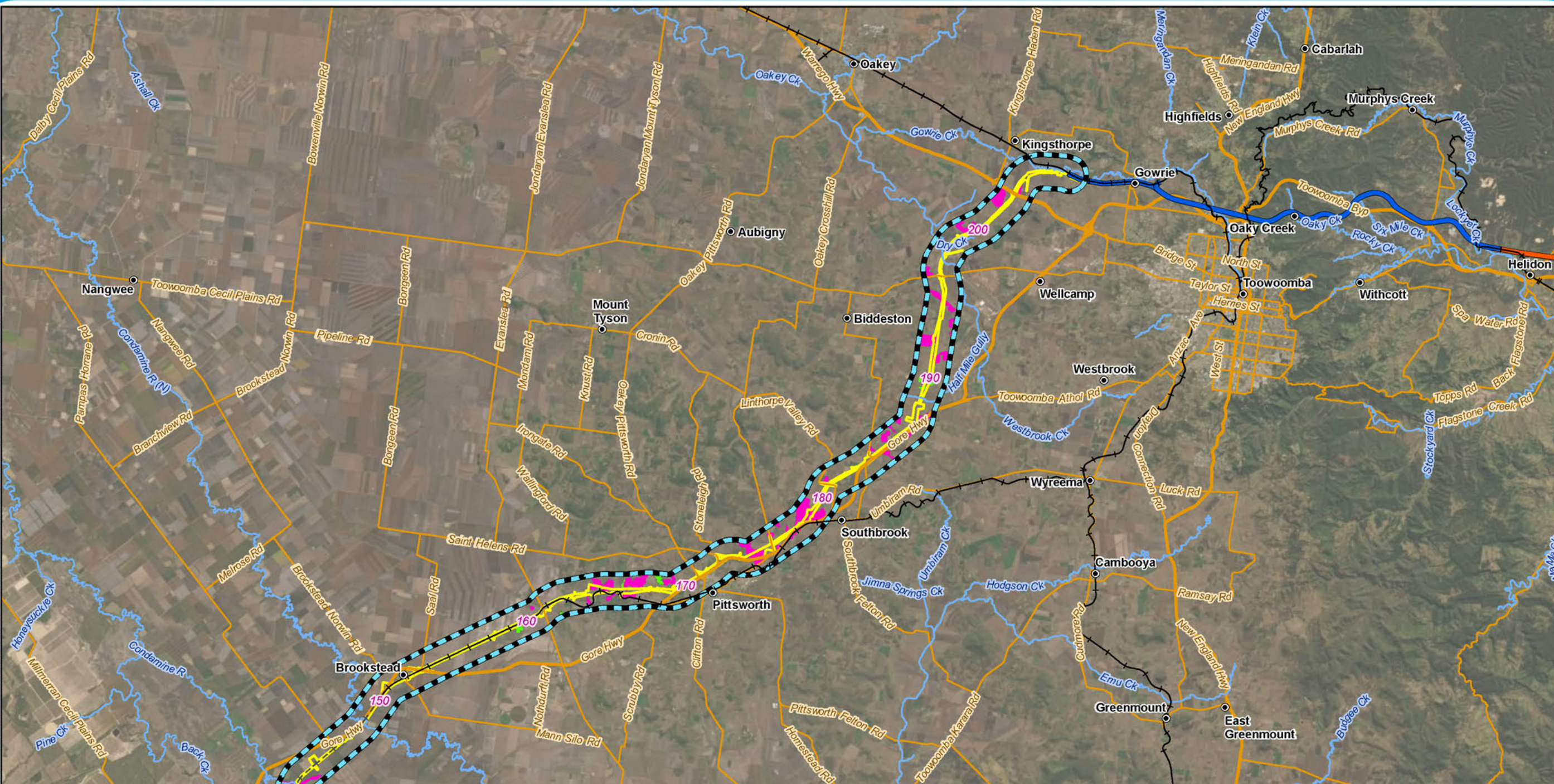
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Regulated vegetation management**
- Category B - Remnant vegetation
- Category C - High value regrowth



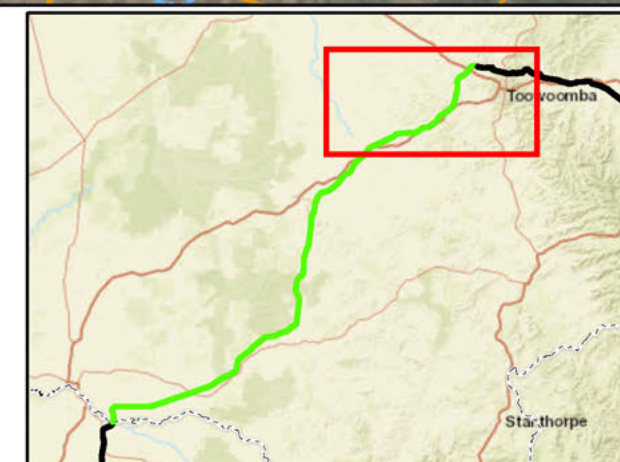
A3 scale: 1:250,000





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
- Regulated vegetation management**
- Category B - Remnant vegetation
- Category C - High value regrowth



A3 scale: 1:250,000



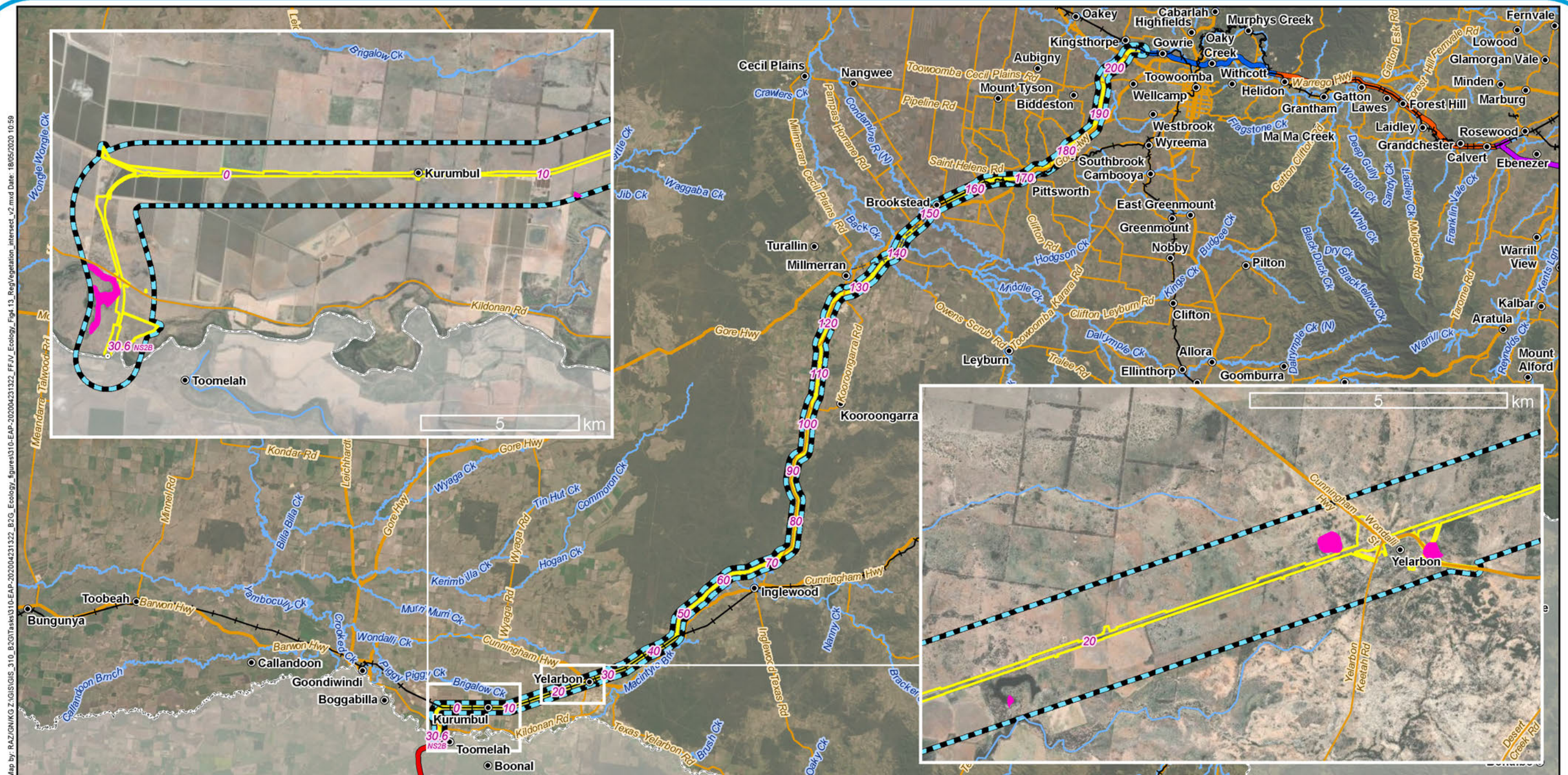
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Border to Gowrie

Figure 4.12d:

Regulated vegetation management mapping



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Project footprint
- Impact assessment area

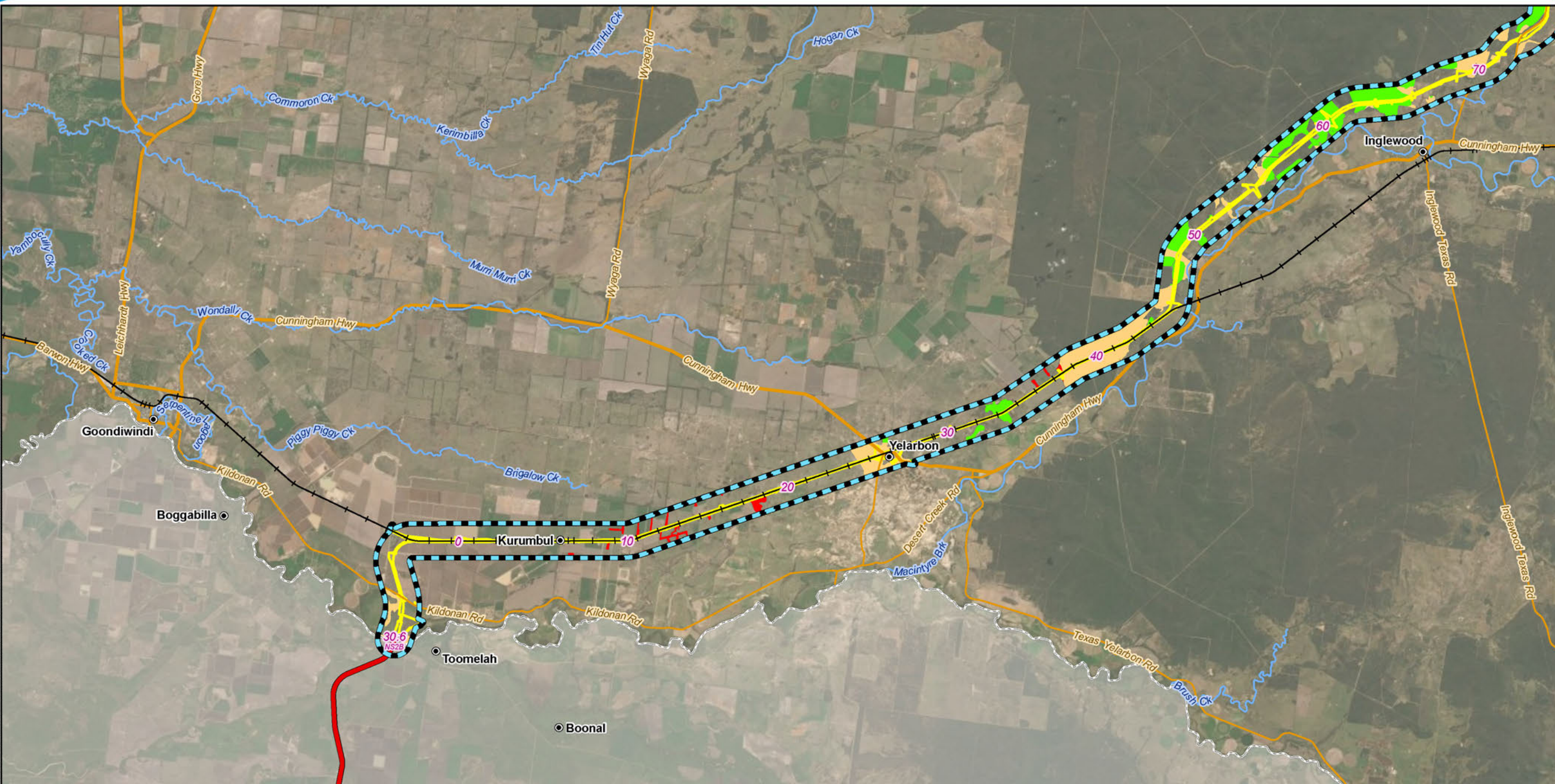
Areas within 100 m of wetlands

- Category B - Remnant

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: 1:800,000





Legend

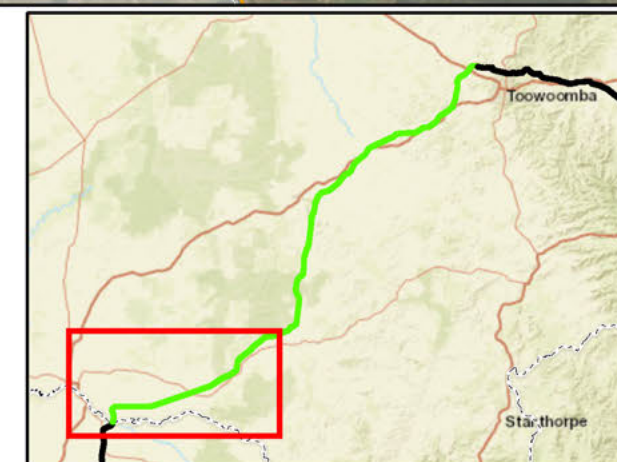
- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border

- Project footprint
- Impact assessment area

Regional ecosystems

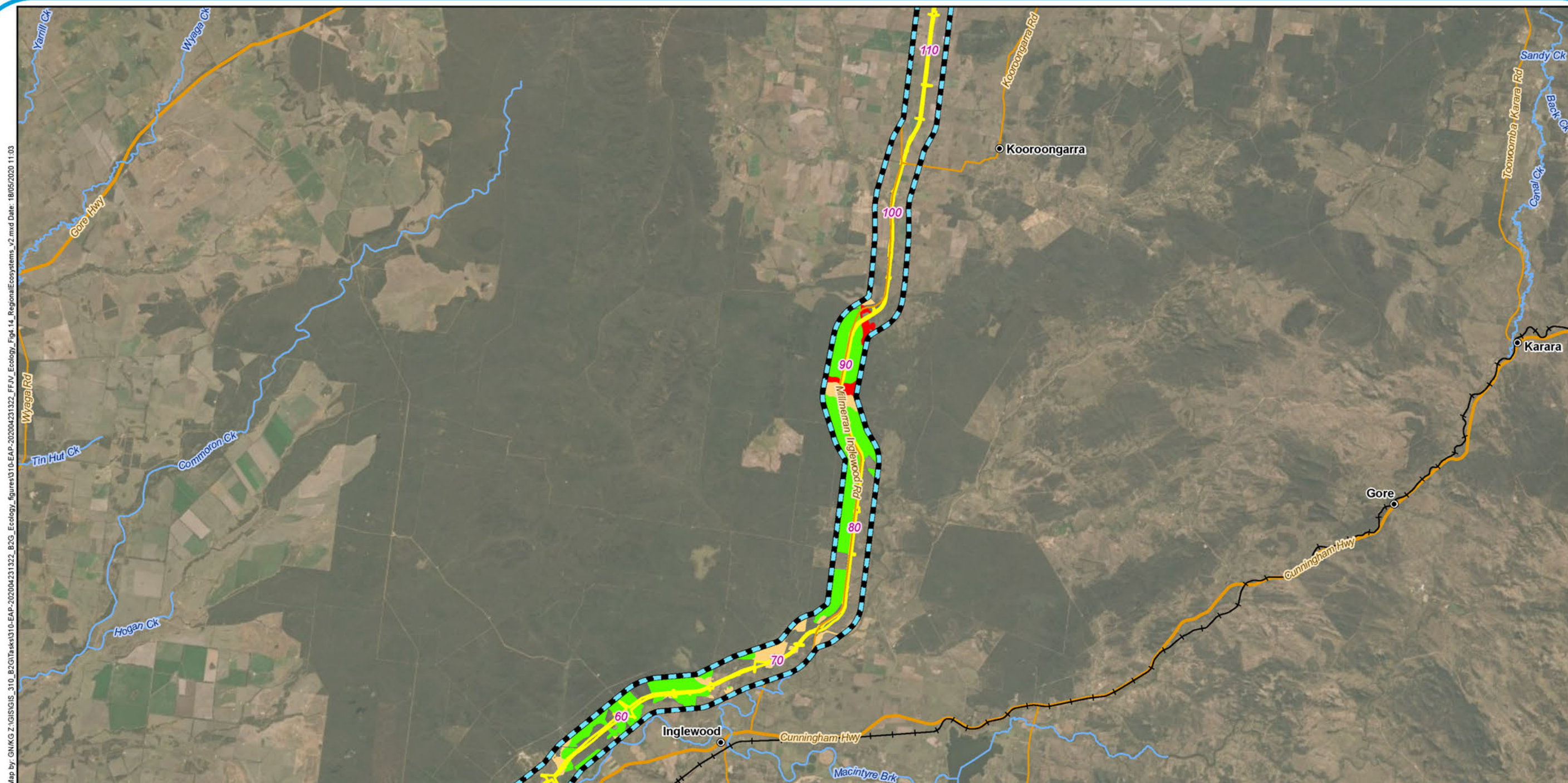
- Category A or B area containing endangered
- Category A or B area containing of concern
- Category A or B area that is least concern

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





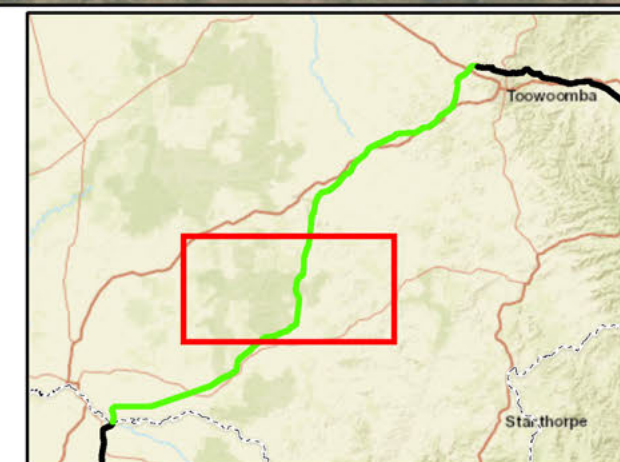
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses

- Project footprint
- Impact assessment area

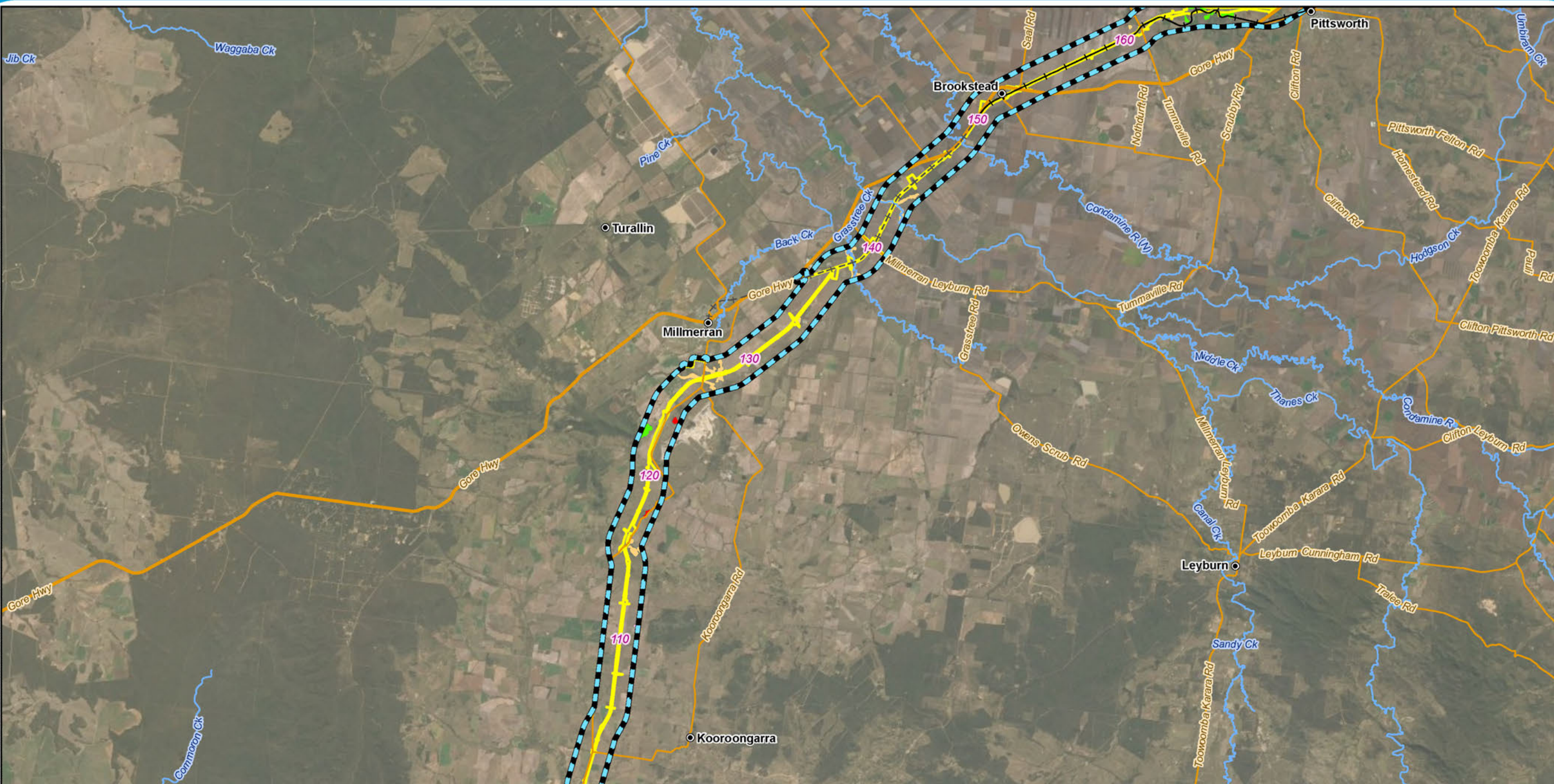
Regional ecosystems

- Category A or B area containing endangered
- Category A or B area containing of concern
- Category C area containing endangered
- Category A or B area that is least concern



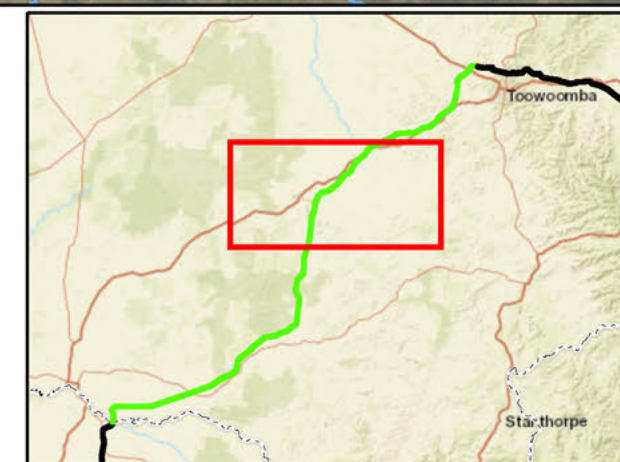
A3 scale: 1:250,000





Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- Regional ecosystems**
- Category A or B area containing endangered
- Category A or B area containing of concern
- Category C area containing endangered
- Category A or B area that is least concern



A3 scale: 1:250,000



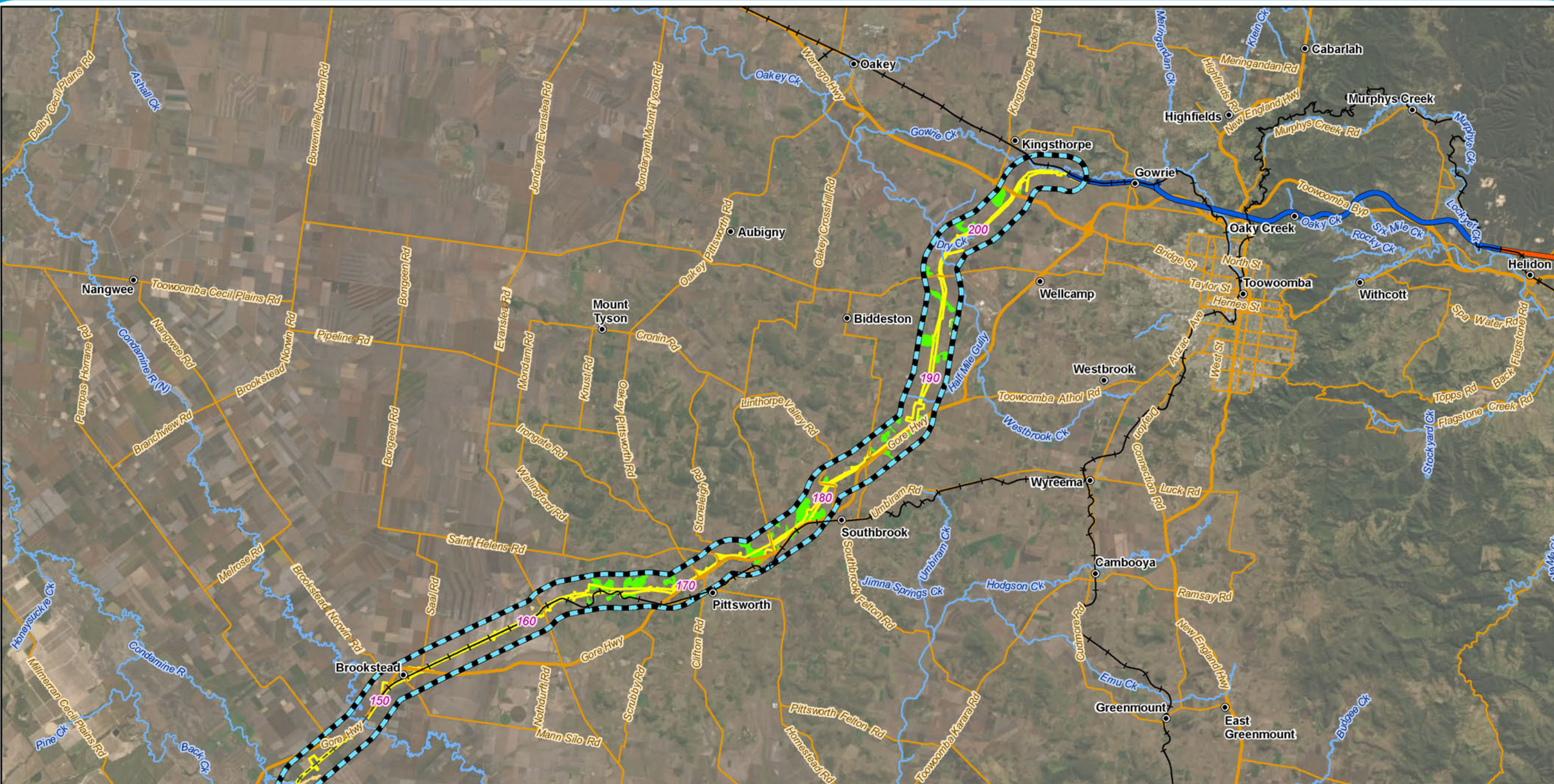
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Figure 4.14c:

Distribution of Regional Ecosystems



Legend

5 Chainage (km)

● Localities

— Gowrie to Helidon alignment

— Existing rail (operational)

--- Existing rail (non-operational)

— Major roads

— Minor roads

— Watercourses

Project footprint

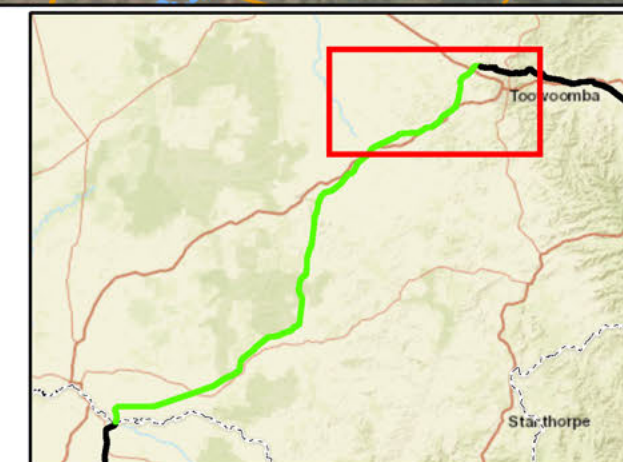
Impact assessment area

Regional ecosystems

Category A or B area containing endangered

Category A or B area containing of concern

Category A or B area that is least concern



A3 scale: 1:250,000

0 4 8 12 16 20 km



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Border to Gowrie

Figure 4.14d:

Distribution of Regional Ecosystems

Table 4.22 Descriptions of regional ecosystems (Category B and C regulated vegetation) within the impact assessment area and Project footprint

REs	Management status		Description (REDD Version 10.0)	Extent (Category A and B regulated vegetation) (ha)	
	VM Act	BD status		Within impact assessment area	Within Project footprint
11.3.2	Of Concern	Of Concern	Poplar box (<i>Eucalyptus populnea</i>) woodland to open woodland. Silver-leaved ironbark (<i>E. melanophloia</i>) may be present and locally dominant. There is sometimes a distinct low tree layer dominated by species including Wilga (<i>Geijera parviflora</i>), False sandalwood (<i>Eremophila mitchellii</i>), Cooba (<i>Acacia salicina</i>), Weeping myall (<i>A. pendula</i>), Lysiphyllum (<i>Lysiphyllum</i> spp.), Brewster's Cassia (<i>Cassia brewsterii</i>), White Cypress pine (<i>Callitris glaucophylla</i>) and Wallowa (<i>Acacia excelsa</i>). The ground layer is grassy dominated by a range of species depending on soil and management conditions. Species include Red leg grass (<i>Bothriochloa decipiens</i>), Curley Windmill Grass (<i>Enteropogon acicularis</i>), Purple wire grass (<i>Aristida ramosa</i>) and Rye Beetle grass (<i>Tripogon loliiformis</i>). Occurs on Cainozoic alluvial plains with variable soil types including texture contrast, deep uniform clays, massive earths and sometimes cracking clays. This RE is analogous to an EPBC Act listed Poplar Box Grassy Woodland on Alluvial Plains TEC. Refer EIS Appendix L: Matters of National Environmental Significance Technical Report for further information.	641.81	39.72
11.3.4	Of Concern	Of Concern	Forest red gum (<i>Eucalyptus tereticornis</i>) woodland to open forest. Other tree species that may be present and locally dominant include River red gum (<i>E. camaldulensis</i>), Black butt (<i>Corymbia tessellaris</i>), Coolabah (<i>E. coolabah</i>), Grey bloodwood (<i>C. clarksoniana</i>), Poplar box (<i>E. populnea</i>) or Brown's box (<i>E. brownii</i>), Silver-leaved ironbark (<i>E. melanophloia</i>), White gum (<i>E. platyphylla</i>) or Rough-barked apple (<i>Angophora floribunda</i>). Narrow-leaved ironbark (<i>E. crebra</i>) and Swamp box (<i>Lophostemon suaveolens</i>) may be locally dominant (subregion 14). A shrub layer is usually absent, and a tall grassy ground layer is often prominent, and may include any of Australian bluestem (<i>Bothriochloa bladhii</i> subsp. <i>Bladhii</i>), Wiregrass (<i>Aristida</i> spp.), Black speargrass (<i>Heteropogon contortus</i>), Bluegrass (<i>Dichanthium</i> spp.) and Kangaroo grass <i>Themeda triandra</i>. Heavily grazed areas tend to have shorter or annual grasses including Button grass (<i>Dactyloctenium radulans</i>) or Red grass (<i>Bothriochloa</i> spp.). Occurs on Cainozoic alluvial plains and terraces. Occurs on variety of soils, including deep cracking clays, medium to fine textured soils, and deep texture-contrast soils.	335.40	14.24
11.3.14	Least Concern	No concern at present	<i>Rough-barked apple</i> (<i>Angophora floribunda</i>), Rusty gum (<i>A. leiocarpa</i>), Forest red gum (<i>Eucalyptus tereticornis</i>) and Red gum (<i>E. chloroclada</i>) woodland with a mid-layer dominated by White Cypress pine (<i>Callitris glaucophylla</i>) and sometimes Bulloak (<i>Allocasuarina luehmannii</i>). A low shrub layer dominated by species including Xylomelum (<i>Xylomelum cunninghamianum</i>), Oleander wattle (<i>Acacia neriifolia</i>), Black cypress pine (<i>Callitris endlicheri</i>), Crowded-leaf wattle (<i>A. conferta</i>), Dogwood (<i>Jacksonia scoparia</i>), Tooton (<i>Leptospermum polygalifolium</i>), Blunt beard-heath (<i>Leucopogon muticus</i>) and Thyme-leaf Honey-myrtle (<i>Melaleuca thymifolia</i>) is often present. Occurs on Cainozoic alluvial plains with sandy soils.	241.52	14.49

REs	Management status		Description (REDD Version 10.0)	Extent (Category A and B regulated vegetation) (ha)	
	VM Act	BD status		Within impact assessment area	Within Project footprint
11.3.18	Least Concern	No concern at present	Poplar box (<i>Eucalyptus populnea</i>) and/or Silver-leaved ironbark (<i>E. melanophloia</i>) dominate the woodland canopy. Other canopy tree species that may be present include White cypress pine (<i>Callitris glaucophylla</i>), Narrow-leaved ironbark (<i>E. crebra</i>) (can be locally dominant), Red gum (<i>E. chloroclada</i>) and Smooth-barked apple (<i>Angophora leiocarpa</i>). A low tree layer dominated by Bulloak (<i>Allocasuarina luehmannii</i>), White cypress pine (<i>Callitris glaucophylla</i>), Wilga (<i>Geijera parviflora</i>) and/or False sandalwood (<i>Eremophila mitchellii</i>) and sometimes Bitterbark (<i>Alstonia constricta</i>) is often present. The ground cover is usually open to sparse and dominated by perennial grasses including Red leg grass (<i>Bothriochloa decipiens</i>), Curley windmill grass (<i>Enteropogon acicularis</i>), Purple plume grass (<i>Triraphis mollis</i>), Purple lovegrass (<i>Eragrostis lacunaria</i>) and wiregrass (<i>Aristida</i> spp.). Occurs on levees, higher alluvial plains and terraces associated with drainage lines. The soils are mainly deep, uniform red sands, or deep, texture contrast soils with a sandy, thick surface horizon overlying neutral, blocky to massive subsoils. Small areas occur on red massive earths and alluvial soils.	254.58	13.95
11.3.21	Endangered	Endangered	Grassland dominated by Silky blue grass (<i>Dichanthium sericeum</i>) and/or a Mitchell grass (including <i>Astrelia</i> spp., <i>A. lappacea</i> , <i>A. elymoides</i> and <i>A. squarrosa</i>). A wide range of other grass and forb species are usually present and may dominant depending on seasonal conditions and management regime. Frequently occurring species include the grasses White spear grass (<i>Aristida leptopoda</i>), Feathertop wiregrass (<i>A. latifolia</i>), Australian bluestem (<i>Bothriochloa bladhii</i> subsp. <i>Bladhii</i>), Common native couch (<i>Brachyachne convergens</i>), Black speargrass (<i>Heteropogon contortus</i>), Native millet (<i>Panicum decompositum</i>), Cup grass (<i>Eriochloa</i> spp.), Rat's Tail couch (<i>Sporobolus mitchellii</i>) and Coolibah grass (<i>Theellungia advena</i>) and the forbs Native rosella (<i>Abelmoschus ficulneus</i>), Corchorus (<i>Corchorus trilocularis</i>), Scurvy weed (<i>Commelina ensifolia</i>), Euphorbia (<i>Euphorbia coghlanii</i>), Cow vine (<i>Ipomoea lonchophylla</i>), Sensitive plant (<i>Neptunia gracilis</i>), Phyllanthus (<i>Phyllanthus maderaspatensis</i>), Hairy sida (<i>Sida trichopoda</i>) and Camel bush (<i>Trichodesma zeylanicum</i> var. <i>latisepalum</i>). Scattered trees and shrubs may occur including Coolabah (<i>E. coolabah</i>), Poplar box (<i>E. populnea</i>), Forest red gum (<i>E. tereticornis</i>) or Wattle (<i>Acacia</i> spp.). Occurs on Cainozoic alluvial plains that are near level (slope <1%), i.e. on flats associated with rivers and creeks, including back-plains, terraces, low levees and back-swamps. Associated soils are usually cracking clays that lack gilgai, are often self-mulching, usually deep and range in colour from dark grey-brown to grey or black. This RE is analogous to an EPBC Act listed Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC. Refer EIS Appendix L: Matters of National Environmental Significance Technical Report for further information.	0.95	0.00

REs	Management status		Description (REDD Version 10.0)	Extent (Category A and B regulated vegetation) (ha)	
	VM Act	BD status		Within impact assessment area	Within Project footprint
11.3.25	Least Concern	No concern at present	River red gum (<i>E. camaldulensis</i>) or Forest red gum (<i>E. tereticornis</i>) open forest to woodland. Other tree species including River sheoak (<i>Casuarina cunninghamiana</i>), Coolabah (<i>E. coolabah</i>), Black tea-tree (<i>M. bracteata</i>), Weeping bottlebrush (<i>M. viminalis</i>), Cabbage palm (<i>Livistona</i> spp.) (in north), Bottlebrush (<i>Melaleuca</i> spp.) and Rough-barked apple (<i>A. floribunda</i>) are commonly present and may be locally dominant. An open to sparse, tall shrub layer is frequently present dominated by species including Cooba (<i>A. salicina</i>), River cooba (<i>A. stenophylla</i>) or <i>Lysiphyllum carronii</i> . Low shrubs are present, but rarely form a conspicuous layer. The ground layer is open to sparse and dominated by perennial grasses, sedges or forbs including Cogon grass (<i>Imperata cylindrica</i>), Australian bluestem (<i>Bothriochloa bladhii</i>), Desert bluegrass (<i>B. ewartiana</i>), Ribbon grass (<i>Chrysopogon fallax</i>), Sedge (<i>Cyperus dactyloides</i>), Variable flatsedge (<i>C. difformis</i>), Giant flat sedge (<i>C. exaltatus</i>), Slender flat sedge (<i>C. gracilis</i>), Rice flat sedge (<i>C. iria</i>), Curly flat sedge (<i>C. rigidellus</i>), Sedge (<i>C. victoriensis</i>), Silky blue grass (<i>Dichanthium sericeum</i>), Leptochloa (<i>Leptochloa digitate</i>), Mat rush (<i>Lomandra longifolia</i>) or Panic grass (<i>Panicum</i> spp.). Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains throughout the region. Soils are very deep, alluvial, grey and brown cracking clays with or without some texture contrast. These are usually moderately deep to deep, soft or firm, acid, neutral or alkaline brown sands, loams or black cracking or non-cracking clays, and may be sodic at depth.	359.45	17.70
11.3.27b	Least Concern	Of Concern	Vegetation ranges from open water +/- aquatics and emergent plants including Curly pondweed (<i>Potamogeton crispus</i>), Redwater milfoil (<i>Myriophyllum verrucosum</i>), Green algae (<i>Chara</i> spp.), Nitella (<i>Nitella</i> spp.), Blue lily (<i>Nymphaea violacea</i>), Swamp lily (<i>Ottelia ovalifolia</i>), Robust marshwort (<i>Nymphoides indica</i>), Wavy marshwort (<i>N. crenata</i>), Floating pondweed (<i>Potamogeton tricaratus</i>), Variable flatsedge (<i>C. difformis</i>), Eelgrass (<i>Vallisneria spiralis</i>) and Water thyme (<i>Hydrilla verticillata</i>). Often with fringing woodland, commonly River red gum (<i>E. camaldulensis</i>) or Coolabah (<i>E. coolabah</i>) but also a wide range of other species including Poplar gum (<i>Eucalyptus platyphylla</i>), Forest red gum (<i>E. tereticornis</i>), Bottlebrush (<i>Melaleuca</i> spp.), Soapbush wattle (<i>A. holosericea</i>) or other wattles (<i>Acacia</i> spp. Occurs on billabongs and lacustrine wetlands.	59.51	0.97

REs	Management status		Description (REDD Version 10.0)	Extent (Category A and B regulated vegetation) (ha)	
	VM Act	BD status		Within impact assessment area	Within Project footprint
11.4.3	Endangered	Endangered	Open forest dominated by Brigalow (<i>A. harpophylla</i>) and/or Belah (<i>Casuarina cristata</i>). 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. Belah may be dominant or form pure stands particularly in the south of the bioregion (subregions 33, 36). Eucalypts including Mountain coolabah (<i>E. orgadophila</i>), Poplar box (<i>E. populnea</i>), Grey box (<i>E. macrocarpa</i>), Narrow-leaved box (<i>E. woollsiana</i>), Dawson gum (<i>E. cambageana</i>) and <i>E. thozetiana</i> (on shallower soils and upper slopes) may be scattered through the canopy or occur as emerging up to 22 m high through the canopy. Queensland Bottle tree (<i>Brachychiton rupestris</i>) may also be present in places. An open to dense, tall shrub layer is present, and is dominated by False sandalwood (<i>Eremophila mitchellii</i>) and/or Wilga (<i>Geijera parviflora</i>). Low shrubs are often present, occasionally forming a distinct layer dominated by species including Currant bush (<i>Carissa ovata</i>) and Scrub boonaree (<i>Alectryon diversifolius</i>). Tree/shrub height may range from 3-8 m. Black tea-tree (<i>M. bracteata</i>) 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. The plains may be flat to gently undulating. Soils are often cracking clay which are usually deep to very deep, often self-mulching, and sometimes with surface stone. Texture contrast soils and other clays may also be present in places. This RE is analogous to an EPBC Act listed Brigalow (<i>Acacia harpophylla</i> dominant and co dominant) ecological community TEC. Refer EIS Appendix L: Matters of National Environmental Significance Technical Report for further information.	336.65	62.42
11.5.1	Least Concern	No concern at present	Narrow-leaved red ironbark (<i>Eucalyptus crebra</i>) and/or Poplar Box (<i>E. populnea</i>) +/- Smooth-barked apple (<i>Angophora leiocarpa</i>) +/- Narrow-leaved box (<i>E. woollsiana</i>) (in south of bioregion) dominate the woodland (to open woodland) canopy. A low tree layer dominated by Bulloak <i>Allocasuarina luehmannii</i> +/- Feather honey-myrtle (<i>Melaleuca decora</i>) +/- White cypress pine (<i>Callitris glaucophylla</i>) +/- Black cypress pine (<i>C. endlicheri</i>) is usually present. In some areas Bulloak low woodland is the dominant layer. The ground cover is usually sparse and dominated by perennial grasses. Occurs on flat to gently undulating plains formed from weathered sandstones. Duplex soils with sandy surfaces.	1,673.20	95.68
11.5.1a	Least Concern	No concern at present	Poplar box (<i>Eucalyptus populnea</i>) woodland with Bulloak (<i>Allocasuarina luehmannii</i>) low tree layer.	155.18	0.47
11.5.4	Least Concern	No concern at present	Red gum (<i>Eucalyptus chloroclada</i>), White cypress pine (<i>Callitris glaucophylla</i>), Smooth-bark apple (<i>Angophora leiocarpa</i>), +/- Rough-bark apple (<i>A. floribunda</i>) +/- Narrow leaved ironbark (<i>E. crebra</i>) woodland with a low tree layer dominated by species including Bulloak (<i>Allocasuarina luehmannii</i>), Woolly oak (<i>A. inophloia</i>) and Black cypress pine (<i>C. endlicheri</i>) Localised areas dominated by <i>E. rhombica</i> . Occurs on Cainozoic plains with deep sandy soils.	1,780.61	107.21

REs	Management status		Description (REDD Version 10.0)	Extent (Category A and B regulated vegetation) (ha)	
	VM Act	BD status		Within impact assessment area	Within Project footprint
11.5.14	Of Concern	Of Concern	Hummock grass (<i>Triodia</i> spp.) grassland with scattered low trees and shrubs. Porcupine grass (<i>Triodia scariosa</i>) grassland with scattered trees and shrubs or patches of shrubland to low open woodland of Bulloak (<i>Allocasuarina luehmannii</i>) with Paperbark (<i>Melaleuca densispicata</i>), False sandalwood (<i>Eremophila mitchellii</i>), Northern sandalwood (<i>Santalum lanceolatum</i>) +/- emergent Narrow-leaved box (<i>E. woollsiana</i>), and occasional Poplar box (<i>E. populnea</i>). River red gum (<i>E. camaldulensis</i>) occurs along the drainage lines. Scattered short grasses and forbs including Slender Chloris (<i>Chloris divaricate</i>), Windmill grass (<i>C. truncata</i>) and Three-spined Bassia (<i>Sclerolaena tricuspis</i>) and Roly-poly (<i>Salsola australis</i>) also occur. Occurs on Cainozoic sandplains with highly alkaline soils	373.20	49.71
11.5.20	Least Concern	No concern at present	Gum-topped box (<i>Eucalyptus moluccana</i>) or Grey box (<i>E. microcarpa</i>) or Narrow-leaved box (<i>E. woollsiana</i>) woodland to open forest. Species including Bulloak (<i>Allocasuarina luehmannii</i>) and White cypress pine (<i>Callitris glaucophylla</i>) often form a low woodland layer. Occurs on flat to gently undulating plains formed from Cainozoic/Quaternary sediments. Soils are mainly texture contrast with sandy surfaces.	1,020.32	25.66
11.7.4	Least Concern	No concern at present	Mixed eucalypt woodland on Cainozoic lateritic duricrusts. Species can include Narrow-leaved red ironbark (<i>Eucalyptus crebra</i>), Gum-topped ironbark (<i>E. decorticans</i>), Brown bloodwood (<i>Corymbia trachyphloia</i>), Narrow-leaved white mahogany (<i>E. tenuipes</i>), Yellowjacket (<i>C. watsoniana</i>) and White cypress pine (<i>Callitris glaucophylla</i>). There is usually a distinct low tree to tall shrub layer comprising species including Brown hazelwood (<i>Lysicarpus angustifolius</i>) or Wattles (<i>Acacia</i> spp.) Occurs on low hills and ranges with shallow soils.	101.86	11.90
11.7.5	Least Concern	No concern at present	Shrubland +/- emergent eucalypts. Characteristic genera include Star flowers (<i>Calytrix</i> spp.), Hakea (<i>Hakea</i> spp.), kunzea (<i>Kunzea</i> spp.), heath myrtle (<i>Micromyrtus</i> spp.), wattles (<i>Acacia</i> spp.), Paperbarks (<i>Melaleuca</i> spp.) and (in the ground layer) hummock grass (<i>Triodia</i> spp.). Often scattered or fringing emergent tree species are present, including Queensland peppermint (<i>Eucalyptus exserta</i>), Yetman ironbark (<i>E. panda</i>), Plunkett mallee (<i>E. curtisii</i>), Brown bloodwood (<i>Corymbia trachyphloia</i>) and Blake's wattle (<i>Acacia blakei</i>). Occurs on shallow soils often associated with natural scalds on Cainozoic lateritic duricrusts and sometimes lithosols derived from quartzose sandstone.	44.76	2.12

REs	Management status		Description (REDD Version 10.0)	Extent (Category A and B regulated vegetation) (ha)	
	VM Act	BD status		Within impact assessment area	Within Project footprint
11.7.7	Least Concern	No concern at present	Blue-leaved ironbark (<i>Eucalyptus fibrosa</i> subsp. <i>nubile</i>) predominates and forms a distinct but discontinuous open forest to woodland canopy (22-25 m high). Narrow-leaved red ironbark (<i>E. crebra</i>) often co dominates or be locally dominant, particularly on lower slopes. Also includes areas with Lemon-scented gum (<i>Corymbia citriodora</i>) as a codominant. Other frequently occurring sub-dominant tree species include Brown bloodwood (<i>Corymbia trachyphloia</i>), Inland white mahogany (<i>E. apothalassica</i>), Red ironbark (<i>E. sideroxylon</i>), Lancewood (<i>Acacia shirleyi</i>) and White cypress pine (<i>Callitris glaucophylla</i>). There is usually a low woodland mid layer dominated by <i>Acacia</i> spp. or sometimes Bullock (<i>Allocasuarina luehmannii</i>) and Black cypress pine (<i>Callitris endlicheri</i>). 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. Occurs on low hills and ranges formed from deeply weathered sediments. Soils are usually shallow (< 30cm deep) uniform sands with stone or rocks covering much of the ground surface.	306.76	25.20
11.8.2a	Least Concern	No concern at present	Forest red gum (<i>Eucalyptus tereticornis</i>) and Yellow box (<i>E. melliodora</i>) woodland occurring on low hills. Occurs on low hills (subregion 31 and 32) formed from basalt. The soils are generally shallow (< 60 cm deep), brown to grey-brown, gradational, clay-loams and clays. Basalt stones and boulders can occur on the surface.	38.79	0.00
11.8.3	Of Concern	Of Concern	Semi-evergreen vine thicket which may have emergent Brigalow (<i>Acacia harpophylla</i>), Belah (<i>Casuarina cristata</i>) and Eucalypts (<i>Eucalyptus</i> spp.). Occurs on Cainozoic igneous rocks. Generally restricted to steeper, rocky hillsides. This RE is analogous to an EPBC Act listed Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions TEC. Refer EIS Appendix L: Matters of National Environmental Significance Technical Report for further information.	38.36	0.00
11.8.4	Least Concern	No concern at present	Silver-leaved ironbark (<i>Eucalyptus melanophloia</i>) and/or Narrow-leaved red ironbark (<i>E. crebra</i>) +/- Mountain coolabah (<i>E. orgadophila</i>) +/- Red bloodwood (<i>Corymbia erythrophloia</i>) grassy open woodland. Cycad palm (<i>Macrozamia moorei</i>) is a conspicuous element of the mid layer in the Central Highlands. Localised patches of Lemon-scented gum (<i>C. citriodora</i>) occur on volcanic plugs including Minerva Hills. Generally, occurs on slopes of mountains and hills formed from Cainozoic igneous rocks usually with shallow stony soils and extensive outcropping.	325.94	49.72

REs	Management status		Description (REDD Version 10.0)	Extent (Category A and B regulated vegetation) (ha)	
	VM Act	BD status		Within impact assessment area	Within Project footprint
11.8.5	Least Concern	No concern at present	Mountain coolabah (<i>Eucalyptus orgadophila</i>) grassy open woodland. Mountain Coolabah predominates and forms a distinct but discontinuous canopy sometimes with other sub-dominant species including Red bloodwood (<i>Corymbia erythrophloia</i>), Silver-leaved ironbark (<i>E. melanophloia</i>) and occasionally Narrow-leaved red ironbark (<i>E. crebra</i>). Shrubs are usually scarce and scattered although a well-defined shrubby layer does develop in some areas. On the lower slopes at better sites, softwood scrub species may form tall and low shrub layers under the canopy of Mountain coolabah. The ground layer is moderately dense to dense and dominated by species that include the grasses Wire grass (<i>Aristida Lazaridis</i>), Purple wire grass (<i>A. ramosa</i>), Desert bluegrass (<i>Bothriochloa ewartiana</i>), Silky blue grass (<i>Dichanthium sericeum</i>), Ribbon grass (<i>Chrysopogon fallax</i>), Black speargrass (<i>Heteropogon contortus</i>), Slender nineawn (<i>Enneapogon gracilis</i>), Kangaroo grass (<i>Themeda triandra</i>) and Small burrgrass (<i>Tragus australianus</i>) and the herbs Blue trumpet (<i>Brunoniella australis</i>), Tropical speedwell (<i>Evolvulus alsinoides</i>), Galactia (<i>Galactia tenuiflora</i>) and Birdsville indigo (<i>Indigofera linnaei</i>). Occurs on undulating plains, rises, low hills or sometimes flat tablelands on top of mountains, formed from basalt. Generally soils are shallow to moderately shallow, often rocky or stony clays.	684.29	60.49
11.8.11	Of Concern	Of Concern	Grassland dominated by Silky blue grass (<i>Dichanthium sericeum</i>), Wire grass (<i>Aristida</i> spp.), Mitchell grass (<i>Astrebla</i> spp.) and <i>Rigid panic</i> (<i>Panicum decompositum</i>) with or without trees including Mountain coolabah (<i>Eucalyptus orgadophila</i>), Silver-leaved ironbark (<i>E. melanophloia</i>), Red bloodwood (<i>Corymbia erythrophloia</i>) and Cooba (<i>Acacia salicina</i>), (height 11 +/- 3 m). However, dominance and cover may vary with seasonal and other environmental conditions. Frequently occurring and sometimes locally dominant, species include the grasses Wire grass (<i>Aristida zazaridis</i>), Purple wire-grass (<i>A. ramosa</i>), Desert bluegrass (<i>Bothriochloa ewartiana</i>), Silky blue grass, Ribbon grass (<i>Chrysopogon fallax</i>), Black speargrass (<i>Heteropogon contortus</i>), Slender nineawn (<i>Enneapogon gracilis</i>), Kangaroo grass (<i>Themeda triandra</i>) and Small burrgrass (<i>Tragus australianus</i>) and the herbs Blue trumpet (<i>Brunoniella australis</i>), Tropical speedwell (<i>Evolvulus alsinoides</i>), Galactia (<i>Galactia tenuiflora</i>) and Birdsville indigo (<i>Indigofera linnaei</i>). Isolated emergent trees (tree height 12 +/- 4 m - species including Mountain coolabah (<i>Eucalyptus orgadophila</i>), Silver-leaved ironbark (<i>E. melanophloia</i>) and Red bloodwood (<i>Corymbia erythrophloia</i>) or small areas of open woodland may also be present. Occurs on Cainozoic igneous rocks, particularly fresh basalt, and is generally associated with undulating to gently undulating rises. It usually occurs on the crests and middle and upper slopes (slopes 2-6 per cent), although also present on lower slopes and flat areas (slopes 0-2 per cent). Associated soils are moderately shallow to deep cracking clay soils, dark brown to reddish brown in colour, often self-mulching, and with gravel, stone or linear gilgai sometimes present. Surface stone 10-15 cm diameter is present in the south-western remnants.	8.56	0.00

REs	Management status		Description (REDD Version 10.0)	Extent (Category A and B regulated vegetation) (ha)	
	VM Act	BD status		Within impact assessment area	Within Project footprint
11.9.5	Endangered	Endangered	Open forest dominated by Brigalow (<i>Acacia harpophylla</i>) and/or Belah (<i>Casuarina cristata</i>) (10-20 m) or Brigalow with a semi-evergreen vine thicket understorey. Open forest dominated by Belah is more common in southern parts of the bioregion. A prominent low tree or tall shrub layer dominated by species including Wilga (<i>Geijera parviflora</i>) and False sandalwood (<i>Eremophila mitchellii</i>), and often with semi-evergreen vine thicket species is often present. The latter include Scrub leopardwood (<i>Flindersia dissosperma</i>), Queensland bottle tree (<i>Brachychiton rupestris</i>), Scrub poison tree (<i>Excoecaria dallachyana</i>), Bonewood (<i>Macropteranthes leichhardtii</i>) and Soft acalypha (<i>Acalypha eremorum</i>) in eastern areas, and species including Currant bush (<i>Carissa ovata</i>), Emu apple (<i>Owenia acidula</i>), Silver croton (<i>Croton insularis</i>), Stiff denhamia (<i>Denhamia oleaster</i>) and Velvet mock olive (<i>Notelaea microcarpa</i>) in south-western areas. Black tea-tree (<i>Melaleuca bracteata</i>) may be present along watercourses. Occurs on fine-grained sediments. The topography includes gently undulating plains, valley floors and undulating footslopes and rarely on low hills. The soils are generally deep texture-contrast and cracking clays. The cracking clays are usually black or grey to brown or reddish-brown in colour, often self-mulching and sometimes with gilgai microrelief in flatter areas. Some texture contrast soils are shallow to only moderately deep. This RE is analogous to the Brigalow (<i>Acacia harpophylla</i> dominant and co dominant) ecological community. Refer EIS Appendix L: Matters of National Environmental Significance Technical Report for further information.	85.54	0.91
11.9.7	Of Concern	Of Concern	Poplar box (<i>Eucalyptus populnea</i>) predominates forming a distinct but discontinuous canopy (10-20 m tall). Occasionally Silver-leaved ironbark (<i>E. melanophloia</i>) is present in the canopy. Lower trees are absent or infrequent. An open to dense, tall shrub layer is always present, with False sandalwood (<i>Eremophila mitchellii</i>) often dominant. A patchy low shrub layer of varying density may be formed, where the tall shrub layer is more than 6 m tall. The ground layer is dominated by perennial grasses and varies from sparse to dense, depending on the shrub and tree density. Red leg grass (<i>Bothriochloa decipiens</i>), Curley windmill grass (<i>Enteropogon acicularis</i>), Purple wire grass (<i>Aristida ramosa</i>) and Jericho wiregrass (<i>Aristida jerichoensis</i>) are the most common dominants in the east with wire grass (<i>Aristida calycina</i> var. <i>praealta</i>), Jericho wiregrass, lovegrass (<i>Eragrostis</i> spp.) and Comb chloris (<i>Chloris pectinate</i>) dominant further west. Forbs are seasonally abundant. Occurs on the lower and middle slopes of gently undulating lowlands and plains formed from Cainozoic to Proterozoic consolidated, fine-grained sediments. Associated soils are predominantly deep loamy red earths with sparse superficial ferruginous gravel, or deep texture contrast soils with thin sandy or loamy surfaces over strongly alkaline subsoils.	181.07	5.33
Non-remnant	-	-	Not applicable	34,509.48	2,605.89

Table notes:

LC = 'Least Concern'

NC = No concern at present

OC = 'Of Concern'

E = 'Endangered'

BD = Biodiversity

Table 4.23 **Extent of remnant 'Endangered', 'Of Concern' and 'Least Concern' regional ecosystems contained within the impact assessment area and Project footprint**

RE VM Act category	Extent (ha)	
	Impact assessment area	Project footprint
Endangered	506.70	62.74
Of Concern	2,583.23	151.51
Least Concern	5,164.15	349.00

4.5.19 Offset areas

No legally secured offsets as defined under the *Environmental Offset Act 2014* are located within the impact assessment area.

4.5.20 Protected plants flora survey trigger map

The flora survey trigger map identifies high-risk areas where 'Endangered', 'Vulnerable' or 'Near Threatened' native plants are present or are likely to be present. High risk areas are located within the impact assessment area. The extent of distribution of high risk areas is shown in Figure 4.15.

4.6 Results of field assessments

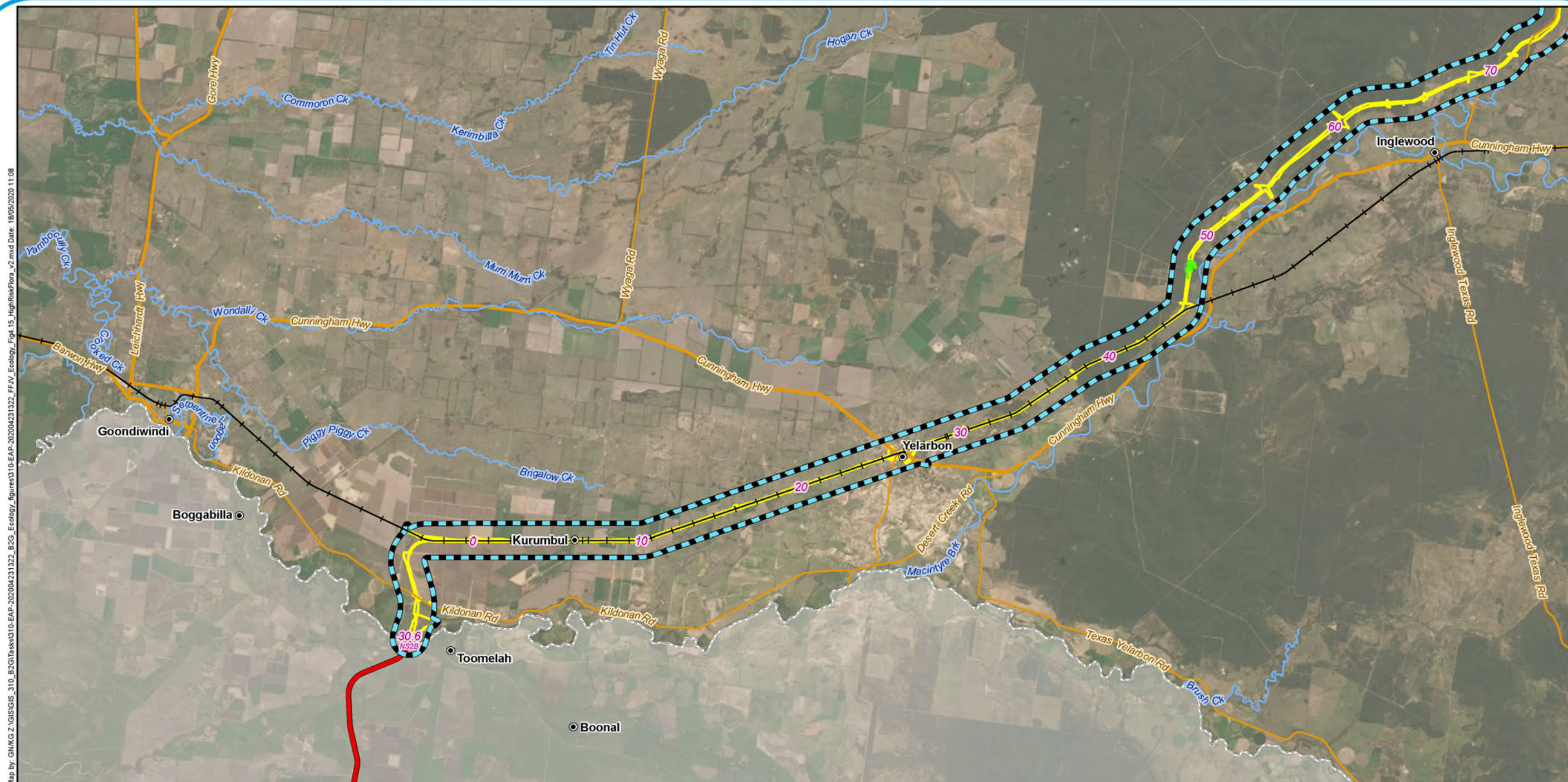
The following subsections provide a description of the existing Sensitive environmental receptors of the impact assessment area based on the results of the field assessments. The results presented in this section detail the existing flora and fauna species (including weeds and pests), habitats and vegetation communities, aquatic values and predicted habitat mapping for conservation significant species as listed under the provisions of the NC Act.

4.6.1 Terrestrial flora

4.6.1.1 Species richness

A total of 404 plant species were identified within the impact assessment area during Project EIS field assessments. This included a total of 283 (70 per cent) native species and 121 (30 per cent) non-native species (refer Appendix E and Appendix I).

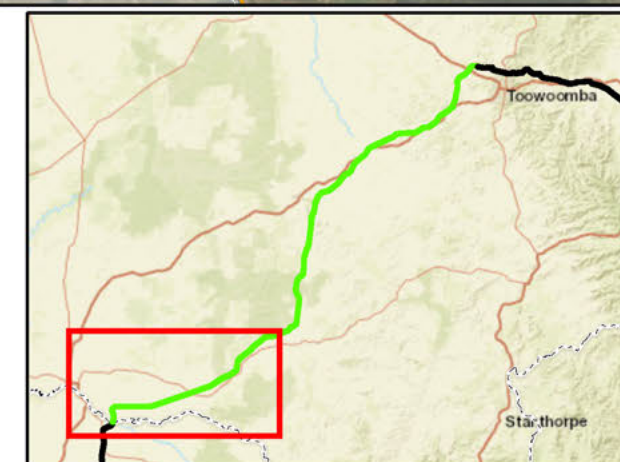
Non-native species were typically more abundant and diverse in areas of high anthropogenic disturbance when compared to those characterised by an intact canopy of native species such as identified as remnant vegetation/intact bushland. However, encroachment of non-native species, particularly those spread by birds (e.g. *Lantana camara* and *Lantana montividenensis*) was evident in relatively undisturbed areas. These species in particular have the potential to outcompete, replace and exclude native flora species within such environments. Aquatic macrophytes were poorly represented throughout the impact assessment area (refer EIS Appendix K: Aquatic Ecology Technical Report for further information).



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
- High Risk Flora

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.



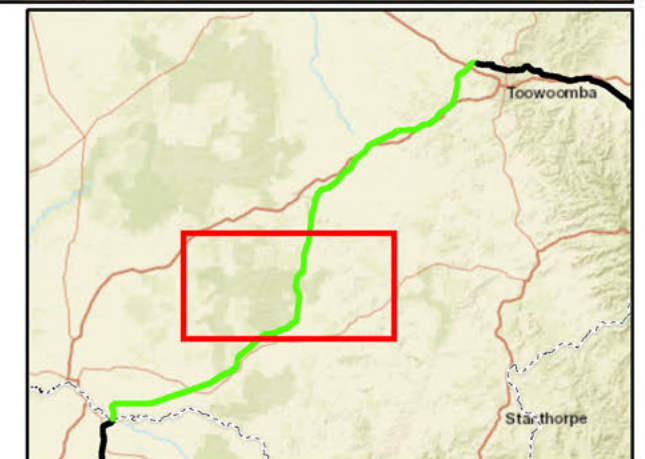
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Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area



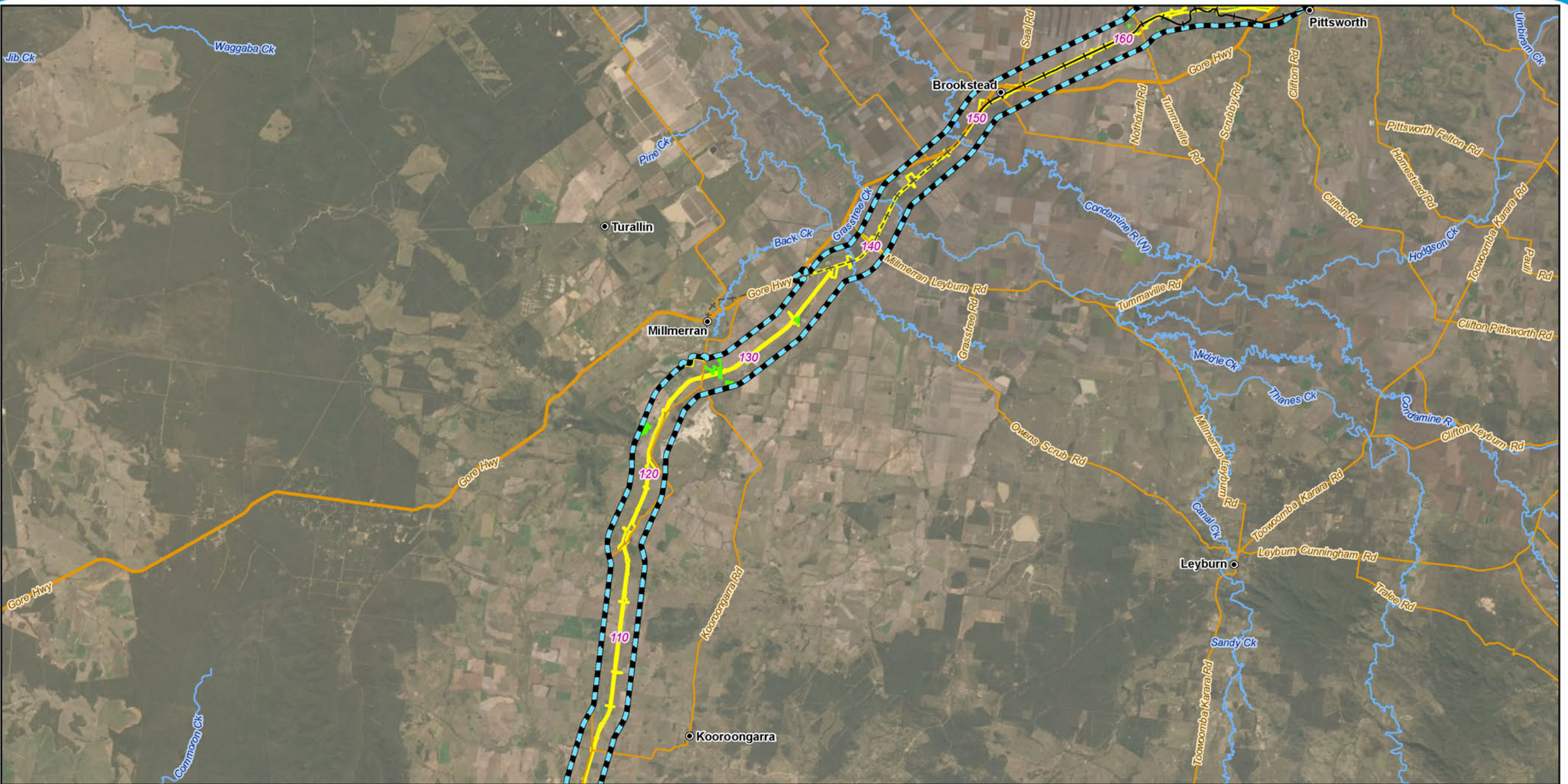
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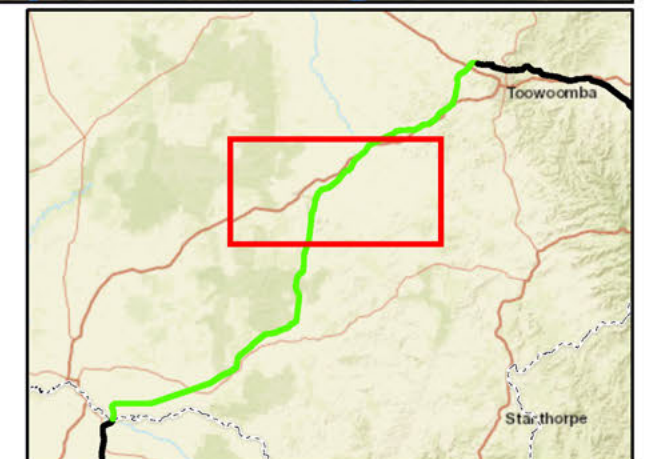
Issue date: 18/05/2020 Version: 2
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie
Figure 4.15b:
High risk flora areas



Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- High Risk Flora



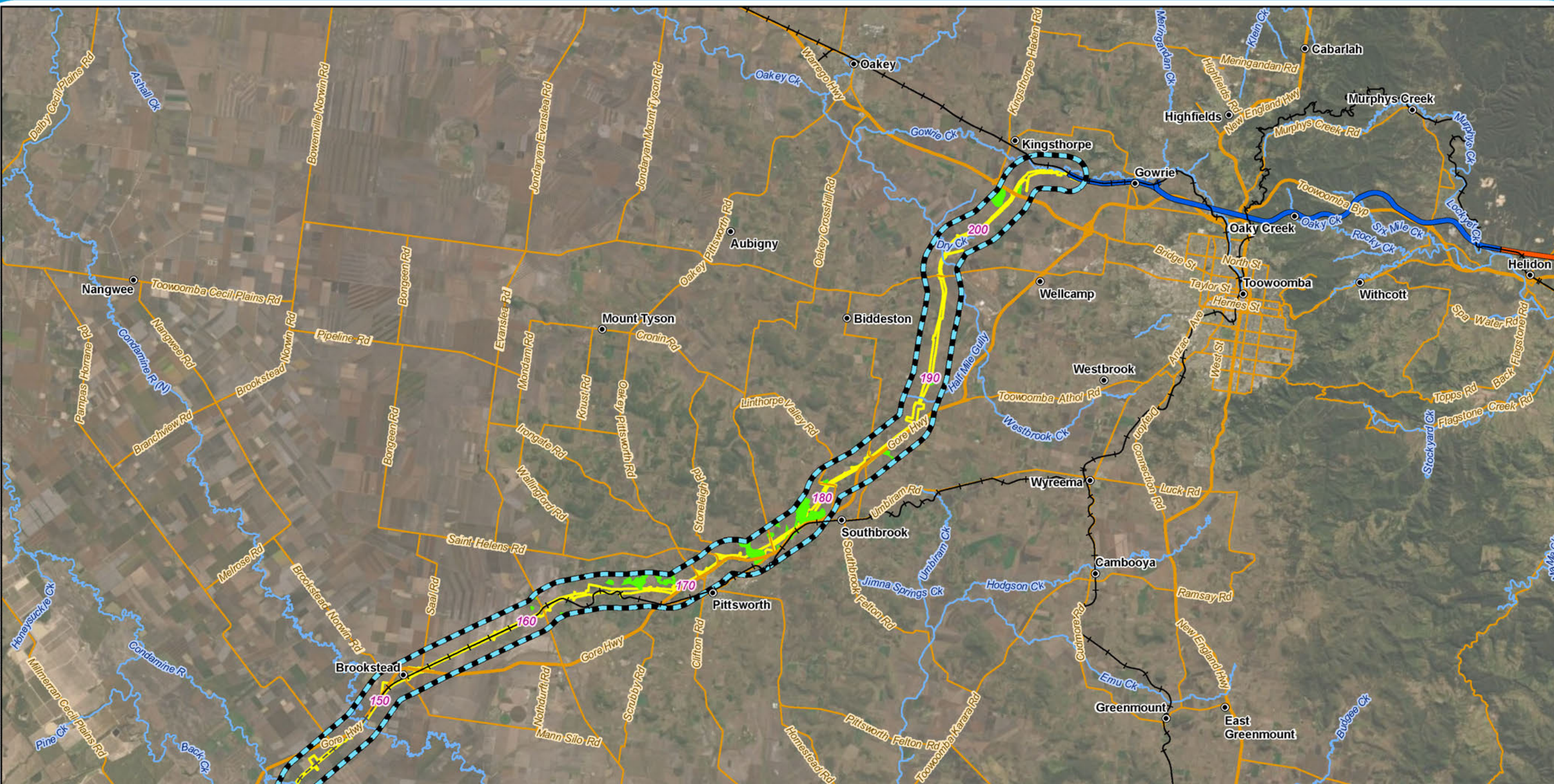
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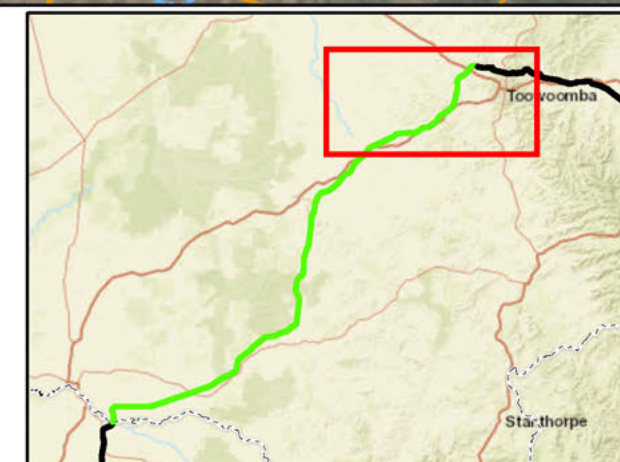
Issue date: 18/05/2020 Version: 2
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Border to Gowrie
Figure 4.15c:
High risk flora areas



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
- High Risk Flora



A3 scale: 1:250,000



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Border to Gowrie
Figure 4.15d:
High risk flora areas

4.6.1.2 NC Act conservation significant and special least concern flora species

Excluding MNES species, two conservation significant flora species, listed under the provision of the NC Act, were recorded within the ecology significant impact area: Tall Hawkweed (*Picris barbarorum*) and Finger panic (*Digitaria porrecta*) (refer Photograph 4.7 and Photograph 4.8).

In addition, eight SLC flora species were observed as relatively common throughout the ecology significant impact area. Table 4.24 summarises the conservation significant and SLC flora species identified during EIS field assessments. Figure 4.16 illustrates the location of observed conservation significant flora species (excluding MNES species). Information related to the occurrence of MNES flora species (i.e. controlling provisions under the EPBC Act) is provided within EIS Appendix L: Matters of National Environmental Significance Technical Report.

Table 4.24 Conservation significant and special least concern flora species observed within the impact assessment area

Family	Species name	Common name	NC Act status
Acanthaceae	<i>Brunoniella australis</i>	Blue trumpet	SLC
Amaryllidaceae	<i>Crinum arenarium</i>	Crinum lily	SLC
Asteraceae	<i>Picris barbarorum</i>	Tall hawkweed	V
Campanulaceae	<i>Wahlenbergia communis</i>	Tufted bluebell	SLC
Campanulaceae	<i>Wahlenbergia gracilis</i>	Sprawling bluebell	SLC
Campanulaceae	<i>Wahlenbergia stricta</i>	Bluebell	SLC
Orchidaceae	<i>Caladenia carnea</i>	Pink fingers	SLC
Orchidaceae	<i>Cymbidium canaliculatum</i>	Black orchid	SLC
Poaceae	<i>Digitaria porrecta</i>	Finger panic	NT
Xanthorrhoeaceae	<i>Xanthorrhoea johnsonii</i>	Grass tree	SLC

Table notes:

- = Species not listed E = 'Endangered' NT = 'Near Threatened' SLC = Special least concern V = 'Vulnerable'

Field investigations also confirmed the presence of habitat, including:

- Finger panic (*Digitaria porrecta*) – potential habitat available in disturbed areas (e.g. road reserved) where they coincide with basalt derived soils (e.g. black soils), particularly within the Condamine and Toowoomba areas
- Tall hawkweed (*Picris barbarorum*) – potential habitat available in disturbed areas (e.g. road reserved) where they coincide with basalt derived soils (e.g. black soils), particularly within the Condamine and Toowoomba areas

The availability of habitat types and their relevance to MSES flora is discussed further in Section 4.6.3.

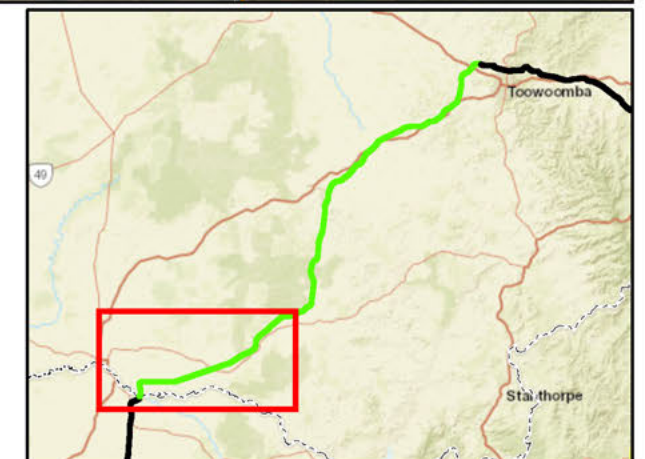
This information was used, in addition to that contained within relevant recovery plans and conservation listing advice, to inform the predictive habitat modelling and mapping for each of the threatened flora species (refer Appendix G for species habitat maps).



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

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.



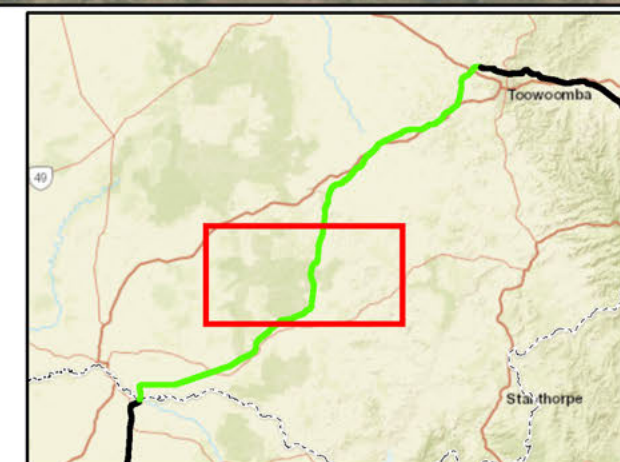
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0 5 10 15 20 km

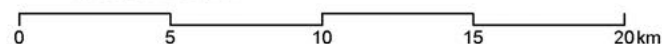


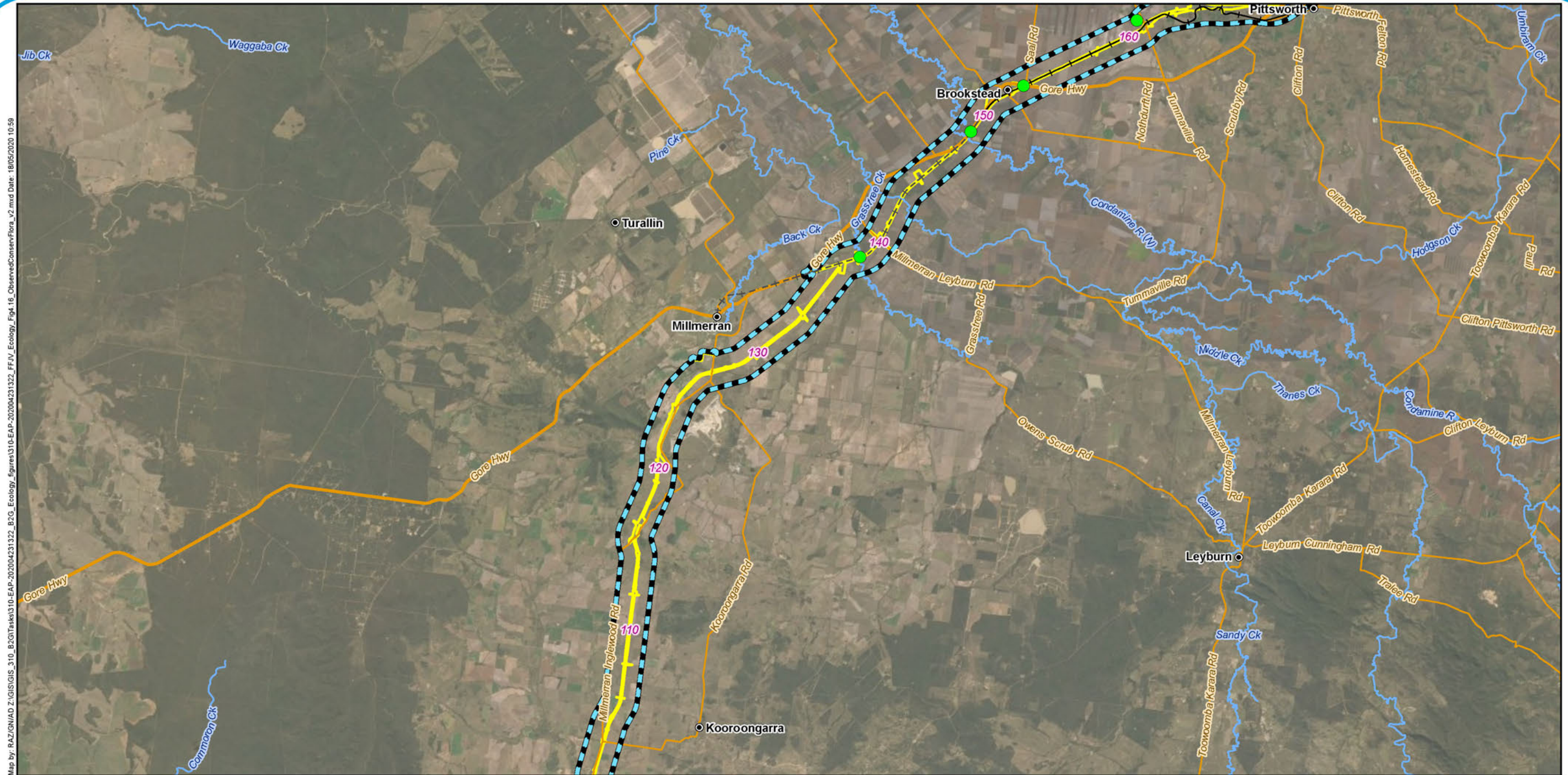
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- EVNT flora records**
- Finger panic grass (*Digitaria porrecta*)



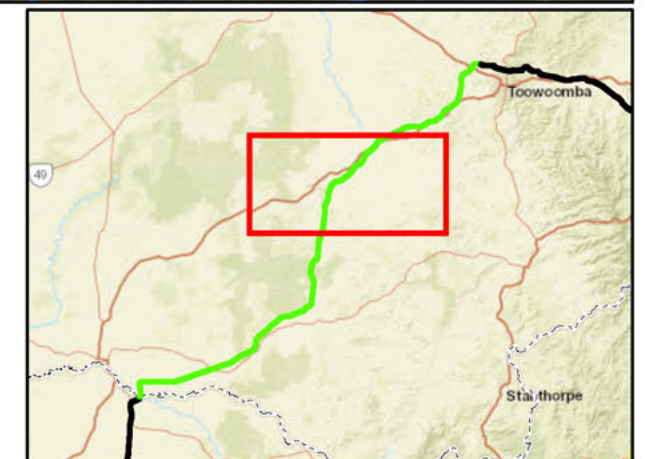
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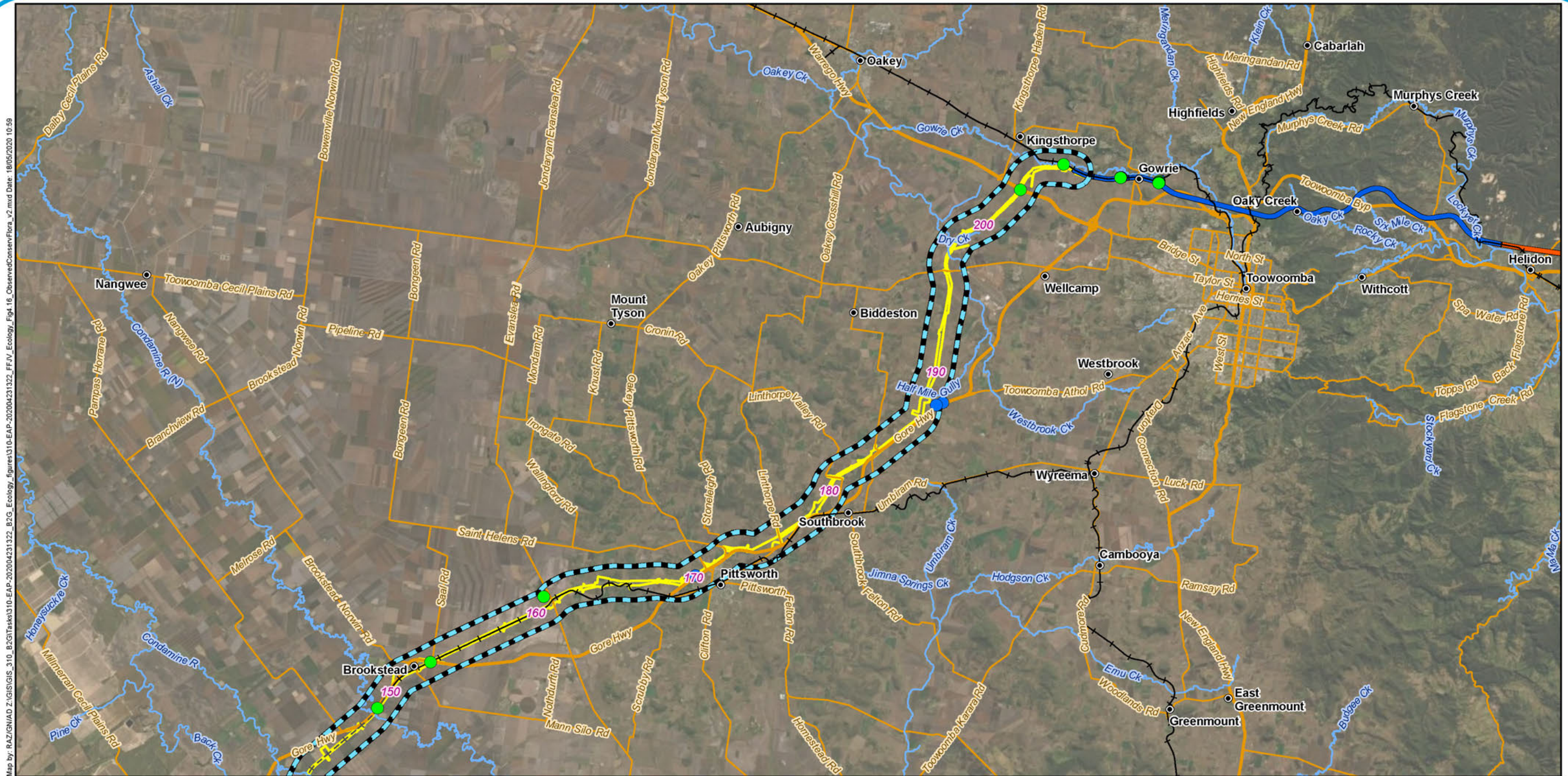
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area
- EVNT flora records**
- Finger panic grass (*Digitaria porrecta*)
- A hawkweed (*Picris barbarorum*)



A3 scale: 1:250,000

0 5 10 15 20 km



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

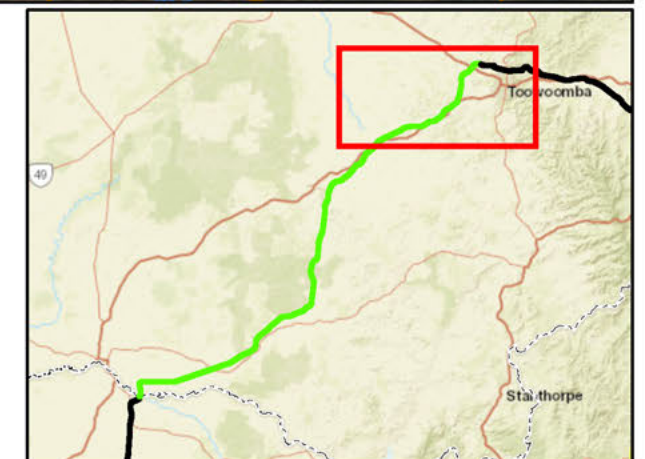
Project footprint

Impact assessment area

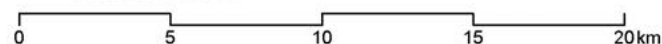
EVNT flora records

● Finger panic grass (*Digitaria porrecta*)

● A hawkweed (*Picris barbarorum*)



A3 scale: 1:250,000



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Border to Gowrie

Figure 4.16d: Observed conservation significant flora species (excluding threatened MNES)



Photograph 4.7 Finger panic (*Digitaria porrecta*) growing in highly disturbed areas within the Gowrie area



Photograph 4.8 Tall hawkweed (*Picris barbarorum*) growing within a road reserve, south of Toowoomba

4.6.1.3 Weed species

The WildNet database search identified seventeen Category 3 restricted matter flora species (under the Biosecurity Act) within the ecology significant impact area (refer Table 4.25). Of the total restricted matters, ten are listed as Weeds of National Significance (WoNS). A total of 121 introduced flora species were identified during the Project EIS field investigations (refer Appendix E and Appendix I). 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.

Table 4.25 Restricted matters identified within the impact assessment area

Family name	Species name	Common name	Weeds of National Significance	Schedule 2 of the Biosecurity Act*	Relative abundance within impact assessment area	Areas containing greatest densities within the impact assessment area
Asparagaceae	<i>Asparagus africanus</i>	Ornamental asparagus	No	Category 3	Wide spread and common. Highest densities south of Inglewood	Associated with areas of disturbance, particularly fence lines
Asparagaceae	<i>Asparagus plumosus</i>	Feathered asparagus-fern	Yes	Category 3	Wide spread and common.	Associated with areas of disturbance, particularly fence lines
Bignoniaceae	<i>Dolichandra unguis-cati</i>	Cat's claw vine	Yes	Category 3	Wide spread and common.	Associated with areas of disturbance, particularly fence lines
Verbenaceae	<i>Lantana camara</i>	Lantana	Yes	Category 3	Wide spread and common.	Associated with areas of disturbance, particularly fence lines
Poaceae	<i>Sporobolus spp.</i>	Giants rats tail grass	No	Category 3	Wide spread and common.	Associated with areas of disturbance, particularly fence lines
Asteraceae	<i>Ambrosia artemisiifolia</i>	Annual ragweed	No	Category 3	Wide spread and common. Highest densities south of Inglewood	Associated with areas of disturbance, particularly fence lines
Asteraceae	<i>Tamarix aphylla</i>	Athol pine	No	Category 3	Wide spread and common. Highest densities south of Inglewood	Associated with areas of disturbance, particularly fence lines
Cactaceae	<i>Opuntia aurantiaca</i>	Tiger pear	Yes	Category 3	Wide spread and common. Highest densities south of Inglewood	Associated with areas of disturbance, particularly fence lines
Cactaceae	<i>Harrisia martinii</i>	Harrisia cactus	No	Category 3	Wide spread and common. Highest densities south of Inglewood	Associated with areas of disturbance, particularly fence lines
Cactaceae	<i>Opuntia stricta</i>	Prickly pear	Yes	Category 3	Wide spread and common. Highest densities south of Inglewood	Associated with areas of disturbance, particularly fence lines
Cactaceae	<i>Opuntia tomentosa</i>	Velvety tree pear	Yes	Category 3	Wide spread and common. Highest densities south of Inglewood	Associated with areas of disturbance, particularly fence lines
Crassulaceae	<i>Bryophyllum delagoense</i>	Mother-of-millions	Yes	Category 3	Wide spread and common. Highest densities south of Inglewood	Associated with areas of disturbance, particularly fence lines
Oleaceae	<i>Ligustrum lucidum</i>	Broad-leaved privet	No	Category 3	Common near Toowoomba	Associated with areas of disturbance, particularly fence lines
Solanaceae	<i>Lycium ferocissimum</i>	African boxthorn	Yes	Category 3	Wide spread and common	Associated with areas of disturbance, particularly fence lines
Ulmaceae	<i>Celtis sinensis</i>	Chinese celtis	No	Category 3	Wide spread and common	Associated with areas of disturbance, particularly fence lines

Family name	Species name	Common name	Weeds of National Significance	Schedule 2 of the Biosecurity Act*	Relative abundance within impact assessment area	Areas containing greatest densities within the impact assessment area
Basellaceae	<i>Anredera cordifolia</i>	Madeira vine	Yes	Category 3	Wide spread and common.	Associated with areas of disturbance, particularly fence lines
Asteraceae	<i>Senecio madagascariensis</i> [#]	Fireweed	Yes	Category 3	Wide spread and common	Associated with areas of disturbance, particularly fence lines

Table notes:

Category 3 = includes noxious fish, weeds and pest animals. You must not distribute this restricted matter. This means it must not be given as a gift, sold, traded or released into the environment unless the distribution or disposal is authorised in a regulation or under permit.

Restricted matter not identified from desktop assessments but observed in the field

4.6.2 Terrestrial fauna

This section outlines the fauna species richness observed within the impact assessment area. This section also summarises the conservation significant species listed under the provisions of the NC Act and EPBC Act (migratory non-threatened species), and the pest species declared under the Biosecurity Act that were recorded within the impact assessment area.

4.6.2.1 Species richness

Project EIS field investigations identified a total of 130 fauna species (refer Appendix F and Appendix H), including 119 (91.5 per cent) native species and 11 (8.5 per cent) non-native species, nine of which were restricted matters (refer Section 4.6.2.1). Recorded species consisted of 91 (70 per cent) birds, 26 (20 per cent) mammals, 10 (8 per cent) reptiles, and 3 (2 per cent) amphibians (refer Appendix F).

Given the fragmented nature of bushland areas within 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.

4.6.2.2 NC Act conservation significant and special least concern fauna species

Excluding MNES, no conservation significant fauna species were identified within the impact assessment area.

Field investigations did not record migratory fauna species within the impact assessment area.

Field investigations confirmed the presence of habitat (foraging and potential breeding), including:

- Suitable habitat for forest/woodland migratory species such as the Oriental cuckoo (*Cuculus optatus*), Satin flycatcher (*Myiagra cyanoleuca*), Rufous fantail (*Rhipidura rufifrons*), Black-faced monarch (*Monarcha melanopsis*) and Spectacled monarch (*Symposiachrus trivirgatus*) in the form of riparian forests and woodlands
- Suitable habitat for wetland/Wader migratory species such as in the form of wetlands and farm dams and ephemeral wetland areas
- Glossy-black cockatoo (*Calyptorhynchus lathamii*) – potential habitat where suitable food resources were available (i.e. *Allocasuarina torulosa*, *Allocasuarina littoralis*, *Allocasuarina inophloia*) within larger tracks of remnant vegetation and State forests
- Echidna (*Tachyglossus aculeatus*) – occurrence of forests, woodlands and grasslands with areas suitable for breeding burrows
- Platypus (*Ornithorinchus anatinus*) – larger drainage lines with permanent water and pools (e.g. Cabbage tree creek).

The availability of habitat types and their relevance to MSES fauna is discussed further in Section 4.6.4. This information was used, in addition to that contained within relevant recovery plans and conservation listing advice, to inform the predictive habitat modelling and mapping for each of the threatened and migratory fauna species (refer Appendix G for species habitat maps). Potential habitat for NC Act conservation significant fauna species is spread throughout the Project alignment.

Information related to the occurrence MNES fauna species (excluding migratory species) (i.e. controlling provisions under the EPBC Act) is provided within EIS Appendix L: Matters of National Environmental Significance Technical Report.

4.6.2.1 Invasive animals

Nine non-native fauna species, all declared as restricted matters (invasive animals) under the Biosecurity Act, were identified within impact assessment area during field investigations (refer Appendix F and Appendix H). These species were widespread across the entire impact assessment area.

The Project intersects the wild dog check fence at four locations between Yelarbon and Millmerran within the Goondiwindi Regional Council, located at approximate chainages Ch 50.0 km, Ch 51.0 km, Ch 54.5 km and Ch 56.0 km. In addition, the Project intersects the 555 km long DDMRB rabbit-proof fence when traversing through the locality of Clontarf, at approximate chainage Ch 120.2 km (refer Section 4.5.4).

Table 4.26 Restricted matter fauna species identified within the impact assessment area

Family name	Species name	Common name	Restricted matter (Biosecurity Act)	Relative abundance
Felidae	<i>Felis catus</i>	Cat	Yes	Widespread
Leporidae	<i>Lepus europaeus</i>	Hare	Yes	Widespread
Leporidae	<i>Oryctolagus cuniculus</i>	Rabbit	Yes	Widespread
Canidae	<i>Canis lupus dingo</i>	Dingo	Yes	Widespread
Canidae	<i>Canis lupus familiaris</i>	Dog	Yes	Widespread
Canidae	<i>Vulpes vulpes</i>	European fox	Yes	Widespread
Suidae	<i>Sus scrofa</i>	Feral pig	Yes	Widespread
Poeciliidae	<i>Gambusia holbrooki</i>	Mosquitofish	Yes	Widespread
Cyprinidae	<i>Cyprinus carpio</i>	European carp	Yes	Widespread

Table note:

- * *Biosecurity Act 2014*, DAF; Category 3 = includes noxious fish, weeds and pest animals. You must not distribute this restricted matter. This means it must not be given as a gift, sold, traded or released into the environment unless the distribution or disposal is authorised in a regulation or under permit.

4.6.3 Predicted habitat for NC Act conservation significant and EPBC Act migratory flora and fauna species

Predictive habitat mapping for NC Act conservation significant and migratory species (refer Section 3.2.4) indicated that potential habitat for eight conservation significant species (including two SLC species) and 15 EPBC Act listed migratory species occurring within the impact assessment area (refer to Table 4.27 and Table 4.28 respectively). Predicted habitat mapping NC Act conservation significant and EPBC Act listed migratory species is presented Appendix A. Habitat critical to the survival of the species has not been identified as occurring within the impact assessment area for EPBC Act listed migratory species.

Table 4.27 Predicted habitat for NC Act conservation significant flora and fauna species (excluding matters of national environmental significance) within the impact assessment area and Project footprint

Species name	Common name	NC Act status	Predicted habitat within the impact assessment area (ha) ¹ (43,560.56 ha)				Predicted habitat within the Project footprint (ha) ¹ (3,203.78 ha) ²			
			General	Essential	Core	Total habitat ³	General	Essential	Core	Total habitat ³
NC Act conservation significant flora										
<i>Cyperus clarus</i>	-	V	974.12	0.00	0.00	974.12	106.00	0.00	0.00	106.00
<i>Digitaria porrecta</i>	-	NT	3,188.66	528.96	0.00	3,717.62	373.87	81.74	0.00	455.61
<i>Picris barbarorum</i>	A hawkweed	V	7,355.76	354.00	0.00	7,709.76	529.35	38.14	0.00	567.49
NC Act conservation significant fauna										
<i>Calyptrorhynchus lathamii lathamii</i>	Glossy black-cockatoo (eastern)	V	6,673.18	102.77	205.9	6,981.85	457.7	14.96	8.2	480.86
<i>Lophochroa leadbeateri</i>	Major Mitchell's cockatoo	V	6,432.52	0.00	0.00	6,432.52	387.77	0.00	0.00	387.77
<i>Acanthophis antarcticus</i>	Common death adder	V	8,159.75	33.52	47.55	8,240.82	540.87	0.00	0.00	540.87
NC Act special least concern animals										
<i>Ornithorhynchus anatinus</i>	Platypus	SLC	2,019.28	0.00	0.00	2,019.28	87.73	0.00	0.00	87.73
<i>Tachyglossus aculeatus</i>	Short-beaked echidna	SLC	9,875.51	0.00	0.00	9,875.51	736.72	0.00	0.00	736.72

Table notes:

V = Vulnerable NT = Near Threatened SLC = Special Least Concern

- 1 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. This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design.
- 2 This area includes 716.5 ha which is existing, cleared and maintained rail corridor
- 3 Total habitat = sum of 'General', 'Essential' and 'Core' habitats.

Table 4.28 Predicted habitat for EPBC Act listed migratory species within the impact assessment area and Project footprint

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the impact assessment area (ha) (43,560.56 ha) ²			Predicted habitat within the Project footprint (ha) (3,203.78 ha) ²		
				Potential habitat	Important habitat	Total habitat	Potential habitat	Important habitat	Total habitat
EPBC Act migratory species									
<i>Actitis hypoleucos</i>	Common sandpiper	SLC	M	924.20	1,246.14	2,170.34	44.98	87.62	132.60
<i>Apus pacificus</i> ¹	Fork-tailed swift	SLC	M	34,509.48	9,051.08	43,560.56	2,605.89	597.89	3,203.78
<i>Calidris acuminata</i>	Sharp-tailed sandpiper	SLC	M	924.20	1,246.14	2,170.34	44.98	87.62	132.60
<i>Calidris melanotos</i>	Pectoral sandpiper	SLC	M	924.20	1,246.14	2,170.34	44.98	87.62	132.60
<i>Calidris ruficollis</i>	Red-necked stint	SLC	M	924.20	1,246.14	2,170.34	44.98	87.62	132.60
<i>Cuculus optatus</i>	Oriental cuckoo	SLC	M	444.93	0.00	444.93	24.45	0.00	24.45
<i>Gallinago hardwickii</i>	Latham’s snipe	SLC	M	924.20	1,246.14	2,170.34	44.98	87.62	132.60
<i>Monarcha melanopsis</i>	Black-faced monarch	SLC	M	444.93	0.00	444.93	24.45	0.00	24.45
<i>Motacilla flava</i>	Yellow wagtail	SLC	M	924.20	1,246.14	2,170.34	44.98	87.62	132.60
<i>Myiagra cyanoleuca</i>	Satin flycatcher	SLC	M	444.93	0.00	444.93	24.45	0.00	24.45
<i>Pandion haliaetus</i>	Osprey	SLC	M	914.83	9.36	924.19	44.98	0.00	44.98
<i>Plegadis falcinellus</i>	Glossy ibis	SLC	M	924.20	1,246.14	2,170.34	44.98	87.62	132.60
<i>Rhipidura rufifrons</i>	Rufous fantail	SLC	M	444.93	0.00	444.93	24.45	0.00	24.45
<i>Symposiachrus trivirgatus</i>	Spectacled monarch	SLC	M	444.93	0.00	444.93	24.45	0.00	24.45
<i>Tringa nebularia</i>	Common greenshank	SLC	M	924.20	1,246.14	2,170.34	44.98	87.62	132.60

Table notes:

SLC = Special Least Concern, M = Migratory

1 Aerial species, all areas are considered habitat.

2 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 Appendices A, B and C). This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design

4.6.4 Flora and fauna habitat located within the impact assessment area

A total of ten broad 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. The condition of the various habitat types was derived from aerial photograph interpretation, RE mapping, relevant database searches, field reconnaissance and previous experience within the impact assessment area.

Discrete areas of remnant vegetation were scattered across the impact assessment area, however, most of the area is characterised by non-remnant vegetation, particularly cleared agricultural areas. These cleared areas provided grassland habitat for fauna species. Grassland was 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.

Most of remnant and non-remnant native vegetation occurred in the Inglewood region and was within protected areas. Extensive but fragmented remnant vegetation also existed in the northern portion of the impact assessment area around Gowrie Mountain. The Condamine River floodplain region was 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.

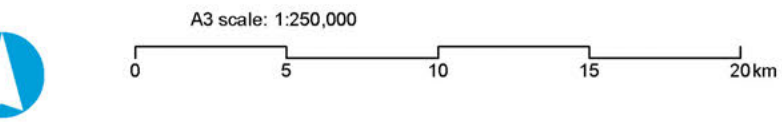
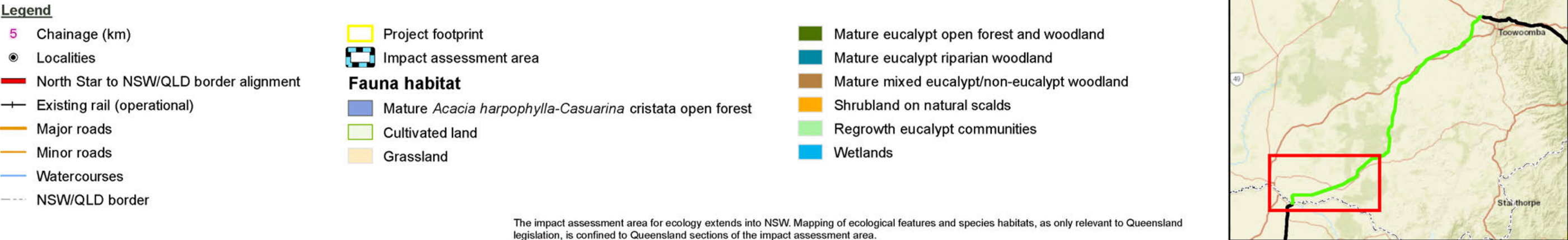
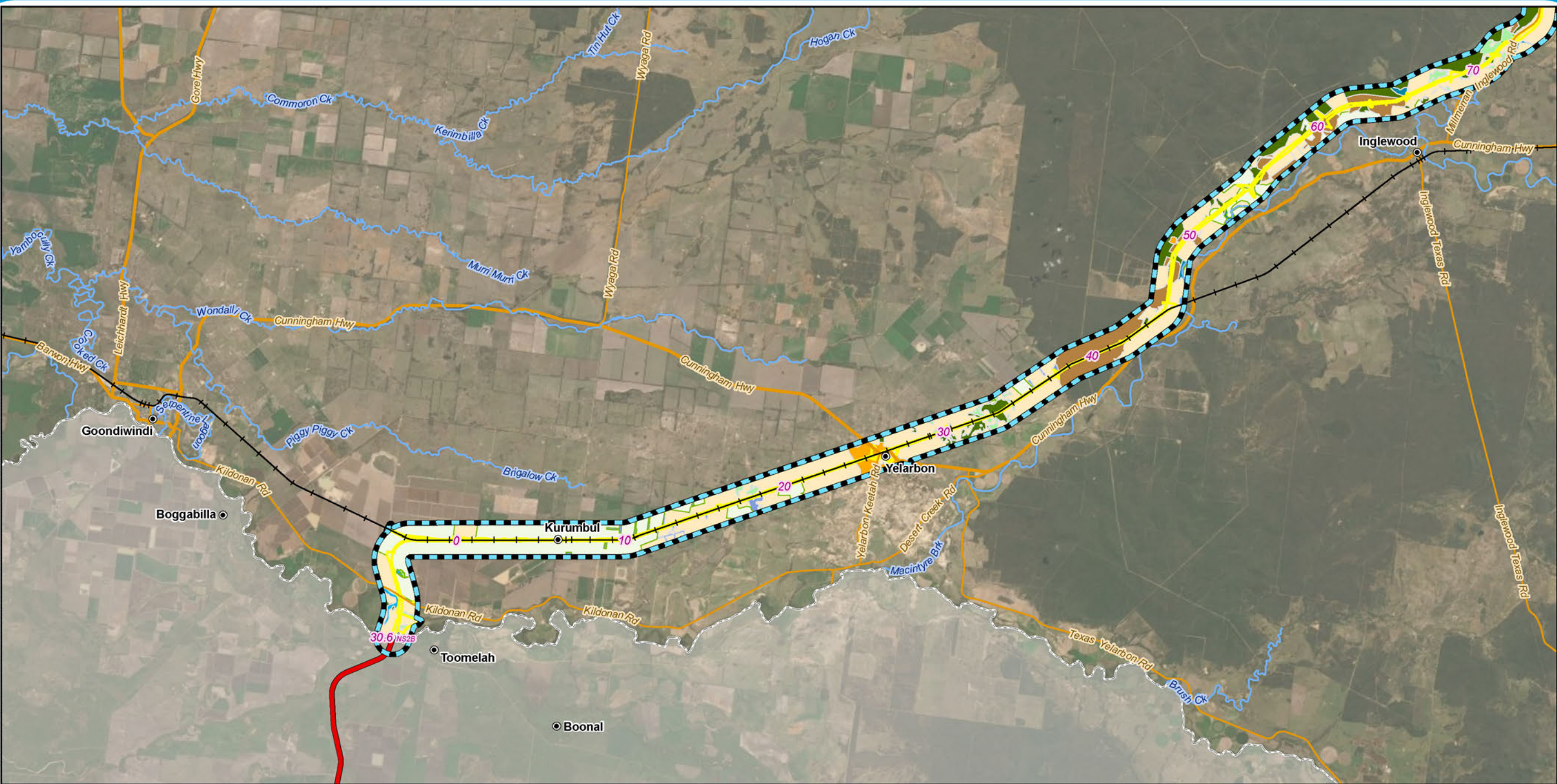
Each broad habitat type is discussed in further detail below and shown in Figure 4.17. An analysis of the quantity of fauna habitat contained within the impact assessment area and within the Project footprint is presented in Table 4.29.

Table 4.29 Extent of fauna habitat located within the impact assessment area and Project footprint

Fauna habitat type (refer Figure 4.17)	Analogous REs (Category B regulated vegetation)	Mapped extent (ha)	
		Impact assessment area	Project footprint ¹
Grassland	RE 11.3.24, 11.5.14, 11.8.11, non-remnant areas	20,021.51 (46.04% of impact assessment area)	1,641.53 (51.24% of Project footprint)
Cultivated land	Non-remnant areas	14,414.85 (33.15% of impact assessment area)	962.76 (30.05% of Project footprint)
Mature eucalypt open forest and woodland	RE 11.3.4, 11.3.2, 11.3.14, 11.3.18, 11.8.2, 11.8.2a, 11.9.7,	3153.98 (7.25% of impact assessment area)	160.42 (5.01% of Project footprint)
Mature eucalypt riparian woodland	RE 12.3.25,	332.29 (0.76% of impact assessment area)	13.2 (0.41% of Project footprint)
Mature mixed eucalypt/non- eucalypt woodland	RE 11.4.10, 11.5.1, 11.5.4, 11.7.4	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	RE 11.9.5, 11.4.3	276.48 (0.64% of impact assessment area)	58.18 (1.82% of Project footprint)
Shrubland on natural scalds	RE 11.7.5, 11.5.14	390.53 (0.90% of impact assessment area)	51.31 (1.60% of Project footprint)
Semi-evergreen vine thicket	RE 11.8.3	38.36 (0.09% of impact assessment area)	0.00 (0.00% of Project footprint)
Regrowth eucalypt communities	High value regrowth (Category C)	579.87 (1.33% of impact assessment area)	27.53 (0.86% of Project footprint)
Wetlands	RE 11.3.27b, non- remnant areas	66.49 (0.15% of impact assessment area)	0.88 (0.03% of Project footprint)

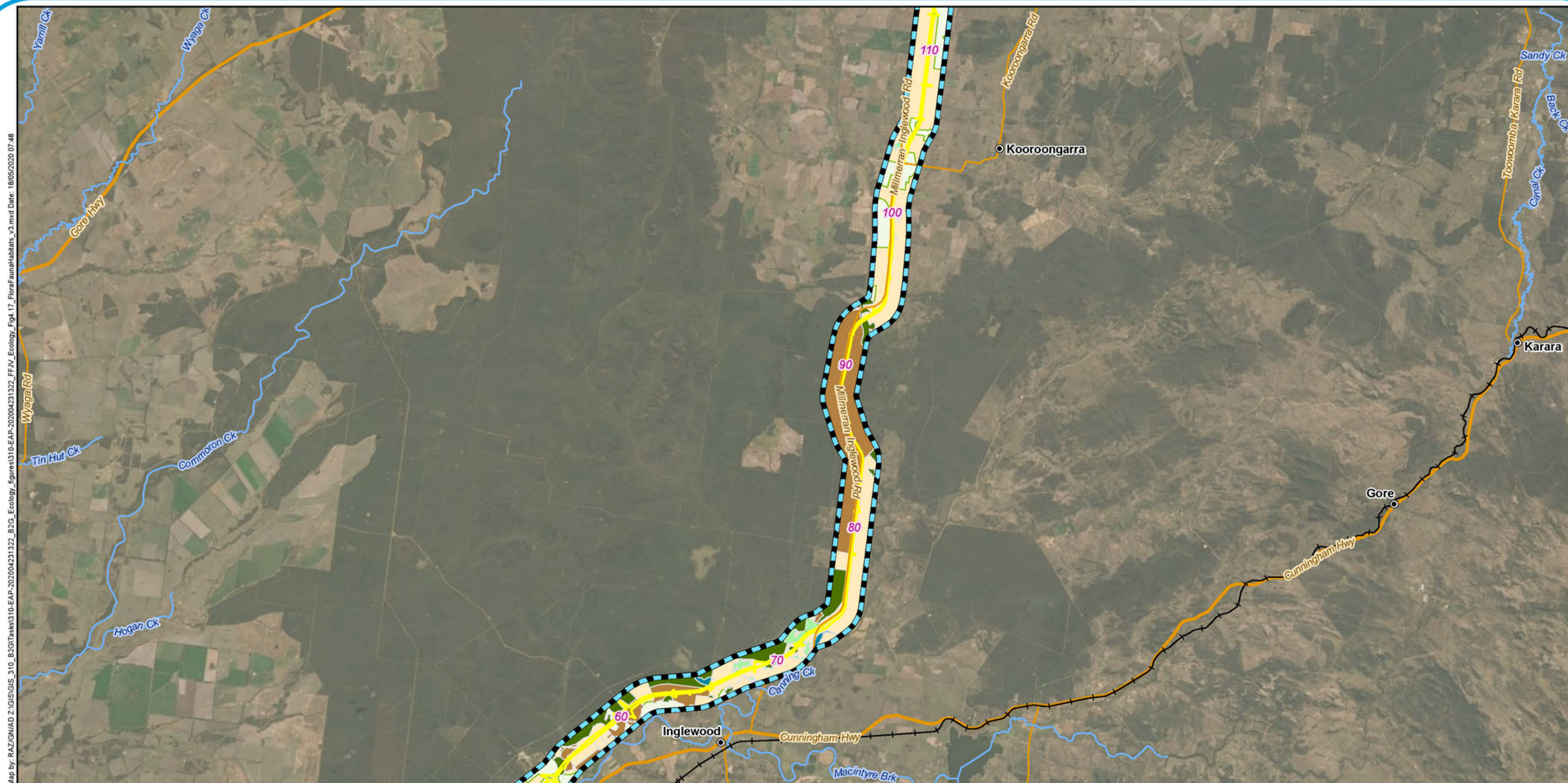
Table note:

- 1 This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design.



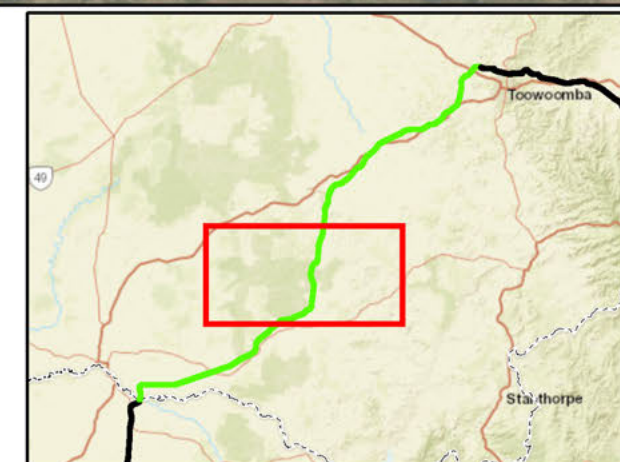
Border to Gowrie

Figure 4.17a: Location of flora and fauna habitat types contained within the impact assessment area

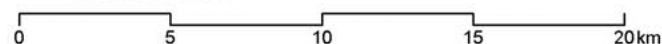


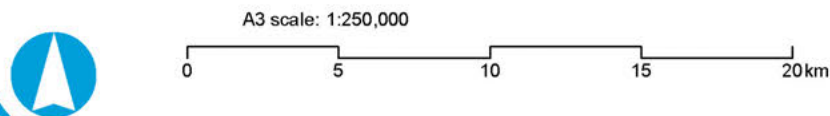
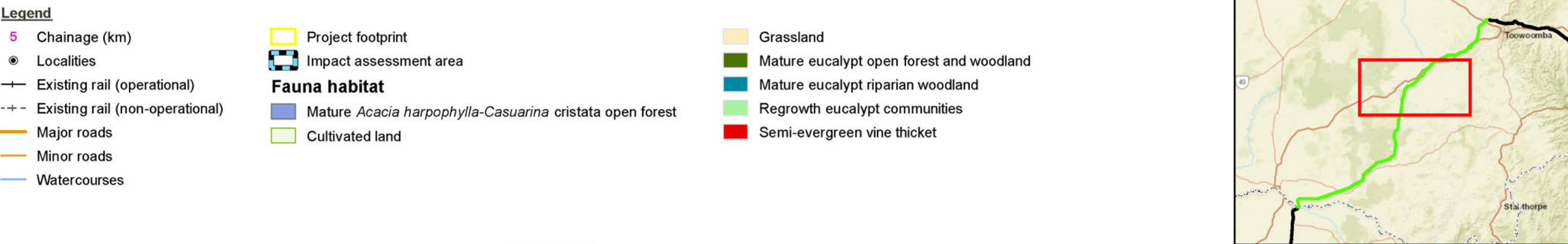
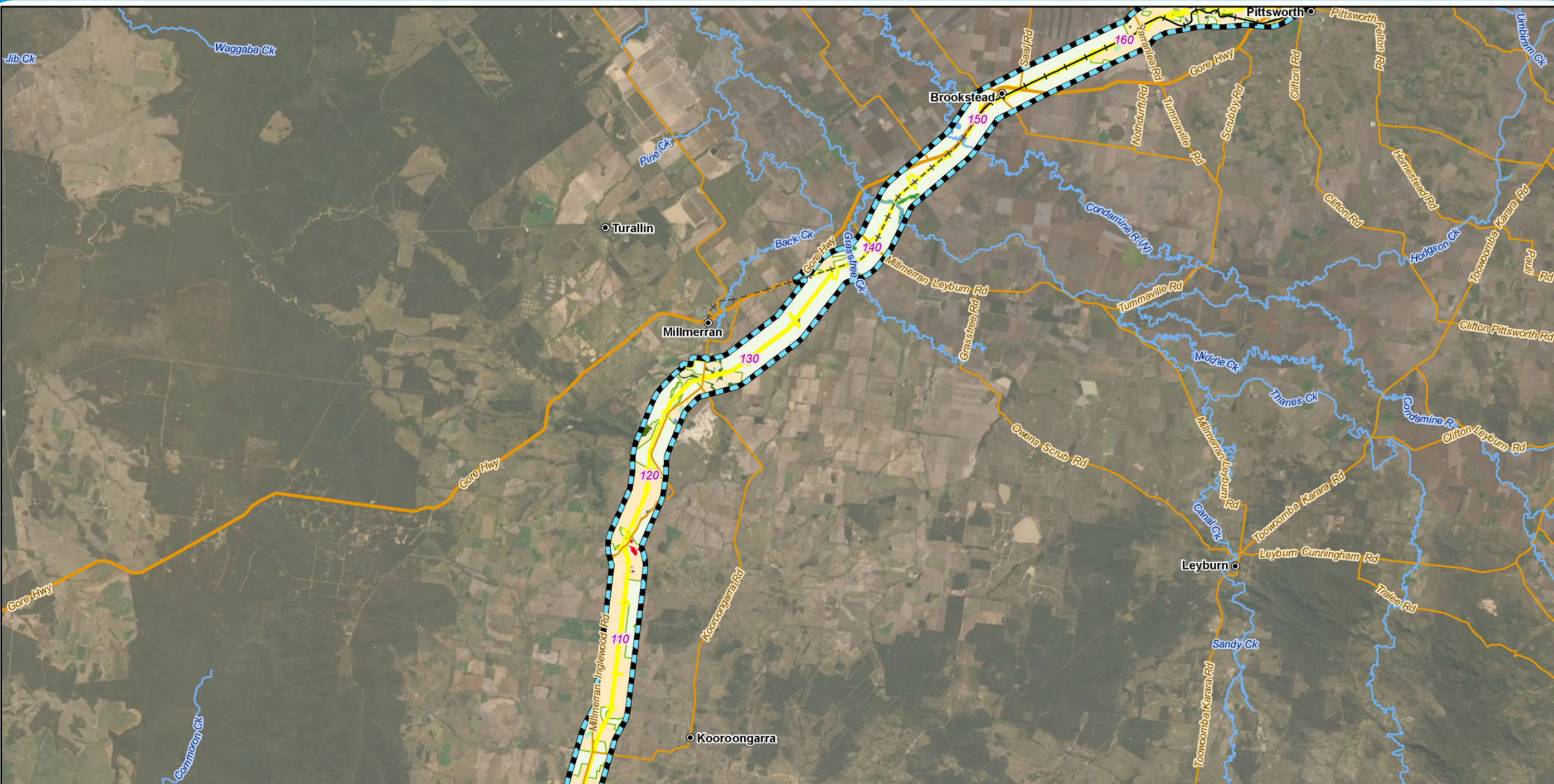
Legend

- | | | |
|-----------------------------|------------------------|---|
| 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 | | |



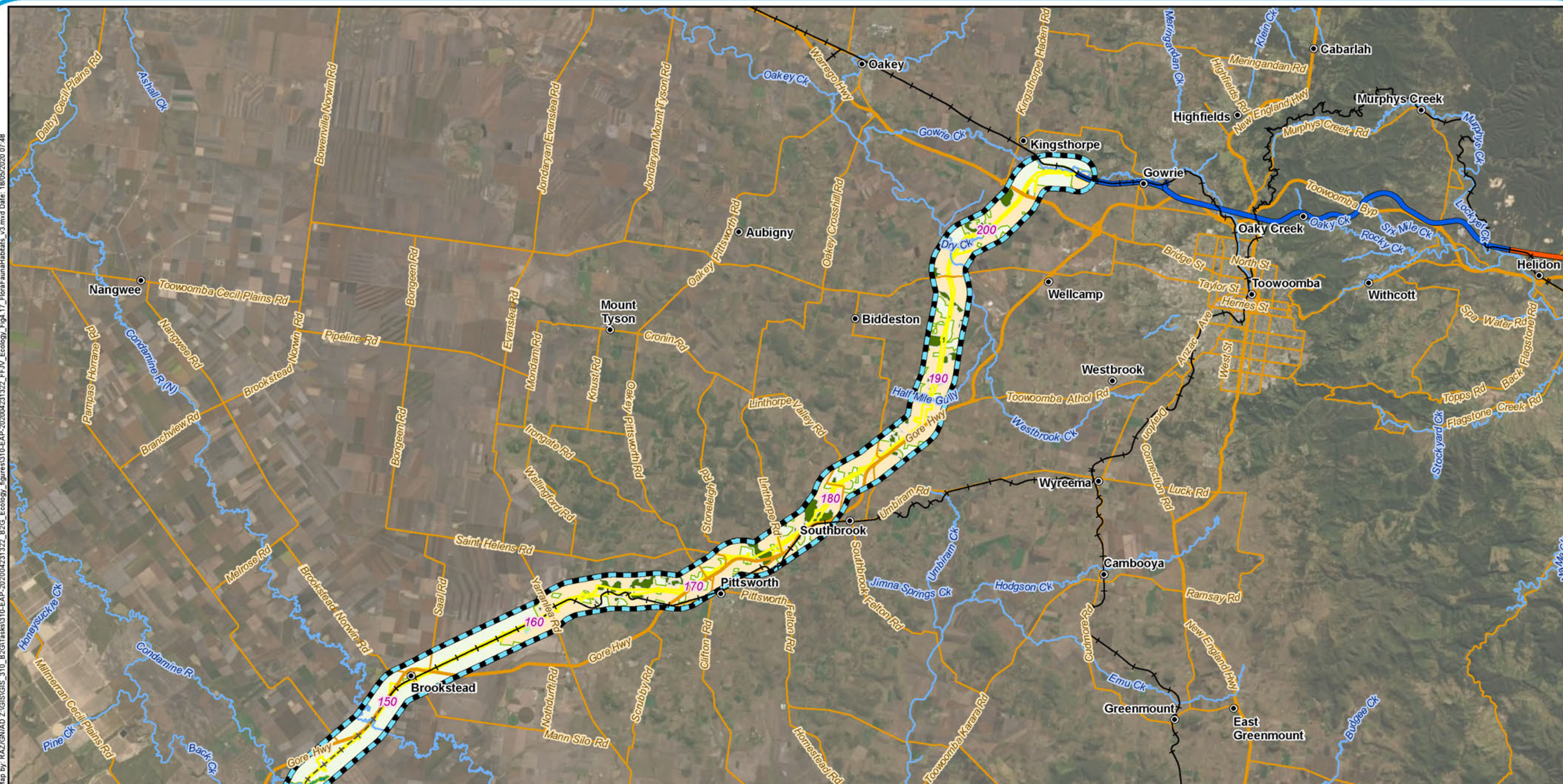
A3 scale: 1:250,000





Border to Gowrie
Figure 4.17c: Location of flora and fauna habitat types contained within the impact assessment area

Map by: RAZ/GNAD Z:\GIS\GIS_310_B20Tasks\310-EAP-202004231322_B2G_Ecology_figures\310-EAP-202004231322_FFIV_Ecology_Fig4.17_FloraFaunaHabitats_v3.mxd Date: 18/05/2020 07:48

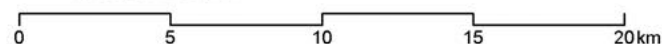


Legend

- | | | |
|---------------------------------|--|--|
| 5 Chainage (km) | Project footprint | Grassland |
| Localities | Impact assessment area | Mature eucalypt open forest and woodland |
| Gowrie to Helidon alignment | Fauna habitat | Mature eucalypt riparian woodland |
| Helidon to Calvert alignment | Mature <i>Acacia harpophylla</i> - <i>Casuarina cristata</i> open forest | Regrowth eucalypt communities |
| Existing rail (operational) | Cultivated land | |
| Existing rail (non-operational) | | |
| Major roads | | |
| Minor roads | | |
| Watercourses | | |



A3 scale: 1:250,000



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 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.17d: Location of flora and fauna habitat types contained within the impact assessment area

4.6.4.1 Grassland

Grassland habitats within the impact assessment area included remnant native grasslands, non-native grasslands and derived native grasslands. Small remnants of native grassland included *Dicanthium sericeum* grassland on Cainozoic igneous rocks (RE 11.8.11), *Themeda avenacea* grassland on alluvial plains (RE 11.3.24), and *Triodia scariosa* grassland (RE 11.5.14).

Non-native grasslands were dominated by exotic pasture grasses and represented by areas of non-remnant vegetation (excluding cultivated land), previously cleared of native-vegetation for agriculture. Dominant pasture grasses included Rhodes grass (*Chloris gayana*), Green panic (*Megathyrsus maximus*), and Johnson grass (*Sorghum halepense*). Scattered native grass species also occurred in these areas including Blue grass (*Dicanthium sericeum*), Crab grass (*Digitaria* spp), Panic grass (*Panicum* spp.), and Blue grass (*Bothriochloa* spp.) (refer Photograph 4.9 and Photograph 4.10).

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 Queensland panic (*Panicum queenslandicum*), Blue grass (*Dicanthium sericeum*), Digitaria (*Digitaria* spp.), Kangaroo grass (*Themeda* spp.), and Blue grass (*Bothriochloa* spp.). Exotic pasture grasses were scattered through the derived native grassland and included Rhodes grass (*Chloris gayana*).

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 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.

Grassland within the impact assessment area provided foraging habitat for granivorous bird species including finches, parrots and pigeons. Grassland habitats also provided important microhabitat refugia (i.e. soil cracks) for small ground fauna including native rodents, skinks, and snakes. Scattered paddock trees occurred across many grassland habitats, providing fauna habitat and connectivity in otherwise cleared and fragmented landscapes. Grassland may provide important habitat or refuge for migratory bird species when flooded. These areas have a high potential to contain threatened grassland specialist flora such as Tall hawkweed (*Picris barbarorum*) and Finger panic (*Digitaria porrecta*) and Sedge (*Cyperus clarus*), particularly when they occur on Basalt derived soils (i.e. black soils).



Photograph 4.9 Grassland composed of native and non-native species within road reserve south of Millmerran.



Photograph 4.10 Grassland composed of native and non-native species within road reserve south of Toowoomba. This area was identified to contain *Picris barbarorum*.

4.6.4.2 Cultivated land

Cultivated land within the impact assessment area was extensive and included irrigated and dryland crops, stubble fields and fallow fields (refer Photograph 4.11). Common crops included winter cereals and irrigated cotton. The availability of soil cracks and other microhabitat refugia had been greatly reduced by soil cultivation.

Cultivated land typically occurred in low-lying areas on fertile clays and provided habitat for generalist bird species including Torresian crow (*Corvus orru*), Australian magpie (*Gymnorhina tibicen*), and Little corella (*Cacatua sanguinea*). Non-native fauna species were typically abundant in cultivated land habitats, including restricted matters (Category 3 invasive animals) including European red fox (*Vulpes vulpes*), Domestic dog (*Canis familiaris*), and Feral pig (*Sus scrofa*).



Photograph 4.11 Cultivated land either side of the existing rail line on the Condamine floodplain

4.6.4.3 Mature Eucalypt open forest and woodland

On sedimentary and igneous rocks

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 Figure 4.17). Areas of mature eucalypt open forest and woodland on sedimentary and igneous rocks within the impact assessment area included 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 were represented by the communities of REs 11.9.7 and 11.8.2.

The condition and structure of these habitats varied 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 included tree hollows, hollow logs and termitaria (arboreal and terrestrial). In addition, important nectar resources may be provided by myrtaceous species.

Canopy species recorded in this habitat type provided 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 shrubs were sources of nectar and pollen resources for a range of fauna species including birds, bats, arboreal mammals and insects. Standing dead trees (stags) provided roosting sites, nesting dens and breeding locations for a similar range of species.

Mature eucalypt open forest and woodlands occurred as fragmented/isolated patches in largely cleared agricultural landscapes. These habitat types were restricted in their capacity to support woodland and forest species and more likely to offer habitat value to transitional species and support mammal and bird species typical of disturbed areas.

Areas of mature eucalypt open forest and woodland (on sedimentary and igneous rock) within the impact assessment area may provide suitable habitat for a range of NC Act listed species including the Glossy black-cockatoo (*Calyptorhynchus lathami*), Short-beaked echidna (*Tachyglossus aculeatus*), and Bailey's cypress (*Callitris baileyi*) where the required microhabitat features are present. In addition, these areas may also provide important migratory habitat for EPBC Act listed migratory species such as Oriental cuckoo (*Cuculus optatus*), Satin flycatcher (*Myiagra cyanoleuca*), Rufous fantail (*Rhipidura rufifrons*), Black-faced monarch (*Monarcha melanopsis*) and the Spectacled monarch (*Symphysistichus trivirgatus*). An image of this community is provided in Photograph 4.12.



Photograph 4.12 Mature Eucalypt woodland on sedimentary rock, located within the Inglewood region

On alluvial plains

Areas of mature eucalypt open forest and woodland on alluvial plains within the impact assessment area included 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.

This habitat type existed on floodplains and creek flats within the impact assessment area and generally exhibits low structural complexity, particularly at lower strata levels. Ground cover was typically low due to grazing by livestock, and the understorey very sparse with an open canopy of large *Eucalyptus tereticornis* or *Eucalyptus camaldulensis*. Mature eucalypt trees on alluvial plains are known to provide important habitat, including food (nectar) and shelter (hollows), for a range of fauna species including birds, mammals, and reptiles.

Threatened and migratory fauna species that may occur in eucalypt open forest and woodland on alluvial plains within the impact assessment area include Glossy black-cockatoo (*Calyptorhynchus lathamii*), Short-beaked echidna (*Tachyglossus aculeatus*), Oriental cuckoo (*Cuculus optatus*), Satin flycatcher (*Myiagra cyanoleuca*) and the Rufous fantail (*Rhipidura rufifrons*).

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. Migratory fauna species that may utilise flooded eucalypt open forest and woodland on alluvial plains include the Glossy ibis (*Plegadis falcinellus*).

It is important to note that 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. An image of this community is provided in Photograph 4.13.



Photograph 4.13 Mature Eucalypt woodland on alluvium, located south of Inglewood

On sand plains

Mature eucalypt woodland and forest on sand plains within the impact assessment area represented community 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 Buloke (*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. An image of this community is provided in Photograph 4.14.



Photograph 4.14 Mature Eucalypt woodland on sand, located south of Millmerran

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 Blue-leaved ironbark (*Eucalyptus fibrosa* subsp. *Nubilis*) forming a distinct but discontinuous open forest to woodland canopy (22 to 25m high). Broad-leaved red ironbark (*E. fibrosa*) provides nectar and hollow resources for fauna including birds, arboreal mammals, insects, reptiles and bats.

Narrow-leaved red 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.

NC Act fauna that may occur in eucalypt forest and woodland on sand plains include Glossy black-cockatoo (*Calyptorhynchus lathamii*).

4.6.4.4 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. This habitat type occurred exclusively along the edge of rivers, creeks and vegetated drainage lines within the impact assessment area. Mature eucalypt riparian open forest and woodlands within the impact assessment area was often structurally complex at all strata levels and potentially supports the greatest fauna diversity per hectare (ha).

A range of fauna, including birds, mammals, and reptiles, utilise this habitat type for foraging, breeding, and dispersal. Specific available resources include shelter (woody debris, hollow logs, hollow in branches and standing trees), nectar and water. The movement corridors provided by this habitat type are important for structural connectivity, in otherwise fragmented landscapes.

Threatened and migratory species that may occur in mature eucalypt riparian open forests and woodland include the Glossy black-cockatoo (*Calyptorhynchus lathami*), Satin flycatcher (*Myiagra cyanoleuca*), Black-faced monarch (*Monarcha melanopsis*), Spectacled monarch (*Symposiachrus trivirgatus*). An image of this community is provided in Photograph 4.15.



Photograph 4.15 Mature Eucalypt riparian woodland located south of Inglewood

4.6.4.5 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.

EVNT species that may occur within mature mixed eucalypt/non-eucalypt woodland on clay plains include Pale imperial hairstreak (*Jalmenus eubulus*), South-eastern long-eared bat (*Nyctophilus corbeni*), and Yakka skink (*Egernia rugosa*). An image of this community is provided in Photograph 4.16.



Photograph 4.16 Mixed mature Eucalypt/non-eucalypt woodland on clay, located south of Millmerran

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. 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.

NC Act species that may occur within mature mixed eucalypt/non-eucalypt woodland include the Common death adder (*Acanthophis antarcticus*). An image of this community is provided in Photograph 4.17.



Photograph 4.17 Mixed mature Eucalypt/non-eucalypt woodland on sand, located north of Inglewood

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 red 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*). There is usually a distinct low tree to tall shrub layer comprising species, including Brown hazelwood (*Lysicarpus angustifolius*) or *Acacia* spp. An image of this community is provided in Photograph 4.18.



Photograph 4.18 Mixed mature Eucalypt/non-eucalypt woodland duricrust, located south of Inglewood

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

On sedimentary rocks

The community Mature *Acacia harpophylla*-*Casuarina cristata* open forest on sedimentary rocks within the impact assessment area was represented by RE 11.9.5. This habitat type is dominated by Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*), or a Brigalow with a semi-evergreen vine thicket understorey. 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.

More generally, this habitat type is suitable for EVNT species, including Pale imperial hair streak (*Jalmenus eubulus*), Yakka skink (*Egernia rugosa*), South-eastern long-eared bat (*Nyctophilus corbeni*), Painted honeyeater (*Grantiella picta*) and Brigalow woodland snail (*Adclarkia cameroni*). An image of this community is provided in Photograph 4.19.



Photograph 4.19 Mature *Acacia harpophylla*-*Casuarina cristata* open forest on sedimentary rock located to the south of Millmerran

On clay plains

The community Mature *Acacia harpophylla*-*Casuarina cristata* open forest on clay plains 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. *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.

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.

The NC Act species that may occur include the Pale imperial hair streak (*Jalmenus eubulus*). An image of this community is provided in Photograph 4.20.



Photograph 4.20 Mature *Acacia harpophylla*-*Casuarina cristata* open forest on clay plains located with road reserves south of Yelarbon

4.6.4.7 Shrubland on natural scalds

Shrubland on natural scalds within the impact assessment area is represented by RE 11.7.5. 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.), Wattle (*Acacia* spp.), Bottlebrush (*Melaleuca* spp.) and (in the ground layer) Hummock grass (*Triodia* spp.) (refer Photograph 4.21). 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.



Photograph 4.21 Shrubland on natural scalds located south of Inglewood

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.

4.6.4.8 Semi-evergreen vine thicket

The community Semi-evergreen vine thickets within the impact assessment area are represented by RE 11.8.3. This habitat type is generally restricted to steeper, rocky hillsides on igneous rocks, with emergent Brigalow, Belah and eucalypts. 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.

4.6.4.9 Regrowth communities

Areas of regrowth vegetation are present throughout the impact assessment area. Extant patches of regrowth vegetation within the impact assessment area are typically in poor ecological condition, suffering from extensive weed invasion and disturbance from cattle grazing practices. However, in instances where patches contain mature larger trees with hollows, the ecological value of these areas significantly increases. Areas of regrowth habitat may provide foraging and perching habitat value for transitional fauna species and suitable microhabitats, including cracking clay soils for reptile species. Where large, isolated hollow bearing trees are present, these features may provide nesting and denning sites for arboreal mammals and birds. An image of this community is provided in Photograph 4.22.



Photograph 4.22 Regrowth community dominated by Eucalyptus and acacia species, located within the Inglewood region

4.6.4.10 Wetlands

Wetland habitats within the impact assessment area included 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 were abundant across agricultural landscapes, have been included as they potentially provide suitable wetland alternatives for vertebrate fauna. Artificial wetlands included 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.

Palustrine wetlands within the impact assessment area typically occur on alluvial floodplains and are dominated by grasses (*Poaceae*), rushes (*Restionaceae*) and sedges (*Cyperaceae*). Areas of remnant Palustrine wetland within the impact assessment area are represented by RE 11.3.27b.

Wetland habitats within the impact assessment area are considered to provide suitable habitat for a variety of fish, amphibian, reptile (including turtles) and bird species. Larger palustrine-wetlands potentially provide important refuge habitat for many bird species, including migratory and dispersive species. Migratory species that may potentially use wetland areas include Yellow wagtail (*Motacilla flava*), Common sandpiper (*Actitis hypoleucos*), Sharp-tailed sandpiper (*Calidris acuminata*), Latham's snipe (*Gallinago hardwickii*), Osprey (*Pandion haliaetus*) and the Glossy ibis (*Plegadis falcinellus*).

No springs are identified on the Queensland wetland mapping (DES 2018) within the impact assessment area.

An image of a representative of this community is provided in Photograph 4.23.



Photograph 4.23 Ephemeral wetland areas located at Yelarbon, associated with the Yelarbon scald

4.7 Environmental values and Sensitive environmental receptors

4.7.1 Environmental values

Consistent with the relevant legislation as stated in Section 2, the overarching environmental values within the impact assessment area, include:

- Queensland'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.

4.7.2 Sensitive environmental receptors

A Sensitive environmental receptor is a feature, area or structure that may be affected by direct or indirect changes to the environment. For conservation significant flora and fauna species, 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 is provided in Table 4.27. In instances where species/communities did not have potential habitat contained within the impact assessment area, these species were not subject to impact assessment and were no longer considered to constitute Sensitive environmental receptors as the risk of impacts to any these species are considered low. The Sensitive environmental receptors identified for terrestrial and aquatic ecology within the impact assessment area are identified in Table 4.30 along with their assigned sensitivity value as determined by Table 3.7.

Table 4.30 Identified Sensitive environmental receptors within the impact assessment area

Associated ecological value	Identified receptors	Assigned sensitivity (refer Table 3.7)	Justification
- Queensland's natural environment and native flora and fauna - Land conducive to the maintenance of existing land forms, ecological health, connectivity, riverine and wetland areas - Biodiversity	Protected areas: - Whetstone State Forest - Bringalily State Forest	High	- Protected by State legislation - Important for biodiversity - Moderate sensitivity, high exposure to impacts
- Queensland's natural environment and native flora and fauna - Biodiversity	Category B regulated vegetation - 'Endangered' REs: 11.3.21 11.4.3 11.9.5	High	- Protected by State legislation - Important for biodiversity - Rare - High sensitivity, high exposure to impacts
	Category B regulated vegetation - 'Of Concern' REs: 11.3.2 11.3.4 11.5.14 11.5.20 11.8.3 11.8.11 11.9.7	Moderate	- Protected by State legislation - Important for biodiversity - Moderate sensitivity, high exposure to impact
	Category B regulated vegetation - 'Least Concern' REs: 11.3.14 11.3.18 11.3.25 11.3.27b 11.5.1 11.5.1a 11.5.4 11.5.20 11.7.4 11.7.5 11.7.7 11.8.2a	Low	- Protected by State legislation - Important for biodiversity - Moderate sensitivity, high exposure to impact

Associated ecological value	Identified receptors	Assigned sensitivity (refer Table 3.7)	Justification
	11.8.4 11.8.5		
	Category C regulated vegetation –HVR vegetation	Moderate	- Protected by State legislation - Important for biodiversity - Moderate sensitivity, high exposure to impact
	Migratory fauna species listed under the provisions of the EPBC Act (including habitat): Migratory Bird species - Osprey (<i>Pandion haliaetus</i>) - Fork-tailed swift (<i>Apus pacificus</i>) - Oriental cuckoo (<i>Cuculus optatus</i>) - Black-faced monarch (<i>Monarcha melanopsis</i>) - Rufous fantail (<i>Rhipidura rufifrons</i>) - Satin flycatcher (<i>Myiagra cyanoleuca</i>) - Spectacled monarch (<i>Symposiachrus trivirgatus</i>) - Yellow wagtail (<i>Motacilla flava</i>) - Common sandpiper (<i>Actitis hypoleucos</i>) - Sharp-tailed sandpiper (<i>Calidris acuminata</i>) - Pectoral sandpiper (<i>Calidris melanotos</i>) - Red-necked stint (<i>Calidris ruficollis</i>) - Latham's snipe (<i>Gallinago hardwickii</i>) - Glossy ibis (<i>Plegadis falcinellus</i>) - Common greenshank (<i>Tringa nebularia</i>)	High	- Protected by Commonwealth legislation - Uncommon - High sensitivity, high vulnerability
	Conservation significant terrestrial flora and fauna species listed under the provisions of the NC Act (including habitat): <i>Picris barbarorum</i> <i>Cyperus clarus</i> <i>Digitaria porrecta</i> - Common death adder (<i>Acanthopis antarcticus</i>) - Glossy black-cockatoo (<i>Calyptorhynchus lathami lathami</i>) - Major Mitchell's cockatoo (<i>Lophochroa leadbeateri</i>)	High	- Protected by State legislation - Rare - High sensitivity, high vulnerability

Associated ecological value	Identified receptors	Assigned sensitivity (refer Table 3.7)	Justification
	Priority Back on Track flora and fauna species (that are not listed under as threatened under the provisions of the EPBC Act or NC Act)	Low	- Protected by State legislation - A common feature of the landscape, not facing endangerment, not rare, low extinction risk - Low sensitivity, high exposure to impact
	Flora and fauna species not listed under the EPBC Act but listed as 'Least Concern' under the provisions of the NC Act and flora that is listed as SLC under the provisions of the NC Act	Low	- Protected by State legislation - A common feature of the landscape, not facing endangerment, not rare, low extinction risk - Low sensitivity, high exposure to impact
- Queensland's natural environment and native flora and fauna - Land conducive to the maintenance of existing land forms, ecological health, connectivity, riverine and wetland areas - Biodiversity	MSES wildlife habitat, State significant vegetation and bioregional corridors and Koala habitat mapping	High	- Important for biodiversity - High sensitivity, high exposure to impact
	Regionally significant vegetation, bioregional corridors and wildlife refugia	Moderate	- Identified as sensitive by State policy - Important for biodiversity - High exposure to impact
	Natural wetlands and watercourses, including: State significant wetlands (HES)	High	- Protected by State legislation - Important for biodiversity - High sensitivity, high exposure to impacts

5 Potential impacts and impact mitigation

Potential Project related impacts are described in the sections below. These impacts are then assessed against the identified Sensitive environmental receptors, with initial mitigation considered as part of 'initial impact mitigation' impact assessment. Project mitigation measures are then used to re-assess the significance of impact to determine any residual risk of impact with all mitigation measures in place is also provided within this section. In instances where preliminary assessment indicates that there is any potential for a residual impact significant with the potential to result in a significant residual impact to an MNES (i.e. migratory species listed under the EPBC Act) or to an MSES (no matter how slight) (refer Section 5.3.2), these Sensitive environmental receptors have been assessed under the relevant State or Commonwealth significant impact guidelines (refer Sections 5.3.3 and 5.3.4).

Through information gathered during the Project EIS process, Sensitive environmental receptors within the receiving environment which have the potential to be subject to significant impacts, have been identified. Mitigation measures have been developed to reduce the potential magnitude of impacts. Impact assessment methods to be adopted, depending on the nature of the Sensitive environmental receptor being assessed, are described in Section 5.1.2.

5.1 Description of potential impacts

5.1.1 Project activities

Infrastructure activities proposed as part of the Project have been categorised into four phases; construction, commissioning and reinstatement, operation and decommissioning. A description of Project related activities and the duration of their disturbance is provided in Table 5.1.

Table 5.1 Description of Project related activities associated with construction, commissioning and operation phases

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.6 for definitions)
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 boreholes and construction water storage	Medium term
		Installation of offices, hardstands etc	Medium term
		Stockpiling	Medium term
		Artificial impoundment dewatering	Permanent
	Utility diversions	Excavation	Temporary
		Trenching	Short term
		Modification, diversion and realignment of utilities and associated infrastructure	Short term/Medium term
	Drainage	Culvert installation	Permanent
	Structures	Construction of bridges over waterways	Medium term
		Road/rail bridge construction	Medium term

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.6 for definitions)
	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 Train signals and communications infrastructure	Short term
		Demobilising site compounds	Short term
	Tunnel construction	Removal of construction material and waste	Temporary
		Roadheader excavation	Short term
		Blasting	Temporary
		Removal of redundant structures	Temporary
		Decommissioning work site signs	Temporary
		Decommissioning access roads	Short term
		Forming and stabilising of spoil mounds	Short term
	Signals and communications installation	Removal of temporary fencing	Temporary
Commissioning	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	Train services	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
		Major periodic maintenance	Temporary

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.6 for definitions)
Operation	Train operations	Train movement along rail	Permanent
	Operational maintenance	Ongoing vehicle movement within rail corridor	Permanent

5.1.2 Potential impacts to terrestrial ecology

5.1.2.1 Habitat loss and degradation from vegetation clearing/removal

The Project footprint encompasses a total of 3,203.8 ha, of which 716.5 ha is existing cleared and maintained rail corridor. Queensland Government (DNRME) vegetation mapping indicates that the Project footprint includes 563.2 ha of remnant vegetation and 34.6 ha of HVR vegetation. The remaining 2,605.9 ha (81.3% 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 classified as Category X non-remnant vegetation.

The removal of vegetation 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). Vegetation clearing, and habitat loss are likely to occur during the construction phase activities. Conservation significant species (including habitats) are included in the likely Sensitive environmental receptors potentially impacted.

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.

5.1.2.2 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 Glossy black-cockatoo (*Calyptorhynchus lathami*), Major Mitchell's cockatoo (*Lophochroa leadbeateri*) and Short-beaked echidna (*Tachyglossus aculeatus*) (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 such as non-native invasive species) (Oli, 2004).

Physical trauma to 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 area (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. However, larger species with defined territories and movement patterns (e.g. Southern greater glider) 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 Sensitive environmental receptors, including conservation significant fauna species listed under the provisions of the NC Act, 'Least Concern' fauna species listed under the provisions of the NC Act and migratory species listed under the EPBC Act.

Some diurnal (active during the day) and mobile species, such as birds, including migratory species, 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 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 (i.e. vehicle movement to facilitate construction) 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 construction of tracks, as well as the general use of 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 development of the Project are ground dwelling species that are capable of moving across modified areas and arboreal which ascend to the ground to disperse.

The unmitigated potential occurrence of fauna species injuries or mortalities resulting from the Project can be short term and permanent, where mortality to the species occurs, or temporary where the species is rehabilitated and re-released (refer Table 3.6 for definitions associated with timeframes).

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

Compaction of 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).

Reduction in soil viability may negatively impact flora such as the Tall hawkweed (*Picris barbarorum*), and Finger panic (*Digitaria praeceps*). Impacts to soil may also have flow on effects to other threatened fauna species through degradation of their associated habitat.

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). This will act directly upon recruitment processes and may impact upon a species/communities ability to recolonise following disturbance.

Soil biota may also be affected by compaction, for example earthworm numbers and activity can be reduced in compacted soils (Pizl 2002). 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.

Larger non-burrowing soil animals such as mites, springtails, and fly larvae may also be affected by soil compaction. Burrowing animals such as earthworms, termites, ants, and beetles can defend themselves better but may still suffer negative effects.

The unmitigated potential impacts of soil compaction resulting from the Project are generally short term and temporary (refer Table 3.6 for definitions associated with timeframes).

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

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 during the operation phase of the Project.

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 Sensitive environmental receptors. These potential impacts are likely to be long term and affect all Sensitive environmental receptors in the Project footprint, including affecting the quality and integrity of remnant vegetation, habitat for conservation significant species, wetlands and waterways.

Non-native species comprised 30 per cent of the flora species and 8.5 per cent of the fauna species recorded in the impact assessment area (refer Sections 4.6.1 and 4.6.2). Of these, seven fauna species and eight flora species were restricted matters, listed under the provisions of the Biosecurity Act, were recorded.

Without appropriate management strategies, the Project activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited, occur in low densities, or have high specific habitat requirements where weed encroachment has been identified as a threatening process.

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 those occupied by the Sensitive environmental receptors such as Tall hawkweed (*Picris barbarorum*) and Finger panic (*Digitaria pruriens*).

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 Project footprint into the surrounding landscape, due to habitat removal, noise disturbance, and human presence during the construction and operational 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 5.1 for definitions associated with timeframes).

5.1.2.5 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 and fragmentation of such corridors have been identified as important threatening process to many threatened species including the Glossy black-cockatoo (*Calyptorhynchus lathami*).

The BPA mapping for Brigalow Belt (Queensland Government 2016) depicts regional and State corridors within the impact assessment area, which portrays vegetation that is significant for the spread and movement of flora and fauna. Connectivity is present north and south of the impact assessment area, and this is particularly evident in areas associated with steep topography and drainage lines.

However, most of the impact assessment area exists in generally fragmented environment. Despite this, 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 mobile species such as birds and bats.

The potential impacts of linear infrastructure traversing these biodiversity corridors include habitat fragmentation, edge effects and barrier effects, resulting in reduced population size and connectivity. 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. Sensitive environmental receptors involving conservation significant and migratory species listed under the provisions of the EPBC Act (migratory) and NC Act (threatened and near-threatened), bioregional corridors and wildlife refugia are likely to be impacted the most from these potential impacts due to the importance of habitat quality and linkages for species at a local scale and the cumulative impacts at a regional landscape scale.

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

5.1.2.6 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 1 km 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, Project activities (vegetation clearing, temporary and permanent) may result in fragmentation and reduction of existing habitat along with associated edge effects.

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. Major Mitchell's cockatoo (*Lophochroa leadbeateri*), Glossy black-cockatoo (*Calyptorhynchus lathami*)). However some species (e.g. Tall hawkweed (*Picris barbarorum*) and Finger panic (*Digitaria porrecta*)) are generally tolerant to edge related impacts and are often found within road reserves.

It is anticipated that threatened species and wetland and waterway may be impacted greatest from edge effects, where avoidance of vegetated areas is not practicable.

It is anticipated that sensitive environmental receptors involving conservation significant species, wetland and waterway habitat may be impacted greatest from edge effects, where avoidance of vegetated areas is not practicable.

The unmitigated potential impacts of edge effects resulting from the Project are considered to be long term and irreversible (refer Table 5.1 for definitions associated with timeframes).

5.1.2.7 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 (Loyn et al 1983) which further decreases population levels of other species remaining in the fragments.

The landscape in which the Project is situated is 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 associated edge effects and reduction in habitat. Sensitive environmental receptors involving conservation significant species, regionally significant vegetation, bioregional corridors and wildlife refugia may be impacted upon the most from habitat fragmentation. 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.

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. It should be noted localised fragmentation may have a greater impact on remnant vegetation communities.

The unmitigated potential impacts of habitat fragmentation resulting from the Project are considered to be long term and irreversible (refer Table 5.1 for definitions associated with timeframes).

5.1.2.8 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, railway line, earthworks embankments, cuttings, alteration to a waterway or a culvert that does not provide movement opportunities. Sensitive environmental receptors that are most vulnerable to barrier effects include the Short-beaked echidna (*Tachyglossus aculeatus*) and small, insectivorous migratory birds that depend on interconnect tracts of vegetation to facilitate migratory movements.

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.

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, while species such as macropods (i.e. kangaroos and wallabies) and smaller amphibian and reptile species are more likely to habituate to human presence.

Waterway barrier works have the potential to impair movement of fish species across the works area, decreasing connectivity of habitat and overall ecological service. Noting that the waterway barrier works for the Project are expected to be restricted to bridge infrastructure works within the construction phase. The bridge infrastructure works are to occur along major watercourses, with corresponding major risk category for waterway barrier works. Unmitigated impacts are likely to cause major impact to waterway works however bridge construction will incorporate piling of pre-fabricated structures outside low-flow areas of the watercourses, and inherently avoid fully unmitigated impact.

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 (Catling and Burt 1995).

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 5.1 for definitions associated with timeframes).

5.1.2.9 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 Sensitive environmental receptors.

Construction noise

Construction activities that may result in the generation of noise, and their anticipated sound power level, are summarised in Table 5.2.

Table 5.2 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 workforce accommodation ■ 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

Construction stage	Activities	Plant and equipment	Overall sound power level (dB(A) ¹)
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-resident workforce accommodation	- 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
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 5.2.

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 threatened 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 Sensitive environmental receptors 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 threatened 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.

5.1.2.10 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 threatened 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 threatened 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.

5.1.2.11 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.

5.1.2.12 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. Littered objects may also provide suitable habitat for disease-spreading insects, such as flies and mosquitoes (Healthy Land and Water 2019) and as such negatively impact aquatic species.

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).

Sensitive environmental receptors 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 highest risk of occurring during the construction phase and the potential to be long in duration due to the varying times of decomposition; however, it is likely to be localised and manageable through construction waste management processes.

5.1.2.13 Aquatic habitat degradation

Without mitigation activities related to the construction and operation of the Project are likely to impact water quality, thereby degrading habitats for aquatic fauna and flora. Erosion and sedimentation, contamination and an increase in litter are all potential mechanisms that could adversely impact aquatic habitat. In addition, direct loss of waterway habitat may occur through activities associated with waterway crossings during construction and operation. Further loss of ecological integrity 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.

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 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 5.1.2.14).

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 if adequate work practices and/or environmental management measures are not implemented or maintained.

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.

5.1.2.14 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 (vertisols).

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.

5.1.2.15 Contamination

An assessment of contaminated land within the impact assessment area was undertaken using a contaminated land risk assessment based on a contaminant (source)-pathway-receptor methodology, whereby:

- **Contaminant (source):** A substance present in or on land, water or site at above background concentrations that presents, or has the potential to present, a risk to human health, the environment or any environmental value
- **Pathway:** The route by which the source is brought into contact with the receptor. This can include the transport of contamination via water (i.e. surface and groundwater), aeolian deposition, vapours, excavation and deposition.
- **Receptor:** Humans, other living organisms, physical systems and built structures that could be affected by the source. A receptor will only be affected if a pathway from the source to the receptor is present. Groundwater and surface water systems can be considered as receptors in their own right as their quality is regulated by statutory bodies, as well as being pathways for contaminant migration to other receptors.

The source-pathway-receptor relationship allows an assessment of potential environmental risk to be carried out, based on the nature of the source, the degree of exposure of a receptor to a source, and the sensitivity of the receptor.

Based on the land uses within the impact assessment area, findings of a desktop assessment and field investigations, the potential sources of contamination in the vicinity of the Project alignment are considered to include:

- **Agricultural activities:** Hydrocarbons (fuel and oil storage and use), pesticides and herbicides, asbestos and lead paint, arsenic (cattle dips) and landfilling
- **Quarries:** Hydrocarbons (fuel and oil storage and use), metals/metalloids and hazardous materials
- **Landfilling, waste disposal:** Hazardous materials, hydrocarbons, metals/metalloids, phenols, polychlorinated biphenyls, phthalates, volatiles and pesticides and herbicides
- **Existing rail corridor:** Metals, asbestos, hydrocarbons and pesticides/herbicides
- **Road crossings:** Metals and hydrocarbons
- **Unknown fill material:** Asbestos, metals/metalloids and hydrocarbons.

The source-pathway-receptor linkage for each of the potential sources of contamination within the impact assessment area is presented in Table 5.3.

Table 5.3 Potential existing contaminated land source, pathway and receptor linkages

Potential source	Located within the Project footprint	Contaminants	Potential pathway	Potential receptor
Agricultural land	Yes	Pesticides and herbicides (agricultural storage and use)	■ Direct contact ■ Dispersion of soil and dust from wind and water ■ Surface water runoff.	Human health: ■ Ingestion, inhalation, dermal contact ■ Current and future site users, construction workers, site visitors, surrounding land users. Ecological: ■ Terrestrial – direct contact and consumption (including bioaccumulation) ■ Aquatic ecosystems – direct contact and consumption (including bioaccumulation).

Potential source	Located within the Project footprint	Contaminants	Potential pathway	Potential receptor
		Hydrocarbons (fuel and oil storage and use) (agricultural storage and use)	- Direct contact - Dispersion of soil and dust from wind and water - Surface water runoff.	Human health: - Current and future site users, construction workers, site visitors, surrounding land users. Ecological: - Potential exposure to surrounding cropping lands. - Aquatic ecosystems.
		Asbestos and lead paint (agricultural buildings/ structures)	- Direct contact - Ingestion - Inhalation - Dispersion of soil and dust from wind and water - Surface water runoff.	Human health: Current and future site users, construction workers, site visitors, surrounding land users.
		Livestock dips or spray races arsenic, DDT, DDE, DDD (agricultural storage and use)	- Direct contact - Ingestion - Dispersion of soil and dust from wind and water - Surface water runoff.	Human health: - Ingestion, inhalation, dermal contact - Current and future site users, construction workers, site visitors, surrounding land users. Ecological: - Terrestrial – direct contact and consumption (including bioaccumulation) - Aquatic ecosystems – direct contact and consumption (including bioaccumulation).
Housing/ sheds/other	Yes	Hydrocarbons (fuel and oil storage and use), pesticides and herbicides, lead paint and asbestos (agricultural and residential storage and use, commercial enterprise)	- Direct contact - Ingestion - Inhalation - Dispersion of soil and dust from wind and water - Surface water runoff	Human health: - Land owners, current and future site users, construction workers, site visitors, surrounding land users Ecological: - Terrestrial – direct contact and consumption - Aquatic ecosystems – direct contact and consumption (including bioaccumulation).
Mines e.g. Lot 8 SP126840	No	Acid mine drainage, metals/ metalloids (commercial enterprise)	- Direct contact - Ingestion - Inhalation - Dispersion of soil and dust from wind and water - Surface water runoff	Human health: - Land owners, current and future site users, construction workers, site visitors, surrounding land users Ecological: - Terrestrial – direct contact and consumption - Aquatic ecosystems – direct contact and consumption (including bioaccumulation).

Potential source	Located within the Project footprint	Contaminants	Potential pathway	Potential receptor
Existing rail corridor	Yes	Metals/metalloids, asbestos, hydrocarbons, pesticides/herbicides (railway land use)	- Direct contact - Dispersion of soil and dust from wind and water - Surface water runoff.	Human health: - Ingestion, inhalation, dermal contact - Current and future site users, construction workers, site visitors, surrounding land users. Ecological: - Terrestrial – direct contact and consumption - Aquatic ecosystems – direct contact and consumption (including bioaccumulation).
Landfill (municipal) e.g. Lot 1 RP835800	No	Hazardous materials, hydrocarbons, metals/metalloids, phenols, polychlorinated biphenyls, phthalates, volatiles and pesticides and herbicides (local Council or commercial enterprise)	- Direct contact - Dispersion of soil and dust from wind and water - Surface water runoff - Leaching.	Human health: - Current and future site users, site workers, site visitors, surrounding land users. Ecological: - Terrestrial – direct contact and consumption (including bioaccumulation) - Aquatic ecosystems – direct contact and consumption (including bioaccumulation).
Roads	Yes	Metals, hydrocarbons, pesticides/herbicides (public roads)	- Direct contact - Dispersion of soil and dust from wind and water - Surface water runoff.	Human health: - Ingestion, inhalation, dermal contact - Current and future site users, construction workers, site visitors, surrounding land users. Ecological: - Terrestrial – direct contact and consumption - Aquatic ecosystems – direct contact and consumption (including bioaccumulation).

Construction activities for the Project have the potential to disturb existing contaminated land. The disturbance of contaminated soil or groundwater during Project activities have the potential to contaminate previously unaffected soil or groundwater, degrade ecosystem health and affect human health through dermal contact or ingestion of contaminants.

The Project footprint and construction methodology will be subject to confirmation through the detail design phase. Following confirmation of these aspects, a further assessment will be required to identify potential contaminated land that is within the Project footprint and will be disturbed by construction activities. Potentially contaminated sites, including existing rail corridor, that will be disturbed will require specific management controls to be developed by a suitably qualified person to outline the process to identify, document and manage contamination in these locations. In some instances, further environmental site investigation may be warranted. Risks to ecological receptors will be considered as a part of further environmental site investigations.

5.1.2.16 Flooding

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 5.4 summarises how the Project design performs against each of the flood impact objectives.

Table 5.4 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
	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.				

Parameter	Objectives and outcomes
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. Potential impacts associated with alterations to hydrology are likely to impact species that are less mobile. For example, the Common death adder 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 5.5), due to potential susceptibility to flood events (ie poor dispersal ability of sessile nature):

- A sedge (*Cyperus clarus*)
- Finger panic (*Digitaria porrecta*)
- Tall hawkweed (*Picris barbarorum*)
- Common death adder (*Acanthopis antarcticus*).

Table 5.5 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 5.5 Potential indirect impact to susceptible sensitive environmental receptors under non-mitigated flooding scenarios

Susceptible sensitive environmental receptor	Modelled flooding scenarios			
	5% AEP	1% AEP	1 in 10,000 AEP	PMF
A sedge (<i>Cyperus clarus</i>)	Nil	Nil	WES – WD, CpW	WES – WD, CpW
Finger panic (<i>Digitaria porrecta</i>)	Nil	PAR - CpW	GOW – CpW, CON – CpW PAR - CpW	GOW – CpW CON – CpW PAR - CpW
Tall hawkweed (<i>Picris barbarorum</i>)	Nil	BAC – WD, CpW	GOW – CpW, WES – WD, CpW CON – CpW BAC – CpW PAR – WD	GOW – CpW WES – WD, CpW CON – CpW BAC – CpW NAT – CpW PAR – WD, CpW MACR - CpW
Common death adder (<i>Acanthopis antarcticus</i>)	Nil	BAC – WD, CpW PAR – CpW	WES – WD CON – CpW BAC – CpW PAR – CpW	WES – WD CON – CpW BAC – CpW NAT – CpW PAR – CpW MACR - CpW

Table notes:

GOW – Gowrie Creek, WES – Westbrook Creek, CON – Condamine River (including Grasstree Creek), BAC – Back Creek, NAT – Native Dog Creek, PAR – Pariagara Creek, MACR – Macintyre River.

Temporary Displacement from Habitat from WD- Wetting/Drying, CpW - change in peak water levels (< or > 0.20 m).

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 is not considered to be varied within any flooding scenario and would not likely be a significant impact. Within the smaller flooding scenarios, identified as occurring more commonly, only no susceptible sensitive environmental receptors were identified as potentially impacted from changes to wet and dry landscape variation or changes to peak water levels. Potential changes associated with the Back Creek and Pariagara Creek within the 1% AEP scenarios were identified for Finger panic (*Digitaria porrecta*), Tall hawkweed (*Picris barbarorum*) and Common death adder (*Acanthopis antarcticus*).

5.2 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 5.2.1), as well as those measures that are proposed to be adopted for future phases of Project delivery (refer Section 5.2.2).

5.2.1 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 terrestrial ecology 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
 - 'Endangered' and 'Of Concern' REs and HVR
 - Riparian vegetation
 - Steep slopes
 - Along riverbanks
- 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 (refer Figure 5.1). 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.
- Opportunities for the provision of fauna fencing and fauna movement solutions have been identified (refer Figure 5.1 and Figure 5.2). 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.

5.2.2 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. 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 (refer Appendix B). Additional strategies from relevant threat abatement plans and recovery plans will be incorporated, as appropriate, into the Project's CEMP and associated sub-plans.

Mitigation measures proposed for implementation in future phases of Project delivery have been grouped and presented, as follows:

- Table 5.6 identifies overarching mitigation and management measures for all ecological values
- Table 5.7 provides mitigation measures specific to Sensitive environmental receptors (flora and fauna) that constitute an MNES
- Table 5.8 provides mitigation measures specific to Sensitive environmental receptors (flora and fauna) that constitute an MSES.

The specific management measures for MNES and MSES target habitat types in the first instance, as opposed to individual species. Therefore, some MNES and MSES species are grouped together in Table 5.7 and Table 5.8 despite being of different taxonomic classes. For example Common sandpiper, Sharp-tailed sandpiper, Pectoral sandpiper, Red-necked stint, Latham's snipe, Yellow wagtail, Osprey, Glossy ibis and Common greenshank have been grouped together in Table 5.7 and *Cyperus clarus*, Finger panic and Tall hawkweed have been grouped together in Table 5.8, as each of these species is known to occupy overlapping habitat within the Project footprint. Species specific measures have been nominated within these groupings, where relevant.

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 Sections 5.3.3 and 5.3.4.

5.2.1 Flora and fauna management and monitoring

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 mitigation measures used on similar projects that have been subject to legislative approval (refer footnotes to Table 5.6). It is acknowledged the effectiveness of these measures may not be subject to rigorous peer-reviewed analysis. 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 measures

In addition, as the Project moves into the detailed design and construction phases, more focused and comprehensive ecological surveys in accordance with the relevant survey guidelines will be undertaken. The surveys will 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, 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 habitat
- 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.

EIS Chapter 22: Draft outline environmental management plan provides further context and the framework for implementation of these proposed mitigation and management measures.

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.

Table 5.6 Project impact mitigation measures

Delivery phase	Aspect	Mitigation and management measures
Detail design	Flora and fauna/ biodiversity	■ 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, 2014). Flora species to be targeted through these surveys include: ■ MNES threatened flora species: ■ MSES flora: – A sedge (<i>Cyperus clarus</i>) – Tall hawkweed (<i>Picris barbarorum</i>) – Finger panic (<i>Digitaria porrecta</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: ■ MNES threatened fauna species ■ MSES fauna: – Common death adder (<i>Acanthopis antarcticus</i>) – Glossy black-cockatoo (<i>Calyptrorhynchus lathamii lathamii</i>) – Major Mitchell's cockatoo (<i>Lophochroa leadbeateri</i>) ■ MNES fauna (non-threatened migratory species): – Common sandpiper (<i>Actitis hypoleucos</i>) – Fork-tailed swift (<i>Apus pacificus</i>) – Sharp-tailed sandpiper (<i>Calidris acuminata</i>) – Pectoral sandpiper (<i>Calidris melanotos</i>) – Red-necked stint (<i>Calidris ruficollis</i>) – Oriental cuckoo (<i>Cuculus optatus</i>) – Latham's snipe (<i>Gallinago hardwickii</i>) – Black-faced monarch (<i>Monarcha melanopsis</i>) – Yellow wagtail (<i>Motacilla flava</i>) – Satin flycatcher (<i>Myiagra cyanoleuca</i>) – Osprey (<i>Pandion haliaetus</i>) – Glossy ibis (<i>Plegadis falcinellus</i>) – Rufous fantail (<i>Rhipidura rufifrons</i>) – Spectacled monarch (<i>Symposiachrus trivirgatus</i>) – Common greenshank (<i>Tringa nebularia</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 Biosecurity Act 2014.

Delivery phase	Aspect	Mitigation and management measures
		– 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) – 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 MNES and MSES. Data obtained from these detailed surveys will be used to refine the quantification of ecological impacts and confirm 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.

Delivery phase	Aspect	Mitigation and management measures
	Water quality	■ A Surface Water Management Sub-plan will be developed as a component of the CEMP (refer EIS 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 – 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

Delivery phase	Aspect	Mitigation and management measures
		– 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 Fauna Sensitive Road Design Manual (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.
	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.

Delivery phase	Aspect	Mitigation and management measures
	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 ■ 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).

Delivery phase	Aspect	Mitigation and management measures
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).
	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)

Delivery phase	Aspect	Mitigation and management measures
		- 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.
	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.

Delivery phase	Aspect	Mitigation and management measures
	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 - 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:

- Mitigation measure successfully implemented as part of the Toowoomba Second Range Crossing Project.
- 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)].
- 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).

Table 5.7 Proposed mitigation measures specific to MNES (non-threatened migratory species)

Sensitive environmental receptor	Receptor-specific mitigation and management measures (in addition to those specified in Table 5.6)
Construction	
Wetland migratory species: Common sandpiper, Sharp-tailed sandpiper, Pectoral sandpiper, Red-necked stint, Latham's snipe, Yellow wagtail, Osprey, Glossy ibis, Common greenshank	- 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 areas or to utilising the Project footprint for shelter - 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.
Woodland birds: Oriental cuckoo, Black-faced monarch, Satin flycatcher, Rufous fantail, Spectacled monarch	- Pre-construction surveys of woodlands identified as potential habitat (refer habitat mapping in Appendix G), particularly any nest sites within the Project footprint, as per MNES draft referral guidelines where suitable nesting habitat is identified. - Should active nest sites be identified restricted work measures will be implemented to allow nesting to continue undisturbed.
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 target habitat types in the first instance, as opposed to individual species. Therefore, some 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).

Table 5.8 Proposed mitigation measures specific to MSES flora and fauna species

Sensitive environmental receptor	Receptor-specific mitigation and management measures (in addition to those specified in Table 5.6)
Construction	
Cyperus clarus, finger panic (<i>Digitaria porrecta</i>), tall hawkweed (<i>Picris barbarorum</i>)	■ Pre-construction protected flora surveys, as per the NC Act, within the Project footprint that target areas identified as potential habitat for the species, as per species habitat mapping (refer Appendix J: Terrestrial Ecology Technical Report). Potential suitable habitat for <i>Cyperus clarus</i>, finger panic (<i>Digitaria porrecta</i>) and tall hawkweed (<i>Picris barbarorum</i>) exists between Millmerran and Toowoomba, particularly within road and rail reserves that contain basalt derived soils (i.e. black soils) ■ Undertake translocation of specimens, where appropriate, for a species where there is documented record of previous translocation trials/schemes ■ 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. ■ 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 occurrence ■ 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. ■ Where possible rehabilitation of disturbed areas, within the Project footprint but outside of the rail corridor, using endemic species.
Platypus	■ 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 ■ 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 requirement for a species management program, should breeding places (i.e. burrows) be present. ■ 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 passage) ■ Implementation of the Biosecurity Management Sub-plan, Soil Management Sub-plan and the Surface Water Management Sub-plan.

Sensitive environmental receptor	Receptor-specific mitigation and management measures (in addition to those specified in Table 5.6)
Common death adder (<i>Acanthophis antarcticus</i>) and short-beaked echidna ¹ (<i>Tachyglossus aculeatus</i>)	- Pre-construction surveys of potential habitat of these species to identify whether individuals occur within the Project footprint. Surveys will target those areas identified as potential habitat for the species as per species habitat mapping (Appendix J: Terrestrial Ecology Technical Report) and be carried out as per relevant DES guidelines. Surveys specifically to look for short-beaked echidna (<i>Tachyglossus aculeatus</i>) breeding burrows and assess the requirement for a Species Management Program to tamper with animal breeding places, in accordance with the <i>Nature Conservation (Wildlife) Regulation 2006</i>. - Undertake pre-clearance ground surveys for the common death adder (<i>Acanthophis antarcticus</i>) and short-beaked echidna (<i>Tachyglossus aculeatus</i>) where pre-construction surveys have identified the species as occurring or likely to occur - Implement measures to allow safe and responsible handling of fauna (where required) and repatriation in pre-identified appropriate habitat outside of the Project footprint - Measures to responsibly handle injured fauna - Measures to control vehicle speed limits onsite to no more than 40 km/hr - Establish and maintain a fauna management and incident register to record sightings and/or incidents involving fauna species during the undertaking of Project activities - Fauna crossing structures and fencing are installed in accordance with design specifications - Rehabilitation of temporary construction areas where habitat has been cleared. Revegetation plant species will be obtained from a reliable source that is certified free of pathogens.
Glossy black-cockatoo (<i>Calyptorhynchus lathami</i>), Major Mitchell's cockatoo (<i>Lophochroa leadbeateri</i>)	- Pre-construction surveys of woodlands within the Project footprint identified as potential habitat (refer habitat mapping in Appendix J: Terrestrial Ecology Technical Report). Surveys for nest sites will be as per DES guidelines where suitable nesting habitat (i.e. large trees containing hollows) is identified. - Should active nest sites for either parrot be identified, restricted works measures will be implemented to allow nesting to continue undisturbed.
Operation	
All sensitive receptors	- Ongoing weed monitoring within the rail corridor with specific reference to maintaining the pre-construction condition of TEC and habitats that adjoin the rail corridor - Maintenance of erosion and sediment controls 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 - 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.

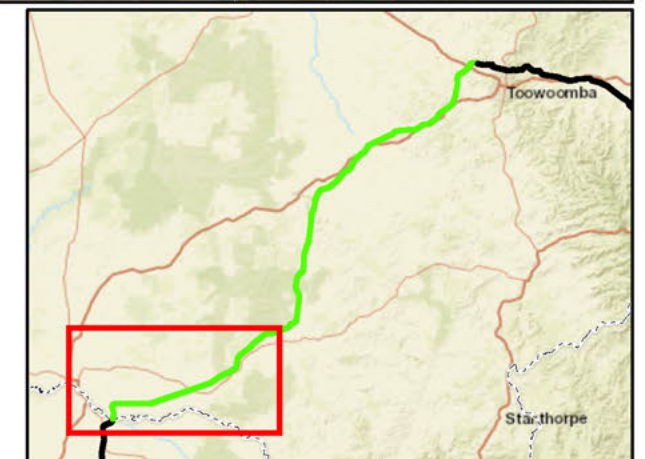
Table note:

- The specific management measures for MSES target habitat types in the first instance, as opposed to individual species. Therefore, some MSES species are grouped together despite being of different taxonomic classes.



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
- Proposed rail bridge over waterway
- Canopy bridge overpass
- Over track at natural level (cut / fill interface)



A3 scale: 1:250,000



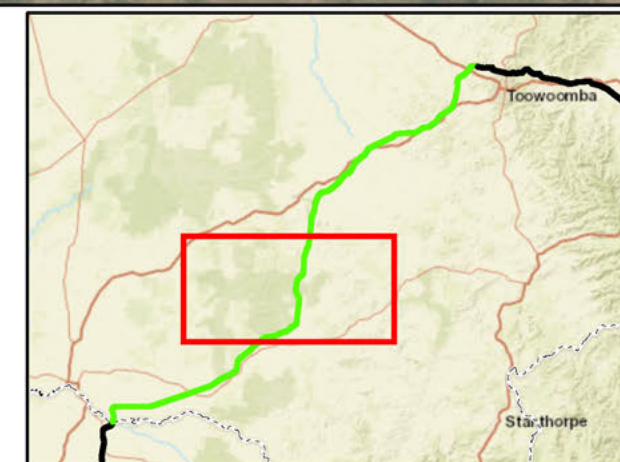


Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Major roads
- Minor roads
- Watercourses
- Project footprint
- Impact assessment area

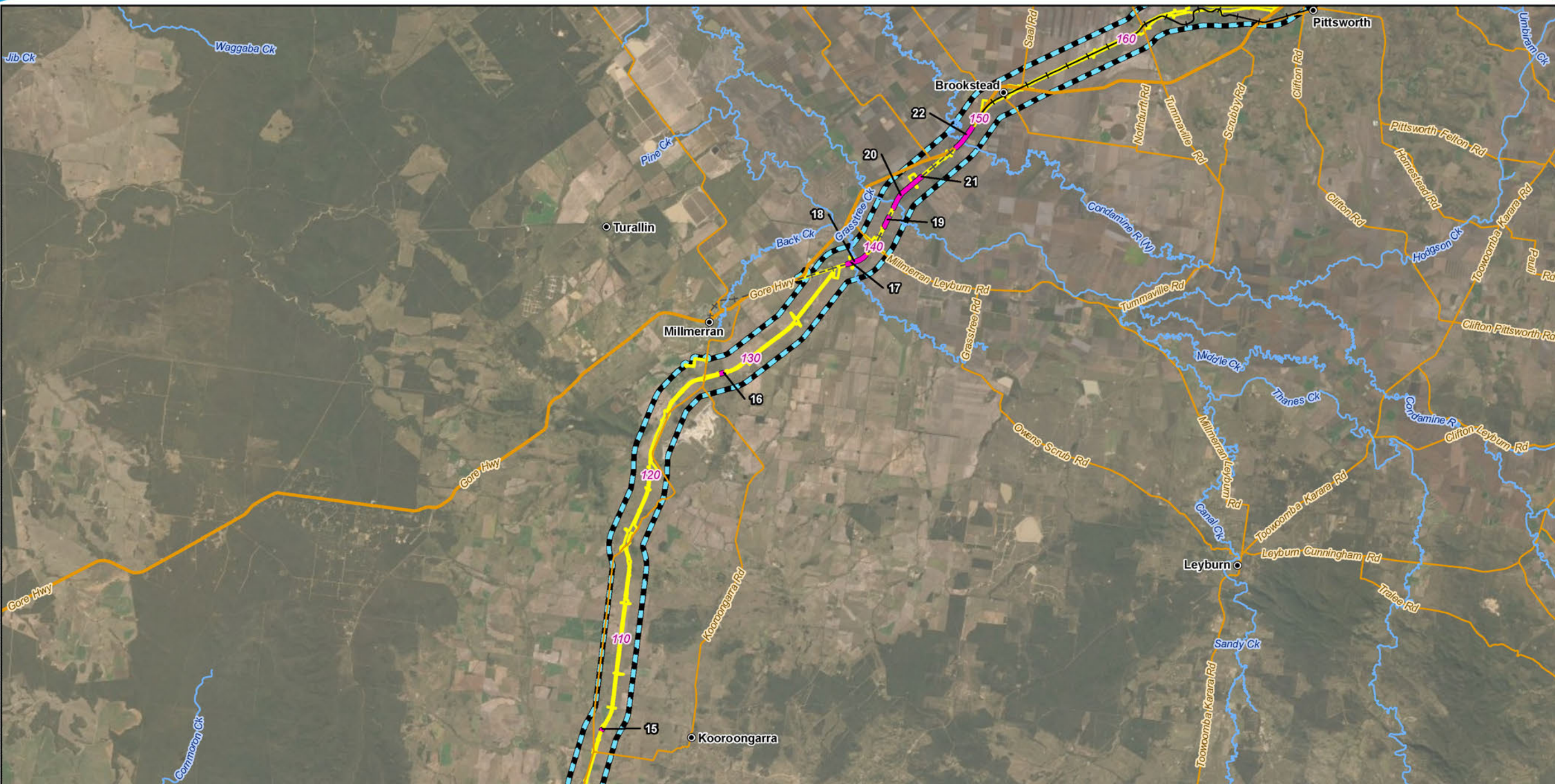
Proposed fauna crossings

- Proposed rail bridge over waterway
- Canopy bridge overpass
- Over track at natural level (cut / fill interface)



A3 scale: 1:250,000



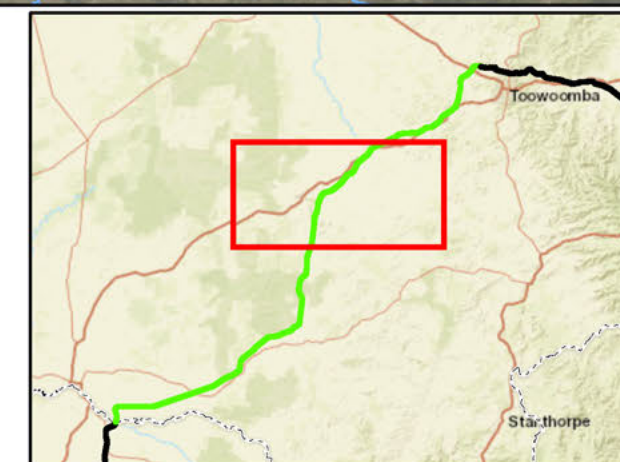


Legend

- 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



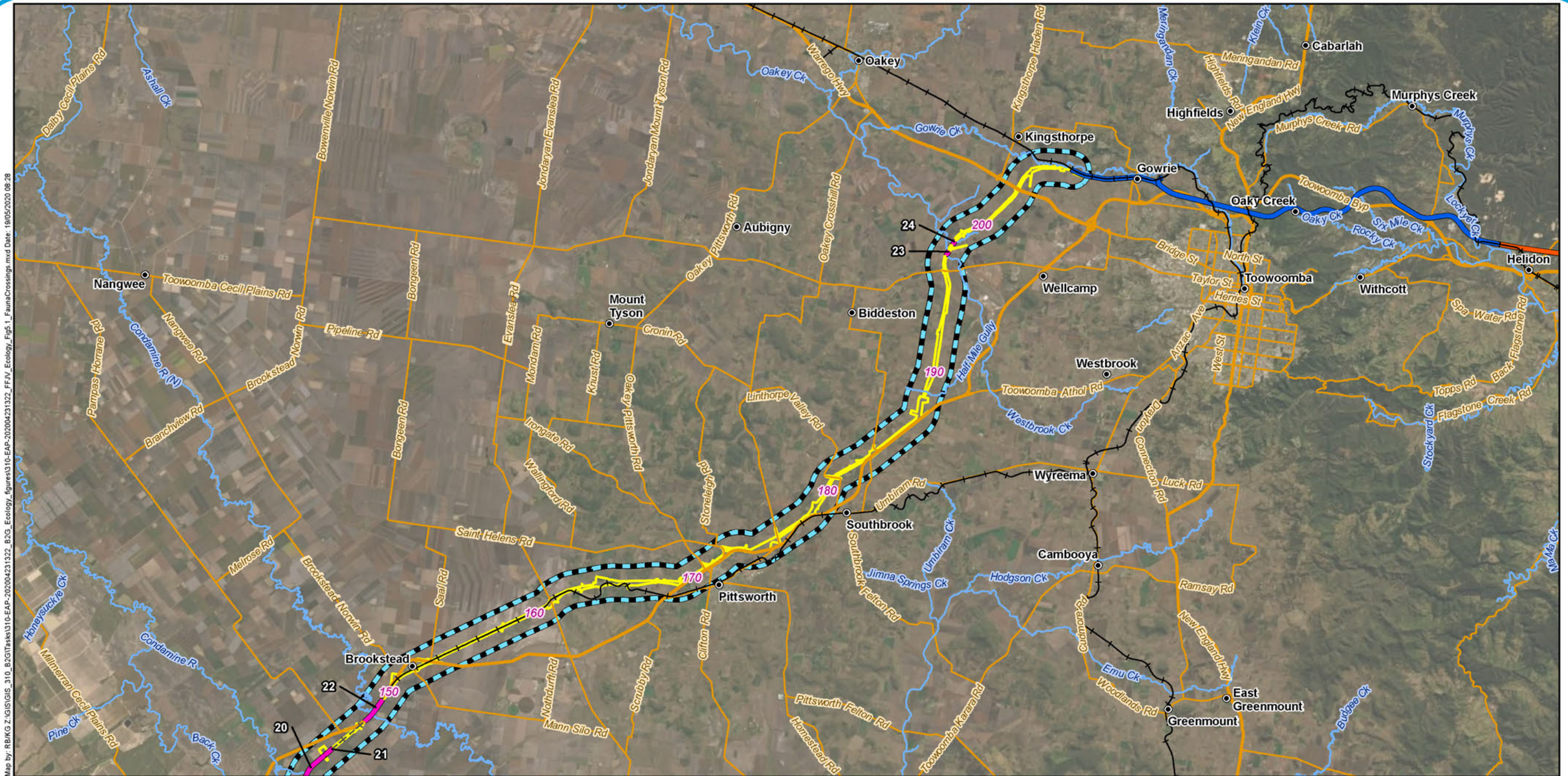
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 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.1c:

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

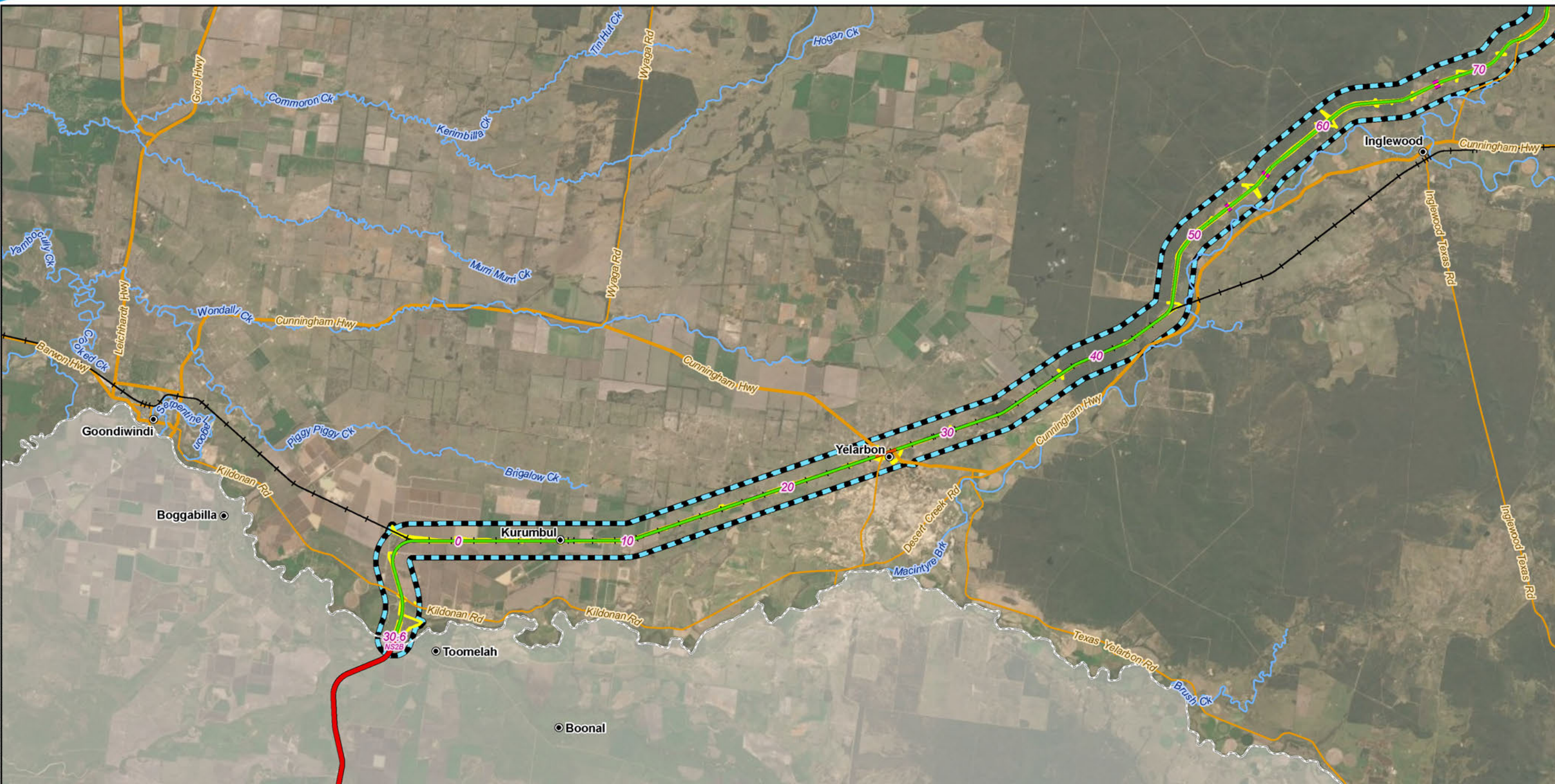
Proposed fauna crossings

- Proposed rail bridge over waterway



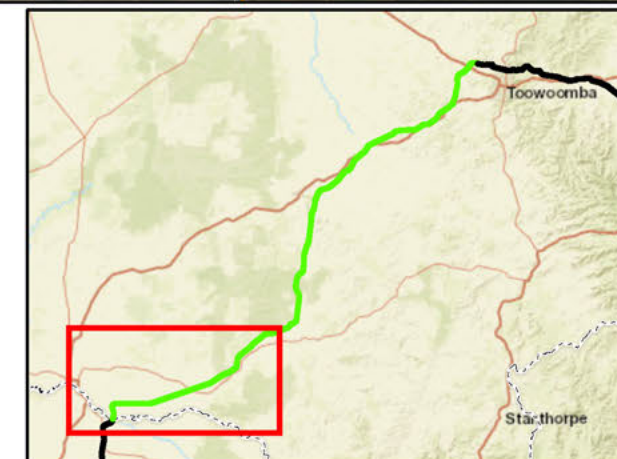
A3 scale: 1:250,000





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
- Fence type
- Fauna exclusion fencing 150m either side of chainage (exclude crossing point)
- Standard chain link boundary fence
- Standard rural chain wire



A3 scale: 1:250,000

0 5 10 15km

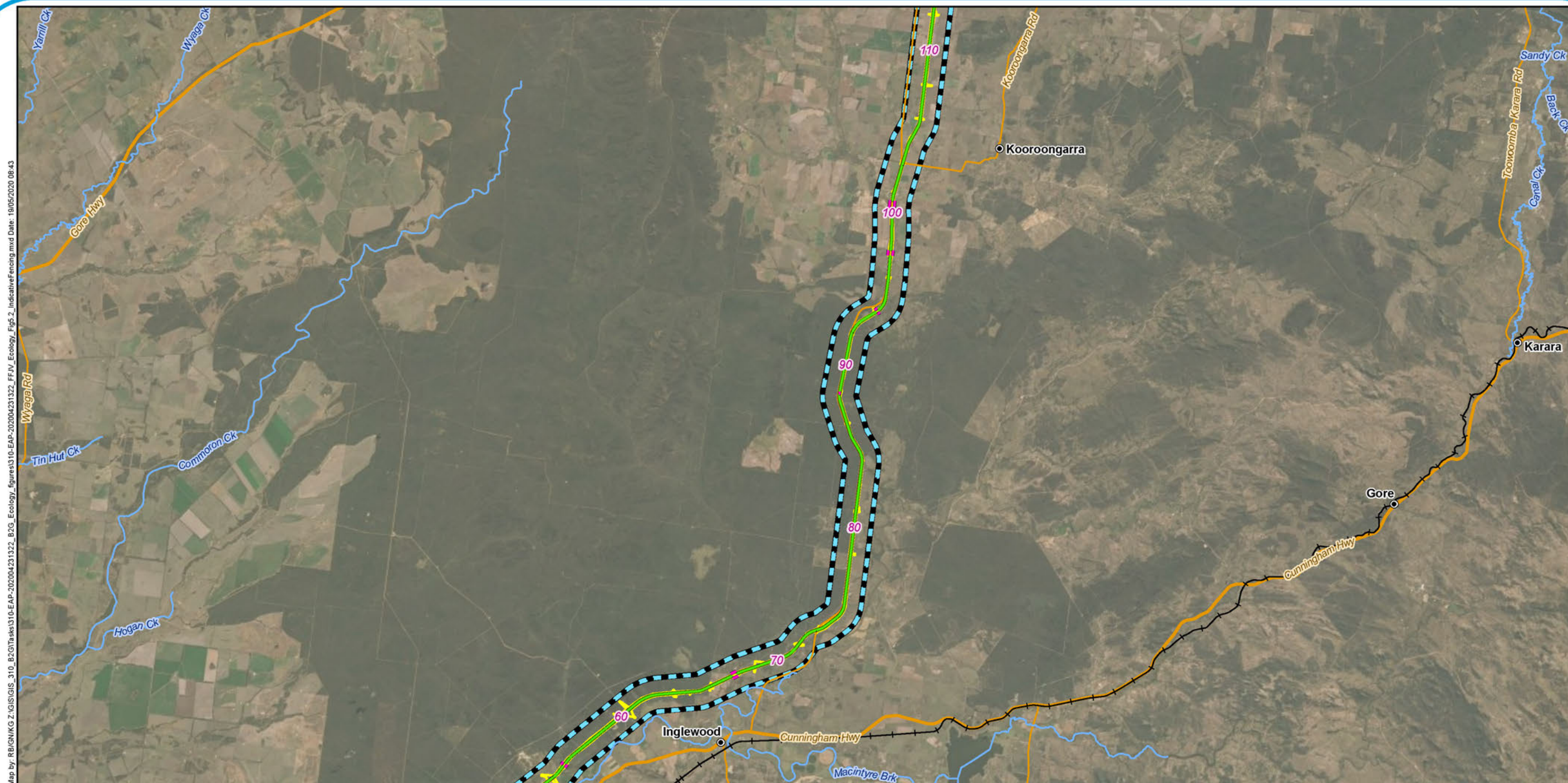


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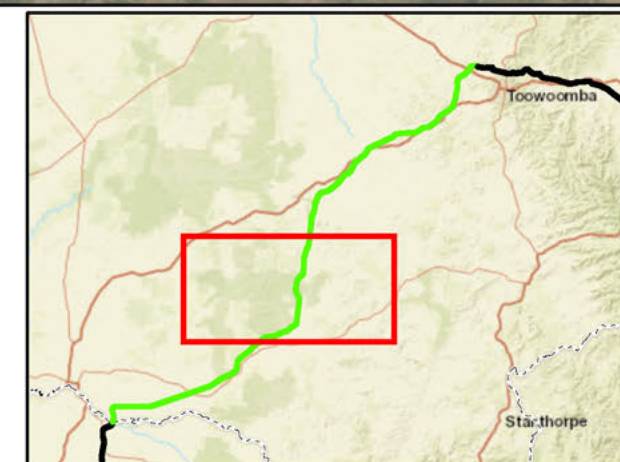
Border to Gowrie

Figure 5.2a: Location of indicative fencing including of fauna crossing solutions



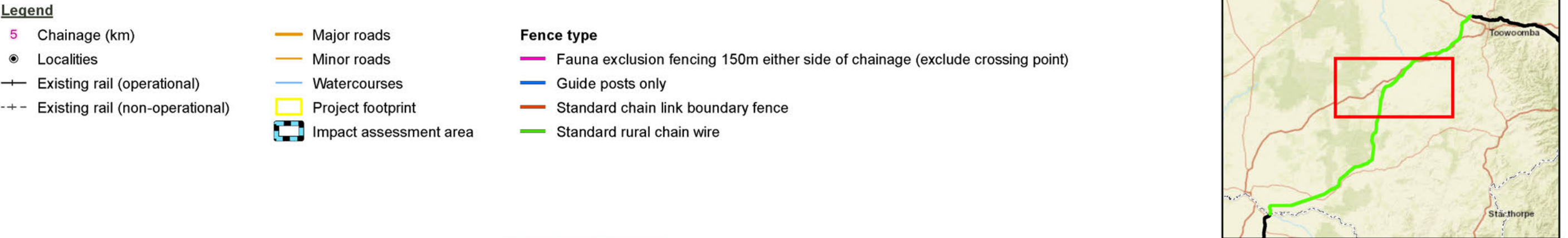
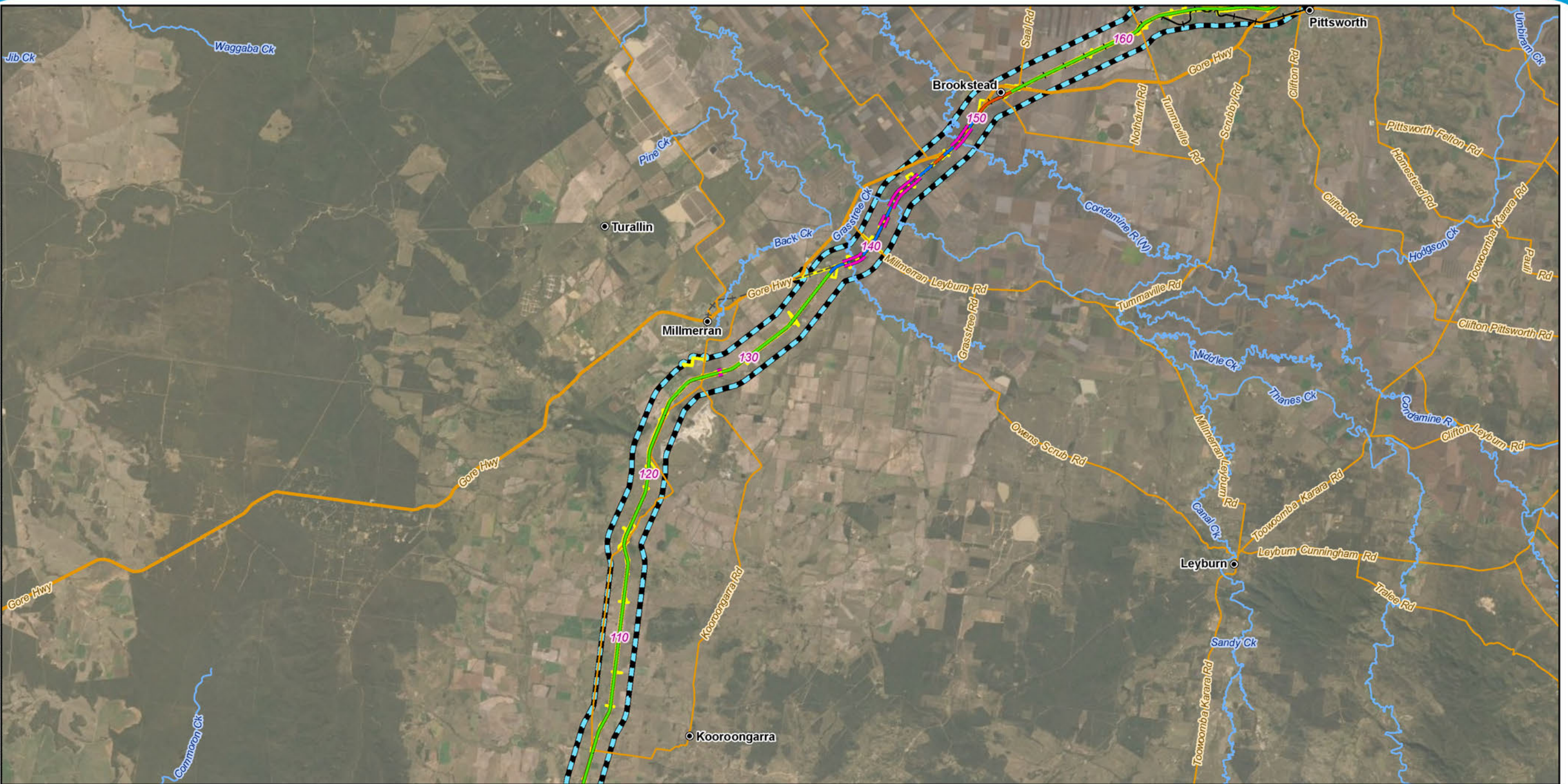
Legend

- | | | |
|-------------------------------|------------------------|---|
| 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 | — Standard rural chain wire |
| | Project footprint | |
| | Impact assessment area | |



A3 scale: 1:250,000

0 5 10 15km



A3 scale: 1:250,000
 0 5 10 15km

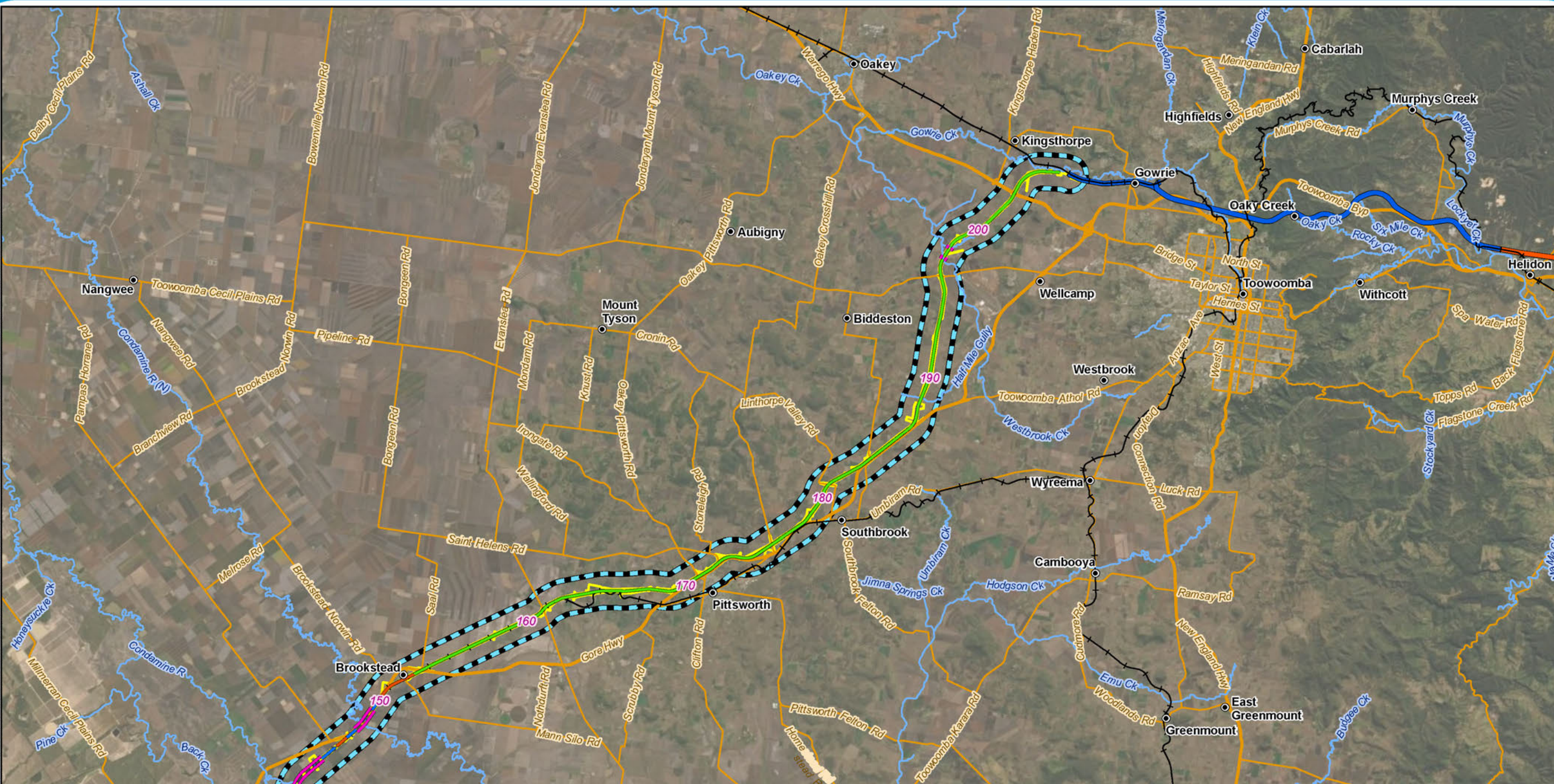


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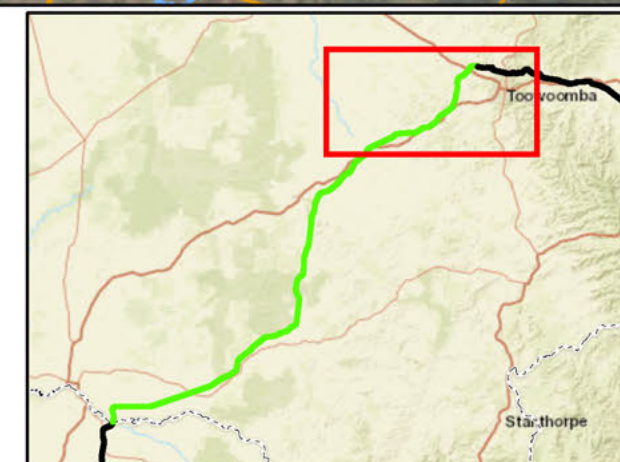
Border to Gowrie

Figure 5.2c: Location of indicative fencing including of fauna crossing solutions



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



Future Freight
 Integrating Community, Environment and Engineering

Issue date: 18/05/2020 Version: 1
 Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.2d: Location of indicative fencing including of fauna crossing solutions

5.3 Impact assessment

Potential flora and fauna impacts during construction, commissioning and operation have been assessed in accordance with the qualitative impact assessment methodology outlined in Section 3.4.3 and EIS Chapter 4: Assessment Methodology.

Potential impacts to Sensitive environmental receptors due to construction of the Project have been assessed in Sections 5.1.2. For the purposes of impact assessment, the maximum potential disturbance to each Sensitive environmental receptor (e.g. areas identified using the predictive habitat mapping or the maximum extent government certified mapping) have been used. This mapping assumes that habitat for threatened species is present unless there is sufficient and robust scientific information to support a species being excluded from the assessment. This represents an application of the precautionary principle and represents a highly conservative estimate of Project impacts. Given the highly conservative approach adopted, 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.

The initial significance assessment is undertaken on the assumption that the design measures factored into the Project design (refer Section 5.2.1) have been implemented. The residual significance level of the potential impacts is reassessed taking into consideration the implementation of the proposed mitigation measures listed in Table 5.6. This has been split into consideration of the construction phase, the commissioning and reinstatement phase, and operations. Environmental offsets in response to residual impacts are discussed in Section 5.4.

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 Sensitive environmental receptors 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 update the quantification of significant residual impacts and confirm the biodiversity offset requirements for the Project.

5.3.1 Quantification of potential magnitude of impacts

Estimation of the potential magnitude of disturbance was undertaken for each of the sensitive environmental receptors identified during the desktop assessment and field surveys. This assessment of impact magnitude was undertaken using predictive habitat modelling, which was supported by field validation and government GIS datasets. In addition, the Project footprint was used to determine the 'unmitigated' disturbance area as a percentage of the extent of the ecological receptors within the broader Project context (i.e. the impact assessment area).

Calculated estimates of potential disturbance magnitudes for each of the Sensitive environmental receptors is provided in the following:

- Table 5.9 for non-threatened, migratory species listed under the EPBC Act
- Table 5.10 for NC Act threatened, near-threatened and SLC species
- Table 5.11 for other state-based sensitive environmental receptors.

The magnitude of impacts is determined using techniques and tools that facilitate an estimation of the **extent**, **duration** and **frequency** of the impacts, as described in Table 3.5 and Table 3.6.

Table 5.9 Estimation of potential magnitude of disturbance for EPBC Act listed, non-threatened migratory species 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 Sensitive environmental receptors within the impact assessment area			Magnitude of disturbance area ^{5,6}
				Potential habitat	Important habitat	Total habitat	Potential habitat	Important habitat	Total habitat	
EPBC Act migratory species										
<i>Actitis hypoleucos</i>	Common sandpiper	SLC	M	44.98	87.62	132.60	4.87	7.03	6.11	Moderate
<i>Apus pacificus</i>	Fork-tailed swift	SLC	M	2,605.89	597.89	3,203.78	7.55	6.61	7.35	Moderate
<i>Calidris acuminata</i>	Sharp-tailed sandpiper	SLC	M	44.98	87.62	132.60	4.87	7.03	6.11	Moderate
<i>Calidris melanotos</i>	Pectoral sandpiper	SLC	M	44.98	87.62	132.60	4.87	7.03	6.11	Moderate
<i>Calidris ruficollis</i>	Red-necked stint	SLC	M	44.98	87.62	132.60	4.87	7.03	6.11	Moderate
<i>Cuculus optatus</i>	Oriental cuckoo	SLC	M	24.45	0.00	24.45	5.50	0.00	5.50	Moderate
<i>Gallinago hardwickii</i>	Latham's snipe	SLC	M	44.98	87.62	132.60	4.87	7.03	6.11	Moderate
<i>Monarcha melanopsis</i>	Black-faced monarch	SLC	M	24.45	0.00	24.45	5.50	0.00	5.50	Moderate
<i>Motacilla flava</i>	Yellow wagtail	SLC	M	44.98	87.62	132.60	4.87	7.03	6.11	Moderate
<i>Myiagra cyanoleuca</i>	Satin flycatcher	SLC	M	24.45	0.00	24.45	5.50	0.00	5.50	Moderate
<i>Pandion haliaetus</i>	Osprey	SLC	M	44.98	0.00	44.98	4.92	0.00	4.87	Moderate
<i>Plegadis falcinellus</i>	Glossy ibis	SLC	M	44.98	87.62	132.60	4.87	7.03	6.11	Moderate
<i>Rhipidura rufifrons</i>	Rufous fantail	SLC	M	24.45	0.00	24.45	5.50	0.00	5.50	Moderate
<i>Symposiachrus trivirgatus</i>	Spectacled monarch	SLC	M	24.45	0.00	24.45	5.50	0.00	5.50	Moderate
<i>Tringa nebularia</i>	Common greenshank	SLC	M	44.98	87.62	132.60	4.87	7.03	6.11	Moderate

Table notes:

M = Migratory SLC = Special Least Concern

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. Sensitive environmental receptors 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 4.28 for areas of habitat within the impact assessment area

5 Based on total habitat available

6 Refer Table 3.5 for magnitude criteria

Table 5.10 Estimation of potential magnitude of disturbance for NC Act conservation significant flora and fauna species (excluding matters of national environmental significance) for the Project

Species name	Common name	NC Act status	Predicted habitat within the Project footprint (ha) ^{1,2,3,4}				Percentage (%) disturbance to Sensitive environmental receptors within the impact assessment area				Magnitude of total habitat disturbance area ^{5,6}
			General	Essential	Core	Total habitat	General	Essential	Core	Total habitat	
NC Act conservation significant flora											
<i>Cyperus clarus</i>	A sedge	V	106.00	0.00	0.00	106.00	10.88	0.00	0.00	10.88	Moderate
<i>Digitaria porrecta</i>	Finger panic	NT	373.87	81.74	0.00	455.61	11.72	15.45	0.00	12.26	Moderate
<i>Picris barbarorum</i>	Tall hawkweed	V	529.35	38.14	0.00	567.49	7.20	10.77	0.00	7.36	Moderate
NC Act conservation significant fauna											
<i>Acanthophis antarcticus</i>	Common death adder	V	540.87	0.00	0.00	540.87	6.63	0.00	0.00	6.56	Moderate
<i>Calyptrorhynchus lathami lathami</i>	Glossy black-cockatoo	V	457.70	14.96	8.20	480.86	6.86	14.56	3.98	6.89	Moderate
<i>Lophochroa leadbeateri</i>	Major Mitchell's cockatoo	V	387.77	0.00	0.00	387.77	6.03	0.00	0.00	6.03	Moderate
NC Act special least concern animals											
<i>Ornithorhynchus anatinus</i>	Platypus	SLC	87.73	0.00	0.00	87.73	4.34	0.00	0.00	4.34	Moderate
<i>Tachyglossus aculeatus</i>	Echidna	SLC	736.72	0.00	0.00	736.72	7.46	0.00	0.00	7.46	Moderate

Table notes:

V = Vulnerable NT = Near Threatened SLC = Special Least Concern

- 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. Sensitive environmental receptors 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 4.27 for areas of habitat within the impact assessment area
- 5 Based on total habitat available
- 6 Refer Table 3.5 for magnitude criteria

Table 5.11 Estimation of potential magnitude of disturbance for each of the Sensitive environmental receptors (excluding threatened and migratory species) identified for the Project

Sensitive environmental receptor	Total coverage of Sensitive environmental receptor within the impact assessment area (ha) ^{1,3,4,5}	Total potential disturbance area within the Project footprint (ha) ^{2,3,4}	Percentage (%) disturbance to Sensitive environmental receptors within the impact assessment area	Magnitude of disturbance area ^{6,7,8}
State significant environmental constraints (MSES)				
Protected areas	3,752.99	124.72	3.32	Moderate
Regulated vegetation (VM Act)				
Endangered remnant vegetation (REs) (Category B)	506.70	62.74	12.38	Moderate
Of Concern remnant vegetation (REs) (Category B)	2,583.23	151.50	5.86	Moderate
Least Concern remnant vegetation (REs) (Category B)	5,164.15	349.00	6.76	Moderate
High value regrowth vegetation (Category C)	111.98	4.23	3.78	Moderate
MSES wildlife habitat	1,125.67	121.83	10.82	Moderate
Essential habitat	1,299.96	117.31	9.02	Moderate
Nature Conservation (Koala) Conservation Plan 2017 mapping				
Koala Priority Areas	0.00	0.00	0.00	Not present – not applicable
Koala Habitat Areas	81.73	7.44	9.10	Moderate
Koala Habitat Restoration Areas	0.00	0.00	0.00	Not present – not applicable
Locally Refined Koala Habitat Areas	0.00	0.00	0.00	Not present – not applicable
Wetlands				
State significant wetlands (HES)	9.85	0.00	0.00	Not present – not applicable
Least Concern flora and fauna (NC Act) and Priority Back on Track flora and fauna species				
Least Concern flora and fauna	115.82	27.76	23.97	High
Priority Back on Track species (not listed under the EPBC Act or NC Act)	115.82	27.76	23.97	High
Biodiversity Planning Assessment				
BPA habitat values for EVNT taxa (State)	414.42	48.96	11.81	Moderate
BPA habitat values for EVNT taxa (regional)	1,245.98	95.23	7.64	Moderate
Regional Terrestrial corridors	2,267.09	235.37	10.38	Moderate

Sensitive environmental receptor	Total coverage of Sensitive environmental receptor within the impact assessment area (ha) ^{1,3,4,5}	Total potential disturbance area within the Project footprint (ha) ^{2,3,4}	Percentage (%) disturbance to Sensitive environmental receptors within the impact assessment area	Magnitude of disturbance area ^{6,7,8}
State Riparian corridors	936.46	37.42	4.00	Moderate
State Terrestrial corridors	3314.8	161.39	4.87	Moderate

Table notes:

- 1 Area of impact assessment area: 43,560.56 ha
- 2 Area of Project footprint: 3,203.78 ha
- 3 No value (i.e. 0) represents areas where habitat modelling has indicated that no predicted habitat occurs. This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design. Sensitive environmental receptors 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.
- 4 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.
- 5 Refer Table 4.27 for areas of habitat within the impact assessment area
- 6 Based on total habitat available
- 7 Refer Table 3.5 for magnitude criteria
- 8 Sensitive environmental receptors 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.

5.3.2 Initial significance of potential impacts

The impact assessment of the Project on Sensitive environmental receptors is provided in Table 5.12. For each Sensitive environmental receptor, 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 Table 5.12, rehabilitation works may also be an effective mitigation measure to minimise potential impacts over time. However, these strategies are not expected to completely diminish negative impacts associated with Project activities. As such, the potential significant residual impacts are likely to require some level of offset in accordance with legislative requirements. This is further discussed in Section 5.4.

Significance ratings of Low, Moderate, High and Major may constitute a potential significant residual impact to an MNES (migratory species) or State based prescribed environmental matters, and were subsequently re-assessed against the MNES significant impact guidelines (for species/communities listed under the EPBC Act, including migratory species) or MSES significant impact guidelines (for prescribed environmental matters) to confirm the initial impact assessment results (refer Section 5.3.3 and Section 5.3.4 respectively).

Table 5.12 Initial impact assessment of the Project upon identified Sensitive environmental receptors

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
Commonwealth receptors (EPBC Act listed migratory species)							
Commonwealth Significant Ecological Constraint (Species listed as migratory under the EPBC Act): - Osprey (<i>Pandion haliaetus</i>) - Fork-tailed swift (<i>Apus pacificus</i>) - Oriental cuckoo (<i>Cuculus optatus</i>) - Black-faced monarch (<i>Monarcha melanopsis</i>) - Rufous fantail (<i>Rhipidura rufifrons</i>) - Satin flycatcher (<i>Myiagra cyanoleuca</i>) - Spectacled monarch (<i>Symposiachrus trivirgatus</i>) - Yellow wagtail (<i>Motacilla flava</i>) - Common sandpiper (<i>Actitis hypoleucos</i>) - Sharp-tailed sandpiper (<i>Calidris acuminata</i>) - Pectoral sandpiper (<i>Calidris melanotos</i>) - Red-necked stint (<i>Calidris ruficollis</i>) - Latham's snipe (<i>Gallinago hardwickii</i>) - Glossy ibis (<i>Plegadis falcinellus</i>)	High	Construction	- Habitat loss from vegetation clearing/removal - Fauna species injury or mortality - 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 - Habitat fragmentation - Barrier effects - Noise, dust, and light impacts - Increase in litter (waste) - Aquatic habitat degradation - Contamination	High	Major	Moderate	High (refer to Section 5.3.3 for assessment against MNES Significant Impact guidelines for migratory species)
		Commissioning and reinstatement	- Fauna species injury or mortality - Displacement of flora and fauna species from invasion of weed and pest species - Noise, dust, and light impacts - Aquatic habitat degradation	Low	Moderate	Negligible	Low
		Operation	- Fauna species injury or mortality - Displacement of flora and fauna species from invasion of weed and pest species - Noise, dust, and light impacts - Aquatic habitat degradation	Low	Moderate	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
Common greenshank (<i>Tringa nebularia</i>)							
State receptors							
State Significant Ecological Constraint (VM Act): Endangered remnant vegetation (REs) (Category B)	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 - Habitat fragmentation - Barrier effects - Increase in litter (waste)	High	Major	Moderate	High (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	Negligible	Low
		Operation	Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	Negligible	Low
State significant ecological constraint (VM Act): Of Concern remnant vegetation (REs) (Category B)	Moderate	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 - Habitat fragmentation - Barrier effects - Increase in litter (waste)	High	High	Moderate	Moderate (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
		Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	Negligible	Low
		Operation	Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	Negligible	Low
State significant ecological constraint (VM Act): 'Least Concern' remnant vegetation (REs) (Category B)	Low	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 - Habitat fragmentation - Barrier effects - Increase in litter (waste)	Moderate	Low	Low	Negligible
		Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species	Moderate	Low	Negligible	Negligible
		Operation	Displacement of flora and fauna species from invasion of weed and pest species	Moderate	Low	Negligible	Negligible
State Significant Ecological Constraint (VM Act): High value regrowth vegetation (Category C)	Moderate	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 - Habitat fragmentation - Barrier effects	High	High	Moderate	Moderate (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
			■ Increase in litter (waste) ■ Aquatic habitat degradation				
		Commissioning and reinstatement	■ Displacement of flora and fauna species from invasion of weed and pest species	Moderate	Moderate	Low	Low
		Operation	■ Displacement of flora and fauna species from invasion of weed and pest species	Moderate	Moderate	Low	Low
State significant ecological constraint (VM Act): ■ MSES wildlife habitat ■ Essential habitat	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 ■ Habitat fragmentation ■ Barrier effects ■ Increase in litter (waste)	Moderate	High	Low	Moderate (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	■ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	Negligible	Low
		Operation	■ Displacement of flora and fauna species from invasion of weed and pest species;	Low	Moderate	Negligible	Low
Nature Conservation (Koala) Conservation Plan 2017 mapping, including: ■ Koala Habitat Areas	High	Construction	■ Displacement of flora and fauna species from invasion of weed and pest species ■ Barrier effects ■ Noise, dust, and light impacts	Moderate	High	Low	Moderate (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	■ Displacement of flora and fauna species from invasion of weed and pest species ■ Noise, dust, and light impacts	Low	Moderate	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
		Operation	- Displacement of flora and fauna species from invasion of weed and pest species - Noise, dust, and light impacts	Low	Moderate	Negligible	Low
State Significant Ecological Constraint (species listed as threatened under the NC Act): Flora: - A Sedge (<i>Cyperus clarus</i>) - Finger panic (<i>Digitaria porrecta</i>) - Tall hawkweed (<i>Picris barbarorum</i>) Fauna: - Common death adder (<i>Acanthophis antarcticus</i>) - Glossy black-cockatoo (<i>Calyptrorhynchus lathamii</i>) - Major Mitchell's cockatoo (<i>Lophochroa leadbeateri</i>)	High	Construction	- Habitat loss from vegetation clearing/removal - Fauna species injury or mortality - 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 - Habitat fragmentation - Barrier effects - Noise, dust, and light impacts - Increase in litter (waste) - Aquatic habitat degradation - Contamination - Flooding	High	Major	Moderate	High (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	- Fauna species injury or mortality - Displacement of flora and fauna species from invasion of weed and pest species - Noise, dust, and light impacts	Low	Moderate	Negligible	Low
		Operation	- Fauna species injury or mortality - Displacement of flora and fauna species from invasion of weed and pest species - Noise, dust, and light impacts - Aquatic habitat degradation - Flooding	Low	Moderate	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
State significant ecological constraint (SLC fauna species): - Echidna (<i>Tachyglossus aculeatus</i>) - Platypus (<i>Ornithorhynchus anatinus</i>)	Moderate	Construction	- Habitat loss from vegetation clearing/removal - Fauna species injury or mortality - Displacement of flora and fauna species from invasion of weed and pest species - Edge effects - Habitat fragmentation - Noise, dust, and light impacts - Increase in litter (waste) - Aquatic habitat degradation - Contamination - Flooding	High	High	Moderate	Moderate (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	Negligible	Low
		Operation	- Displacement of flora and fauna species from invasion of weed and pest species - Noise, dust, and light impacts - Flooding	Low	Low	Negligible	Low
State significant ecological constraint: Priority Back on Track flora and fauna species (that are not listed under as threatened under the provisions of the EPBC Act or NC Act)	Low	Construction	- Habitat loss from vegetation clearing/removal - Fauna species injury or mortality - 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 - Habitat fragmentation - Barrier effects - Noise, dust, and light impacts	High	Moderate	Moderate	Low (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
			■ Increase in litter (waste) ■ Aquatic habitat degradation				
		Commissioning and reinstatement	■ Displacement of flora and fauna species from invasion of weed and pest species	Negligible	Negligible	Negligible	Negligible
		Operation	■ Fauna species injury or mortality ■ Displacement of flora and fauna species from invasion of weed and pest species ■ Noise, dust, and light impacts ■ Aquatic habitat degradation	Moderate	Low	Negligible	Negligible
State significant ecological constraint: Flora and fauna species not listed under the EPBC Act but listed as 'Least Concern' under the provisions of the NC Act and flora that is listed as SLC under the provisions of the NC Act	Low	Construction	■ Habitat loss from vegetation clearing/removal ■ Fauna species injury or mortality ■ 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 ■ Habitat fragmentation ■ Barrier effects ■ Noise, dust, and light impacts ■ Increase in litter (waste) ■ Aquatic habitat degradation ■ Contamination ■ Flooding.	High	Moderate	Moderate	Low (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	■ Displacement of flora and fauna species from invasion of weed and pest species	Negligible	Negligible	Negligible	Negligible

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
		Operation	- Fauna species injury or mortality - Displacement of flora and fauna species from invasion of weed and pest species - Noise, dust, and light impacts - Aquatic habitat degradation - Flooding	Moderate	Low	Negligible	Negligible
State significant ecological constraint (BPA): - BPA habitat values for EVNT taxa (State) State Riparian corridors State Terrestrial corridors	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 - Habitat fragmentation - Barrier effects - Increase in litter (waste) - Aquatic habitat degradation	High	Major	Moderate	High (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	Negligible	Low
		Operation	Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity ¹	Phase	Potential impacts ²	Initial significance (application of initial mitigation measures presented in Section 5.2.1)		Residual significance following the application of Project mitigation measures presented in Table 5.6, Table 5.7 and Table 5.8 ³	
				Magnitude ¹	Significance	Magnitude	Significance ⁴
State significant ecological constraint (BPA): - BPA habitat values for EVNT taxa (regional) Regional Terrestrial corridors	Moderate	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 - Habitat fragmentation - Barrier effects - Increase in litter (waste)	Moderate	Moderate	Low	Low (refer to Section 5.3.4 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	Negligible	Low
		Operation	Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	Negligible	Low

Table notes:

- 1 Refer to Section 3.4.1 and Section 3.4.2 for the assessment methodology for 'sensitivity' and 'magnitude' criteria.
- 2 Potential impacts to Sensitive environmental receptors identified in the table above, are based upon those presented in Section 5.1.2, 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.
- 4 In instances where the mitigated significance returns a rating of High or above, offsets may be an option to reduce the residual ecological impacts in the long term. Offset for biodiversity values are discussed further in Section 5.4.

5.3.3 Significant residual impact assessment for matters of national environmental significance (migratory species)

This section summarises assessment of the potential for significant residual impacts from the Project on migratory fauna species using the relevant criteria outlined in the MNES Significant Impact Guideline. Following the MNES Significant Impact Guideline the Project is likely to have a significant impact on a migratory species if there is a possibility that it will:

- Substantially modify, destroy or isolate an area of important habitat for a migratory species
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the species
- Seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

An area of important habitat for a migratory species is:

- Habitat utilised by a migratory species within a region that supports an ecologically significant proportion of the population of the species
- Habitat that is of critical importance to the species at particular life-cycle stages
- Seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

There are 15 migratory species relevant to the impact assessment area (i.e. that are identified in desktop searches, have predicted habitat within the impact assessment area, and are not listed as threatened under the EPBC Act). These include four marine migrant species, five woodland migrant species and three wetland migrant species. Marine migratory fauna (e.g. cetaceans and pelagic marine birds) were excluded from this list due to the absence of marine environments in the impact assessment area. The ecology, life history and distribution of these species are summarised in Sections 5.3.3.1, 5.3.3.2 and 5.3.3.3. Relevant Commonwealth documents applicable to each species including threat abatement plans, approved conservation advice, and recovery plans are also summarised in Appendix B.

Key potential impacts to migratory fauna are considered to include the following:

- Direct clearing of species habitats
- Injury/mortality to individuals during vegetation clearing in the construction period (where nests are present).
- A range of mitigation measures have been proposed to ameliorate these impacts wherever possible (refer Section 5.2.2). These include measures considered as effective in addressing the recognised threats for each species as recognised in 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 Sub-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
- Soil Management Sub-plan with erosion and sediment controls 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.

Given the degraded nature of the majority of the woodlands within the disturbance 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.

The assessment of significant impacts on the identified migratory species from the Project is based on:

- Current knowledge of the species, including local populations, specimen records and habitat requirements
- Predictive habitat modelling for each species (refer Appendix A) based on the habitat assumptions associated with each species (refer Appendix A), along with the findings of ecological surveys. Where 'suitable habitat' is referred to in the following assessments it refers to the predicted habitat area output of the habitat modelling as specific to the species addressed. This mapping will be verified through detailed ecological surveys of the Project footprint in parallel to the development of the detail design.
- The current understanding and layout of the Project (refer Section 1.5)
- Information on potential impacts of Project during construction and operation (refer Section 5.1)
- Proposed Project mitigation measures (refer Section 5.2.2).

A summary of the findings of the significant residual impact assessment for migratory species is provided in Table 5.13.

Table 5.13 Summary of the results of the significant impact assessment for migratory species

Species name	Common name	NC Act status	EPBC Act status	Results of assessment ¹	Table containing assessment against MNES Guidelines
Aerial migrants					
<i>Apus pacificus</i> [^]	Fork-tailed swift	SLC	M	No significant impact likely	Table 5.14
Marine migrants					
<i>Actitis hypoleucos</i>	Common sandpiper	SLC	M	No significant impact likely	Table 5.15
<i>Calidris acuminata</i>	Sharp-tailed sandpiper	SLC	M	No significant impact likely	Table 5.15
<i>Calidris melanotos</i>	Pectoral sandpiper	SLC	M	No significant impact likely	Table 5.15
<i>Calidris ruficollis</i>	Red-necked stint	SLC	M	No significant impact likely	Table 5.15
<i>Gallinago hardwickii</i>	Latham's snipe	SLC	M	No significant impact likely	Table 5.15
<i>Tringa nebularia</i>	Common greenshank	SLC	M	No significant impact likely	Table 5.15
Woodland migrants					
<i>Myiagra cyanoleuca</i>	Satin flycatcher	SLC	M	No significant impact likely	Table 5.16
<i>Monarcha melanopsis</i>	Black-faced monarch	SLC	M	No significant impact likely	Table 5.16
<i>Symphysistura trivirgatus</i>	Spectacled monarch	SLC	M	No significant impact likely	Table 5.16
<i>Rhipidura rufifrons</i>	Rufous fantail	SLC	M	No significant impact likely	Table 5.16
<i>Cuculus optatus</i>	Oriental cuckoo	SLC	M	No significant impact likely	Table 5.16
Wetland migrants					
<i>Plegadis falcinellus</i>	Glossy ibis	SLC	M	No significant impact likely	Table 5.17
<i>Motacilla flava</i>	Yellow wagtail	SLC	M	No significant impact likely	Table 5.17
<i>Pandion haliaetus</i>	Osprey	SLC	M	No significant impact likely	Table 5.17

Table notes:

M = migratory SLC = Special least concern

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

It is unlikely that the thresholds outlined in the guideline will be exceeded for any of the migratory species subject to this assessment. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project a significant impact resulting from a loss of important habitat is unlikely to occur.

5.3.3.1 Aerial migrants

This section provides a summary of information related to the aerial migratory species that have potential to occur within the impact assessment area and assesses this species against the MNES significant impact criteria for migratory species.

Fork-tailed swift (*Apus pacificus*)

Fork-tailed swift is an aerial, insectivorous bird that weighs 30 to 40 g. The species breeds in Siberia and migrates to Australia, arriving during October-September. The species feeds aerially on flying insects and possibly also roosts aerially. The species forages over all terrestrial habitats, and is most commonly observed over open habitats, such as woodlands and marshes. The species is less common over forest and rainforest (DAWE 2020).

There are no significant threats to the species in Australia (DAWE 2020). Habitat loss and predation by feral animals are potential threats, although the threat is thought to be negligible due to the wide range of the species (BirdLife International 2009).

The Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (DAWE 2020) considers a wide range of habitats important for this species, from inland open plains to wooded areas, where it is exclusively aerial. The threshold for an ecologically significant proportion of a population (individuals) is 1,000 individuals internationally and 100 individuals nationally. No area threshold can be determined for this species. The proportion likely to result in a significant impact if affected is 1,000 internationally and 100 nationally (DAWE 2020).

Database records for Fork-tailed swift occur within the Project footprint and the impact assessment area. A recent record from within the last two years occurs within the Project footprint at Yelarbon Lagoon on to the south of the Yelarbon township. A second record occurs within the impact assessment area to the east of Yelarbon and the record is also recent from 2018. A record from Pittsworth occurs within the impact assessment area however this is an old record dated from the early 1970s. Most records within a 50 km radius of the Project occur in the surrounding landscape around the northern section of the alignment near Toowoomba.

Given this is an aerial species and does not breed in Australia habitat associated with the Project footprint is not likely to support an ecologically significant proportion of a population, hold critical importance for breeding or is at the limit of the species range. Predictive habitat mapping indicates that there is an estimated 9,051.08 ha of important habitat for this species within the impact assessment area and 597.89 ha of important habitat within the ecology project footprint (refer Table 4.28). These estimates are conservative and likely to be an overestimation of the actual area considered important for the species.

Assessment against the significant impact criteria for Fork-tailed swift is shown in Table 5.14.

Table 5.14 Assessment against the significant impact criteria: Aerial migrants for Fork-tailed swift

Criterion	Assessment against the significance criteria ¹
Substantially modify, destroy or isolate an area of important habitat for a migratory species	The Project will impact areas of open floodplain and woodland that are suitable habitat for the species. This area is considered to constitute important habitat for the species, however considering the vast amount of habitat available for this species and the relatively small area being cleared there will not be enough to substantially modify destroy or isolate important habitat.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the species	The Biosecurity Management Sub-plan will mitigate the impacts of invasive species on the species. If the abundance of feral predators (i.e. cats and foxes) increase due to the Project, it is unlikely to have any impact due to the aerial behaviour of the species.

Criterion	Assessment against the significance criteria ¹
Seriously disrupt the lifecycle of an ecologically significant proportion of the population if a migratory species	The species breeds in Siberia. When over-wintering in Australia the species feeds aerially and possible also roosts aerially. It is considered unlikely that the Project will result in a disruption of the species' lifecycle.
Assessment of potential for significant impacts	Under the three-part test detailed above, it is currently considered unlikely a 'significant impact' on aerial migrants (Fork-tailed swift) will result from the Project.

Table note:

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

5.3.3.2 Marine migrants

Latham's snipe (*Gallinago hardwickii*)

Latham's snipe is an omnivorous medium-sized migratory wader, typically 30 cm in length. It feeds on plant material, seeds, molluscs, crustaceans, arachnids and insects. The species does not breed in Australia. This species breeds in Japan and far eastern Russia, and then migrates to Australia during the northern hemisphere winter (between August and January). They inhabit wetlands such as swamps, creek or river margins, lakes, dams, claypans, sewage works and inundated vegetation/floodplains. They prefer areas that include some form of shelter or cover (low/dense vegetation). Latham's Snipe has also been recorded near artificial habitats such as airfields, ploughed paddocks, irrigation channels, dairy farms and drainage ditches. Their roosting habitats include dense vegetation near foraging habitats. They could also potentially occur in Bluegrass *Dichanthium* dominant grasslands in the Brigalow Belt Bioregion (DAWE 2020).

Important habitat nationally and internationally for migratory birds has been described in the *Wildlife Conservation Plan for Migratory Shorebirds – Department of the Environment*. Habitat of international importance is considered as an area of suitable habitat that has the capacity to regularly support 1 per cent of individuals in a population of one species or sub-species of waterbird or a total of 20,000 individual waterbirds. Habitat of national importance is considered similarly in that habitat can regularly support 0.1 per cent of the flyaway population of a single species or 2000 individual shorebirds or 15 species of migratory shorebirds (DotE 2015). No important habitat has been identified for this species. Threats identified include loss or degradation of habitat, vehicle strikes and pollution. Migratory waders in general can be threatened by the increase in invasive species by either predation (feral cats, dogs and foxes), or habitat degradation (carp, weed incursion). Migratory waders in general can be threatened by the increase in invasive species by either predation (feral cats, dogs and foxes), or habitat degradation (carp, weed incursion).

This species is not listed as one of the 14 migratory species outlined in the Draft Referral Guideline for migratory bird species under the EPBC Act. No records for this species occur within the Project footprint or within the impact assessment area. Few records occur within a 50 km buffer of the Project footprint with the most recent record (2015) occurring at the Gold Coast. Another record occurs approximately 50 km from the Project footprint from 2009 at Victoria Point, Brisbane. No database records exist inland and this is a coastal species. It is highly unlikely construction activities associated with the Project will have a significant residual impact on this species.

Given this is a coastal species, habitat associated with the Project footprint is not likely to support an ecologically significant proportion of a population, hold critical importance for breeding or is at the limit of the species range. Predictive habitat mapping indicates that there is an estimated 87.62 ha of important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). The Project is not at the limit of this species range. A review of the literature has not identified an area of habitat in which the species is declining associated with the Project. Therefore, the Project is currently considered unlikely to have a significant impact on this species.

Assessment against the significant impact criteria for Latham's snipe is shown in Table 5.15.

Common sandpiper (*Actitis hypoleucos*)

Common sandpiper is a small migratory wader, typically 20 cm in length. They mostly eat molluscs, crustaceans and insects. This species breeds in Europe, Asia and Africa from April to August and then migrates south to Australia. Their habitat includes coastal wetlands, rocky shores, and mudflats as well as inland wetlands such as lakes, reservoirs, dams, claypans, and sometimes in marginal grasslands. Important habitat nationally and internationally for migratory birds has been described in the *Wildlife Conservation Plan for Migratory Shorebirds – Department of the Environment*. Habitat of international importance is considered as an area of suitable habitat that has the capacity to regularly support 1 per cent of individuals in a population of one species or sub-species of waterbird or a total of 20,000 individual waterbirds. Habitat of national importance is considered similarly in that habitat can regularly support 0.1 per cent of the flyaway population of a single species or 2000 individual shorebirds or 15 species of migratory shorebirds (DotE 2015). No important habitat has been identified for this species. Habitat loss and predation by feral animals are potential threats, although the threat is thought to be negligible due to the wide range of the species (DAWE 2020).

This species is not listed as one of the 14 migratory species outlined in the Draft Referral Guideline for migratory bird species under the EPBC Act. No records for this species occur within the Project footprint or the impact assessment area. No records for this species occur within the Project footprint or the impact assessment area. The nearest records occur to the north and south of Gatton (2016), Laidley (2017) and Atkinsons Lagoon (1980s). Inland records for this species are sparse and most occur along the eastern coastline. It is highly unlikely construction activities associated with the Project will have a significant residual impact on this species.

Predictive habitat mapping indicates that there is an estimated 87.62 ha of important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). The Project is not at the limit of this species range. A review of the literature has not identified an area of habitat in which the species is declining associated with the Project. Therefore, the Project is currently considered unlikely to have a significant impact on this species.

Assessment against the significant impact criteria for Common sandpiper is shown in Table 5.15.

Sharp-tailed sandpiper (*Calidris acuminata*)

Sharp-tailed sandpiper is a medium-sized summer migratory wader, typically 20 cm in length. This species breeds in Siberia from June to August and then migrates south to Australia. They are most common around coastal environments but are also sparsely scattered around inland wetlands such as lakes, dams, claypans, sewage works and inundated vegetation. Important habitat nationally and internationally for migratory birds has been described in the *Wildlife Conservation Plan for Migratory Shorebirds – Department of the Environment*. Habitat of international importance is considered as an area of suitable habitat that has the capacity to regularly support 1 per cent of individuals in a population of one species or sub-species of waterbird or a total of 20,000 individual waterbirds. Habitat of national importance is considered similarly in that habitat can regularly support 0.1 per cent of the flyaway population of a single species or 2000 individual shorebirds or 15 species of migratory shorebirds (DotE 2015). No important habitat has been identified for this species. Habitat loss and predation by feral animals are potential threats, although the threat is thought to be negligible due to the wide range of the species (DAWE 2020).

This species is not listed as one of the 14 migratory species outlined in the Draft Referral Guideline for migratory bird species under the EPBC Act. No records for this species occur within the Project footprint or the impact assessment area. No records for this species occur within the Project footprint or within the impact assessment area. The nearest record is recent from 2002 and occurs north of Millmerran approximately 8 km from the Project at Lemon Tree Weir. A number of recent records from within the last 25 years occur at Lake Coolmunda 11 km south-east of the southern end of the Project. There are a number of records within a 50 km radius of the Project with most of these associated with water bodies and watercourses towards the norther section of the alignment. Records from inland Australia are numerous and occur across much of the interior. Records are denser along the coast and specimen backed records occur along most of Australia's coastline. It is highly unlikely construction activities associated with the Project will have a significant residual impact on this species.

Predictive habitat mapping indicates that there is an estimated 87.62 ha of important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). The Project is not at the limit of this species range. A review of the literature has not identified an area of habitat in which the species is declining associated with the Project. Therefore, the Project is currently considered unlikely to have a significant impact on this species.

Assessment against the significant impact criteria for Sharp-tailed sandpiper is shown in Table 5.15.

Pectoral sandpiper (*Calidris melanotos*)

Pectoral sandpiper is a medium-sized migratory wader, ranging from 19 to 24 cm in length with a wingspan of 37 to 45 cm. Males of the species are generally heavier at 85 g whilst females eight around 60 g. Their flat back and plumpish body that tapers to a drawn-out rear is characteristic of the species (Higgins and Davies 1996). As an omnivore this species consumes a varied diet of algae, seeds, and invertebrates. They forage in grass-fringed waters moving slowly as they probe for food. This species does not breed in Australia, typically they breed in northern Russia and North America. Pectoral sandpiper occurs in Australia from September to June (Higgins and Davies 1996). Where the species occurs in Australia, they occupy the shallow waters of coastal habitats associated with saline wetlands and freshwater wetlands from the coast to inland systems. Foraging in these different types of habitat occurs in shallow water or soft mud at the edge of wetlands (Higgins and Davies 1996).

Important habitat nationally and internationally for migratory birds has been described in the *Wildlife Conservation Plan for Migratory Shorebirds – Department of the Environment*. Habitat of international importance is considered as an area of suitable habitat that has the capacity to regularly support 1 per cent of individuals in a population of one species or sub-species of waterbird or a total of 20,000 individual waterbirds. Habitat of national importance is considered similarly in that habitat can regularly support 0.1 per cent of the flyaway population of a single species or 2000 individual shorebirds or 15 species of migratory shorebirds (DotE 2015). No important habitat has been identified for this species. In Australia threats to the species are associated with habitat loss and degradation, particularly where juveniles stay in Australia year-round; disturbance from recreational activities where the species roosts and forages; and direct mortality as a result of human impacts include wind farms around migratory pathways, bird strike from aircraft and pollution from chemical or oil spills.

This species is not listed as one of the 14 migratory species outlined in the Draft Referral Guideline for migratory bird species under the EPBC Act. No records for this species occur within the Project footprint or within the impact assessment area. The nearest record occurs approximately 4 km south of the Project footprint west of Pittsworth. However, the record is old (1979) as is not spatially reliable. The next nearest records occur approximately 13 km north of the western section of the alignment near Oakey and these records are also old (1979). Few other records occur within a 50 km buffer of the Project footprint. Several records exist from around Gatton between 40 and 50 km east of the Project footprint and are dated between 2009 and 2018. It is highly unlikely construction activities associated with the Project will have a significant residual impact on this species.

Given this is predominantly a coastal species, habitat associated with the Project footprint is not likely to support an ecologically significant proportion of a population or is at the limit of the species range. Predictive habitat mapping indicates that there is an estimated 87.62 ha of important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). Given the species breeds outside of Australia there is no habitat associated with the Project that is considered important breeding habitat for the species. The Project is not at the limit of this species range. A review of the literature has not identified an area of habitat in which the species is declining associated with the Project. Therefore, the Project is currently considered unlikely to have a significant impact on this species.

Assessment against the significant impact criteria for Pectoral sandpiper is shown in Table 5.15.

Red-necked stint (*Calidris ruficollis*)

The Red-necked stint is the smallest shore bird in Australia (Geering et al. 2007) measuring 13 to 16 cm in length, weighing 25 g and a wing-span of 29 to 33 cm. This species has a varied diet consisting of plant seeds and a range of invertebrates including molluscs, marine worms, gastropods, shrimp, spiders, beetles, flies and ants. The species does not breed in Australia. Breeding grounds are in Siberia and west Alaska, migration to Australia occurs sometimes in July but usually between August and early September. Most adult birds arrive before the end of September and juveniles begin to arrive late September or early October with most arriving by early November. In general Red-necked stints return to their breeding grounds across Australia from late March with most leaving in April (Higgins & Davies 1996). In Australia the species is predominantly associated with coastal areas including inlets, bays, lagoons, estuaries with intertidal mudflats, spits, inlets, banks, and occasionally protected sandy shores. They will occasionally occupy beaches, rocky shores, reefs or shoals along with artificial/modified habitat such as sewage farms and agricultural land that gets flooded (Higgins & Davies 1996). The species will often roost in habitat that provides sufficient shelter but will also roost on exposed reef, open beaches, amongst beach cast seaweed, mud and even dried cow-pats (Hobbs 1961).

Important habitat nationally and internationally for migratory birds has been described in the *Wildlife Conservation Plan for Migratory Shorebirds – Department of the Environment*. Habitat of international importance is considered as an area of suitable habitat that has the capacity to regularly support 1 per cent of individuals in a population of one species or sub-species of waterbird or a total of 20,000 individual waterbirds. Habitat of national importance is considered similarly in that habitat can regularly support 0.1 per cent of the flyaway population of a single species or 2000 individual shorebirds or 15 species of migratory shorebirds (DotE 2015). No important habitat has been identified for this species. In Australia threats to Red-necked stint includes the loss of important habitat which results in reduced availability of foraging and roosting sites. In order to migrate successfully migratory species must build up the required stores of energy needed to travel such distances, disturbance impacts their ability to do so. In Australia juveniles remain at sites considered important for the species year-round until they reach maturity. Habitat can be impacted directly as a result of land clearing, inundation, infilling or draining. Indirect impacts or loss of suitable habitat result from poor water quality and changes to hydrology along with changes to habitat structure at roosting sites (DEWHA 2009).

This species is not listed as one of the 14 migratory species outlined in the Draft Referral Guideline for migratory bird species under the EPBC Act. No records for this species occur within the Project footprint or the impact assessment area. The nearest records occur approximately 12 km from the Project footprint to the east of Inglewood at Lake Coolmunda and are dated recent (2019). Other records occur approximately 13 km north of the Project footprint near Oakey. One of these records is old (1980) and the other has a large degree of spatial uncertainty and therefore not reliable. Other records within a 50 km buffer of the Project footprint occur to the north-east of the Project footprint at the Toowoomba Range. Inland records for this species are scattered and most occur along the eastern coastal regions. It is highly unlikely construction activities associated with the Project will have a significant residual impact on this species.

Given this is predominantly a coastal species, habitat associated with the Project footprint is not likely to support an ecologically significant proportion of a population or is at the limit of the species range. Predictive habitat mapping indicates that there is an estimated 87.62 ha of important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). Given the species breeds outside of Australia there is no habitat associated with the Project that is considered important breeding habitat for the species. The Project is not at the limit of this species range. A review of the literature has not identified an area of habitat in which the species is declining associated with the Project. Therefore, the Project is currently considered unlikely to have a significant impact on this species.

Assessment against the significant impact criteria for Red-necked stint is shown in Table 5.15.

Common greenshank (*Tringa nebularia*)

Common greenshank is a carnivorous shorebird which is heavily built measuring 30 to 35 cm in length. Their wingspan averages 55 to 65 cm and sexes are similarly sized weighing up to 190 g. Their diet consists of molluscs, crustaceans, insects, fish and even frogs. The species has been incidentally recorded feeding on annelids, lizards and rodents and hunts prey by day and night. This species does not breed in Australia, breeding occurs from Eurasia to Russia and occupies Europe, Africa, Asia, Melanesia and Australasia (Higgins and Davies 1996). In Australia the Common greenshank's flyway migrating population consists of an estimated 110,000 individuals (Hansen et al. 2016) with roughly 18,000 to 19,000 remaining during the non-breeding season (Bamford et al. 2008; Clemens et al. 2008). The species inhabits a variety of coastal sheltered habitats and inland wetlands that predominantly consist of mudflats, saltmarsh, mangrove, sea grass, permanent/ephemeral wetlands, swamps, lakes, dams, rivers and creeks. Artificial wetlands and agricultural land that becomes inundated with water are also areas utilised by the species (Higgins and Davies 1996). Along the coast roosting habitat consists of wetlands, shallow pools, elevated rocks, sandbanks or muddy islets (Higgins and Davies 1996), whilst inland they will roost at claypans (Collins et al. 2001).

Important habitat nationally and internationally for migratory birds has been described in the *Wildlife Conservation Plan for Migratory Shorebirds – Department of the Environment*. Habitat of international importance is considered as an area of suitable habitat that has the capacity to regularly support 1 per cent of individuals in a population of one species or sub-species of waterbird or a total of 20,000 individual waterbirds. Habitat of national importance is considered similarly in that habitat can regularly support 0.1 per cent of the flyaway population of a single species or 2000 individual shorebirds or 15 species of migratory shorebirds (DotE 2015). Threats identified include loss or degradation of habitat, vehicle strikes and pollution. Migratory waders in general can be threatened by the increase in invasive species by either predation (feral cats, dogs and foxes), or habitat degradation (carp, weed incursion). Migratory waders in general can be threatened by the increase in invasive species by either predation (feral cats, dogs and foxes), or habitat degradation (carp, weed incursion) (AGDEH 2005).

This species is not listed as one of the 14 migratory species outlined in the Draft Referral Guideline for migratory bird species under the EPBC Act. No records for this species occur within the Project footprint or within the impact assessment area. The nearest record is from 1998 and is located approximately 2.5 km from the Project footprint to the south of Whetstone State Forest. Few records occur within a 50 km buffer of the Project footprint. Several records from 2016 occur at Lake Coolmunda to the east of Inglewood, from 2000 at Oakey along with an old record (1971) near Pechey State Forest to the west of Toowoomba Range. Most records for this species occur to the east along the coast. It is highly unlikely construction activities associated with the Project will have a significant residual impact on this species.

Given this is a coastal species, habitat associated with the Project footprint is not likely to support an ecologically significant proportion of a population, hold critical importance for breeding or is at the limit of the species range. Predictive habitat mapping indicates that there is an estimated 87.62 ha of important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). The Project is not at the limit of this species range. A review of the literature has not identified an area of habitat in which the species is declining associated with the Project. Therefore, the Project is currently considered unlikely to have a significant impact on this species.

Assessment against the significant impact criteria for Common greenshank is shown in Table 5.15.

Table 5.15 Assessment against the significant impact criteria: Marine migrants

Criterion	Assessment against the significance criteria ¹
Substantially modify, destroy or isolate an area of important habitat for a migratory species	The important habitat identified for these species does not exceed the significant thresholds identified in the SIA criteria for migratory species. Therefore the Project is not likely to significantly modify, destroy or isolate important habitat for the species.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the species	The Biosecurity Management Sub-plan will mitigate the impacts of invasive species on these species. If the abundance of feral predators (i.e. cats and foxes) increases due to the Project, it is unlikely to have any impact

Criterion	Assessment against the significance criteria ¹
Seriously disrupt the lifecycle of an ecologically significant proportion of the population if a migratory species	These species do not breed in Australia. When over-wintering in Australia the large proportion of the respective populations occur in coastal regions and may only use inland wetlands as stop overs whilst migrating. Disturbance as a result of the Project is not likely to seriously disrupt the lifecycle of an ecologically significant proportion of marine migrant species.
Assessment of potential for significant impacts	Under the three-part test detailed above, it is currently considered unlikely a 'significant impact' on marine migrants will result from the Project

Table note:

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

5.3.3.3 Woodland migrants

Oriental cuckoo (*Cuculus optatus*)

The Oriental cuckoo does not breed in Australia, it migrates to from north-east Asia during its non-breeding season which occurs from September to May (DAWE 2020). During the northern hemisphere autumn, the species migrates south to Indonesia, New Guinea and northern Australia. Whilst some individuals remain in Australia through winter most return north in autumn (Morcombe 2003). This species utilises habitat associated with the coastal regions of northern and eastern Australia including offshore islands. This species primarily utilises a variety of habitat including monsoon rainforest, wet sclerophyll forest and open woodlands (DAWE 2020) however, will also occupy vine scrub, riverine thicket, paperbark swamps and mangroves (Morcombe 2003).

The Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (DAWE 2020) considers important habitat as any non-breeding habitat that this species occupies including monsoonal rainforest, vine thicket, wet sclerophyll forest or open Acacia, Casuarina or Eucalypt wooded areas. The threshold for an ecologically significant proportion of a population (individuals) is 10,000 internationally and 1,000 nationally. The area threshold for the loss of important habitat likely to result in a significant impact is 250,000 ha internationally and 25,000 ha nationally. The proportion likely to result in a significant impact if affected is 10,000 ha internationally and 1,000 ha nationally (DAWE 2020).

Threats to this species includes the substantial loss or modification of important habitat, the construction of tall or large structures (e.g. buildings, wind turbines, over-head powerlines, etc.) or actions that would cause a serious disruption to an ecologically significant proportion of a population (DAWE 2020). A review of the available literature does not reveal any impacts from invasive species on the Oriental cuckoo.

No database records occur within the Project footprint. One record occurs within the impact assessment area to the south of the Project footprint near Pittsworth. This is an older record (1972), two other records occur nearby from Pittsworth however, these are also old records dated 1972 and 1976. Few other records occur within a 50 km buffer of the Project footprint, particularly inland. Most of these records occur to the east of the Project footprint at the Toowoomba Range located approximately 25 km from the alignment.

It is unlikely that the thresholds outlined in the guideline will be exceeded. There is no important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). This species is associated with coastal habitat in northern and eastern Australia, this is evident by a large density of specimen backed records closer to the coast and a lack of records inland. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project and the small amount of habitat being cleared, a significant impact is currently considered unlikely.

Assessment against the significant impact criteria for Oriental cuckoo is shown in Table 5.16.

Black-faced monarch (*Monarcha melanopsis*)

The Black-faced monarch migrates between Australia and New Guinea. During the summer breeding months this species is found along the eastern coastal region of Australia, during winter the species retreats to the north overwintering in New Guinea. Rather than making the full migration north to New Guinea a portion of the population remains in northern Australia during winter usually consisting of younger birds (DAWE 2020). This species utilises rainforest as breeding habitat selecting trees with large leaves as nesting sites where they construct a nest at the top of the tree, in smaller saplings or in low shrubs. The species is known to breed from the Atherton region of Queensland's wet tropics, south-east Queensland and near Lake Entrance in south-east Victoria (DAWE 2020). Breeding generally occurs between October and March although there is regional variation across the species' range. Eggs hatch between 13 and 15 days with fledging occurring seven days or more later. Fledgling success appears to be poor for this species with an estimated 0.1 fledged young per nest per breeding event (BA NRS 2002).

The Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (DAWE 2020) considers important habitat to be wet sclerophyll forest in sheltered gullies with dense understorey consisting of ferns and shrubs. The threshold for an ecologically significant proportion of a population (individuals) is 4,600 internationally and 460 nationally. The area threshold for the loss of important habitat likely to result in a significant impact is 2,600 ha internationally and 260 ha nationally. The proportion likely to result in a significant impact if affected is 465 (individuals) internationally and 47 nationally (DAWE 2020).

Threats to this species includes the substantial loss or modification of important habitat, the construction of tall or large structures (e.g. buildings, wind turbines, over-head powerlines, etc.) or actions that would cause a serious disruption to an ecologically significant proportion of a population (DAWE 2020). Threats to this species include collision with windows (Taplin 1991) and lighthouses (Makin 1961). Invasive species that have the potential to impact the Satin flycatcher includes Black rat, *Rattus rattus* and exotic vines associated with riparian area (e.g. Rubber vine *Cryptostegia grandiflora*) (DAWE 2020).

Database records indicate this species occurs within the impact assessment area but does not occur within the Project footprint. A record exists from 2003 at the eastern section of the impact assessment area to the north of Gowrie Mountain. A second record occurs within the impact assessment area from 2003 to the north of the Toowoomba Airport. Most records for this species within a 50 km buffer of the Project footprint occur at the Toowoomba Range. Other records, whilst not as dense occur north of Pittsworth and between Oakey and Dalby.

It is unlikely that the thresholds outlined in the guideline will be exceeded. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project a significant impact resulting from a loss of important habitat is unlikely. Habitat considered breeding habitat is not likely to occur within the Project footprint. There is no important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). This area does not exceed the threshold outlined in the referral guideline. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project and the loss of habitat below the threshold, a significant impact is currently considered unlikely.

Assessment against the significant impact criteria for Black-faced monarch is shown in Table 5.16.

Satin flycatcher (*Myiagra cyanoleuca*)

Satin flycatchers tree species including paperbarks, eucalypts and banksias for nest building constructing nests in the outer branches (Gilbert 1935, (BA NRS 2002). The species lays three or four eggs in a clutch with both sexes incubating the eggs for short durations over a period of 17 days (BA NRS 2002). Breeding occurs between November and January where the species occurs above 600 m above sea level in south-eastern Australia (Frith 1969). This varies slightly at lower elevations and different regions in Australia. Satin flycatchers will occupy eucalypt forests with an open understorey or with a grass as ground cover, they are not associated with rainforest (DAWE 2020).

This species generally occupies eucalypt forest that occurs near wetlands or waterways. Compared to other flycatcher species they tend to occupy forests that are taller and wetter frequently in gullies (DAWE 2020). The Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (DAWE 2020) considers important habitat as essential habitat during breeding which includes high elevation eucalypt forest and woodland whilst common habitat includes tall wet sclerophyll forest associated with gullies or waterways and open grassy woodlands. Migratory habitat is more general whilst wintering habitat includes rainforest, mangroves and paperbark swamps. The threshold for an ecologically significant proportion of a population (individuals) is 17,000 internationally and 1,700 nationally. The area threshold for the loss of important habitat likely to result in a significant impact is 4,400 ha internationally and 440 ha nationally. The proportion likely to result in a significant impact if affected is 1,700 (individuals) internationally and 170 nationally (DAWE 2020).

Threats to this species includes the substantial loss or modification of important habitat, the construction of tall or large structures (e.g. buildings, wind turbines, over-head powerlines, etc.) or actions that would cause a serious disruption to an ecologically significant proportion of a population (DAWE 2020). Nest parasitism from cuckoo species could be considered as a threat to the species (Brooker & Brooker 1989). The main threats to this species result from land clearing and logging of mature forest in Australia's south-east (Blakers et al. 1984). Invasive species that have the potential to impact the Satin flycatcher includes Black rat, *Rattus rattus* and exotic vines associated with riparian area (e.g. Rubber vine *Cryptostegia grandiflora*) (DAWE 2020).

Database records indicate this species does not occur within the impact assessment area or the Project footprint. The nearest database records occur within 2 km of the Project footprint at Pittsworth (2008) and Bringalily State Forest (2001). Scattered records occur within a 50 km buffer of the Project footprint with most of these concentrated around the Toowoomba Range. Records also occur at Durakai State Forest, west of Brookstead, Clifton and Oakey. Records are largely confined to forested reserves and national parks.

It is unlikely that the thresholds outlined in the guideline will be exceeded. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project a significant impact resulting from a loss of important habitat is unlikely. There is no important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). This area does not exceed the threshold outlined in the referral guideline. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project and the loss of habitat below the threshold, a significant impact is currently considered unlikely.

Assessment against the significant impact criteria for Satin flycatcher is shown in Table 5.16.

Spectacled monarch (*Symposiachrus trivirgatus*)

Breeding for Spectacled monarch typically occurs between September and April nesting in the vertical fork of a tree sampling or shrub located near a water body or watercourse. Two eggs are typically laid with the female undertaking most of the incubation. The incubation period is typically between 15 and 18 days. Both parents feed young until a few days after fledging which occurs 17 to 20 days after the young hatch (DAWE 2020).

The Spectacled monarch typically occupies rainforests, mangroves and wet gullies associated with dense wet eucalypt forests (Morcombe 2003). Other densely vegetated habitats are utilised by this species including mangroves, drier forest and woodlands (DAWE 2020).

The Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (DAWE 2020) considers important habitat as dense vegetation consisting mostly of rainforest, moist forest or wet sclerophyll forest along with mangroves, drier forest and woodlands that provide dense vegetation. The threshold for an ecologically significant proportion of a population (individuals) is 6,500 internationally and 650 nationally. The area threshold for the loss of important habitat likely to result in a significant impact is 2,100 ha internationally and 210 ha nationally. The proportion likely to result in a significant impact if affected is 650 (individuals) internationally and 65 nationally (DAWE 2020).

Threats to this species includes the substantial loss or modification of important habitat, the construction of tall or large structures (e.g. buildings, wind turbines, over-head powerlines, etc.) or actions that would cause a serious disruption to an ecologically significant proportion of a population (DAWE 2020). Invasive species that have the potential to impact the Spectacled monarch includes Black rat, *Rattus rattus* and exotic vines associated with riparian area (e.g. Rubber vine *Cryptostegia grandiflora*) (DAWE 2020).

Database records indicate this species does not occurs within the impact assessment area or the Project footprint. The nearest database records occur within 12 km east of the eastern section of the Project footprint at the Toowoomba Range. These records are recent (>2016) occurring to the north of Blue Mountain Heights. A number of recent records (>2006) occur to the east of Toowoomba and approximately 16 km east of the Project footprint. Other records within a 50 km buffer of the Project footprint occur at the Toowoomba Range. Most records for this species are restricted between the eastern side of the Great Diving Range and the coast at forest reserves and national parks.

It is unlikely that the thresholds outlined in the guideline will be exceeded. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project a significant impact resulting from a loss of important habitat is unlikely. There is no important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). Given this species occupies forests and woodlands that provide dense vegetation areas of open forest and woodland have not been included in the predicted area. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project and the loss of habitat below the threshold, a significant impact is currently considered unlikely.

Assessment against the significant impact criteria for Spectacled monarch is shown in Table 5.16.

Rufous fantail (*Rhipidura rufifrons*)

Rufous fantails typically breed from September to February with the majority of eggs laid between November and December. Breeding occurs slightly later at higher elevations with two to four eggs typically laid in a small nest that forms a cup-shape. Nesting material consists of a variety of plant material, moss and spider web (Higgins et. al 2006). Nests are constructed in trees, shrubs or vines between 34 cm and six metres from the ground and are typically placed 1.6 m high (Higgins et. al 2006). It is suggested that trees with big leaves are selected as to hide the nest (Huggett 2000). Both male and female will share incubation of the eggs, if the first nesting attempt is unsuccessful the pair will re-lay a second clutch (Higgins et. al 2006). Incubation takes between 5 and 17 days (Huggett 2000).

Where Rufous fantails are found in east and south-east Australia, they are associated with primarily wet sclerophyll forest, typically in gullies with a dense understorey of ferns. The species also occurs in sub-tropical to temperate regions where rainforest exists. Rufous fantails appear to have a tolerance for secondary forest. Whilst migrating they will stopover in drier sclerophyll forest and woodland ecosystems that have a shrubby, heath like understorey. In the north and north-east of their distribution they are known to occupy tropical rainforest, monsoonal rainforest and various type of vine thicket (Higgins et. al 2006).

The Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (DAWE 2020) considers important habitat as moist habitat with dense vegetation, across mangrove, rainforest, riparian forest and thickets, along with wet eucalypt forest with a dense understorey. A wider range of habitat becomes important for this species during migration including dry eucalypt forest/woodlands and Brigalow shrublands. The threshold for an ecologically significant proportion of a population (individuals) is 48,000 internationally and 4800 nationally. The area threshold for the loss of important habitat likely to result in a significant impact is 7,500 ha internationally and 750 ha nationally. The proportion likely to result in a significant impact if affected is 3,400 (individuals) internationally and 344 nationally (DAWE 2020).

The main threat to this species is thought to be fragmentation of habitat through the loss of core moist forest breeding habitat as a result of land clearing and urban encroachment particularly where clearing has occurred along remnant forest along migratory routes (Huggett 2000). Invasive species that have the potential to impact the Spectacled monarch includes Black rat, *Rattus rattus* and exotic vines associated with riparian area (e.g. Rubber vine *Cryptostegia grandiflora*) (DAWE 2020).

Database records indicate this species does not occur within the impact assessment area or the Project footprint. The nearest database records occur within 2 km of the eastern section of the Project footprint at Gowrie Junction from 1999. Two records occur at Pittsworth from 2001/2002 approximately 2 km from the Project footprint. Numerous records occur within a 50 km buffer of the Project footprint with most of these concentrated around Toowoomba Range. Most records for this species are restricted between the eastern side of the Great Diving Range and the coast at forest reserves and national parks.

It is unlikely that the thresholds outlined in the guideline will be exceeded. Few records occur within and around the ecology study compared to those in the surrounding areas, it is unlikely that a significant proportion of the population will be impacted. There is no important habitat in which this species is predicted to occur within the Project footprint (refer Table 4.28). Given this species occupies forests and woodlands that provide dense understory vegetation areas of open forest and woodland have not been included in the predicted area. Given the extensive remnant habitat that will not be disturbed adjacent to and surrounding the Project and the loss of habitat below the threshold, a significant impact is currently considered unlikely.

Assessment against the significant impact criteria for Rufous fantail is shown in Table 5.16.

Table 5.16 Assessment against the significant impact criteria: Woodland migrants

Criterion	Assessment against the significance criteria ¹
Substantially modify, destroy or isolate an area of important habitat for a migratory species	It is unlikely that important habitat for woodland migrants will be substantially modified, destroyed or isolated. The total area of predicted habitat considered important for woodland migrants that occurs within the Project footprint is below the guideline threshold for all species outlined above.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the species	The Biosecurity Management Sub-plan will mitigate the impacts of invasive species on the species. If the abundance of feral predators (i.e. cats and foxes) increase due to the Project, it is unlikely to have any impact due to the aerial behaviour of the species.
Seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species	Whilst breeding habitat for woodland migrants may occur within the Project footprint the predicted area for various habitats may not be representative of the actual breeding habitat available for these species. Therefore, the areas provided are likely to be a vast over estimation, furthermore these areas fall below the guideline thresholds. Disturbance as a result of the Project is not likely to seriously disrupt the lifecycle of an ecologically significant proportion of woodland migrant species.
Assessment of potential for significant impacts	Under the three-part test detailed above, it is currently considered unlikely a 'significant impact' on woodland migrants will result from the Project

Table note:

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

5.3.3.4 Wetland migrants

Glossy ibis (*Plegadis falcinellus*)

Glossy ibis is the smallest ibis in Australia and known to live up to 8 years on average. Glossy Ibis feed on aquatic invertebrates such as molluscs and crustaceans. They have been occasionally observed to feed on fish, frogs and tadpoles, dryland invertebrates, lizards, small snakes and nestling birds. They sexually mature in one or two years and typically breed from mid-spring to the end of summer and may persist breeding from September to April pending the availability of resources. They normally lay up to 3 to 6 eggs at a time, and chicks take 25 to 28 days to fledge. Parents will care for young several weeks after fledging. This species forms colonies for nesting, sometimes with a mix of other species of ibis and colonial birds. Nesting material consists of a platform nest of sticks, usually with a lining of aquatic plants, between the upright branches of trees or shrubs growing in water (Birdlife 2020). Australian breeding habitat types include vegetated swamps in the semi-arid and arid regions. In Queensland this species breeds in Channel Country and wetlands of the Bulloo, Diamantina and Georgina River systems, occasionally including Cooper Creek (DAWE 2020).

Globally they occur in North America, Europe, Asia, and Africa. In Australia, Glossy ibis are found from Kimberley down south to the Eyre Peninsula and east to Queensland New South Wales and Victoria. Glossy Ibis' preferred habitat for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. The species is occasionally found in wooded swamps, artificial wetlands (such as irrigated fields). No important habitat has been identified.

The main threat to this species is thought to be wetland destruction or degradation, this includes water diversion and drainage alteration. Increasing salinity, groundwater extraction human disturbance, pollution and grazing also threaten the species. Invasive species that have the potential to impact the Glossy ibis include invasive plants that can alter or degrade the health of wetland ecosystems and exotic fish (tilapia) species that may outcompete with food resources (DAWE 2020). This species is not listed as one of the 14 migratory species outlined in the Draft Referral Guideline for migratory bird species under the EPBC Act.

Recent database records (2019) indicate this species occurs within the Project footprint at Yelarbon. Six records occur within the Project footprint at this point with a number of other records within the impact assessment area in the surrounding landscape. A record from 1999 occurs within the impact assessment area to the south-west of Whetstone State Forest. The next nearest records occur Inglewood and Lake Coolmunda and between Brookstead and Pittsworth. Database records occur in all direction of the Project including inland. However, the majority occur between Toowoomba and Brisbane.

The Project will intersect a number of waterways/watercourses and various construction phase activities are likely to impact water quality associated with these (refer to the Appendix M: Surface Water Quality Technical Report). A total of 34 waterways will be crossed by the Project alignment, seven of these will be intersected multiple times. A total area of 132.60 ha of wetland and riparian zone/waterway habitat considered important for the species is predicted to occur within the Project footprint and will be lost as a result of construction activities. There is 87.62 ha of important habitat in which this species is predicted to occur that will be cleared from the Project footprint (refer Table 4.28). Given this area is relatively small and mitigation measures will be implemented during construction phase of the Project the impact associated with the loss of predicted habitat is not likely to have a significant impact on the species. Furthermore, the Project is outside of areas that are considered important breeding habitat, is not at the limit of the species range or provides habitat in an area where this species is declining.

Assessment against the significant impact criteria for Glossy ibis is shown in Table 5.17.

Eastern osprey (*Pandion haliaetus*)

The Eastern osprey (*Pandion haliaetus*) is a medium-sized raptor with a total length of 50 to 65 cm and wingspan 145 to 170 cm. Ospreys are one of the most widely distributed birds of prey, second to the Peregrine falcon. They are distributed globally occupying both temperate and tropical regions across all continents except Antarctica. Their diet mainly consists of fish, however, they have been known to feed on crustaceans, insects, reptiles, birds and mammals (DAWE 2020). They live on average 30 years, and have clutch sizes of one to four eggs, with brooding attempts separated by periods of up to three years. They typically inhabit coastal habitat and terrestrial wetlands of tropical and temperate Australia. Less frequently they are seen travelling over heath, woodland or forest when travelling between foraging sights (DAWE 2020). No important populations have been identified in Australia, although a management plan has been developed for New South Wales and one proposed for South Australia.

The Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (DAWE 2020) considers important habitat as moist habitat with dense vegetation, across mangrove, rainforest, riparian forest and thickets, along with wet eucalypt forest with a dense understorey. A wider range of habitat becomes important for this species during migration including dry eucalypt forest/woodlands and Brigalow shrublands. The threshold for an ecologically significant proportion of a population (individuals) is 48,000 internationally and 4,800 nationally. The area threshold for the loss of important habitat likely to result in a significant impact is 7,500 ha internationally and 750 ha nationally. The proportion likely to result in a significant impact if affected is 3,400 (individuals) internationally and 344 nationally (DAWE 2020).

Major threats include habitat loss or degradation, bioaccumulated pollutants, and food reduction due to competition with fisheries. Any invasive species that has the capacity to greatly reduce fish abundance is considered harmful to this species.

Records for this species do not occur within the Project footprint or within the impact assessment area. The nearest records occur approximately 12 km east of the Project footprint east of Inglewood at Lake Coolmunda from 2013. Other records within a 50 km buffer of the Project footprint occur to the north of the Project at Toowoomba Range. Most records for this species occur to the east along the coast whilst inland records are sparse and scattered.

The Project will intersect a number of waterways/watercourses and various construction phase activities are likely to impact water quality associated with these (refer to the Appendix M: Surface Water Quality Technical Report). A total of 34 waterways will be crossed by the Project alignment, seven of these will be intersected multiple times. There is no important habitat for this species within the Project disturbance (refer Table 4.28) footprint and will be lost as a result of construction activities. Given this area is relatively small and mitigation measures will be implemented during construction phase of the Project the impact associated with the loss of predicted habitat is not likely to have a significant impact on the species. The Project is not likely to exceed thresholds for this species as outlined in the guidelines referring to a loss of an ecologically significant proportion of a population or a significant proportion of important habitat.

Assessment against the significant impact criteria for Eastern osprey is shown in Table 5.17.

Yellow wagtail (*Motacilla flava*)

Yellow wagtails are a small passerine wagtail around 15-16cm long. Several races exist for this species however these are typically uniform grey-green or olive-green across the back and rump. The breast to vent underparts become bright yellow during breeding. This species does not breed in Australia and only breeding males are known to visit Australia. The species that breed in Europe, Siberia and Alaska migrate to Africa, south and south-east Asia, Indonesia and Papua New Guinea. They regularly migrate to the coastal regions of Australia during summer from Broome to north-east Queensland from November to April (Pizzey and Knight 2003). This species prefers open habitat near water, swamp margins, salt marshes, human modified landscapes such as sewage ponds and playing fields and can be found on drier inland plains (Morcombe 2003).

The Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act (DAWE 2020) considers important habitat as mostly well-watered open grasslands and the fringes of wetlands. Roosts in mangroves and other dense vegetation. The threshold for an ecologically significant proportion of a population (individuals) is 10,000 internationally and 1,000 nationally. No area threshold can be determined for this species. The proportion likely to result in a significant impact if affected is 10,000 internationally and 1,000 nationally (DAWE 2020).

Severe fragmentation of habitat, a reduction in habitat quality can lead to a decrease in the area of occurrence for the Yellow wagtail. These factors have potentially lead to a general decrease in the population size (Birdlife International 2020). It is not known if invasive species have the potential to impact the Yellow wagtail (DAWE 2020).

Database records do not indicate that this species occurs within the Project footprint, impact assessment area or from within a 50 km buffer of the Project footprint. The nearest records for this species occur a little more than 50 km north-east of the Project footprint at Wynnum North from 2014. Only a few other records occur along the coast between Brisbane and Caboolture. Most database records for this species occur in norther Australia.

Predictive habitat mapping indicates that there is 87.62 ha of important habitat in which this species is predicted to occur that will be cleared from the Project footprint (refer Table 4.28). A lack of database records combined with the fact that the Project is outside of the species' Australian migratory distribution means a significant impact on this species is unlikely. The Project is not likely to exceed thresholds for this species as outlined in the guidelines referring to a loss of an ecologically significant proportion of a population.

Assessment against the significant impact criteria for Yellow wagtail is shown in Table 5.17.

Table 5.17 Assessment against the significant impact criteria: Wetland migrants

Criterion	Assessment against the significance criteria ¹
Substantially modify, destroy or isolate an area of important habitat for a migratory species	It is unlikely that important habitat for woodland migrants will be substantially modified, destroyed or isolated. The total area of predicted habitat considered important for woodland migrants that occurs within the Project footprint is below the guideline threshold for all species outlined above.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the species	The Biosecurity Management Sub-plan will mitigate the impacts of invasive species on the species. If the abundance of feral predators (i.e. cats and foxes) increase due to the Project, it is unlikely to have any impact due to the aerial behaviour of the species.
Seriously disrupt the lifecycle of an ecologically significant proportion of the population if a migratory species	Whilst breeding habitat for wetland migrants (excluding Yellow wagtail) may occur within the Project footprint the predicted area for various habitats may not be representative of the actual breeding habitat available for these species. Therefore, the areas provided are likely to be a vast over estimation, furthermore these areas fall below the guideline thresholds. Disturbance as a result of the Project is not likely to seriously disrupt the lifecycle of an ecologically significant proportion of wetland migrant species.
Assessment of potential for significant impacts	Under the three-part test detailed above, it is currently considered unlikely a 'significant impact' on wetland migrants will result from the Project.

Table note:

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

5.3.4 Significant residual impact assessment for matters of State environmental significance

This section summarises assessment of the potential for significant residual impacts as a consequence of the Project on prescribed environmental matters associated with Queensland (MSES). The *Queensland Environmental Offsets Policy Significant Residual Impact Guidelines* (SRI Guideline) (DEHP, 2014b) criteria details when an action is likely to have a 'significant residual impact' to a MSES as defined in the *Environmental Offsets Regulation 2014*. Table 5.18 presents a preliminary significant residual impact assessment of the MSES identified as present in the desktop and field investigations, and in accordance with the SRI Guideline.

The extent of remnant habitat located within the Project footprint comprises 19 regional ecosystems as mapped by DNRME. This largely comprises open forests, woodlands and shrubby woodlands dominated by eucalypts, *Angophora*, *Callitris* and *Acacia* species. The analogous REs within this area include three listed as 'Endangered' (covering 62.74 ha), four listed as 'Of Concern' (151.50 ha). There is also 4.23 ha of high value regrowth and 2,605.89 ha of non-remnant lands within the Project footprint (refer Table 4.19 and Table 4.20 for further information regarding REs within the Project footprint). High value regrowth is listed as Category C vegetation and is not a prescribed environmental matter under the Environmental Offsets Regulation 2014. As such, it is not treated further in the following assessment.

The State Development Assessment Provision requires assessment of the Project against the criteria set out in the SRI Guideline (DSDIP 2014). The SRI Guideline criteria details when an action is likely to have a 'significant residual impact' to a MSES as defined in the Environmental Offsets Regulation 2014.

Table 5.18 presents a preliminary significant residual impact assessment of the MSES identified as present in the desktop and field review and in accordance with the SRI Guideline. The impacts to 'regulated vegetation' are based on the current VM Act vegetation mapping as will be required when considering environmental offsets. The areas of significant impacts are based on the Project footprint as currently known. The significant residual impact assessment will be updated, as necessary, following the conclusion of detailed ecological surveys of the Project footprint (refer Table 5.6). 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.

Table 5.18 Preliminary significant residual impact assessment

MSES	Significant residual impact guideline criteria	Likelihood of significant impact ¹															
Regulated vegetation																	
'Endangered' or 'Of Concern' regional ecosystem (RE)	An action is likely to have a SRI on an 'Endangered' or 'Of Concern' RE if the action will result in: (a) clearing of more than 5 ha of 'Endangered' or 'Of Concern' RE vegetation; (b) clearing that results in an overall area (not confined to property boundaries) of 'Endangered' or 'Of Concern' RE vegetation of less than 5 ha; OR (c) clearing that results in the physical separation of 'Endangered' and 'Of Concern' RE communities within and on adjoining sites.	Significant impact anticipated. Under current RVM mapping the Project footprint encompasses 62.74 ha of 'Endangered' and 151.50 ha of 'Of Concern' remnant vegetation (Category B) Clearing will result in the clearing of more than 5 ha of 'Endangered' and 'Of Concern' vegetation Clearing will occur resulting in areas of 'Endangered' and 'Of Concern' vegetation being reduced to less than 5 ha The clearing will result in the physical separation of 'Of Concern' and 'Endangered' communities.															
A prescribed RE (<i>Category B other than grassland</i>) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature (<i>Appendix 3 of the Queensland Environmental Offsets Policy</i>)	An action is likely to have a SRI on remnant vegetation within the defined distance of a watercourse if the action will result in: a) permanent removal of vegetation within the defined distance of a stream order 2 or higher where no rehabilitation is proposed; b) building of an online detention basin greater than 1 ha in size or other similar works that result in the clearing of vegetation which fragments up and downstream remnant areas on any stream order; OR c) permanent clearing of more than 0.5 ha of an 'Endangered' or 'Of Concern' RE, within the defined distance of a watercourse.	Significant impact anticipated. The defined distance for 1st and 2nd order, 3rd and 4th order, 5th order streams and greater in the Project footprint is 25 m, 50 m and 100 m respectively from a defined bank. The removal of the vegetation associated with Project construction is expected to be permanent and will not be rehabilitated. The Project will require the permanent removal of 48.85 ha of Category B vegetation within the defined distance of a watercourse.															
Remnant vegetation intersection with a VM Act wetland	An action is likely to have a SRI on remnant vegetation intersecting with a wetland if the action will result in: (a) clearing within the defining banks of a defined wetland area exceeding the thresholds specified in Table 2, SDAP Module 8 (b) clearing involving the permanent removal of more than 25% of the vegetation located within 50m of the defining bank of a defined wetland or (c) clearing involving the permanent removal of more than 50% of the vegetation located between 50 m and 100 m of the defining bank of a defined wetland.	Significant impact uncertain. There will be minimal impact within the defining banks of a defined wetland area. There will be permanent removal of approx. 0.97 ha of Category B regulated vegetation within 100 m of the defining bank of a defined wetland within the Project footprint. It is uncertain whether the impact thresholds for clearing within 50 m, and between 50 m and 100 m of a defined wetland will be exceeded.															
Essential Habitat (EH)	An action is likely to have a SRI on EH if the action will result in clearing of EH exceeding the thresholds specified in Table 1, SDAP Module 8, and resulting in a greater than 10% permanent reduction in the extent of EH mapped on site. <table border="1"> <thead> <tr> <th colspan="3">Clearing limits per RE</th></tr> <tr> <th>Structure Category</th><th>Width (m)</th><th>Area (ha)</th></tr> </thead> <tbody> <tr> <td>Dense and mid-dense</td><td>10</td><td>0.5</td></tr> <tr> <td>Sparse and very sparse</td><td>20</td><td>2</td></tr> <tr> <td>Grassland</td><td>25</td><td>5</td></tr> </tbody> </table>	Clearing limits per RE			Structure Category	Width (m)	Area (ha)	Dense and mid-dense	10	0.5	Sparse and very sparse	20	2	Grassland	25	5	Significant impact anticipated. There will be permanent removal of approx. 117.31 ha of Category B regulated vegetation mapped as essential habitat within the Project footprint.
Clearing limits per RE																	
Structure Category	Width (m)	Area (ha)															
Dense and mid-dense	10	0.5															
Sparse and very sparse	20	2															
Grassland	25	5															

MSES	Significant residual impact guideline criteria	Likelihood of significant impact ¹
Connectivity areas		
Connectivity areas	In deciding if a SRI is likely to occur on a connectivity area, an administering agency (that is the State) must consider the significance of the vegetation in the context of the local and the regional landscape. The measure of impact significance is based on how the prescribed activity will change the size and configuration of remnant vegetation areas and the level of fragmentation that will result at the local scale (5 km radius) given regard to the regional scale (20 km radius). Impact significance is measured by the reduction in the extent of remnant vegetation and increase in patchiness at the local scale. In highly fragmented landscapes at the regional scale, a SRI on connectivity areas will be associated with smaller impacts compared to impacts within regionally intact landscapes, as the extent and configuration of existing connectivity areas in fragmented landscapes is limited.	Significant impact anticipated. The landscape Project impacts to the extent of remnant vegetation in the area have been analysed using DES's 'landscape fragmentation and connectivity' tool. The analysis determined there will be a significant impact under significance test 2 - a change from core to non-core remnant at the site scale.
Designated precincts in Strategic Environmental Areas		
Designated precincts in Strategic Environmental Areas	The <i>Regional Planning Interests Act 2014</i> (RPI Act), which commenced on 13 June 2014, repealed the <i>Wild Rivers Act 2005</i>. The river systems that were declared under the Wild Rivers legislation have been rolled into the RPI Act framework as Strategic Environmental Areas (SEAs). The RPI Act SEAs are:- ■ The Cape York Strategic Environmental Area ■ The Channel Country Strategic Environmental Area the Fraser Island Strategic Environmental Area ■ The Gulf Rivers Strategic Environmental Area ■ The Hinchinbrook Island Strategic Environmental Area	Not anticipated. Outside of any designated Strategic Environmental Areas.
Wetlands and watercourses		
A wetland in a wetland protection area (WPA), or wetlands of high ecological significance shown on the map of Queensland wetland Sensitive environmental receptors a wetland or watercourse in high ecological value waters	An action is likely to have a SRI on a wetland or watercourse if: (a) works are undertaken within a wetland in a WPA, a wetland of HES or the bed or banks of a HEV watercourse that will result in a permanent degradation of the landform, vegetation or water quality (b) in an urban area, works are undertaken within 50m of a wetland in a WPA, a wetland of HES or the bed or banks of a HEV watercourse that will result in a permanent and significant change to surface or groundwater hydrology or water quality OR (c) in a non-urban area, works are undertaken within 200 m of a wetland in a WPA, a wetland of HES, or the bed or banks of a HEV watercourse that will result in a permanent and significant change to surface or groundwater hydrology or water quality.	Not anticipated. The works are not considered to be in an 'urban area' as defined under Schedule 26 of the Sustainable Planning Regulation 2009. The works are located approximately 800 m from mapped HES wetland located south of Yelarbon Kurumbul Road east of Kurumbul at the southern end of the alignment. The Project is more than 200 m from HES wetlands which is not likely to result in permanent and significant change to surface hydrology and water quality associated with this area.

MSES	Significant residual impact guideline criteria	Likelihood of significant impact ¹
Protected wildlife habitat		
An area contains plants that are 'Endangered' wildlife or 'Vulnerable' wildlife	Plants - Protected wildlife habitat (plants that are 'Endangered' or 'Vulnerable' wildlife)* An action is unlikely to have a SRI on a plant that is 'Endangered' or 'Vulnerable' wildlife if the action will result in: (a) clearing of plants that are threatened wildlife and not located within a natural setting (i.e. does not meet the definition of 'in the wild' under the <i>Nature Conservation Act 1992</i>) where the proposal includes translocation; (b) clearing of up to 10% of the total number of plants that are threatened wildlife occurring on a site where the proposal results in 90% of all plants that are threatened wildlife being retained and protected as a reserve or similar (c) clearing of regenerating plants that are threatened wildlife which have previously been cleared within the last 5 years and that are historically maintained through slashing or grazing OR (d) the proposed relocation of an area of plants that are threatened wildlife less than 1000 m² not occurring in a relatively natural ecological situation (e.g. bushland), to a permanent retention area via an approved management plan.	Significant impact uncertain. Protected plant trigger maps indicate that 'Endangered' or 'Vulnerable' flora exists within the Project footprint to the south of Millmerran, to the north of Pittsworth and to the west of Southbrook. There are a number of plant species which are listed as MNES. These species have been assessed under the MNES significant impact guidelines and as such are not assessed here (refer EIS Appendix L: Matters of National Environmental Significance technical report). At this stage it is not known if these species occur. Pre-clearing surveys will be required to identify if any threatened plant species occur within the Project footprint. In the event threatened species are found to occur it is assumed translocation will not take place and that all plants within the Project footprint will be removed.
A habitat for an animal that is: ■ Endangered wildlife, or ■ Vulnerable wildlife, or ■ A SLC animal (an <i>Echidna</i> or a <i>Platypus</i>)	Protected wildlife habitat (habitat for an animal that is 'Endangered' or 'Vulnerable' wildlife or a SLC animal). Refer to the assessment of the SRI Guideline significant impact criteria for threatened fauna (refer Table 5.20) and SLC fauna (refer Table 5.21).	Significant impact anticipated. There is potential for significant impact to Glossy-black cockatoo, Major Mitchell's cockatoo, Common death adder, Platypus and Echidna as suitable habitat for these species occur within the Project footprint. There are a number of other species which are listed as MNES. These species have been assessed under the MNES significant impact guidelines and as such are not assessed here (refer EIS Appendix L: Matters of National Environmental Significance technical report). The species-specific assessments indicated no significant residual impacts are likely to occur to these species.
Fish habitat area		
an area declared under the <i>Fisheries Act 1994</i> (Qld) to be a fish habitat area	An action is likely to have a SRI on a declared FHA or highly protected zones of marine parks if the action: (a) is not for a listed purpose or a structure type; AND (b) will result in a residual disturbance footprint within the declared FHA and/or highly protected marine park zone of 40 m² or greater in area.	Not anticipated. Minimal fish habitat areas were mapped within the water quality impact assessment area. The area was highly unlikely to provide suitable habitat for any EVNT or SLC aquatic flora or fauna species, nor were these detected (refer EIS Appendix P: Surface Water Quality Technical Report).

MSES	Significant residual impact guideline criteria	Likelihood of significant impact ¹
Waterway providing for fish passage		
Any part of a waterway providing for passage of fish only if the construction, installation or modification of waterway barrier works will limit the passage of fish along the waterway	An action is likely to have a SRI on a <u>waterway providing for fish passage</u> if the action will result in: a) A permanent modification to the volume, depth, timing, duration or flow frequency of the waterway b) Permanent modification or fragmentation of fish habitat including but not limited to in stream vegetation, snags and woody debris, substrate, bank or riffle formation necessary for breeding and/or survival of native fish species c) The mortality or injury of fish species or d) Works that permanently reduce the level of fish passage provided in a tidal waterway or a waterway identified as a major high-risk waterway for waterway barrier works, to a level that would increase stress on fish populations.	Significant impact uncertain. There are 82 individual waterways which cross the Project alignment. Of those there are 15 major waterways (stream order ≥ 3) and 66 minor waterways (stream order < 3) defined as watercourses under the Water Act and as mapped waterways (drainage lines and unmapped watercourses) (refer EIS Appendix P: Surface Water Quality Technical Report). The Project has potential to permanently modify fish habitat, although it is anticipated final design will maintain flows along creek lines via installation of culverts/bridges at crossings.

Table note:

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

5.3.4.1 Matters of State environmental significance threatened species assessments

Section 4.5.1.1 and 4.5.2.1 details the threatened species as known or possibly occurring within the Project footprint. The Project footprint provides possible habitat values for a number of threatened species, including a number of species listed as MNES and MSES. These species have already been assessed under the MNES significant impact guidelines (refer EIS Appendix L: Matters of National Environmental Significance Technical Report).

The Project footprint provides predicted habitat suitable for the Sedge (*Cyperus clarus*) ('Vulnerable' under the NC Act), Finger panic grass (*Digitaria porrecta*) ('Near Threatened' under NC Act) and Hawkweed (*Picris barbarorum*) ('Vulnerable' under NC Act). When considering the potential for significant residual impacts to flora species during the Project construction phase pre-clearance surveys that are part of the Project commitments were considered. The listed flora that has not already been assessed under the MNES significant impact guidelines have been assessed in Table 5.19, Table 5.20 and Table 5.21.

The Project footprint also provides predicted habitat suitable for the Common death adder, Major Mitchell's cockatoo, Glossy-black cockatoo ('Vulnerable' under the NC Act), Platypus and Short-beaked echidna (SLC under the NC Act). Predictive habitat mapping for these species has been based on ground-truthed vegetation data and is considered conservative in approach for the reference design stage of the Project (i.e. is likely to be an overestimate of the actual suitable habitat present).

Of these, one species is not considered further here:

- Major Mitchell's cockatoo (*Lophochroa leadbeateri*) ('Vulnerable' under the NC Act) – there are three database records located within 50 km of the Project footprint. Two of these are from the 1980s. A third, is from 2014 and is located 10 km west of the Project footprint (south-west of Millmerran). The species core range is inland well to the west of the Project footprint where it occurs east to Roma and Saint George (Hurley 2012) (also refer the AoLA (2020) expert distribution of the species). Although there are scattered records of the species east of the core distribution (including the Brisbane area) these will be vagrant individuals or potential cage escapees from suburban areas. The species is not considered further in this impact assessment.

The SRI Guideline criteria for assessing significant impacts to 'Vulnerable' species are similar in some respects to the criteria set out for threatened species in the MNES guidelines. Table 5.19 provides a significant impact assessment for Common death adder and Glossy-black cockatoo and Table 5.21 provides an assessment for Short-beaked echidna and Platypus according to the SRI Guideline criteria.

Table 5.19 Matters of State environmental significance significant residual impact criteria – Threatened flora

Criteria	Assessment against significance criteria A sedge (<i>Cyperus clarus</i>) ¹	Assessment against significance criteria Finger panic grass (<i>Digitaria porrecta</i>) ¹	Assessment against significance criteria Tall hawkweed (<i>Picris barbarorum</i>) ¹
Lead to a long term decrease in the size of a local population of the species	<i>Cyperus clarus</i> has been recorded within the Project impact assessment area previously (1934 and 1976) within 500 m from the rail corridor. Whilst these are reliable specimen back records, they are considerably old. A recent record (2018) occurs outside of the impact assessment area. Predictive habitat mapping indicates that the Project footprint contains 106 ha of suitable habitat for the species. Numerous specimen backed records occur in the area to the east of the northern section of the alignment and will not be disturbed by the Project. The Project will follow an area that has encountered previous disturbance (agricultural land). Whilst records exist within the impact assessment area there are none from within the Project footprint. Given the relatively small amount of suitable habitat that is estimated to be removed when compared to the species' distribution it likely that the Project will only have a minor impact on a local population. The Project is not expected to lead to a long term decrease in the size of a local population.	<i>Digitaria porrecta</i> has been recorded within the Project footprint at the northern end of the alignment recently (2018) where the alignment intersects the Warrego Highway. Two records from within the impact assessment area occur at Pittsworth dated 1995 and a further two records from 1994 occur within the impact assessment area at Brookstead. Predictive habitat mapping indicates that the Project footprint contains 455.61 ha of suitable habitat for this species. Specimen backed records occur to the north and south of the eastern section of the alignment from Jandowae to Warwick indicating that this could be a sub-population. These areas will not be disturbed by the Project. The area of habitat in which this species is predicted to occur within the Project footprint is conservative and likely to be an overestimate. The Project is not at the limit of the species' distribution. The Project is not likely to lead to a long term decrease in the size of this local population.	<i>Picris barbarorum</i> has been recorded within the Project footprint at several locations. Records within the disturbance area occur at Brookstead where the alignment intersects the Gore Highway with three records dated from 2002. A record from 2018 at Pittsworth noted six individuals at the sighting location. Several database records from 1999 exist within the impact assessment area at Brookstead with one record within 50 m of the disturbance area. Predictive habitat mapping indicates that the Project footprint contains 567.49 ha of suitable habitat for the species. Few records exist within a 50 km buffer of the disturbance area and those that do are largely disjunct. In Queensland database records indicate the species occurs between Tambo in central Queensland and Allora in the south-east of the State. The records associated with the Project footprint could be considered local populations given the distance between other records in the area. The loss of the records at Brookstead and Pittsworth would be considered a long term decrease in the size of local populations.
Reduce the area of occurrence of the species	Predictive habitat mapping indicates that the Project footprint contains 106 ha of habitat considered suitable for the species. There is potential for this species to occur within the Project footprint and it is likely that the Project will reduce the area of occupancy of the species but only to a minor extent.	Predictive habitat mapping indicates that the Project footprint contains 455.61 ha of habitat considered suitable for the species and it is likely that the species occurs in the area given the specimen backed records. It is likely that the Project will reduce the area of occupancy of the species but only to a minor extent.	Predictive habitat mapping indicates that the Project footprint contains 567.49 ha of suitable habitat for the species with the species known to occur within the Project footprint. Therefore, it is likely that the Project will result in a reduction of the area of occurrence for <i>P. barbarorum</i> due to clearing activities.

Criteria	Assessment against significance criteria A sedge (<i>Cyperus clarus</i>) ¹	Assessment against significance criteria Finger panic grass (<i>Digitaria porrecta</i>) ¹	Assessment against significance criteria Tall hawkweed (<i>Picris barbarorum</i>) ¹
Fragment an existing population	Predictive habitat mapping indicates that the Project footprint contains 106 ha of suitable habitat for the species representing only a minor proportion of the range of occurrence. The Project is linear and unlikely to fragment an existing population. Specimen backed records indicate areas outside of the disturbance area where this species occurs and will be left undisturbed by the Project. The Project is considered unlikely to fragment an existing population.	Predictive habitat mapping indicates that the Project footprint contains 455.61 ha of suitable habitat for the species. The Project, although linear in its design is not wide enough to separate this species into fragmented populations. Therefore, the Project is considered unlikely to fragment an existing population.	Predictive habitat mapping indicates that the Project footprint contains 567.49 ha of suitable habitat for the species. The Project, although linear in its design will result in the removal of individuals from already disjunct populations and is likely to further fragment these.
Result in genetically distinct populations forming as a result of habitat isolation	Predictive habitat mapping indicates that the Project footprint contains 106 ha of suitable habitat for the species. The Project, although linear in its design is not wide enough to separate this species into genetically distinct populations. The Project is not likely to produce genetically distinct populations through the process of habitat isolation.	Predictive habitat mapping indicates that the Project footprint contains 455.61 ha of suitable habitat for the species. The Project, although linear in its design is not wide enough to separate this species into genetically distinct populations and is not likely to be a barrier for pollinators. The Project is not likely to produce genetically distinct populations through the process of habitat isolation.	Predictive habitat mapping indicates that the Project footprint contains 567.49 ha of suitable habitat for the species. The Project, although linear in its design is not wide enough to separate this species into genetically distinct populations. The Project is not likely to produce genetically distinct populations through the process of habitat isolation.
Result in invasive species that are harmful to a vulnerable species becoming established in the species habitat	Future works for the Project will be conducted under a CEMP. The CEMP will incorporate mitigation measures to control the introduction and spread of weed and pest species across the Project footprint. The local landscape is already subject to extensive weed infestation with Lantana (<i>Lantana camara</i>) and Rubber vine (<i>Cryptostegia grandiflora</i>) commonly observed within the Project footprint in the November 2019 survey. The CEMP will be in place for the duration of construction of the Project and will minimise the potential for weed invasion. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.		
Introduce disease that may cause the population to decline	The CEMP 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	No State recovery plan exists for <i>C. clarus</i> nor is there a relevant recovery plan. Predictive habitat mapping indicates that there is an estimated 106 ha of habitat in which this species is predicted to occur. The existing landscape is predominantly agricultural land. Whilst not clear whether the Project will interfere with the recovery of the species it is unlikely.	A State recovery plan exists for <i>D. porrecta</i> in New South Wales but not in Queensland. The recovery plan is site specific for sub-populations in New South Wales and focuses recovery actions on grazing regimes, weed control, habitat restoration and tracking the species over time. Whilst the Project is estimated to remove 455.61 ha of habitat in which this species is predicted to occur the Project may contribute to the recovery of the species by controlling the spread of weeds along the alignment. This Project is unlikely to interfere with the recovery of the species.	No State recovery plan exists for <i>P. barbarorum</i> . Any loss of suitable habitat for this species would limit its chance to extend its range and would result in further restriction of its occurrence. The estimate removal of 567.49 ha of suitable habitat may interfere with the recovery of this species locally.

Criteria	Assessment against significance criteria A sedge (<i>Cyperus clarus</i>) ¹	Assessment against significance criteria Finger panic grass (<i>Digitaria porrecta</i>) ¹	Assessment against significance criteria Tall hawkweed (<i>Picris barbarorum</i>) ¹
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	Ecologically significant locations could be considered as small populations/sub-populations at risk of local extinction. The database records close to the Project are not recent and may have already been impacted by historical disturbance (agriculture) in the area. Nevertheless, if the species was to occur within the Project footprint the Project would result in the further range contraction of this sub-population. Therefore, the Project, although unlikely, has the potential to cause disruption to an ecologically significant location for this species.	Ecologically significant locations could be considered as small populations/sub-populations at risk of local extinction. There is potential for this species to be encountered during vegetation clearing for the Project given that there are specimen backed records from within the Project footprint. Given the abundance of specimen backed records in the surrounding landscape the Project is not likely to cause disruption to an ecologically significant location for this species.	Ecologically significant locations could be considered as small populations at risk of local extinction. There is a high likelihood that this species is going to be encountered during vegetation clearing for the Project given there are specimen backed records from within the Project footprint. The records around Brookstead and Pittsworth could each be considered small populations. As such they could be considered at risk of local extinction as a result of the Project. Therefore, the Project has the potential to cause disruption to ecologically significant locations for this species.
Assessment of potential for significant residual impacts	The Project will result in the clearance of 106 ha of habitat suitable for <i>C. clarus</i>. The Project has the potential to reduce the area of occurrence for the species however this only on a local scale. The Project, although unlikely, has the potential to cause disruption to an ecologically significant location for this species. The Project has the potential to cause a 'significant residual impact' on this species.	The Project will result in the clearance of 455.61 ha of habitat suitable for <i>D. porrecta</i> which has potential to reduce the area of occurrence for the species. The Project is likely to cause a 'significant residual impact' on this species.	The Project will result in the clearance of 567.49 ha of habitat suitable for <i>P. barbarorum</i>. The Project has the potential to lead to a long term decrease in the size of local populations, reduce the area of occurrence, interfere with the recovery of the species and cause disruption to ecologically significant locations. The Project is likely to cause a 'significant residual impact' on this species.

Table note:

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

Table 5.20 Matters of State environmental significance significant residual impact criteria – Threatened fauna

Criteria	Assessment against significance criteria (Common death adder) ¹	Assessment against significance criteria (Glossy-black cockatoo) ¹
Lead to a long term decrease in the size of a local population of the species	There are a number of database records (including recent) from the State Forest reserves surrounding Inglewood. Three of these are located within or adjacent to the Impact assessment area. There are no other records located within 40 km of the Project elsewhere along the alignment. Predictive habitat mapping indicates that the Project footprint contains 540.87 ha of suitable habitat for the species. This is a conservative estimate based on predictive mapping and may be a substantial overestimate of the actual habitat available for the species. Common death adders are slow-moving sedentary snakes that lie motionless while partially buried in leaf litter, vegetation or soil. They occur in a wide variety of well-drained habitats with a well-developed shrub and leaf litter layer including rainforest, shrublands and heathlands (Wilson and Swan 2013). There is substantial remnant and regrowth vegetation surrounding the Project in the Inglewood area where there is a number of species records across the wider area. As such there will be substantial suitable habitat for the species in the surrounds that will not be disturbed by the Project. The Project skirts the edge of several reserves in the Inglewood area which may comprise habitat for the species. There will be extensive similar habitat remaining undisturbed outside of the alignment. Outside of this portion of the Project footprint the species is not known, and the Project largely impacts lands that have already been cleared for grazing/agriculture. The Project is not expected to lead to a long term decrease in the size of a local population.	There are numerous database records (including recent) from the State Forest reserves surrounding Inglewood. Two of these are located adjacent to the Project footprint. There are several records from Pittsworth (three within the Impact assessment area) and surrounds, although these are all older records (<1990) excepting a single 2005 record located approximately 10 km north of the Project footprint. There are numerous records to the east of the northern extent of the Project associated with the Toowoomba Range, the nearest of which is 9 km from the Project footprint. Predictive habitat mapping indicates that the Project footprint contains 480.86 ha of suitable habitat for the species. This is a conservative estimate based on predictive mapping and may be a substantial overestimate of the actual habitat available for the species. Given the extant database records the species is likely to occur only in the Inglewood area. They feed almost exclusively on the seeds of species of she-oaks. In the Project footprint they will feed on <i>Casuarina cristata</i> and <i>Casuarina cunninghamiana</i>. They do not appear to feed to any great degree on the more widespread <i>Allocasuarina luehmannii</i>. Feeding areas are often restricted, showing a strong fidelity to particular trees. This species is capable of traveling 10 km from roosting or nesting sites to feed trees and require large hollow trees for nesting. There is substantial remnant and regrowth vegetation surrounding the Project in the Inglewood area where there is a number of species records across the wider area. As such there will be substantial suitable habitat for the species in the surrounds that will not be disturbed by the Project. It is uncertain how many individuals may use habitat within the Project footprint. The need for large hollow bearing trees and <i>Allocasuarina/casuarina</i> food trees indicates that a reduction of these resources has the potential to reduce suitable habitat for the species. Nevertheless, given the relatively small area that will be impacted within the Project footprint compared to the extensive similar habitat remaining in the surrounding area, it is considered unlikely the Project will have a major impact that would lead to a long term decrease in the size of a local population.
Reduce the area of occurrence of the species	There is potential the species occurs in the Inglewood area given the specimen backed records from the Impact assessment area and surrounds. Predictive habitat mapping indicates that the Project footprint contains 540.87 ha of habitat considered suitable for the species, although this is likely a substantial overestimation. There is potential for the Project to reduce the area of occupancy of the species.	Predictive habitat mapping indicates that the Project footprint contains 480.86 ha of habitat considered suitable for the species although this is likely to be a substantial overestimate. There are extensive areas adjacent to the east and west of the Project footprint in the Inglewood area that would comprise suitable habitat for the species. It is likely that the species occurs in the Inglewood area given the specimen backed records. There is potential for the Project to reduce the area of occupancy of the species but only to a minor extent given the availability of habitat in the local area.

Criteria	Assessment against significance criteria (Common death adder) ¹	Assessment against significance criteria (Glossy-black cockatoo) ¹
Fragment an existing population	Predictive habitat mapping indicates that the Project footprint contains 540.87 ha of habitat considered suitable for the species, although this is likely a substantial overestimation. There are large areas of similar habitat to adjacent to the Project that would be considered suitable habitat for the species. The linear nature of the Project has potential to fragment a relatively sedentary species. The Project intersects contiguous woodland habitat, and therefore the Project may fragment an existing population of Common death adder.	Predictive habitat mapping indicates that the Project footprint contains 480.86 ha of habitat considered suitable for the species although this is likely to be a substantial overestimate. There are extensive areas adjacent to the east and west of the Project footprint in the Inglewood area that would comprise suitable habitat for the species. The linear nature of the Project could fragment existing populations; however this is an avian species and highly mobile. The Project is considered unlikely to fragment an existing population.
Result in genetically distinct populations forming as a result of habitat isolation	Predictive habitat mapping indicates that the Project footprint contains 540.87 ha of habitat considered suitable for the species, although this is likely a substantial overestimation. There are large areas of similar habitat to adjacent to the Project that would be considered suitable habitat for the species. The linear nature of the Project has potential to fragment a relatively sedentary species, although the species may occur widely in the surrounding area. The Project is not considered likely to result in habitat isolation to the extent genetically distinct populations will occur.	Predictive habitat mapping indicates that the Project footprint contains 480.86 ha of habitat considered suitable for the species although this is likely to be a substantial overestimate. There are extensive areas adjacent to the east and west of the Project footprint in the Inglewood area that would comprise suitable habitat for the species. Although the Project is linear this is an avian species and highly mobile. The Project will not result in habitat isolation occurring on a local population of the species.
Result in invasive species that are harmful to a vulnerable species becoming established in the species habitat	Future works for the Project will be conducted under a CEMP. The CEMP will incorporate mitigation measures to control the introduction and spread of weed and pest species across the Project footprint. The local landscape is already subject to extensive weed infestation with nine species listed under the Biosecurity Act identified during Project surveys. The CEMP will be in place for the duration of construction of the Project and will minimise the potential for weed invasion. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.	
Introduce disease that may cause the population to decline	The CEMP 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 Common death adder. Predictive habitat mapping indicates that the Project footprint contains 540.87 ha of habitat considered suitable for the species, although this is likely a substantial overestimation. The species distribution extends from northern Queensland to southern New South Wales extending west into South Australia. The Project will not interfere with the recovery of the species.	There is no State recovery plan for Glossy-black cockatoo. Predictive habitat mapping indicates that the Project footprint contains 480.86 ha of suitable roost/foraging habitat for the species which is likely to be an overestimate. There is abundant similar habitat in the surrounding area. The Project is considered unlikely to interfere with the recovery of the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	It is uncertain what an ecologically significant location for the species may be. It is a sit and wait predator which prefers a deep leaf litter layer. The species gives birth to live young from December to March. The species has potential to be encountered during vegetation clearing for the Project. Where possible construction clearing in suitable habitat will be programmed to occur outside of the breeding season. Mitigation measures during clearing will include the presence of qualified fauna spotter/catcher during clearing, including pre-clearing surveys to move individuals (should they occur). The Project is considered unlikely to disrupt an ecologically significant location.	Ecologically significant locations include large tree hollows in which this species relies on for breeding and preferred <i>Allocasuarina/Casuarina</i> food trees. Given that this species has an affinity for particular food trees the loss of any trees could be considered a disruption to an ecologically significant location. Mitigation measures during clearing will include the presence of qualified fauna spotter/catcher, including pre-clearing habitat to identify evidence of Glossy-black cockatoo feeding evidence and potential habitat features (such as large tree hollows). Nevertheless, the Project has potential to disrupt an ecologically significant location.

Criteria	Assessment against significance criteria (Common death adder) ¹	Assessment against significance criteria (Glossy-black cockatoo) ¹
Assessment of potential for significant residual impacts	Predictive habitat mapping indicates that 540.87 ha of habitat suitable for Common death adder may be cleared for the Project, which has potential to reduce the area of occurrence of the species somewhat and fragment a population. The Project has potential to cause a 'significant residual impact' on this species.	Predictive habitat mapping indicates that the Project footprint contains 480.86 ha of habitat suitable for Glossy-black cockatoo may be cleared for the Project, which has potential to reduce the area of occurrence of the species. The Project also has potential to disrupt an ecologically significant location (large tree hollows and food trees). The Project has potential to cause a 'significant residual impact' on this species.

Table note:

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

Table 5.21 Matters of State environmental significance Guideline criteria – Special Least Concern fauna species

Criteria	Assessment against significance criteria (Short-beaked echidna) ¹	Assessment against significance criteria (Platypus) ¹
Lead to a long term decrease in the size of a local population of the species	Echidna has been recorded from within the Project impact assessment area previously to the south-west of Brookstead (2003 and 2013) and west of Gowrie Mountain (2003). There are numerous records in the surrounding landscape throughout the alignment. Predictive habitat mapping indicates that the Project footprint contains 736.72 ha of predicted suitable habitat for the species. This is a wide-ranging species which occurs all over Australia and in most habitats. Echidnas have ranges observed between 21 and 93 ha and are able to live anywhere that provides a good supply of ants and termites (AoLA 2020). There is extensive suitable habitat surrounding the Project, particularly in bushland remnants around Inglewood, which will remain undisturbed. The Project will largely impact lands already subject to extensive disturbance from agriculture and grazing. Whilst records exist within the impact assessment area there are none from within the Project footprint. Given the relatively small amount of suitable habitat that is estimated to be removed when compared to the species' distribution it is likely the Project would only have minor impact on a local individual's home range. The Project is not expected to lead to a long term decrease in the size of a local population.	There are three records of Platypus from the Inglewood area associated with the Macintyre River catchment. The nearest of these is a 2002 record from Macintyre Brook located 2.5 km south of the Project footprint. Further east of Inglewood there are two records (including from 2018) from Coolmunda Dam. Further west there is a 2019 record approximately 5 km south of the Project footprint near Kurumbul. Further downstream there are records from the Macintyre River near Goondiwindi and Boggabilla. The only other records in the vicinity of the Project are located east of Toowoomba. There are no records from the Condamine River catchment excepting a single record in the vicinity of Miles. Given these records are located in coastal drainages they are not considered relevant to the Project. Predictive habitat mapping indicates that the Project footprint contains 87.73 ha of predicted suitable habitat for the species. This is a conservative estimate based on predictive mapping and is very likely a substantial overestimate of the actual habitat available for the species. The project will cross the Macintyre River at its southernmost point and lies close to (but does not intersect) Macintyre Brook for a substantial portion of its length. The Project will cross minor waterways in the Macintyre rook catchment. Construction disturbance at crossings will be temporary and localised. The Project will not create flow disturbance or create new impoundments when construction is finished. The Project will not lead to a long term decrease in the size of a local population.
Reduce the area of occurrence of the species	Predictive habitat mapping indicates that the Project footprint contains 736.72 ha of habitat considered suitable for the species. This is a wide-ranging species which occurs all over Australia and in most habitats. The Project is not considered likely to reduce the occurrence of the species and it is likely that the species occurs in the area given the specimen backed records. There is potential for the Project to reduce the area of occupancy of the species but only to a very minor extent.	Predictive habitat mapping indicates that the Project footprint contains 87.73 ha of predicted suitable habitat for the species. This is a conservative estimate based on predictive mapping and is very likely a substantial overestimate of the actual habitat available for the species. The species is likely only present in the Macintyre River catchment. Impacts to waterways will be temporary and restricted to construction of crossing structures. The Project is not expected to reduce the area of occupancy of the species
Fragment an existing population	Predictive habitat mapping indicates that the Project footprint contains 736.72 ha of suitable habitat for the species. There are extensive areas surrounding the Project comprising suitable habitat for the species. This species is wide ranging and is able to live in a variety of habitats as long as food is available. Given the linear nature of the Project and the fact this is a terrestrial species there is potential to fragment a local population either side of the alignment. Nevertheless, the final design of the Project will incorporate fauna-friendly crossing structures allowing passage across the alignment. The Project is considered unlikely to fragment an existing population.	The species is likely only present in the Macintyre River catchment. The project will cross the Macintyre River at its southernmost point and lies close to (but does not intersect) Macintyre Brook for a substantial portion of its length. The Project will cross minor waterways in the Macintyre rook catchment. Construction disturbance at crossings will be temporary and localised. The project will not create flow disturbance or create new impoundments when construction is finished. The Project will not fragment an existing population.

Criteria	Assessment against significance criteria (Short-beaked echidna) ¹	Assessment against significance criteria (Platypus) ¹
Result in genetically distinct populations forming as a result of habitat isolation	Predictive habitat mapping indicates that the Project footprint contains 736.72 ha of suitable habitat for the species. There are extensive areas to the north and south of the Project that comprise suitable habitat for the species. This species is wide ranging and is able to live in a variety of habitats as long as food is available. Given the linear nature of the Project and the fact this is a terrestrial species there is potential to fragment local population either side of the alignment. Nevertheless, the final design of the Project will incorporate fauna-friendly crossing structures allowing passage across the alignment. The Project is considered unlikely to cause fragmentation such that genetic isolation of populations will occur.	The species is likely only present in the Macintyre River catchment. The project will cross the Macintyre River at its southernmost point and lies close to (but does not intersect) Macintyre Brook for a substantial portion of its length. The Project will cross minor waterways in the Macintyre rook catchment. Construction disturbance at crossings will be temporary and localised. The project will not create flow disturbance or create new impoundments when construction is finished. The Project will not cause fragmentation such that genetic isolation of populations will occur.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	Ecologically significant locations include ground timber such as hollow logs in which the species may utilise for feeding, refuge and reproduction. This species has potential to be encountered during vegetation clearing for the Project. Mitigation measures during clearing will include the presence of qualified fauna spotter/catcher during clearing, including pre-clearing surveys to investigate potential habitat features. Individuals will be translocated to suitable habitat away from the works area. The Project is unlikely to disrupt an ecologically significant location to the extent a significant impact is likely to occur on the species.	Ecologically significant locations for this species include streambank burrows which the species uses for breeding and resting. Mitigation measures during construction disturbance will include pre-clearing surveys to investigate potential Platypus presence and burrows in the vicinity of crossing areas. Individuals will be translocated or encouraged to move away from the works area. Platypus is known to have home ranges well over 2.5 km and will use multiple burrows. The Project is considered unlikely to disrupt an ecologically significant location to the extent a significant impact is likely to occur on the species.
Assessment of potential for significant residual impacts	No significant residual impacts are currently considered likely to occur for this species.	No significant residual impacts are currently considered likely to occur for this species.

Table note:

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

5.4 Biodiversity offsets

Impacts to Sensitive environmental receptors will be avoided where possible and then minimised and mitigated to the greatest extent practicable. 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 5.3.2, reflects the effectiveness of the proposed mitigation measures but also allows for the identification of areas where further management measures may be required.

This section summarises the quantification of significant residual impacts to MNES (non-threatened migratory species) and MSES and provides discussion on how ARTC proposes to provide its offset obligations for the Project.

5.4.1 Matters of national environmental significance

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).

Significant impact assessment for non-threatened migratory species potentially impacted by the Project indicated that significant impacts are unlikely to occur for these species. As such the provisions of offsets for non-threatened migratory species as listed under the EPBC Act is not required under the EPBC Act Offsets Policy.

5.4.2 Matters of State environmental significance

For MSES, impacts to Prescribed environmental matters that are considered to constitute significant residual impacts are required to be offset in accordance with the Offsets Act. The Environmental Offsets Regulation 2014 and associated Queensland Environmental Offsets Policy 2017 (the Offsets Policy), provide guidance related to offsets for MSES. The purpose of the Offsets Policy is to provide a decision-support tool to enable administering agencies the ability to assess offset proposals to ensure that they meet the requirements of the Offsets Act.

Assessment of MSES prescribed matters has been undertaken in accordance with the MSES significant impact criteria (refer Section 5.3.4). Analysis, based on predictive habitat modelling and mapping, indicates that significant residual impacts for the following Sensitive environmental receptors have potential to occur:

- ‘Endangered’ or ‘Of Concern’ REs
- Regulated vegetation (Category B (other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature)
- Remnant vegetation intersection with a VM Act wetland
- Essential Habitat

- Connectivity areas
- Protected wildlife habitat for the following species:
 - A sedge (*Cyperus clarus*)
 - Finger panic (*Digitaria porrecta*)
 - Tall hawkweed (*Picris barbarorum*)
 - Common death adder (*Acanthopis antarcticus*)
 - Glossy black-cockatoo (*Calyptorhynchus lathami lathami*)
 - *Nature Conservation (Koala) Conservation Plan 2017* mapping (Koala Habitat Areas)

An initial quantification of anticipated significant residual impacts to MSES is presented in Table 5.22.

In order to mitigate the residual impacts to the sensitive environmental receptors identified above, environmental offsets will be required. ARTC's Environmental Offset Delivery Strategy – Qld (Strategy) (EIS Appendix N: Draft Offset Strategy) informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans

Table 5.22 Quantification of anticipated significant residual impacts and may require offsets

Sensitive environmental receptor	Identified significant residual impact ¹
Regulated vegetation	
'Endangered' regional ecosystems (RE)	62.74 ha
'Of Concern' regional ecosystems (RE)	151.50 ha
A prescribed RE (Category B other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature	43.88 ha
Essential Habitat (EH)	117.31 ha
Connectivity areas	
Regional Terrestrial corridors	235.37 ha
State Riparian corridors	37.42 ha
State Terrestrial corridors	161.39 ha
Protected wildlife habitat	
Flora	
<i>Cyperus clarus</i> (a sedge)	106.00 ha—general habitat
<i>Digitaria porrecta</i> (Finger panic)	455.61 ha—(373.87 ha general habitat, 81.74 ha essential habitat)
<i>Picris barbarorum</i> (Tall hawkweed)	567.49 ha—(529.35 ha general habitat, 38.14 ha essential habitat)
Fauna	
Common death adder (<i>Acanthopis antarcticus</i>)	540.87 ha—general habitat
Glossy black-cockatoo (<i>Calyptorhynchus lathami lathami</i>)	480.86 ha—(457.70 ha general habitat, 14.96 ha essential habitat, 8.20 ha core habitat)
<i>Nature Conservation (Koala) Conservation Plan 2017</i> mapping: ■ Koala Habitat Areas	81.73 ha

Table notes:

- 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.
- 2 **Red text** indicates highly significant areas in relation to recovery plans and listing advice

5.4.3 Provision of offsets

The Project will result in significant residual adverse impact on prescribed environmental matters, 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, EO Act and relevant policies.

ARTC's Environmental Offset Delivery Strategy – Qld (refer EIS Appendix N: Draft Offset Strategy). This Strategy informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans. An Environmental Offsets Delivery Plan will be developed and implemented by ARTC prior to construction. The Environmental Offsets Delivery Plan will:

- Quantify the significant residual impact of the Project on MSES and MNES
- Detail offsets to address significant residual impacts for MSES (except where those matters are also significant residual impacts 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.

6 Cumulative impact assessment

Cumulative impacts were assessed using the methodology identified in Section 3.5, incorporating the projects identified in Table 3.10 and depicted in Figure 3.4. This assessment has been based on Sensitive environmental receptors occurring within the Project footprint (refer Table 6.1).

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.

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 significant Sensitive environmental receptors contained within the combined footprint of the 20 projects occurring within the cumulative impact assessment area has been quantified and is provided in Table 6.1. 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 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 6.2 (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 Section 5.2.1 and Section 5.2.2
- 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 6.1 Cumulative impacts as calculated for within the cumulative impact assessment area

Receptor	Occurrence in the cumulative impact assessment area (50 km) (ha) ¹	Occurrence in the cumulative impact Project footprint (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						
Migratory bird species habitat (EPBC Act)						
Common sandpiper (<i>Actitis hypoleucos</i>)	181,418.10	77,860.56	77,993.16	42.9	0.17	Low
Fork-tailed swift (<i>Apus pacificus</i>)	2,874,133.44	814,808.92	818012.70	28.46	0.39	Low
Sharp-tailed sandpiper (<i>Calidris acuminata</i>)	183,807.58	77,437.14	77569.74	42.20	0.17	Low
Pectoral sandpiper (<i>Calidris melanotos</i>)	181,418.10	77,860.56	77993.16	42.99	0.17	Low
Red-necked stint (<i>Calidris ruficollis</i>)	124,397.79	77,702.65	77835.25	62.57	0.17	Low
Oriental cuckoo (<i>Cuculus optatus</i>)	47,909.55	13,310.09	13334.54	27.83	0.18	Low
Latham's snipe (<i>Gallinago hardwickii</i>)	185,580.54	78,005.98	78138.58	42.10	0.17	Low
Black-faced monarch (<i>Monarcha melanopsis</i>)	52,922.99	13,699.97	13724.42	25.93	0.18	Low
Yellow wagtail (<i>Motacilla flava</i>)	181,418.10	77,860.56	77993.16	42.99	0.17	Low
Satin flycatcher (<i>Myiagra cyanoleuca</i>)	55,340.01	13,311.39	13335.84	24.10	0.18	Low
Osprey (<i>Pandion haliaetus</i>)	51,620.01	7,930.23	7975.21	15.45	0.56	Low
Glossy ibis (<i>Plegadis falcinellus</i>)	186,069.48	77,251.00	77383.60	41.59	0.17	Low
Rufous fantail (<i>Rhipidura rufifrons</i>)	57,292.63	13,501.46	13525.91	23.61	0.18	Low
Spectacled monarch (<i>Symposiachrus trivirgatus</i>)	50,033.69	13,346.07	13370.52	26.72	0.18	Low
Common greenshank (<i>Tringa nebularia</i>)	181,418.10	77,860.56	77993.16	42.99	0.17	Low
State significant ecological constraints						
Protected nature areas:	7,946.28	0.00	0.00	0.00	0.00	Low
■ Alice Creek Nature Refuge ■ Berlin Scrub Nature Refuge ■ Dilladerri Nature Refuge ■ Ellangowan Nature Refuge ■ Fair Hills Nature Refuge						

Receptor	Occurrence in the cumulative impact assessment area (50 km) (ha) ¹	Occurrence in the cumulative impact Project footprint (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
- Gattonview Nature Refuge - JAL Nature Refuge - Kalisha Nature Refuge - Long Grass Nature Refuge - Myall Park Nature Refuge - Pine Cliffs Nature Refuge - Ravensbourne Nature Refuge - The Gullies Nature Refuge - Thompson's Nature refuge - Walker's Wilderness Nature Refuge - Whilaloo Nature Refuge - Wilga Park Nature Refuge - Xanthorrhoea Nature Refuge						
Protected area estates (<i>excluding state forests</i>): - Bendidee National Park - Coolmunda Conservation Park - Crows Nest National Park - Dwyers Scrub Conservation Park - Esk National Park - Flagstone Creek Conservation Park - Gatton National Park - Geham National Park - Hampton National Park - Irongate Conservation Park - Lockyer National Park - Lockyer Resources Reserve - Mount Binga National Park - Ravensbourne National Park - Tenthill Conservation Park - Wondul Range National Park <i>Note: State forests are not an MSES</i>	295,306.56	4,450.10	4,610.46	1.56	3.48	Low

Receptor	Occurrence in the cumulative impact assessment area (50 km) (ha) ¹	Occurrence in the cumulative impact Project footprint (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
Regulated vegetation (VM Act)						
Category B - 'Endangered' REs:	46,668.45	201.32	264.06	0.57	23.76	Low
Category B - 'Of Concern' REs:	202,417.66	3,530.07	3681.57	1.82	4.12	Low
Category B - 'Least Concern' REs:	465,876.54	11,556.00	11905.00	2.56	2.93	Low
Category C – HVR	33,835.69	228.87	233.10	0.69	1.81	Low
MSES wildlife habitat	84,262.99	1,263.97	1385.80	1.64	8.79	Low
State significant wetlands (HES Wetlands)	7,476.06	22.02	22.02	0.29	0.00	Low
Threatened flora habitat (NC Act):						
a sedge (<i>Cyperus clarus</i>)	42,108.95	886.54	992.54	2.36	10.68	Low
Finger panic (<i>Digitaria porrecta</i>)	61,952.92	4,153.08	4608.69	7.44	9.89	Low
Tall hawkweed (<i>Picris barbarorum</i>)	336,729.74	11,856.53	12424.02	3.69	4.57	Low
Threatened fauna habitat (NC Act):						
Common death adder (<i>Acanthophs antarcticus</i>)	714,191.76	14,717.13	15258.00	2.14	3.54	Low
Glossy black-cockatoo (<i>Calyptorhynchus lathami lathami</i>)	439,933.59	13,484.88	13965.74	3.17	3.44	Low
Major Mitchell's cockatoo (<i>Lophochroa leadbeateri</i>)	434,798.66	13,427.68	13815.45	3.18	2.81	Low
Least Concern flora and fauna, special least concern fauna (NC Act) and Priority Back on Track flora and fauna species						
Platypus (<i>Ornithorhynchus anatinus</i>)	104,511.33	2,304.67	2392.40	2.29	3.67	Low
Echidna (<i>Tachyglossus aculeatus</i>)	841,385.10	16,508.94	17245.66	2.05	4.27	Low
Least Concern flora and fauna	2,367,317.00	47,908.34	49348.84	2.08	2.92	Low
Priority Back on Track species (not listed under the EPBC Act or NC Act)	2,367,317.00	47,908.34	49348.84	2.08	2.92	Low

Receptor	Occurrence in the cumulative impact assessment area (50 km) (ha) ¹	Occurrence in the cumulative impact Project footprint (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
Biodiversity Planning Assessment (BPA)						
BPA habitat values (local or other)	2,034.26	0.00	1112.29	1.36	8.56	Low
BPA habitat values (regional)	81,685.73	1,017.06	13543.18	2.39	0.36	Low
BPA habitat values (State)	566,566.36	13,494.22	1958.89	1.60	12.02	Low
Corridor (Regional Terrestrial)	122194.40	1723.52	7429.71	1.79	2.17	Low
Corridor (State Riparian)	58074.21	305.42	1112.29	1.36	8.56	Low
Corridor (State Terrestrial)	415966.65	7268.32	13543.18	2.39	0.36	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 Category B - 'Endangered' REs is 23.76% of 0.57%, which equates to 0.14%.

Table 6.2 Significance assessment of cumulative impacts within the cumulative impact assessment area

Receptor(s)	Potential cumulative impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth significant ecological constraint (migratory species listed under the EPBC Act): - Common sandpiper (<i>Actitis hypoleucos</i>) - Fork-tailed swift (<i>Apus pacificus</i>) - Sharp-tailed sandpiper (<i>Calidris acuminata</i>) - Pectoral sandpiper (<i>Calidris melanotos</i>) - Red-necked stint (<i>Calidris ruficollis</i>) - Oriental cuckoo (<i>Cuculus optatus</i>) - Latham's snipe (<i>Gallinago hardwickii</i>) - Black-faced monarch (<i>Monarcha melanopsis</i>) - Yellow wagtail (<i>Motacilla flava</i>) - Satin flycatcher (<i>Myiagra cyanoleuca</i>) - Osprey (<i>Pandion haliaetus</i>) - Glossy ibis (<i>Plegadis falcinellus</i>) - Rufous fantail (<i>Rhipidura rufifrons</i>) - Spectacled monarch (<i>Symposiachrus trivirgatus</i>) - Common greenshank (<i>Tringa nebularia</i>)	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	- Edge effects - Habitat fragmentation - Barrier effects - Reduction in connectivity of biodiversity corridors	2	2	1	3	8	Medium
	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
State Significant Ecological Constraint (VM Act): Category B - 'Endangered' remnant vegetation (REs)	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	- Edge effects - Habitat fragmentation - Barrier effects - Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	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

Receptor(s)	Potential cumulative impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
	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
State Significant Ecological Constraint (VM Act): Category B - 'Of Concern' remnant vegetation (REs)	Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	- Edge effects - Habitat fragmentation - Barrier effects - Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	Fauna species injury or mortality	1	1	1	2	5	Low
	Dust and light and contaminant disturbance	1	1	1	2	5	Low
	Increase in litter (waste)	1	1	1	2	5	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
	Habitat loss from vegetation clearing/removal	2	3	1	1	7	Medium
	- Edge effects - Habitat fragmentation - Barrier effects - Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
State Significant Ecological Constraint (VM Act): Category B - 'Least Concern' remnant vegetation (REs)	Fauna species injury or mortality	1	1	1	1	4	Low
	Dust and light and contaminant disturbance	1	1	1	1	4	Low
	Increase in litter (waste)	1	1	1	1	4	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low
	Habitat loss from vegetation clearing/removal	2	3	1	1	7	Medium
	- Edge effects - Habitat fragmentation - Barrier effects - Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	Fauna species injury or mortality	1	1	1	1	4	Low

Receptor(s)	Potential cumulative impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint (VM Act): Category C - HVR vegetation	Habitat loss from vegetation clearing/removal	2	3	1	2	6	Low
	- Edge effects - Habitat fragmentation - Barrier effects - Reduction in connectivity of biodiversity corridors	1	2	1	2	8	Medium
	Fauna species injury or mortality	1	1	1	2	5	Low
	Dust and light and contaminant disturbance	1	1	1	2	5	Low
	Increase in litter (waste)	1	1	1	2	5	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
State significant ecological constraint: State Significant Wetlands (HES)	Habitat loss from vegetation clearing/removal	1	3	1	3	8	Medium
	- Edge effects - Habitat fragmentation - Barrier effects - Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	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

Receptor(s)	Potential cumulative impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint (species listed as threatened under the NC Act): Flora: ■ A sedge (<i>Cyperus clarus</i>) ■ Finger panic (<i>Digitaria porrecta</i>) ■ Tall hawkweed (<i>Picris barbarorum</i>) Fauna: ■ Common death adder (<i>Acanthopis antarcticus</i>) ■ Glossy black-cockatoo (<i>Calyptorhynchus lathami lathami</i>) ■ Major Mitchell's cockatoo (<i>Lophochroa leadbeateri</i>)	■ Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	■ 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	Medium
State significant ecological constraint: SLC fauna species: ■ Platypus (<i>Ornithorhynchus anatinus</i>) ■ Echidna (<i>Tachyglossus aculeatus</i>)	■ Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	■ Fauna species injury or mortality	1	1	1	2	5	Low
	■ Dust and light and contaminant disturbance	1	1	1	2	5	Low
	■ Increase in litter (waste)	1	1	1	2	5	Low
	■ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	■ Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low

Receptor(s)	Potential cumulative impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State significant ecological constraint: ■ Priority Back on Track flora and fauna species (that are not listed under as threatened under the provisions of the EPBC Act or NC Act)	■ Habitat loss from vegetation clearing/removal	2	3	1	1	7	Medium
	■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	■ Fauna species injury or mortality	1	1	1	1	4	Low
	■ Dust and light and contaminant disturbance	1	1	1	1	4	Low
	■ Increase in litter (waste)	1	1	1	1	4	Low
	■ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	■ Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low
State significant ecological constraint: ■ Flora and fauna species not listed under the EPBC Act but listed as 'Least Concern' under the provisions of the NC Act and flora that is listed as SLC under the provisions of the NC Act	■ Habitat loss from vegetation clearing/removal	3	3	1	1	8	Medium
	■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	■ Fauna species injury or mortality	1	1	1	1	4	Low
	■ Dust and light and contaminant disturbance	1	1	1	1	4	Low
	■ Increase in litter (waste)	1	1	1	1	4	Low
	■ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	■ Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low

Receptor(s)	Potential cumulative impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint (BPA): ■ BPA habitat values (State) ■ State habitat for EVNT taxa ■ Corridor (State Terrestrial) ■ Corridor (State Riparian)	■ Habitat loss from vegetation clearing/removal	1	3	1	3	8	Medium
	■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	■ 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
State Significant Ecological Constraint (BPA): ■ BPA habitat values (regional) ■ Corridor (regional terrestrial)	■ Habitat loss from vegetation clearing/removal	1	3	1	2	7	Medium
	■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	■ Fauna species injury or mortality	1	1	1	2	5	Low
	■ Dust and light and contaminant disturbance	1	1	1	2	5	Low
	■ Increase in litter (waste)	1	1	1	2	5	Low
	■ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	■ Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low

Receptor(s)	Potential cumulative impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint (BPA): BPA habitat values (local or other)	Habitat loss from vegetation clearing/removal	1	3	1	1	6	Low
	- Edge effects - Habitat fragmentation - Barrier effects - Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	Fauna species injury or mortality	1	1	1	1	4	Low
	Dust and light and contaminant disturbance	1	1	1	1	4	Low
	Increase in litter (waste)	1	1	1	1	4	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low

Table notes:

Relevance factors between 1 and 3 were determined using professional judgement to select most appropriate relevance factor for each aspect and summing the relevance factors.

Sum of relevant factors definition:

- Low (1-6): Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general project monitoring program.
- Medium (7-9): Mitigation measure likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate.
- High (10-12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate.

7 Conclusion

This technical report has been prepared in accordance with Sections 11.92 to 11.104 of the ToR and has been prepared to accompany EIS Appendix L: Matters of National Environmental Significance Technical Report of the EIS, which specifically addresses the EPBC Act controlling provisions of the Project (i.e. threatened species and communities listed under the EPBC Act) and EIS Appendix K: Aquatic Ecology Technical Report. Therefore, in order to avoid repetition, the EPBC Act controlling provisions and issues associated with aquatic ecology have been excluded from this document.

The impact assessment area provides suitable habitat for a six non-MNES, NC Act listed conservation significant species (i.e. three plants and three animals) as well as potential habitat for 11 non-threatened, migratory species as listed under the EPBC Act. In addition, a number of 'Endangered', 'Of Concern' and 'Least Concern' REs are also present within the impact assessment area that are protected under the VM Act. The impact assessment area contains a suite of Sensitive environmental receptors, including protected areas, HVR vegetation, conservation significant flora and fauna species regionally significant species as well as bioregional corridors (local, regional and State significant).

Forty-two (42) Sensitive environmental receptors were identified within the impact assessment area for the purposes of this assessment. These varied from broad scale Sensitive environmental receptors such as protected areas and bioregional corridors, down to finer species-scale Sensitive environmental receptors, including conservation significant and migratory species. These Sensitive environmental receptors 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 and operation of the Project has the potential to impact on ecology Sensitive environmental receptors via 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
- 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
- Contamination
- Flooding.

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 Sensitive environmental receptors 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 additional 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 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 Sensitive environmental receptors were generally reduced following the implementation of an additional mitigation measures and management plans. A key reason for disturbance to Sensitive environmental receptors 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 Sensitive environmental receptors 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.

In accordance with the outcomes of the Sensitive environmental receptors significant impact guideline, there are **no significant impacts expected**, based on predictive habitat mapping, for the following non-threatened EPBC Act listed migratory species:

- Common sandpiper (*Actitis hypoleucos*)
- Fork-tailed swift (*Apus pacificus*)
- Sharp-tailed sandpiper (*Calidris acuminata*)
- Pectoral sandpiper (*Calidris melanotos*)
- Red-necked stint (*Calidris ruficollis*)
- Oriental cuckoo (*Cuculus optatus*)
- Latham's snipe (*Gallinago hardwickii*)
- Black-faced monarch (*Monarcha melanopsis*)
- Yellow wagtail (*Motacilla flava*)
- Satin flycatcher (*Myiagra cyanoleuca*)
- Osprey (*Pandion haliaetus*)
- Glossy ibis (*Plegadis falcinellus*)
- Rufous fantail (*Rhipidura rufifrons*)
- Spectacled monarch (*Symposiachrus trivirgatus*)
- Common greenshank (*Tringa nebularia*).

Assessment of prescribed MSES has been undertaken in accordance with the MSES significant impact criteria (refer Section 5.3.4). Analysis, based on predictive habitat mapping, indicates that the Project is likely to result in significant residual impacts to following Sensitive environmental receptors:

- Endangered or 'Of Concern' REs: 214.24 ha
- Regulated vegetation (Category B (other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature): 43.88 ha
- Essential Habitat: 117.31 ha
- Connectivity areas:
 - Regional Terrestrial corridors: 235.37 ha
 - State Riparian corridors: 37.42 ha
 - State Terrestrial corridors :161.39 ha
- Protected wildlife habitat for the following species:
 - A sedge (*Cyperus clarus*): 106.00ha
 - Finger panic (*Digitaria porrecta*): 455.61 ha
 - Tall hawkweed (*Picris barbarorum*): 567.49ha
 - Common death adder (*Acanthophis antarcticus*): 540.87 ha
 - Glossy black-cockatoo (*Calyptorhynchus lathami lathami*): 480.86 ha
 - Nature Conservation (Koala) Conservation Plan 2017 mapping (Koala Habitat Areas): 81.73 ha.

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). 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 confirm offset requirements for the Project. Additional species, communities and habitats may be identified through this process. This process is expected to result in a reduction in the total Project footprint area and subsequent impacts to Sensitive ecological receptors.

Potential predicted cumulative impacts within 50 km of the Project were assessed incorporating the footprints projects identified in Table 3.10. Impacts 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 added to the other similar projects that occur within 50 km of the Project boundary are likely to be higher on the following Sensitive environmental receptors:

- EPBC Act listed, non-threatened migratory species:
 - Common sandpiper (*Actitis hypoleucos*), Sharp-tailed sandpiper (*Calidris acuminata*), Pectoral sandpiper (*Calidris melanotos*), Red-necked stint (*Calidris ruficollis*), Yellow wagtail (*Motacilla flava*), Glossy ibis (*Plegadis falcinellus*), Common greenshank (*Tringa nebularia*) – Project impact makes a 0.17 per cent contribution to the clearing of approximately 77,993.16 ha (sum of cumulative impact) which constitutes 42.9 per cent of the available habitat within the cumulative impact assessment area

- NC Act listed flora and species habitat:
 - Finger panic (*Digitaria porrecta*) – Project impact makes a 9.89 per cent contribution to the clearing of approximately 4,608.69 ha (sum of cumulative impact) which constitutes 7.44 per cent of the available habitat within the cumulative impact assessment area
 - Common death adder (*Acanthophs antarcticus*) – Project impact makes a 3.54 per cent contribution to the clearing of approximately 15258.00 ha (sum of cumulative impact) which constitutes 2.14 per cent of the available habitat within the cumulative impact assessment area
- Category B regulated vegetation 'Of Concern' - Project impact makes a 4.12 per cent contribution to the clearing of approximately 3,681.57 ha (sum of cumulative impact) which constitutes 1.82 per cent of the available habitat within the cumulative impact assessment area
- MSES Wildlife habitat - Project impact makes an 8.79 per cent contribution to the clearing of approximately 1,385.80 ha (sum of cumulative impact) which constitutes 1.64 per cent of the available habitat within the cumulative impact assessment area.

The proposed project mitigation measures (including the provision of offsets) are expected to minimise the Project's overall contribution to cumulative impact within the broader region.

This assessment has concluded that the Project will result in significant residual adverse impact on Sensitive environmental receptors, 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.

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. Data obtained from these detailed surveys will be used to refine the quantification of ecological impacts and confirm the calculation of offset requirements for the Project.

ARTC's Environmental Offset Delivery Strategy – Qld (refer EIS Appendix N: Draft Offset Strategy) will inform 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.

8 References

- Adair, R.J. and Groves, R.H. (1998). Impact of environmental weeds on biodiversity: a review and development of a methodology, Environment Australia, Canberra.
- AECOM (2017). *Corridor Options Report - Yelarbon to Gowrie*, s.l.: AECOM. In collaboration with Aurecon
- Atlas of Living Australia (2018). Online Species Database. Available from: <https://www.ala.org.au/> (Accessed 19/09/2018).
- Atlas of Living Australia occurrence download at <https://biocache.ala.org.au/occurrences/search?q=qid%3A1537310069200> (Accessed Sep 19 10:45:25 AEST 2018).
- Australian Government (2012). *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy. Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- Australian Government. EPBC Act Protected Matters Search Tool. Available from: <http://www.environment.gov.au/epbc/protected-matters-search-tool> (Accessed 07/06/2018).
- Australian Government. Register of critical habitat. Available from: <http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl> (Accessed 07/06/2018).
- Australian Museum (2018). Animals Database. Available from: <https://australianmuseum.net.au/animals>
- Australian Native Plants Society (2017). Photo Gallery and Plant Profiles. Available from: <http://anpsa.org.au/gallery.html>
- Australian Rail Track Corporation (2015). *Melbourne to Brisbane Inland Rail, Attachment A: ARTC 2015 Inland Rail Programme Business Case*, s.l.: s.n.
- Australian Rail Track Corporation (2015). *The Case for Inland Rail - Summary of the 2015 Business Case*. s.l.:s.n.
- Australian Rail Track Corporation (2016). *Phase 1 Concept Assessment Report*, s.l.: s.n.
- Ayers, D. and Wallace, G. (1997). Pipeline trenches: an underutilized resource for finding fauna. Pp. 349-357 in *Conservation Outside Nature Reserves*, edited by P. Hale and D. Lamb. Centre for Conservation Biology, The University of Queensland, Brisbane.
- BA NRS (2002). Birds Australia Nest Record Scheme.
- Bali, R. (2005). Discussion Paper - Compensating for Edge Effects, Ecosense Consulting for the NSW Roads and Traffic Authority, Sydney.
- Bamford M., D. Watkins, W. Bancroft, G. Tischler & J. Wahl. (2008). Migratory Shorebirds of the East Asian - Australasian Flyway: Population estimates and internationally important sites. Canberra, ACT: Department of the Environment, Water, Heritage and the Arts, Wetlands International-Oceania. Available from: <http://www.environment.gov.au/biodiversity/migratory/publications/shorebirds-east-asia.html>.
- Bennett, A.F. (1990). *Habitat Corridors. Their Role in Wildlife Management and Conservation.*, Department of Conservation and Environment, Sydney.
- BirdLife International. (2020). Species factsheet: *Motacilla flava*. Available from: <http://www.birdlife.org> (Accessed 24/03/2020)
- Birdsall, J.L., McCaughey, W. and Runyon, J.B. (2012). Roads Impact the Distribution of Noxious Weeds More Than Restoration Treatments in a Lodgepole Pine Forest in Montana, U.S.A, *Restoration Ecology*, vol. 20, no. 4, pp. 517 – 523.
- Brickell, C.D. & Baum, Bernard & Hetterscheid, Wilbert & Leslie, A.C. & McNeill, John & Trehane, P & Vrugtman, Freek & Wiersema, J.H. (2004). International Code of Nomenclature for Cultivated Plants. *Acta Horticulturae*. 647. 85-123. 10.17660/ActaHortic.2004.647.13.

Brummitt, R. K & Powell, C. E. (C. Emma) & Royal Botanic Gardens, Kew (1992). Authors of plant names. Royal Botanic Gardens, Kew, Kew.

Caro, T. (2005). Antipredator defenses in birds and mammals, University of Chicago Press, Chicago, Illinois, USA.

Clarke, G.M., Grosse, S., Matthews, M., Catling, P.C., Baker, B., Hewitt, C.L., Crowther, D. and Saddler, S.R. (2000). Environmental Pest Species in Australia, Australia: State of the Environment, Second Technical Paper Series (Biodiversity), Department of the Environment and Heritage, Canberra.

Clemens, R.S., A. Haslem, J. Oldland., L. Shelley, M.A. Weston & M.A.A. Diyan (2008). Identification of Significant Shorebird Areas in Australia: Mapping, Thresholds and Criteria. Birds Australia report the Australian Government. Canberra, ACT: Department of the Environment, Water, Heritage, and the Arts.

Coffin, A.W. (2007). From roadkill to road ecology: A review of the ecological effects of roads, Journal of Transport Geography, vol. 15, no. 5, pp. 396 – 406.

Collins, P., A. Boyle, C. Minton & R. Jessop. (2001). The importance of inland claypans for waders in Roebuck Bay, Broome, NW Australia. Stilt. 38:4--8.

Creuzer, JC, Hargiss, LM, Norland, JE, DeSutter, T, Casey, FX, DeKeyser, ES & Ell, M (2016). 'Does Increased Road Dust Due to Energy Development Impact Wetlands in the Bakken Region?' *Water, Air and Soil Pollution*, vol. 227: 39 (<https://doi.org/10.1007/s11270-015-2739-1>).

Department of Agriculture Water and the Environment (2020). Species Profile and Threats Database. Available from: <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl> Accessed: (7 April 2020).

Department of Environment and Energy (2018). Species Profile and Threats Database Available from: <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>

Department of Environment and Energy (2018). Species Profile and Threats Database Available from: <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>

Department of Environment and Heritage Protection (2014a). Biodiversity Assessment and Mapping Methodology. Version 2.2. Department of Environment and Heritage Protection, Brisbane

Department of Environment and Heritage Protection (2014b). Queensland Environmental Offsets Policy: Significant Residual Impact Guidelines. Queensland Government

Department of Environment and Heritage Protection (2015). Aquatic Conservation Assessment using AQUABAMM for the riverine and non-riverine wetlands of Southeast Queensland. Available from: https://wetlandinfo.ehp.qld.gov.au/resources/static/pdf/assessment-monitoring/aquabamm/seq/aca_seq_v1_1_full_20151104.pdf. Section 4.2.8

Department of Environment and Heritage Protection (2016a). A Biodiversity Planning Assessment Southeast Queensland Bioregion v4.1. Fauna Expert Panel Report: Department of Environment and Heritage Protection, Queensland Government.

Department of Environment and Heritage Protection (2016b). A Biodiversity Planning Assessment Southeast Queensland Bioregion v4.1. Flora Expert Panel Report: Department of Environment and Heritage Protection, Queensland Government.

Department of Environment and Heritage Protection (2016c). A Biodiversity Planning Assessment Southeast Queensland Bioregion v4.1. Landscape Expert Panel Report: Department of Environment and Heritage Protection, Queensland Government.

Department of Environment and Heritage Protection (2017). Guide to determining terrestrial habitat quality: A toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy. Available from: https://environment.des.qld.gov.au/__data/assets/pdf_file/0015/90312/habitat-quality-assessment-guide.pdf

Department of Environment and Resource Management (2010), Border Rivers Maranoa-Balonne Natural Resource Management Region Back on Track Actions for Biodiversity, Department of Environment and Resource Management, Brisbane.

Department of Environment and Resource Management (2010), Condamine Natural Resource Management Region Back on Track Actions for Biodiversity, Department of Environment and Resource Management, Brisbane.

Department of Environment and Resource Management (2010). Bremer River Sensitive environmental receptors and water quality objectives. Basin No 143 (part) including all tributaries of the Bremer River. Available from: <https://www.ehp.qld.gov.au/water/policy/pdf/documents/bremer-river-ev-2010.pdf>.

Department of Environment and Science (2018). Animals Database. Available from: <https://www.ehp.qld.gov.au/wildlife/>

Department of Environment and Science (2018). Monitoring and Sampling Manual. Available from: <https://www.ehp.qld.gov.au/water/monitoring/sampling-manual/pdf/monitoring-sampling-manual-2018.pdf>.

Department of Environment and Science (2019). Flora Survey Guidelines – Protected Plants (Version 2.01). Available from: https://www.qld.gov.au/data/assets/pdf_file/0028/99901/ql-wl-pp-flora-survey.pdf

Department of Natural Resources, Mines and Energy (2018). Guide: New vegetation management laws. Available from: https://www.dnrme.qld.gov.au/data/assets/pdf_file/0010/1396486/new-vegetation-management-laws-guide-2018.pdf.

Department of Science, Information Technology and Innovation (2015). Soil conservation guidelines for Queensland. Queensland Government. <https://www.publications.qld.gov.au/dataset/soil-conservation-guidelines>

Department of Science, Information Technology and Innovation (2016). Regional Ecosystem Description Database (REDD) – Version 10.0 (December 2016). Queensland Herbarium, Department of Science, Information Technology and Innovation, Queensland Government, Brisbane. Available from: <https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/>

Department of Sustainability, Environment, Water, Population and Communities (2012). Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy. Available from: http://www.environment.gov.au/system/files/resources/12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-policy_2.pdf.

Department of the Environment (2013). Matters of National Environmental Significance. Significant impact guidelines 1.1. Australian Government. Available from: https://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/neg-guidelines_1.pdf.

Department of the Environment (2013). Matters of National Environmental Significance Significant impact guidelines 1.1. Available from https://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/neg-guidelines_1.pdf.

Department of the Environment (2015). Referral guideline for 14 birds listed as migratory species under the EPBC Act. Available from: <http://www.environment.gov.au/system/files/resources/c05f5b87-0a99-4998-897e-7072c236cf83/files/migratory-birds-draft-referral-guideline.pdf>. Accessed: (4 April 2020).

Department of the Environment (2015). Wildlife Conservation Plan for Migratory shorebirds. Available from: <http://www.environment.gov.au/system/files/resources/9995c620-45c9-4574-af8e-a7cfb9571deb/files/wildlife-conservation-plan-migratory-shorebirds.pdf>. Accessed: (4 April 2020).

Department of the Environment and Energy (2019). *Nyctophilus corbeni* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <http://www.environment.gov.au/sprat>. Accessed Wed, 27 Mar 2019

Department of the Environment and Heritage (2005). Background Paper to the Wildlife Conservation Plan for Migratory Shorebirds. Canberra, ACT: Department of the Environment and Heritage. Available from: <http://www.environment.gov.au/biodiversity/migratory/publications/pubs/shorebird-plan-background.pdf>.

Department of the Environment, Water, Heritage and the Arts (2009). Migratory Waterbirds Information Page, Departmental Website. Available from: <http://www.environment.gov.au/biodiversity/migratory/waterbirds/index.html#conservation>. Accessed: (7 April 2020).

Department of Transport and Regional Services (2006). North-South Rail Corridor Study Executive Report. DOTARS. Australian Government.

Doody, J. S., West, P., Stapley, J., Welsh, M., Tucker, A., Guarino, e., Pauza, M., Bishop, N., Head, M., Dennis, S., West, G., Pepper, A., and Jones, A. (2003). Fauna by-catch in pipeline trenches: conservation, animal ethics, and current practices in Australia. *Australian Zoologist* 32:410-419.

Duiker, S.W. (2004). Effects of Soil Compaction, College of Agricultural Sciences, Available: <http://pubs.cas.psu.edu/FreePubs/pdfs/uc188.pdf>. Accessed 4 September 2018.

Duncan, A, Baker, GB and Montgomery, N (Eds.). (1999) The Action Plan for Australian Bats. Environment Australia, Canberra.

Environmental Protection Regulation (2008). Available from: <https://www.legislation.qld.gov.au/view/pdf/2012-11-09/sl-2008-0370>.

Eyre TJ, Ferguson DJ, Hourigan CL, Smith GC, Mathieson MT, Kelly, AL, Venz MF, Hogan, LD & Rowland, J. (2018). Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland. Department of Environment and Science, Queensland Government, Brisbane.

Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015). BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane. Fahrig, L. (2002). Effect of habitat fragmentation on the extinction threshold: a synthesis, *Ecological Applications*, vol. 12, no. 2, pp. 346 – 351.

Fitzpatrick, R.W., McKenzie, N. and Maschmedt, D.J. (1999). Soil morphological indicators and their importance to soil fertility in Soil Analysis: an Interpretation Manual, (eds) K.T. Peverill, L.A. Sparrow and D.J. Reuter, CSIRO Publishing, Collingwood, VIC.

Forman, R.T.T., Sperling, D., Bissonette, J.A., Clevenger, A.P., Cutshall, C.D., Dale, V.H., Fahrig, L., France, R., Goldman, C.R., Heanue, K., Jones, J.A., Swanson, F.J., Turrentine, T. and Winter, T.C. (2000). Road Ecology. Science and Solutions., Island Press, Washington.

Geering, A., L. Agnew & S. Harding, eds. (2007). Shorebirds of Australia. Melbourne: CSIRO Publishing.

Gilbert, P.A. (1935). The seasonal movements and migrations of birds in eastern New South Wales. *Emu*. 35:17-27

Great Barrier Reef Marine Park Authority (2009). EAM Risk Management Assessment Framework. http://www.gbrmpa.gov.au/data/assets/pdf_file/0008/4949/gbrmpa_EAMRiskManagementFramework.pdf.

Grimshaw P., Sands D. & Gynther I. (2015). Birdwing Butterfly Vine. Available from: http://wildlife.org.au/wp-content/uploads/2013/12/Birdwing_Butterfly_Vine_Factsheet.pdf

Healthy Waterways (2014). Litter in our waterways, Available: <http://www.healthywaterways.org/HealthyWaterways/PlasticPollutionRevolution/Litterinourwaterways.aspx>. Accessed: 19 February 2014.

Higgins, P.J. & S.J.J.F. Davies, eds. (1996). Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons. Melbourne, Victoria: Oxford University Press.

Hobbs, J.N. (1961). The birds of south-west New South Wales. *Emu*. 61:21-55.

Hoskins A. (2018). Swordgrass Brown. Available from: <https://www.learnaboutbutterflies.com/Australia%20-%20Tisiphone%20abeona.htm>

Huggett, A.J. (2000). An experimental study of the impact of gaps and clusters silviculture on insectivorous birds in a continuous forest landscape. Ph.D. Thesis. University of New England, Armidale, NSW.

Ingram, G.J., McDonald, K.R. and Nattress, A.E.O. (2002). Revised common names for Queensland frogs in Nattress, A.E.O. (ed) *Frogs in the Community: Proceedings of the Brisbane symposium* 13-14 February 1999. Queensland Frog Society, Brisbane.

International Erosion Control Association (2008). Best Practice Erosion & Sediment Control – November 2008.

- Kutt, A.S., Vanderduys, E.P., Ferguson, D. and Mathieson, M. (2012). Effect of small-scale woodland clearing and thinning on vertebrate fauna in a largely intact tropical savanna mosaic, *Wildlife Research*, vol. 39, no. 4, pp. 366 – 373.
- Last P.R. and Stevens J.D. (2009). *Sharks and Rays of Australia* (second ed). Harvard University Press. pp. 130.
- Loyn, R.H., Runnalls, R.G., Forward, G.Y. and Tyers, J. (1983). Territorial bell miners and other birds affecting populations of insect prey, *Science*, vol. 221, pp. 1411 – 1412.
- Marsh H, Dennis A, Hines H, Kutt A, McDonald K, Weber E, Williams S & Winter J. (2007). Optimizing allocation of management resources for wildlife. *Conservation Biology*, 21, 387-399.
- McKenzie, N.J.; Grundy, M.J.; Webster, R.; Ringrose-Voase, A.J. (2008). *Guidelines for Surveying Soil and Land Resources*. In: Melbourne: CSIRO Publishing; 2008.
- McNeill J, Barrie FR, Burdet HM *et al.* (2006). *International Code of Botanical Nomenclature (Vienna Code) adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005*. Regnum Vegetabile. v. 146. Konigstein, Koeltz Scientific Books.
- Menkhorst, P. & Knight, F. (2011). *A field guide to the mammals of Australia*. South Melbourne, Vic: Oxford University Press.
- Moenting, A.E. and Morris, D.W. (2006). Disturbance and habitat use: is edge more important than area?, *Oikos*, vol. 115, no. 1, pp. 23 – 32.
- Morcombe, M. (2003). *Field guide to Australian birds*. Revised edition. Steve Parish Publishing Pty Ltd. Archerfield, Australia.
- National Committee on Soil and Terrain (2009). *Australian Soil and Land Survey Field Handbook Third Edition*. The National Committee on Soil and Terrain. CSIRO Publishing. Collingwood, Victoria.
- Neldner, V.J., Niehus, R.E., Wilson, B.A., McDonald, W.J.F., Ford, A.J. and Accad, A. (2017). *The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 3*. Queensland Herbarium, Department of Science, Information Technology and Innovation.
- Office of Environment & Heritage (2018). *Threatened biodiversity profile search*
<https://www.environment.nsw.gov.au/threatenedspeciesapp/>
- Picris evae (Hawkweed). Available from:
<http://www.environment.gov.au/biodiversity/threatened/species/pubs/10839-conservation-advice.pdf>
- Pizzey, G. & Knight, F. & Menkhorst, P. (2007). *Graham Pizzey & Frank Knight The field guide to the birds of Australia*. Pymble, N.S.W: HarperCollins Publishers.
- PlantNet (2018). *NSW Flora Online*. Available from: <http://plantnet.rbgsyd.nsw.gov.au/search/simple.htm>
- Pusey, B., Kennard, M. and Arthington, A. (2004). *Freshwater fishes of north-eastern Australia*. CSIRO Pub, Collingwood, Vic.
- Queensland Government (2014). *Biodiversity Assessment and Mapping Methodology (Version 2.2)*, December 2014.
- Queensland Government (2016). *Census of the Queensland Flora*. Available from:
<https://data.qld.gov.au/dataset/census-of-the-queensland-flora-2016>.
- Queensland Government (2018) *Queensland Government Environmental Offsets Policy Version 1.6*. Available from: <https://www.ehp.qld.gov.au/assets/documents/pollution/management/offsets/offsets-policyv1-6.pdf>.
- Queensland Government 2016. *Biodiversity Planning Assessment for South-east Queensland*, version 4.1. Department of Environment and Heritage Protection, Brisbane.
- Queensland Government. *Biodiversity Planning Assessment (BPA) mapping*. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Essential Habitat Map, version 4.18. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Fish Habitat Areas. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Map of Referable Wetlands. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Matters of State Environmental Significance. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Queensland Springs Database. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Queensland waterways for waterway barrier works. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Queensland waterways for waterway barrier works. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Regulated Vegetation Management Map. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Watercourse Identification Mapping. Available from:
<http://qldspatial.information.qld.gov.au/catalogue/custom/index.page> (Accessed 07/06/2018).

Queensland Government. Wildlife Online Database. Available from:
<https://environment.ehp.qld.gov.au/species-search/> (Accessed 07/06/2018).

Queensland Museum (2018). Find Out About Database. Available from:
<http://www.qm.qld.gov.au/Find+out+about#.W5CHmEYzZ9M>

Redland City Council (RCC) (2018). Wildlife in the Redlands. Available from:
https://www.redland.qld.gov.au/info/20254/wildlife_in_the_redlands

Rowden, P., Steinhardt, D. and Sheehan, M. 2008. Road crashes involving animals in Australia, Accident Analysis and Prevention, vol. 40, no. 6, pp. 1865 – 1871.

Royal Botanic Gardens Foundation Victoria (2015). VICFLORA Database. Available from:
<https://vicflora.rbg.vic.gov.au/>

SEQ Catchments 2006, Bremer Subcatchments. Department of Natural Resources, Mine and Water. Available from: <http://www.bremercatchment.org.au/bremer_subcatchments.pdf> (3 August 2018)

SEQ Catchments 2017, Logan-Albert Catchment Action Plan 2017 – 2020. Resilient Rivers Initiative. Available from: <https://seqmayors.qld.gov.au/wp-content/uploads/2017/04/Logan-Albert-Catchment-Action-Plan-FINAL_LR-Web.pdf> (3 August 2018).

Thorp, J. and Lynch, R. (2011). The Determination of Weeds of National Significance, National Weeds Strategy Executive Committee, Launceston.

Threatened Species Scientific Committee (2008a). Approved Conservation Advice for *Corynocarpus rupestris* subsp. *rupestris* (Glenugie Karaka). Available from:
www.environment.gov.au/biodiversity/threatened/species/pubs/19303-conservation-advice.pdf

Threatened Species Scientific Committee (2008c). Approved Conservation Advice for *Zieria* sp. Brolga Park (A.R. Bean 1002). Available from:
<http://www.environment.gov.au/biodiversity/threatened/species/pubs/64548-conservation-advice.pdf>

Threatened Species Scientific Committee (2013a). Approved Conservation Advice for *Brachychiton* sp. Ormeau (L.H. Bird AQ435851) (Ormeau bottle tree). Available from:
www.environment.gov.au/biodiversity/threatened/species/pubs/84105-conservation-advice.pdf.

Threatened Species Scientific Committee (2013b). Approved Conservation Advice for *Selaginella andrewsii* (*Tallebudgera spikemoss*). Available from:
<http://www.environment.gov.au/biodiversity/threatened/species/pubs/67901-conservation-advice.pdf>.

Western Australian Government. (Undated). Litter Facts and Impacts, Department of the Environment and Conservation, Available: http://www.kabc.wa.gov.au/downloads/doc_download/298-litter-facts-and-impacts.html. Accessed 19 February 2014.

Wetland Info (2018). Plants, animals, soils, water and more. Available from:
<https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/>.

Wildlife Preservation Society of Qld (2018). Species Profiles. Available from:
<http://wildlife.org.au/category/information-gallery/species-profiles/>.

Wilson, A. and Lindenmayer, D.B. (1995). Lindenmayer Corridors and the Conservation of Biodiversity: A Review, National Corridors of Green Program, Green Australia Ltd., Canberra.

Wilson, S. & Swan, G. (2010). A complete guide to reptiles of Australia (3rd ed). New Holland Publishers, Chatswood, N.S.W.

Woinarski, J.C.Z., McCosker, J.C., Gordon, G., Lawrie, B., James, C.D., Augusteyn, J., Slater, L. and Danvers, T. (2006). Monitoring change in the vertebrate fauna of central Queensland, Australia, over a period of broad-scale vegetation clearance, 1973–2002, *Wildlife Research*, vol. 33, no. 4, pp. 263 – 274.

Appendices

