APPENDIX

J

Matters of National Environmental Significance Technical Report

Part 1 of 2

HELIDON TO CALVERT ENVIRONMENTAL IMPACT STATEMENT

INLAND RAIL

ARTC

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

IR_1381

Inland Rail Helidon to Calvert EIS

Appendix J – Matters of National Environmental Significance Technical Report

Australian Rail Track Corporation

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Abbreviations

Abbreviation	Explanation
AoLA	Atlas of Living Australia
ARTC	Australian Rail Track Corporation
AUSRIVAS	Australian River Assessment System
BAMM	Biodiversity Assessment and Mapping Methodology
BPA	Biodiversity Planning Assessment
C2K	Calvert to Kagaru
CE	Critically Endangered
CEMP	Construction Environmental Management Plan
Cth	Commonwealth
DAF	Department of Agriculture and Fisheries
DAWE	Department of Agriculture, Water and the Environment
DES	Department of Environment and Science
DNRME	Department of Natural Resources, Mines and Energy (former)
DotEE	Department of the Environment and Energy (former)
DSDILGP	Department of State Development, Infrastructure, Local Government and Planning
DSDMIP	Department of State Development, Manufacturing, Infrastructure and Planning (former)
DTMR	Department of Transport and Main Roads
E	Endangered
EHP	Department of Environment and Heritage Protection (former)
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1994 (Qld)*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
FFJV	Future Freight Joint Venture
G	Ground
G2H	Gowrie to Helidon
GDE	Groundwater Dependent Ecosystem
GIS	geographic information system
H2C	Helidon to Calvert
ha	hectare
HES	High Ecological Significance
HVR	High Value Regrowth
IAS	Initial Advice Statement
Inland Rail	Melbourne to Brisbane Inland Rail
kg/m	kilogram/metre
km	kilometre
km^2	square kilometre
LC	Least concern
m	metre
mm	millimetre
MNES	matters of national environmental significance

Abbreviation	Explanation
MSES	matters of state environmental significance
NRM	Natural Resource Management
NSW	New South Wales
OC	Of concern
PMST	Protected Matters Search Tool
Project	Helidon to Calvert Project
Qld	Queensland
QLD	Queensland
QR	Queensland Rail
RCBC	Reinforced concrete box culvert
RCP	Reinforced concrete pipe
RE	Regional Ecosystem
SDPWO Act	*State Development and Public Works Organisation Act 1971* (Qld)
SFRC	Southern Freight Rail Corridor
SPP	State Planning Policy 2017
SPRAT	Species Profile and Threats database
tal	Total axle load
TEC	threatened ecological community
Threatened	Critically endangered, Endangered, and Vulnerable
ToR	Terms of Reference
V	Vulnerable
VM Act	*Vegetation Management Act 1999* (Qld)
WoNS	Weeds of national significance
WQO	Water Quality Objective

Glossary

Term	Explanation
Adverse impact	Adverse impacts are defined as those impacts that result in an unwanted and/or 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.
Anaerobic	Process taking place in the absence of oxygen.
Anthropogenic	Associated with or relating to human influence (or impact) on the environment.
Aquatic ecosystems	The physical and chemical environment that contains a community of organisms (plants, animals, and microbes) and ecological processes within rivers and their riparian zones and reservoirs, lakes, wetlands and their fringing vegetation.
Arable	Capable of producing crops or grazing land.
Biocondition	The degree to which the attributes of a patch of vegetation differ from the attributes of the same vegetation in its reference (undisturbed) state.
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) (QLD Government 2014). The BPAs draw upon the Department of Environment and Science (DES) certified Regional Ecosystem (RE) mapping, database information, and expert panel reports and incorporate information about threatened ecosystems and/or species, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, as well as buffers to wetlands or other types of important areas for ecological processes. There are three biodiversity significance levels to which an area can be assigned: ▪ State significance – areas assessed as being significant for biodiversity at the bioregional or State scales ▪ Regional significance – areas assessed as being significant for biodiversity at the sub-bioregional scale ▪ Local significance and or other values – local values that are of significance at the local government scale All remnant vegetation will qualify into one of the above three categories.
Biodiversity offsets	Biodiversity offsets are measures that benefit biodiversity by compensating for the adverse impacts elsewhere of an action, such as clearing for development. Biodiversity offsets work by protecting and managing biodiversity values in one area in exchange for impacts on biodiversity values in another. In Queensland, the term used is 'environmental offsets'.
Bioregion	A bioregion as defined in An Interim Biographic Regionalisation of Australia (Thackway and Cresswell (1995)). The relevant bioregion for the Project is the south-east Queensland bioregion.
Biosecurity Act 2014 (Qld) *(*Biosecurity Act*)*	The Biosecurity Act lists declared plants and animals that have, or could have, serious economic, environmental or social impacts and are targeted for control. There are legal obligations associated with the control supply, sale, keeping and transport of declared species. Where these exotic pests and weeds are encountered, landowners have an obligation under the *Biosecurity Act* to control the declared weeds and pest animals, in accordance with relevant guidelines and local government area pest management plans. There are seven categories for restricted matter defined in the Biosecurity Act: ▪ Categories 1 and 2 are restricted matters that have specific urgent reporting requirements ▪ Categories 3, 4, 5, 6 and 7 relate to restricted matter that is in a person's possession, under their control and is also about not feeding restricted matter Several restriction categories apply to some restricted matter. In such cases, you would need to follow the requirements of all restriction categories for these restricted matter listings.
Conservation significant	A collective term used with reference to species that are listed as Critically endangered, Endangered or Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) (refer EPBC Act conservation significance for more details)).

Term	Explanation
Controlled action	A proposed action designated under the controlling provisions of the Environment Protect*ion and Biodiversity Conservation Act 1999* (Cth) that is likely to have a significant impact on a matter of national environmental significance, the environment or Commonwealth land (even if the action is taken outside Commonwealth land).
Controlling provision	Under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), an action that a person proposes to take is a *controlled action* if the taking of the action by the person without approval under Part 9 for the purposes of a provision of Part 3 would be (or would, but for section 25AA or 28AB, be) prohibited by the provision. The provision is a *controlling provision* for the action.
Critical habitat (also referred to as *Habitat critical to the survival of the species*)	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 defined within the Commonwealth's *EPBC Act Significant Impact Guidelines 1.1* and relevant species recovery plans.
Critically endangered	Designated as Critically endangered under the EPBC Act. Refer to definition of EPBC Act conservation status for meaning of Critically endangered under the Act.
Cumulative impacts	The impacts that result from the incremental impact of an activity when it is added to past, present, and reasonably foreseeable future activities. Cumulative impacts arise when several developments that may have insignificant effects but when taken together have a significant effect.
Direct impacts	Impacts that result from a direct interaction between integral Project activities and identified Matters of National Environmental Significance (MNES) (e.g. land clearing resulting in vegetation and habitat loss)
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.
Ecological MNES	An ecological value or group of ecological values that has the potential to be adversely impacted by Project related activities.
Ecosystem	An organic community of plants, animals and bacteria and the physical and chemical environment they inhabit.
Ecologically sustainable development	Using, conserving and enhancing the community's resources so that ecological processes are maintained and the total quality of life, both now and in the future, can be increased.
EIS investigation corridor	The EIS investigation corridor is an approximately 2 km wide study area, 1 km either side of the proposed rail alignment. The study area includes the disturbance footprint, which encompasses all areas where works are proposed, including both permanent and temporary works. Investigations for the purposes of this EIS and ongoing engineering design, including field surveys, were generally undertaken within the EIS investigation corridor (or as required by the individual technical assessments) to ensure a robust assessment and to allow for potential future design changes. Some technical assessments used a different study area to the EIS investigation corridor depending on the requirements of the environmental aspect being assessed.
Endangered	Designated as Endangered under the EPBC Act. Refer to definitions of EPBC Act conservation status for meaning of Endangered.
Endemic	Native to a country or a locality, although also found elsewhere.
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 ▪ 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

Term	Explanation
	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 **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 include birds such as albatrosses and petrels, mammals such as whales or reptiles. Listed migratory species appear 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).
Environmental values	Desirable characteristics, properties and behaviours or an aspect of the environment.
Ephemeral	Relates to the amount of time that surface water persists in a watercourse or wetland; ephemeral watercourses flow only during significant rainfall events and for a short time following rainfall events.
Habitat	An area or areas permanently, periodically or occasionally occupied by a species, population or ecological community, including any and all biotic and abiotic features of the area or areas occupied.
High constraint area	The environmental value is at risk from the Project activity. The activity will only be allowed with a specific set of stringent mitigation measures.
High Value Regrowth	According to the Department of Natural Resource Management and Energy (DNRME) (2018), regulated regrowth vegetation includes vegetation that falls into one of the following categories: ▪ Vegetation identified on a regulated vegetation map as High Value Regrowth vegetation (Category C; light blue) ▪ Vegetation located within 50 m of watercourses in priority reef catchment areas (Category R; yellow) ▪ Vegetation that is a Least concern, Of concern or Endangered RE High Value Regrowth vegetation is mature native vegetation that has not been cleared in the last 15 years.
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.
Intergenerational equity	The principle of intergenerational equity is that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.
Helidon Hills	Used to describe the area to the north of Helidon which encompasses several reserves including Lockyer National Park, Lockyer State Forest and Lockyer Resources Reserve
Matters of national environmental significance	The nine MNES 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.

Term	Explanation
MNES study area	This includes the H2C disturbance footprint plus a nominal 1 km buffer area. Where multiple options were identified, a 1 km buffer was maintained from the edge of each option, resulting in areas that are wider in some locations.
MSES wildlife habitat	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.
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.
Naturalness and ecological condition	The apparent naturalness or health/condition of an ecological community, as assessed against the following criteria: ▪ Disturbance — described in terms of its cause (natural or human), its degree or severity, its extent and distribution within the community ▪ Weed content — description of species abundance, horizontal and vertical distribution of each species ▪ Ecological viability — measure of a community's ability to survive in the longer term ▪ Ecological health — measure of regeneration, size, structure and number of dead or dying plants within a community ▪ Ecological relationships — the sequential relationship of one community to another, such as diurnal systems.
Negative impact	An impact that is considered to result in an unfavourable or adverse change to the MNES.
Non-remnant vegetation	Vegetation that is not mapped as remnant vegetation by DES and/or which fails to meet DESs criteria for remnant vegetation (refer 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 et al. 2017).
Permanent impact	The impact will last indefinitely.
Pest	Means any species: ▪ Listed as Prohibited or Restricted under the *Biosecurity Act 2014* (Qld) ▪ Declared under local government local laws That may become invasive in the future.
Precautionary principle	The precautionary principle stipulates that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Pre-clearing Regional Ecosystems (Pre-clearance REs)	Pre-clearing Regional Ecosystems are defined as the vegetation or regional ecosystem present before clearing. This generally equates to terms such as 'pre-1750' or 'pre-European' used elsewhere.
Project cumulative impact area	The Inland Rail Project cumulative impact area encompasses the Inland Rail disturbance footprint and extends 50 km beyond the disturbance footprint boundary.
Project disturbance footprint	The Project disturbance footprint is the area subject to direct disturbance (both temporary and permanent) associated with the project.
Project works	Project works include early works and pre-construction activities, works described as pre-construction, construction and commissioning works. Project works exclude enabling works.
Qualitative	Relating to or concerned with quality or qualities, rather than quantity or measured value.
Quantitative	An assessment based on quantities or quantifiable data.
Ramsar wetland	An area designated as a wetland of international importance under the Ramsar Convention (also known as the Convention on Wetlands of International Importance signed by Australia in 1971) because of its role in preserving biological diversity, or because it is a representative, rare or unique wetland type.
Rare	Defined as 'not occurring very often'

Term	Explanation
Regional Ecosystem (RE)	A vegetation community, within a bioregion, that is consistently associated with a particular combination of geology, landform and soil (Neldner 2017). REs are mapped by the Queensland Government and are defined by the Regional Ecosystem Description Database (REDD). The RE codes are applicable to mapping from Remnant vegetation, High value regrowth and pre-clearing REs that are not considered remnant. REs may be classified under schedules 1 to 3 of the Qld Vegetation Management Regulation as Endangered, Of concern or Least concern. These terms in reference to REs in this report refers to the RE status under the Act.
Regrowth vegetation	As defined under the Qld *Vegetation Management Act 1999* (VM Act), regrowth is any vegetation that is not 70 per cent of height of an equivalent community of undisturbed vegetation or 50 per cent of what would be undisturbed foliage cover and a mix of species represented in undisturbed communities.
Remnant vegetation	Remnant woody vegetation is defined as vegetation where the dominant canopy has >70 per cent of the height and >50 per cent of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy (Neldner et al. 2017).
Residual impact	The impact that is remaining or leftover following the implementation of mitigation measures.
Significant impact	In accordance with the intent of the EPBC Act, a significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.
Spatial extent	Impacts are considered with respect to the biologically meaningful spatial extents of local, regional, State, and national/international
Threatened	A collective term used with reference to species that are listed as Critically endangered, Endangered or Vulnerable under the provisions of the EPBC Act (refer EPBC Act conservation significance for more details).
Threatening process	Processes that threaten, or have the capability to threaten, the survival or evolutionary development of species, populations, or ecological communities. According to the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), a process is a threatening process if it threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community. Such processes can be listed as a key threatening process if it can: ▪ Cause a native species or ecological community to become eligible for inclusion in a threatened list (other than the conservation dependent category) ▪ Cause an already listed threatened species or threatened ecological community to become more endangered Adversely affect two or more listed threatened species or threatened ecological communities.
Vulnerable	Designated as Vulnerable under the EPBC Act. Refer to definitions of EPBC Act conservation status for meaning of Vulnerable under this Act.
Weeds	Plant species that invade native ecosystems and can adversely affect the survival of indigenous flora and fauna, often competing with indigenous plants for resources such as nutrients, moisture and light. They can prevent natural regeneration, reduce wildlife habitat, alter water flows, increase soil erosion, introduce poisons into the soil or poison animals, change fire behaviour and may introduce foreign genes into local plant populations. Weed species are not necessarily exotic non-indigenous species, but can also be non-endemic natives that are naturalised to areas outside of their natural distribution.
Weeds of National Environmental Significance (WoNS)	Thirty-two (32) species of weeds are declared to be weeds of national significance, based on their invasiveness, potential for spread and environmental, social and economic impacts. The State Government is responsible for the legislation and administration of WoNS in Queensland and landowners 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 minimising 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.

Term	Explanation
Wetland	■ Areas shown on the *Map of Referable Wetlands* 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 Environmental Protection Regulation 2008 (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 Qld *Map of Referable Wetlands* (DES).
Wildlife corridor	Habitat linked to other habitats (often remnant patches) to allow natural migration or movement of wildlife.

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 significant 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 (Inland Rail) will provide a safe and sustainable solution to Australia's freight challenge. Inland Rail 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 (ARTC) proposes to construct and operate the Helidon to Calvert (H2C) (the Project) section of Inland Rail. The Project consists of 47 kilometres (km) of greenfield and brownfield rail corridor which generally follows Queensland Rail's (QRs) West Moreton Rail Line and will connect the Gowrie to Helidon and Calvert to Kagaru sections of Inland Rail.

The Project was submitted as an *Environment Protection and Biodiversity Conservation Act* (EPBC Act) referral to the Department of the Environment and Energy (DotEE) in February 2017 (EPBC 2017/7883) and the Minister for the Environment declared the Project a 'controlled action' on 17 March 2017, requiring assessment and approval under the EPBC Act. The controlling provision for the controlled action is:

- Listed threatened species and communities.

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), as of 16 March 2017. This declaration initiates 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.

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.

This Matters of National Environmental Significance (MNES) Technical Report has been prepared to address the matters set out in the Terms of Reference (ToR) for the Environmental Impact Statement (EIS), issued on Thursday 5 October 2017 by the Coordinator-General. This report has been prepared to meet the requirements of section 11 of the *Terms of Reference for an environmental impact statement: Inland Rail – Helidon to Calvert Project.*

The Project consists of approximately 47 kilometres (km) of single-track dual gauge railway with four crossing loops to accommodate double stack freight trains up to 1,800 metres (m) long. It will also involve the construction of an approximately 850 m long tunnel through the Little Liverpool Range to facilitate the required gradient across the undulating topography. 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 design development has been based on environmental, social and economic considerations, aimed at minimising disturbance, meeting engineering design criteria and achieving the service offering. The design response to key environmental features has been progressively developed and optioneered in line with reasonable and feasible engineering constraints.

The Project disturbance footprint is situated within the South-east Queensland (SEQ) bioregion. The Project disturbance footprint has experienced a long history of human disturbance from agricultural practices, urban development and resource development. At a regional level, large tracts of remnant vegetation are typically fragmented, occurring on areas that are generally less attractive to development (i.e. rocky ranges, sloping topography) and roadside vegetation. Small isolated patches of remnant vegetation are also noted, which are subject to edge related impacts.

The Project disturbance footprint provides habitat for several threatened species listed under the EPBC Act and their associated habitat. There are no Threatened Ecological Communities (TECs) listed under the EPBC Act directly within the Project disturbance footprint. The closest TEC for consideration within this assessment is a patch of mapped vegetation equivalent to the Brigalow (*Acacia harpophylla* dominant and codominant) TEC located approximately 30 m form the Project disturbance footprint. The presence of this community has not been confirmed by ground-truthing.

The Project assessment framework has been designed to provide an objective approach to identifying the Project's environmental constraints and potential impacts to MNES.

Based on literature review, database searches, and field surveys supporting habitat modelling, habitat for 26 threatened flora and fauna species were confirmed within the Project disturbance footprint. This includes significant habitat associated with the Helidon Hills and Little Liverpool Range and critical habitat for a several species including Collared delma (*Delma torquata*) and Koala (*Phascolarctos cinereus*).

Informed by the outcomes of the desktop analysis and field assessments, an assessment of potential impacts from Project activities upon the identified MNES was undertaken.

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

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

To determine the significance of potential impacts of the Project upon the identified MNES, sensitivity categories were applied to each of the MNES. The sensitivity of the MNES was grouped into three distinct categories: high, moderate and low. These groupings were based on factors including, but not limited to, legislative status, resilience and representation in the broader landscape. In addition to sensitivity, the magnitude of each potential impact was assigned based on the extent, duration and resultant change to the MNES. The magnitude of impact was grouped into five categories: major, high, moderate, low and negligible. Both the sensitivity of a MNES and the magnitude of the potential impact were used to determine the significance of a potential impact.

The proposed mitigation measures for the Project were considered in order to reduce the initial magnitude and ultimately the significance of the potential impacts upon the listed threatened species and communities. Project mitigation measures included (but were not limited to):

- Reducing the Project disturbance footprint as far as reasonably practical
- Development and implementation of a Flora and Fauna Sub-plan as a component of the Project Environmental Management Plan (EMP)
- Development and implementation of a Biosecurity Management Plan as a component of the EMP
- Development and implementation of a Soil Management Plan, including erosion and sedimentation controls, as a component of the EMP

- Identification and implementation of fauna movement features to reduce barrier effects associated with the Project and enable fauna passage
- Development and implementation of a Reinstatement and Rehabilitation Plan and a Landscape and Rehabilitation Management Plan
- Development and implementation of the CEMP.

Following the implementation of a range of mitigation measures and management plans including, but not limited to, avoidance, minimisation and mitigation, the magnitude of residual impacts to the listed threatened species were generally reduced, followed by a subsequent reduction in the significance of the impact. However, the loss of habitat from vegetation clearing/removal upon most of the terrestrial MNES was not predicted to significantly reduce in magnitude of impact following the implementation of Project mitigation measures. In addition, whilst measures will be implemented to reduce impacts due to fragmentation associated with barrier effects (e.g. the provision of crossing structures to facilitate fauna passage), terrestrial species such as Koala (*Phascolarctos cinereus*) are still likely to be subject to adverse impacts.

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

- Flora
  - Lloyd's olive (*Notelaea lloydii*) – likely impact of 21.26 ha to *Habitat critical to the survival of the species* and 112.77 ha of *potential habitat*
- Fauna
  - Collared delma (*Delma torquata*) – likely impact of 85.33 ha to *important habitat*
  - Koala (*Phascolarctos cinereus*) – likely impact of 98.66 ha to *Habitat critical to the survival of the species* and 205.29 ha to *potential habitat.*

There are also several threatened fauna species of which there is uncertainty as to whether they occur in the area, or if impacts of the Project may be considered as residual impacts. The assessment has followed a conservative approach and assumed there is also potential to have significant residual impacts to the following flora and fauna species:

- Flora
  - Four-tailed grevillea (*Grevillea quadricauda*) –potential impact of 26.06 ha to *potential habitat*
  - Blunt-leaved leionema (*Leionema obtusifolium*) –potential impact of 29.26 ha to *potential habitat*
  - *Paspalidium grandispiculatum* (a grass) - potential impact of 84.58 ha to *potential habitat*
- Fauna
  - Spotted-tail quoll (*Dasyurus maculatus maculatus*) - potential impact of 77.07 ha to *potential habitat* and *Habitat critical to the survival of the species*
  - Red goshawk (*Erythrotriorchis radiatus*) - potential impact of 88.82 ha to *potential habitat* and *Habitat critical to the survival of the species*
  - Swift parrot (*Lathamus discolor*) - potential impact of 13.34 ha to *potential habitat* and *Habitat critical to the survival of the species*
  - Brush-tailed rock-wallaby (*Petrogale penicillata*) –potential impact of 41.25 ha to *potential habitat* and *Habitat critical to the survival of the species*
  - New Holland mouse (*Pseudomys novaehollandiae*) - potential impact of 88.12 ha to *potential habitat*
  - Grey-headed flying-fox (*Pteropus poliocephalus*) –potential impact of 99.46 ha to *Habitat critical to the survival of the species*
  - Australian painted snipe (*Rostratula australis*) –potential impact of 33.38 ha to *potential habitat* and *Habitat critical to the survival of the species.*

A key factor that causes disturbance is the potential loss of habitat. Habitat loss may result from the Project disturbance footprints (primarily temporary construction). The Project may also result in permanent barrier effects and habitat fragmentation. During the detailed design phase, the extent of the clearing will be confirmed, along with the implementation of design solutions to mitigate barrier effects (e.g. fauna fencing and fauna passage ways which will facilitate the movement of wildlife across the alignment).

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

- Lloyd's olive (*Notelaea lloydii*)
- *Paspalidium grandispiculatum* (a grass)
- Grey falcon (*Falco hypoleucos*)
- White-throated needletail (*Hirundapus caudacutus*)
- Swift parrot (*Lathamus discolor*)
- Spotted-tail quoll (*Dasyurus maculatus maculatus*)
- Koala (*Phascolarctos cinereus*)
- Grey-headed flying-fox (*Pteropus poliocephalus*)

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

Significant residual impacts to *Habitat critical to the survival of the species* and *Important habitat* will be offset through the development and implementation of an Environmental Offset Delivery Plan during the detailed design phase and prior to any construction works commencing.

There is the potential for some project activities (e.g. vegetation clearing) to have a cumulative, irreversible and/or permanent impact upon some ecological MNES, even after the implementation of all project mitigation measures. An Environmental Offset Delivery Plan for the Project will be prepared in consultation with the relevant State and Commonwealth agencies. Strategic offsets will be provided in consideration of relevant Commonwealth and State based policies. These will be in the form of direct land based contributions and financial settlements. The Environmental Offset Management Plan will be developed and implemented during the detailed design phase and prior to any construction works commencing.

1 Introduction

1.1 Project overview

The Australian Government has committed to delivering the Inland Rail Program (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 significant national transport infrastructure which will enhance Australia's existing rail network and serve the interstate freight market.

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

- Using the existing interstate rail corridor through Victoria and southern NSW
- Upgrading approximately 400 km of existing corridor, mainly in western NSW
- Providing approximately 600 km of new corridor in northern NSW and southeast QLD.

The Inland Rail Program (Inland Rail) has been divided into 13 separate projects to assist with the delivery of the Inland Rail Program of works.

The Australian Rail Track Corporation (ARTC) proposes to construct and operate the Helidon to Calvert (H2C) section (the Project), which consists of approximately 47 km of single track dual gauge railway with four crossing loops to accommodate double stack freight trains up to 1,800 m long. It will also involve the construction of an approximately 850 m long tunnel through the Little Liverpool Range to facilitate the required gradient across the undulating topography. 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.

It is noted that although ARTC are applying for approval to build infrastructure to accommodate trains up to 1,800 m in length, infrastructure will be designed such that the future extension of some crossing loops to accommodate 3,600 m trains is not precluded. ARTC intend to acquire the land for the future 3,600 m crossing loop extension with the initial land acquisition, however, the approval for the construction of future 3,600 m crossing loops will be subject to separate approval applications in the future. This assessment is based on 1,800 m train lengths.

The Project is classed as greenfield, and brownfield where the Project aligns with existing railway corridors. It is expected to cost approximately $1 Billion due to its overall length, the significant infrastructure elements of the tunnel, and significant earthworks required for the Little Liverpool Range crossing and where the alignment crosses through the Helidon Hills area.

1.2 Objectives

The objectives of the Project are to:

- Provide rail infrastructure that meets the Inland Rail specifications, to enable trains using the Inland Rail corridor to travel between Helidon and Calvert, connecting with other sections of Inland Rail
- Minimise the potential for adverse environmental and community impacts.

The objectives of Inland Rail are to:

- Provide a rail link between Melbourne and Brisbane that is interoperable with train operations to Perth, Adelaide, and other locations on the standard gauge rail network, to serve future rail freight demand, and stimulate growth for inter-capital and regional/bulk rail freight
- Provide an increase in productivity that will benefit consumers through lower freight transport costs
- Provide a step-change improvement in rail service quality in the Melbourne to Brisbane corridor and deliver a freight rail service that is competitive with road

- Improve road safety, ease congestion, and reduce environmental impacts by moving freight from road to rail
- Bypass bottlenecks within the existing metropolitan rail networks and free up train paths for other services along the coastal route
- Act as an enabler for regional economic development along the Inland Rail corridor.

1.3 Scope and purpose

In February 2017, a referral for the Project was submitted in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2017/7883). On 17 March 2017, the Minister for the Environment determined the Project a 'controlled action', with the controlling provision for the Project being:

- Listed threatened species and communities.

The assessment has been conducted under the Bilateral Agreement between the Commonwealth and the State of Queensland. The EIS must address the controlling provision for the Project and describe the aspects of the environment and the Project that are subject to the controlled action decision as detailed above. A principal purpose of the EIS is to provide sufficient information to enable the Coordinator-General and the Commonwealth Minister for the Environment to evaluate and assess the Project under the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act) and EPBC Act respectively.

The Project proponent is still required to obtain all other secondary development approvals from local authorities as required (e.g. waterway barrier works permit under the *Fisheries Act 1994* (Qld)). Secondary approvals are listed in EIS Chapter 3: Project Approvals.

This technical report addressed Section 11.1 to Section 11.35 of the *Terms of Reference for an environmental impact statement: Inland Rail – Helidon to Calvert Project* issued on 5 October 2017 by the Coordinator-General. It has been prepared as a 'stand-alone' document that assesses potential impacts on listed threatened species and communities under the EPBC Act during construction of the Project. Furthermore, this report draws on other impact assessments completed for this EIS as relevant to listed threatened species and communities, including air quality, surface water and hydrology, groundwater, and noise and vibration. This technical report has been prepared for the purpose of the EPBC Act assessment for the Project.

For the purpose of this report, the assessment of potential impacts was focussed on the Project disturbance footprint and Matters of National Environmental Significance (MNES) study area presented in Figure 1.1.The Project disturbance footprint and MNES study area does not include the surface area associated with the rail tunnel where the alignment intersects a portion of the Little Liverpool Range as no surface disturbance is predicted. The MNES study area was based on a 1 km buffer from the identified Project disturbance footprint, increasing in buffer extent where multiple design options were identified and explored during design development (refer Section 1.7). The MNES study area was used to identify MNES that are in proximity to the Project and therefore relevant to the assessment of potential impacts. The identified Project disturbance footprint includes the proposed temporary construction disturbance footprint (land required for construction of the rail alignment, laydown areas and stockpile locations) and the permanent operational disturbance footprint (land required for operation of the Project).

An impact assessment was undertaken in accordance with the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (MNES Guidelines) (DotE 2013a). MNES potentially to be subject to significant residual impacts as a result of the Project were determined by:

- Assessing direct impacts from the Project (immediate impacts from Project activities such as vegetation clearing and fauna injury)
- Assessing indirect impacts (offsite and/or longer term impacts resulting from Project activities such as impacts to surface water quality and barriers to fauna movement) on each MNES
- Identification of mitigation measures for each potential impact/MNES and the Project as whole to avoid, minimise and mitigate assessed impact(s).

The EPBC Act Offsets Policy states: *'Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures'*. In accordance with this policy, an offset strategy has been developed for the Project (refer Appendix I) for any significant residual impacts on MNES, where appropriate (as not all impacts can be avoided).

It is acknowledged that, whist migratory species, as listed under the EPBC Act, are MNES, they are not a controlling provision within the ToR for the Project. Therefore, migratory species have been excluded from this technical report. However, to suitably inform the EIS, migratory species have been incorporated into the EIS and its associated EIS Appendix I: Terrestrial and aquatic ecology technical report (and relevant EIS chapters).

1.4 Proponent

Australian Rail Track Corporation (ARTC) was created in 1997 after the Australian and State governments agreed to the formation of a 'one stop shop' for all operators seeking to access the national interstate rail network. ARTC is the Project proponent and is a Commonwealth Government Business Enterprise as prescribed by section 5(2) of the *Public Governance Performance and Accountability Rule 2014* (Cth).

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

Across the network, ARTC is responsible for:

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

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

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

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

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

ARTC has also previously entered into a Voluntary Enforceable Undertaking with the Commonwealth Department of the Environment (currently known as the Department of Agriculture, Water and the Environment (DAWE)) under the *Environment Protection Biodiversity Conservation Act 1999* (Cth) (EPBC Act), in 2011.

Contact details for ARTC Inland Rail are:

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

The ARTC Environmental Policy provides a framework for continual improvement of ARTC's Environmental Management System and sets out commitments for managing potential environmental risks. ARTC is committed to best-practice environmental management and reducing environmental impact in all ARTC activities. ARTC also implements a 'no harm' policy in regard to workplace health and safety.

Further information on ARTC and Inland Rail can be found at www.artc.com.au and www.inlandrail.com.au respectively. ARTC's corporate policies can also be found at Appendix F: Corporate Policies.

The Environmental Impact Statement (EIS) study team is made up of personnel from Future Freight Joint Venture (FFJV), ARTC and various technical specialist service providers.

1.5 Terms of reference

Table 1.1 provides a list of the requirements relevant to MNES as outlined in the ToR issued on 8 December 2017 by the Coordinator-General and as they are presented in this report, associated Appendices and related Project Chapters and documents.

Table 1.1 Terms of Reference compliance table relevant to MNES

Flora and fauna Terms of Reference requirement		Report section
Information requirements		
MNES – background and context		
11.1	This section should provide a stand-alone description and detailed assessment of the impacts of the project on the controlling provision for the project under the EPBC Act inclusive of any avoidance, mitigation and offset measures.	Introduction – Section 1.3 and 1.4
11.2	The Commonwealth Minister for the Environment and Energy (the Commonwealth Minister) has determined that the project (EPBC 2017/7944) is likely to impact upon listed threatened species and communities (sections 18 and 18A of the EPBC Act).	
11.3	The EIS must be prepared in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland relating to environmental assessment. This will enable the EIS to meet the impact assessment requirements under both Commonwealth and Queensland legislation.	
11.4	The statutory obligations for conduct of the EIS process under the bilateral agreement are set out in Part 13 of the State Development and Public Works Organisation Regulation 2010.	
11.5	Once the draft EIS has been prepared to the satisfaction of the Coordinator-General and MNES addressed to the satisfaction of the Australian Government Department of the Environment and Energy, the draft EIS will be made available for public comment.	
11.6	The proponent may be required by the Coordinator-General or the Department of the Environment and Energy to provide additional material to address matters raised in submissions on the EIS	
11.7	At the conclusion of the environmental assessment process, the Coordinator-General will provide a copy of the report evaluating the environmental impacts of the project to the Commonwealth Minister.	

Flora and fauna Terms of Reference requirement		Report section
11.8	After receiving the evaluation report and sufficient information about the relevant impacts of the action, the Commonwealth Minister for the Environment and Energy has 30 business days to consider whether the impacts of the proposal are acceptable, or not, and to decide whether or not to approve each controlling provision.	
11.9	The Commonwealth Minister's decision under Part 9 of the EPBC Act is separate to the approval decisions made by Queensland state agencies and other agencies with jurisdiction on state matters.	
Information Requirements		
11.10	Consideration must be given to any relevant policy statements available from www.environment.gov.au, including: a) Matters of National Environmental Significance: Significant impact guidelines 1.1 b) *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy and c) any approved conservation advice, recovery plans and threat abatement plans (as relevant) for listed threatened species and ecological communities.	Guidelines and plans – Sections 5.3.3, 5.3.4 and 5.3.5 and Appendix B Offsets – Section 5.4 and Appendix I
11.11	The EIS must: a) assess all the relevant impacts that the action has, will have or is likely to have, including on receiving environments of the project b) provide enough information about the action and its relevant impacts to allow the Commonwealth Minister to make an informed decision on whether or not to approve the action c) address the matters set out in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth) (EPBC Regulations).	Project description – Section 1.7 and EIS Chapter 6 – Project Description Impacts – Section 5.1 and throughout relevant EIS Chapters Mitigations – Section 5.2 and 5.3.2 and throughout relevant EIS Chapters Chapter 3 Environmental record – EIS Chapter 1 Introduction Information sources – Appendix B and Section 9 Chapter 11, Sections 11.4 and 11.1
11.12	The MNES section of the EIS should bring together assessments of impacts from other chapters and produce a stand-alone assessment in a format suited for assessment under the EPBC Act.	Sections 5.1.2, 5.1.3 and 7
11.13	The project should initially be assessed in its own right followed by an assessment of the cumulative impacts related to existing major projects and/or development that is progressing through a publicly available planning and approval process. Cumulative impacts not solely related to the project development should also be described.	Section 3.5 and 7 EIS Chapter 22 Cumulative Impacts Chapter 11, Sections 11.8 and 11.13
11.14	Predictions of the extent of threat (risk), impact and the benefits of any mitigation measures proposed, should be based on sound science and quantified where possible. All sources of information relied upon should be referenced.	Mitigations – Section 5.2 and 5.3.2 Information sources – Appendix B and Section 9 Chapter 11, Sections 11.8, 11.9, 11.9.3 and 11.10
11.15	An estimate of the reliability of any predictions should be provided.	Appendix A of this document
11.16	Any positive impacts of the Project should be identified and evaluated.	Section 1.9 Chapter 2, Section 2.4 Chapter 16, Sections 16.10 and 16.12
11.17	The extent of any new field work, modelling or testing should be commensurate with risk and should be such that when used in conjunction with existing information, provides sufficient confidence in predictions that well-informed decisions can be made.	Section 3.2 and 3.3 Chapter 11, Section 11.5

Flora and fauna Terms of Reference requirement		Report section
11.18	In accordance with Schedule 4 of the EPBC Regulations, feasible project alternatives must be discussed, including: (a) if relevant, the alternative of taking no action (b) a comparative description of the impacts of each alternative on the triggered MNES protected by the controlling provision (c) sufficient detail to make clear why any alternative or option is preferred to another.	Section 1.7 Chapter 2, Sections 2.5, 2.6, 2.7 and 2.8.3
11.19	Short, medium and long-term advantages and disadvantages of the alternatives or options must be discussed.	Section 1.7 Chapter 2, Sections 2.4 to 2.7
11.20	The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: (a) the person proposing to take the action (b) for an action for which a person has applied for a permit, the person making the application. If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must also be included.	Section 1.4 Chapter 1, Section 1.2 Appendix F: Corporate Policies
11.21	The economic and social impacts of the action, both positive and negative, must be summarised. Matters of interest should include: (a) consideration at the local, regional and national levels (b) any public consultation activities undertaken, and their outcomes (c) any consultation with indigenous stakeholders (d) identification of affected parties and communities that may be affected and a description of the views of those parties and communities (e) project economic costs and benefits of the project and project alternatives, including the basis for their estimation through cost/benefit analysis or similar studies; and (f) employment and other opportunities expected to be generated by the project in each of the construction and operational phases.	Section 1.9 and 1.10 Chapter 2, Sections 2.3 to 2.5 Chapter 5, Sections 5.6 to 5.7 Chapter 16, Section 16.9 to 16.12 Chapter 17, Sections 17.8 to 17.12
11.22	The EIS must provide background to the action and describe in detail all components of the action for example (but not limited to), the construction, operation and (if relevant) decommissioning components of the action. This must include the location of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Section 1.7 and 1.8 Chapter 6: Project Description Chapter 11, Section 11.8.1
11.23	The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.	Section 1.7 and 1.8 Chapter 6: Project Description
11.24	The EIS must also provide details on the current state of groundwater and surface water in the region as well as any use of these resources.	Section 4.2 Chapter 13, Sections 13.6.2 to 13.6.5 Chapter 14, Section 14.6 Appendix L, Sections 5 and 6 Appendix N, Sections 4 to 7
Listed threatened species and communities		
11.25	The EIS must describe the listed threatened species and ecological communities identified below (including EPBC Act status, distribution, life history and habitat).	Sections 5.3.3, 5.3.4 and 5.3.5 and Appendix B Chapter 11, Section 11.6.2.3

Flora and fauna Terms of Reference requirement		Report section
11.26	The EIS must consider and assess the impacts to the listed threatened species and ecological communities identified in section 11.29 and 11.31 (including EPBC Act status, distribution, life history and habitat and any others that are found to be or may potentially be present in areas that may be impacted by the project. Impacts from each component of the project of relevance to each listed threatened species or ecological community should be identified. Impacts may result from: (a) a decrease in the size of a population or a long-term adverse effect on an ecological community (b) reduction in the area of occupancy of the species or extent of occurrence of the ecological community (c) fragmentation of an existing population or ecological community (d) disturbance or destruction of habitat critical to the survival of the species or ecological community (e) disruption of the breeding cycle of a population (f) modification, destruction, removal, isolation or reduction of the availability or quality of habitat to the extent that the species is likely to decline (g) modification or destruction of abiotic (non-living) factors (such as water, nutrients or soil) necessary for the ecological community's survival (h) the introduction of invasive species that are harmful to the species or (i) ecological community becoming established (j) interference with the recovery of the species or ecological community.	Sections 5.1 and 5.2, 5.3.3, 5.3.4 and 5.3.5 Chapter 11, Sections 11.8, 11.11 and 11.1
11.27	The EIS should describe any mitigation measures proposed to reduce the impact on the listed threatened species and ecological communities and proposed mitigation measures. Supporting evidence should be provided to demonstrate the appropriateness of mitigation measures proposed. Where the likely success of mitigation measures cannot be supported by evidence, identify contingencies in the event the mitigation is not successful.	Sections 5.2, 5.3.2 and 5.4 Chapter11, Section 11.9
11.28	The EIS should describe any offsets proposed to compensate for residual impacts.	Section 5.4 and Appendix I Chapter 11, Section 11.1
List of potential listed threatened species and their status		
11.29	The EIS must address impacts on, but not limited to, the following listed threatened species for the proposed action: (a) Regent Honeyeater (*Anthochaera phrygia*) – critically endangered; (b) Australasian Bittern (*Botaurus poiciloptilus*) – endangered; (c) Curlew Sandpiper (*Calidris ferruginea*) – critically endangered; (d) Coxen's Fig-Parrot (*Cyclopsitta diophthalma coxeni*) – endangered; (e) Eastern Bristlebird (*Dasyornis brachypterus*) – endangered; (f) Red Goshawk (*Erythrotriorchis radiatus*) – vulnerable; (g) Squatter Pigeon (southern subspecies) (*Geophaps scripta scripta*) – vulnerable; (h) Painted Honeyeater (*Grantiella picta*) – vulnerable; (i) Swift Parrot (*Lathamus discolor*) – critically endangered, marine; (j) Eastern curlew, Far Eastern Curlew (*Numenius madagascariensis*) – critically (k) endangered, marine, migratory; (l) Black-throated Finch (southern) (*Poephila cincta cincta*) – endangered; (m) Australian Painted Snipe (*Rostratula australis*) – endangered, marine; (n) Black-breasted Button-quail (*Turnix melanogaster*) – vulnerable; (o) Mary River Cod (*Maccullochella mariensis*) – endangered; (p) Pink Underwing Moth (*Phyllodes imperialis smithersi*) – endangered; (q) Large-eared Pied Bat (*Chalinolobus dwyeri*) – vulnerable; (r) Northern Quoll (*Dasyurus hallucatus*) – endangered; (s) Spotted-tail Quoll (SE mainland population) (*Dasyurus maculatus*) – (t) endangered; (u) Greater Glider (*Petauroides Volans*) – vulnerable; (v) Brush-tailed Rock-wallaby (*Petrogale penicillata*) – vulnerable; (w) Koala (*Phascolarctos cinereus*) (combined population of Queensland, New South Wales and the Australian Capital Territory) – vulnerable; (x) Long-nosed Potoroo (SE mainland) (*Potorous tridactylus tridactylus*) – vulnerable; (y) New Holland Mouse (*Pseudomys novaehollandiae*) – vulnerable; (z) Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable;	Species relevance to Project - Section 4.3 and 4.4 Impacts relevant to species – Section 5.1 and 5.3.2 Chapter 11, Sections 11.8 11.9.3 and 11.11

Flora and fauna Terms of Reference requirement		Report section
	(aa) Five-clawed Worm-skink, Long-legged Worm-skink (*Anomalopus mackayi*) – vulnerable; (bb) Marlborough blue (*Cycas ophiolitica*)– endangered; (cc) Hairy-joint Grass (*Arthraxon hispidus*) – vulnerable; (dd) A shrub (*Bertya ernestiana*) – vulnerable; (ee) Three-leaved Bosistoa, Yellow Satinheart (*Bosistoa transversa*) – vulnerable; (ff) Miniature Moss-orchid, Hoop Pine Orchid (*Bulbophyllum globuliforme*) – vulnerable; (gg) Boonah Tuckeroo (*Cupaniopsis tomentella*) – vulnerable; (hh) Bluegrass (*Dichanthium setosum*) – vulnerable; (ii) Wandering Pepper-cress (*Lepidium peregrinum*) – endangered; (jj) Macadamia nut, Queensland Nut Tree, (*Macadamia integrifolia*) – vulnerable; (kk) Rough-shelled Bush Nut, Rough-leaved Queensland Nut (*Macadamia tetraphylla*) – vulnerable; (ll) Cooneana Olive (*Notelaea ipsviciensis*) – critically endangered; (mm)Lloyd’s Olive (*Notelaea lloydii*) – vulnerable; (nn) Lesser Swamp-orchid (*Phaius australis*) – endangered; (oo) Mt Berryman Phebalium (*Phebalium distans*) – critically endangered; (pp) Shiny-leaved Condoo, Black Plum, Wild Apple (*Planchonella eerwah*) – endangered; (qq) Austral Cornflower, Native Thistle (*Rhaponticum australe*) – vulnerable; (rr) Quassia (*Samadera bidwillii*) – vulnerable; (ss) Brush sophora (*Sophora fraseri*) – vulnerable; (tt) Austral Toadflax, Toadflax (*Thesium australe*) – vulnerable (uu) Adorned Delma, Collared Delma (*Delma torquata*) – vulnerable; (vv) Dunmall's Snake (*Furina dunmalli*) – vulnerable; (ww) Three-toed Snake-tooth Skink (*Saiphos reticulatus*) – vulnerable;	
11.30	The EIS must address how the impacts to each of the listed species is not inconsistent with relevant recovery plans, threat abatement plans and conservation advices.	Sections 5.3.4 and 5.3.5 Chapter 11, Section 11.9.3 and 11.11
List of potential listed threatened communities		
11.31	The EIS must address impacts on the following listed threatened ecological communities for the proposed action: (a) Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland – critically endangered; (b) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Bon-Gum Grassy Woodland and Derived Grassland)– critically endangered; (c) Lowland Rainforest of Subtropical Australia – critically endangered; (d) Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered.	TEC relevance to Project – Section 4.3.1.2 and 4.4.1.3 Impacts relevant to TEC – Section 5.1, 5.3.2 and 5.3.3 Chapter 11, Sections 11.8, 11.9.3 and 11.11
11.32	The EIS must address how the impacts to each of the listed communities is not inconsistent with relevant recovery plans, threat abatement plans and conservation advices.	Section 5.3.3 and Appendix B Chapter 11, Section 11.9.3 and 11.11
Offsets		
11.33	The EIS must describe any significant adverse residual impacts of the action for each relevant matter protected by the EPBC Act, after all proposed avoidance and mitigation measures are considered.	Section 5.3.3, 5.3.4 and 5.3.5 Chapter 11, Section 11.11
11.34	The EIS must propose offsets for all residual impacts to matters protected by the EPBC Act consistent with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy.	Section 5.4 and Appendix I Chapter 11, Section 11.1

Flora and fauna Terms of Reference requirement		Report section
Conclusion		
11.35	The EIS must include an overall conclusion for the action describing the acceptability of the impact of undertaking the action in the manner proposed on the protected matters, in the context of: (a) the requirements of the EPBC Act; (a) the principles of ecologically sustainable development and the precautionary principle; and (b) the proposed avoidance, mitigation measures, and if relevant, offsets (c) measures proposed to address any residual impacts.	Section 8 Chapter 11, Sections 11.5.6, 11.9, 11.1 and 11.13

1.6 Project location and existing land use

The location of the Project and the MNES study area is shown on Figure 1.1. The Project is located within the Ipswich City and Lockyer Valley Local Government Areas (LGAs) within the South East Queensland (SEQ) Bioregion. The Project is located within the Lockyer Creek and Bremer River catchments (of the Moreton hydrological basin) and, is expected to cross four major watercourses and several unnamed tributaries along the alignment.

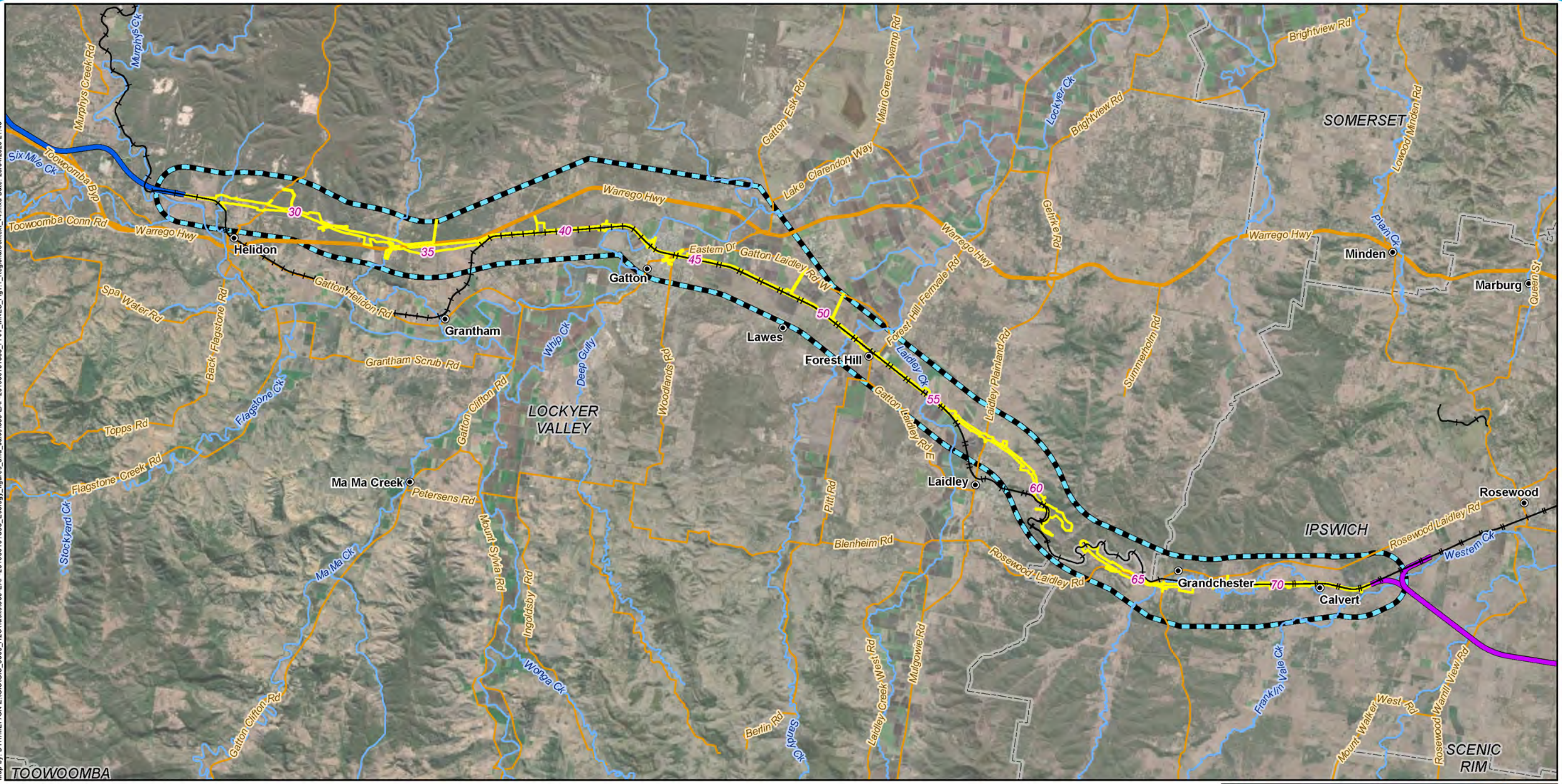
The Project starts within the existing Queensland Rail (QR) West Moreton System rail corridor at Helidon, traversing east for approximately 1.3 km. The Project then deviates from the West Moreton System rail corridor and continues east for approximately 4 km. The Project aligns with the Gowrie to Grandchester Future State transport corridor west of Grantham, continuing within the gazetted future railway corridor for approximately 6.3 km. The Project then utilises the QR West Moreton System rail corridor north-west of Placid Hills, continuing within the existing rail corridor for approximately 18.4 km whilst traversing through the localities of Gatton, Lawes and Forest Hill.

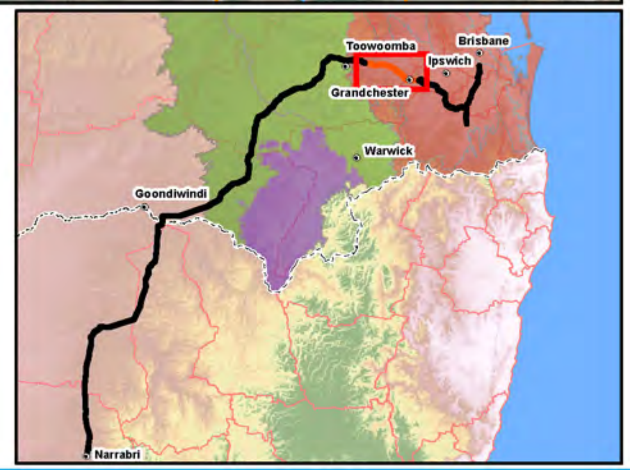
The Project deviates from the West Moreton System rail corridor at Laidley North, continuing south-east for approximately 4.9 km whilst predominately within the Gowrie to Grandchester future State transport corridor. Deviating from the Gowrie to Grandchester corridor, the Project enters the western tunnel portal at Laidley and passes through the Little Liverpool Range. The Project exits the tunnel at the eastern tunnel portal and continues east for approximately 4.2 km. The Project re-joins the West Moreton System rail corridor east of Grantham, continuing within the existing corridor for approximately 5.9 km through to Calvert.

Grazing land is the predominant land use within the Project permanent operational and temporary construction disturbance footprints. The next most common land use is also generally of an agricultural nature, being land classified as irrigated seasonal horticulture. Other land uses include land classified as residential, services (which primarily includes commercial and recreational services located within the Gatton township) and land in transition (which includes land located to the north of Laidley currently being developed into a housing estate).

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map by: DTH/MEF/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig1.1_RegionalContext_v4.mxd Date: 23/04/2020 21:48





Legend

- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas

Bioregions

- Brigalow Belt South
- Nandewar
- South Eastern Queensland

A3 scale: 1:150,000

0 1 2 3 4 5km

Future Freight
Integrating Community, Environment and Engineering

Issue date: 20/04/2020 Version: 4
Coordinate System: GDA 1994 MGA Zone 56

Helidon to Calvert

Figure 1.1:
Location of the Project and MNES study area

The purpose of the second study, the *Melbourne-Brisbane Inland Rail Alignment Study* (ARTC 2010), was to evaluate route options within the 'far western sub-corridor'. Two key criteria – capital cost and journey time – were used to shortlist route options between Melbourne and Parkes, Parkes and Moree, and Moree and Brisbane. The shortlist of route options was then subject to technical, financial and economic assessment, focussing on:

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

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

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

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

1.6.1 Alternative locations and route options for the Project

The Project consists of both greenfield and brownfield rail corridors. The Project utilises the existing West Moreton System rail corridor for approximately 50 per cent of the length of the alignment (refer Figure 1.1). Where the Project deviates from the existing West Moreton System rail corridor, the Project predominantly follows the protected Gowrie to Grandchester future State transport corridor, a greenfield corridor gazetted for future railway land under the *Transport Planning and Coordination Act 1994*.

The Gowrie to Grandchester Rail Corridor Study was a joint initiative between the Department of Transport and Main Roads (DTMR) and QR. The purpose of the study was to identify a rail corridor to relieve the constraints on rail operations caused by the Toowoomba and Little Liverpool Range crossings. The rail corridor would provide rail infrastructure to support development in Toowoomba, south-west QLD and northern NSW. The study was completed in May 2003.

Various options were assessed as part of the EIS and initial design to refine the alignment within the Gowrie to Grandchester future State transport corridor. A number of different corridors were investigated in recent years, with preference for using existing publicly-owned corridors, including rail lines and road reserve areas. Various factors were considered during design, including:

- The nature of the terrain in these areas (e.g. steep grades and/or the need to wind through such areas are not desirable due to the size and weight of the trains)
- Flooding and hydrology (e.g. ensure a 98 per cent level of serviceability for Inland Rail, so the corridor needs to be developed to withstand flood conditions)
- Environmental, social and heritage constraints (e.g. vegetation communities, sensitive receptors, waterway crossings, registered heritage sites)
- Cost (e.g. due to the physical construction requirements in some locations, critical construction constraints exist)
- Travel time (e.g. ARTC has a service offering requirement of less than 24 hours between Melbourne and Brisbane express)
- Constructability (e.g. some locations will make construction more difficult)

- Easement setback requirements (e.g. several minimum clearances required from road, power and other public utility easements must be met).

Several optioneering analyses were carried out to identify potential significant efficiencies in construction and reductions in potential environmental and social impacts. The optioneering analyses considered the following possible impacts:

- Environmental impacts:
  - Ecological (flora, fauna, and habitats)
  - Landscape and visual
  - Noise and vibration
  - Flooding and waterway
  - Air quality
  - Greenhouse gas emissions
- Community and property impacts:
  - Land use and tenure
  - Heritage
  - Impact on community (e.g. Through roads and other amenity aspects)
  - Community response (stakeholder risk)
- Constructability (e.g. design and engineering) considerations
- Cost implications.

Optioneering analyses included

- Investigation of alignment routes at the Warrego Highway Crossing, Gatton, Forest Hill, Little Liverpool Range, and Grandchester
- Road-rail interface options at Helidon, Gatton and Forest Hill.

1.7 Project description

Elements of the Project design have responded to environmental and engineering constraints to produce a feasible rail design. The Project design is based on minimising environmental and social impacts, minimising disturbance to existing infrastructure and meeting engineering design criteria.

Key components of the Project include:

- 47 km of single track dual gauge rail line with 4 crossing loops to accommodate 1,800 m long trains
- Approximately 24 km of the Project established through existing rail corridors
- The rail corridor has a width ranging from 40 m to a typical 62.5 m – with the width varying along the alignment based on constraints present (including the existing QR West Moreton Line and parallel running roads) and may be wider where earthworks, structures and other associated infrastructure are required.
- The approximately 850 m Little Liverpool Range tunnel, bridges and viaducts to accommodate topography and Project crossings of waterways, roads and other infrastructure
- Approximately 34 km of embankments (excluding structures)
- Approximately 1,200,000 m^3 of excess cut
- A total of 31 bridges proposed, including 13 rail-over-water, 6 rail-over-water-and-road (identified above), 6 rail-over-road, 4 road-over-rail, 1 rail-over-existing-rail and one pedestrian-over-rail bridge

- 67 waterway crossings including 19 bridge structures and 86 drainage structures (51 reinforced concrete pipe (RCP) locations and 35 reinforced concrete box culvert (RCBC) locations)
- The construction of associated rail infrastructure, including maintenance sidings, rail maintenance access roads and signalling infrastructure to support the train control system
- Ancillary works, including road and public utility crossings, and realignments (excluding those undertaken as enabling works)
- Environmental design matters including fauna sensitive design measures (fauna fencing and vegetative screening), landscaping and habitat rehabilitation requirements, and concept noise barriers
- Construction laydowns, storage, workspace and temporary access roads.

Construction activities for the Project will likely include temporary roads, upgrades and/or alterations to existing roads. The construction of the Project may also require relocation of some services, depending on their proximity to the construction zone. These aspects will be further examined in future design stages.

Subject to procurement, detailed design and obtaining all the necessary approvals for the Project, construction of the Project is anticipated to start in 2021 and estimated to be completed in 2026.

1.7.1 Rail line

The Project is both greenfield, with sections involving a new single line of track, standard (1,435 mm) and narrow (1,067 mm) gauge, and brownfield, where utilising the existing West Moreton System rail corridor. The track structure consists of continuously welded 60 kilogram/metre (kg/m) rail, resilient fasteners, rail pads and concrete dual gauge full-depth sleepers at minimum 600 mm centres. For the initial phase of operation, design is for 21 tonne axle load (tal) intermodal trains and 25 tal coal trains.

1.7.2 Tunnel infrastructure

The Project proposes an approximately 850 m long tunnel through the Little Liverpool Range. The tunnel portal areas will require a substation building for power supply and distribution to electrical equipment, fire water tanks and a pump station for the tunnel hydrant system, and an emergency services staging area. A tunnel control centre will be required at one of the portals that will be predominantly unmanned.

Stormwater runoff at the western portal area will be collected in a portal stormwater sump to prevent it running the length of the tunnel. This water will then be pumped to a nearby drain. Any water collected inside the tunnel (e.g. groundwater, washdown, firefighting) will be collected at the tunnel low end sump at the eastern tunnel portal. This water will likely be processed through a water treatment plant and include hydrocarbon separation.

The tunnel will have a ventilation building above each portal that will include large axial fans and air nozzles able to control the direction of smoke and heat in the event of a tunnel fire for passenger trains. The tunnel is sized such that fans are not required for normal train operation. Furthermore, for emergency events there is a fire rated longitudinal egress passage provided throughout the tunnel with access every 60 m. Communication facilities to the operator will be provided inside these passages.

The tunnel will likely only have minimal internal lighting, with only low-level lighting and emergency lighting expected.

1.7.3 Crossing loops

Four new crossing loops are proposed for the Project, spaced at approximately 13 km intervals. The loops would be constructed as new sections of track parallel with the new track. They will range in length to accommodate the surrounding area and topography and fit the design length of the train (1,800 m). The Project corridor will be of sufficient width to accommodate the new crossing loops.

1.7.4 Crossovers

Cross overs are included in the design to provide connectivity between the Inland Rail and QR West Moreton Systems. This is achieved by a combination of dual gauge and narrow-gauge turnouts to allow trains to be guided from one track to another. Four sets of cross overs are proposed at Helidon, Placid Hills, Forest Hill, and Calvert between Inland Rail and the QR West Moreton System. In addition, a set of crossovers are proposed between Inland Rail and the QR West Moreton System at the Calvert end.

1.7.5 Bridges

There are two existing bridges that require reinstatement or reconstruction along the alignment as a result of the Project.

The Project requires 31 new bridge structures – this includes 13 rail-over-water, 6 rail-over-water-and-road, 6 rail-over-road, 4 road-over-rail, 1 rail-over-existing-rail and one pedestrian-over-rail bridge. The bridges are of various lengths and spans to suit the alignment and topography. One of these bridges also provides for a pedestrian bridge and two bridges will provide fauna crossing structures. The proposed fauna crossing structures to be located at each crossing point will consider the fauna species relevant to each area and identified during the final design process of the Project.

1.7.6 Drainage infrastructure

A number of waterway crossings span over ‘QLD Waterways for Waterway Barrier Works’ as identified by the Department of Agriculture and Fisheries (DAF) (2018). These waterways for waterway barrier works are classified along their length according to the risk of adverse impact from instream barriers on fish movement. There are 26 marked waterways for water barrier works waterways which are intersected 29 times by the Project. These intersections (made up of culvert crossings and bridge crossings) include:

- Eight major risk crossings
- Three high risk crossings
- Six moderate risk crossings
- Twelve low risk crossings.

The locations of the new drainage features have been selected to maintain the existing flow paths and minimise the potential impacts to flood depths upstream and downstream. The cross-drainage structures have been designed in accordance with the relevant industry standards identified. The design of new drainage features has been informed by a hydrologic and hydraulic assessment of the Project disturbance footprint, a geotechnical assessment, and a preliminary assessment of the existing structures.

The drainage features at cuttings have been designed in accordance with the relevant industry standards. The total number of cross drainage structures are as follows:

- 19 bridges
- 51 RCP locations (multiple cells in places)
- 35 RCBC locations (multiple cells in places).

The culverts do not directly intersect identified watercourses (as per the *Water Act 2000* (Qld)). Noting this, culverts are considered to intersect waterways that provide fish connectivity and as such fall under relevant *Queensland Waterways for Waterway barrier Works* mapping assessment.

1.7.7 Level crossings

The Project adopts seven active level crossings and no passive level crossings along the alignment.

1.7.8 Rail maintenance access road

A rail maintenance access road (RMAR) is required to facilitate maintenance for critical infrastructure (e.g. turnouts), and to provide access for emergency recovery. Formation level access has been proposed for all turnout locations, and, where reasonably practical, for the full extent of crossing loops.

RMARs will also be provided following natural surface level where deemed necessary outside of critical infrastructure locations. It is proposed that access points to RMARs will be provided at the frequent locations and connecting directly with the public road network.

1.7.9 Fencing

Fencing will be provided for the extent of the rail corridor (excepted where noted otherwise) and its primary purpose is to limit access to the railway during operations. Fencing is to extend between the corridor and lands of owners or occupiers adjoining the railway, with any specific requirements to be designed in consultation with the adjoining landowner.

The Project alignment will be fenced with three-strand or four-strand barbed-wire fencing where the alignment occurs within the existing rail corridor. The barbed-wire fencing is reflective of the largely agricultural land use and generally consistent with existing fencing found within this this section of the alignment. The proposed fencing will seek to ensure that stock and people do not enter the rail corridor. Any fencing will be subject to agreement with relevant landowners during the detailed design phase of the Project.

The barbed-wire fencing will maintain the current barriers of the existing landscape will also allow animals to move along the alignment, maintaining current movement opportunities across the existing corridor. Most of the Project alignment will maintain this style of fencing.

1.7.10 Fauna fencing

Fauna fencing is constructed in association with fauna crossings to reduce mortality from train collisions and facilitate safe and effective movement of fauna to maintain existing movement corridors and animal behaviours within the vicinity of infrastructure where it is deemed that there is a risk of population fragmentation. Fencing and tie-ins with fauna crossings are designed to deter or effectively prevent animals entering the operating rail environment, and is an important aspect aimed at guiding animals towards the preferred fauna-crossing structure or passage. The elevation of fencing to fauna exclusion fencing is proposed where the alignment is considered likely to represent a moderate to high risk of fauna entering the rail alignment and become trapped within the active track area. A 3 m buffer clear of vegetation on the habitat side of the fauna exclusion fence is required to ensure that species cannot use vegetation to climb onto the exclusion fencing. Vegetation within the alignment will also be removed in these areas identified as moderate to high risk to ensure that fauna is not encouraged into the active track area.

The fauna corridor fencing strategy seeks to focus on areas of greenfield development where existing fauna movement may be impacted by the Project. All proposed fauna crossings are within areas of greenfield development for the Project. Options for fauna fencing include:

1. General fauna exclusion fencing where relevant
2. Koala fencing only where koalas are considered likely to occur following completion of fauna surveys

Three fauna crossings are proposed for the Project. The proposed fauna crossing structures to be located at each crossing point will consider the fauna species relevant to each area and identified during the final design process of the Project.

Crossing 1 (Ch 29.7 km) is not considered to require fauna exclusion fencing; however, further design development will consider the potential requirements for short lengths of fencing to guide species away from operational environments and provide a tie-in to safe movement areas. Crossing 1 is at natural ground level and therefore represents a likely choice for fauna to cross with minimal guidance. Crossings 2 and 3 (Ch 32.6 km and Ch 65.7 km) are located with bridge crossings and may require fauna fencing to funnel species into waterways for use as the movement corridor. Design development should consider the potential requirements for short lengths of fencing to guide species away from operational environments.

1.7.11 Fish passage

Fish passage is an essential requirement for the survival and productivity of many species of QLD fish. Due to the construction of instream structures (such as dams and culverts) on waterways, the loss of access to habitat has caused the decline in distribution of native fish populations.

The *Fisheries Act 1994* and the *Planning Act 2016* legislate that works within waterways that are the development of new, or raising of existing waterway barriers, in addition to maintenance of existing structures, must be designed, constructed, maintained and operated to provide adequate fish passage.

Confirmation of the design of culverts, bridges (under both rail and road) and any other cross drainage structures and how they meet fish passage requirements is to be undertaken for the detailed design.

1.8 Proposed construction

1.8.1 Construction phases

Following detailed design, and subject to obtained required approvals, undertaking post-EIS activities, and successful contractor procurement, it is anticipated that the construction phase will commence in 2021.

The construction program defines several stages and activities. These comprise:

- Pre-construction activities and early works, including detailed design, land acquisition, obtaining environmental planning approvals, surveys and geotechnical investigations, establishment of access tracks, and utility and service relocations
- Site preparation, including site clearance, establishment of construction site compounds and facilities, installation of temporary and permanent fencing, installation of drainage and water management controls and construction of site access, including temporary haul roads
- Civil works, including bulk earthworks, construction of cuts and embankments, construction of tunnel portals and tunnels, installation of permanent drainage controls, bridge and watercourse crossing construction
- Track works, including the installation of ballast, sleepers and rails
- Rail systems infrastructure and wayside equipment, including signals, turnouts and asset monitoring infrastructure
- Commissioning, integration testing and handover process to achieve operational readiness.

1.8.1.1 Site preparation

Vegetation clearing and installation of construction infrastructure

The site clearing includes the sequential removal of vegetation and debris. Site clearing will occur prior to mobilisation of the main earthworks' construction teams. The clearing of vegetation will be undertaken in accordance with the Construction Environmental Management Plan (CEMP) which will include any permit requirements. All turf, topsoil and other organic and unsuitable material shall be stripped from the Project construction temporary footprint. Wherever possible and appropriate, such material will be stockpiled and recycled within the immediate Project temporary construction footprint. Potential weed incursion or proliferation resulting from vegetation clearing activity will be managed under the Project's Biosecurity Management Plan.

Access roads will be required along the alignment to allow drainage, earthworks and bridge structure crews to access work locations. The primary access roads to the alignment will be designed and constructed/upgraded with due consideration to minimising disruption to landowners and public infrastructure.

A direct construction access is proposed to be provided adjacent to all rail works along the Project corridor and will be sized to allow free flow and unhindered access for all construction and support traffic vehicles. These access points will also be utilised for the transport of water, personnel, fuel and materials for maintenance purposes.

A series of temporary construction site compounds and facilities will be established along the Project corridor.

The clearing and grubbing activities would commence on multiple work fronts and should always be ahead of the primary earthworks operations, but not so far ahead that exposed soil is left open for long periods of time. Clearing and grubbing activities will be preceded by:

- Develop a Project specific Environmental Offset Proposal
- Development of an Environmental Offset Delivery Plan and Offset Area Management Plans prior to commencement of construction
- Obtaining of the relevant vegetation clearing approvals/permits
- Threatened flora and fauna surveys
- Appropriate flora and fauna treatments/re-locations (e.g. spotter catcher works under the Project Flora and Fauna Sub-plan, relevant damage mitigation permits and Species management programs (SMP))
- Identification of any underground utilities
- Appropriate utility works (i.e. protection/re-location)
- Clear demarcation of required clearing limits to avoid or minimise unnecessary vegetation/habitat clearing
- Any requirements under the Cultural Heritage Management Plan (CHMP)
- Installation of erosion and sediment control measures, including the proposed sediment basins.

The clearing and grubbing operation shall be performed within the Project temporary construction footprint. Protective measures shall be enabled around creek and river banks to ensure that the existing profiles are preserved. Cleared vegetation ready for mulching will be stockpiled within the Project temporary construction footprint ready for mulching. The mulched material will be stockpiled and managed to facilitate re-use, and to prevent combustion. Possible alternatives to mulching of vegetation matter will be considered and appropriately assessed as part of the detailed design and construction phases.

Utility relocations

Site preparation also includes modification, diversion or realignment of any utilities and associated infrastructure. Utilities and services such as water, sewer, electricity and telecommunications will need to be supplied to each of the laydown areas and construction compounds for use in site offices and amenities.

Of the 662 identified impacted utilities or potential clashes, 56 per cent and 16 per cent of which involve Telstra and Energex assets respectively. Out of the 662 impacted utilities, 11 per cent were rated high risk, 32 per cent were rated medium risk and 57 per cent were rated low risk.

Consultation has commenced with the various utility owners regarding their requirements for relocation or protection of the utilities impacted by the Project. Where feasible, the Project will share power, water, sewage, construction materials and communications infrastructure with the adjoining Gowrie to Helidon (G2H) and Calvert to Kagaru (C2K) projects.

Corridor acquisition and access

The Project permanent disturbance footprint traverses approximately 193 land parcels. The acquisition and resumption of land and interests will be undertaken by the nominated Construction Authority (with ARTC continuing to work closely with landowners, stakeholders and relevant State government agencies) prior to construction.

To reduce severance of land parcels, the alignment of the Project has been chosen to align with roads and property boundaries where possible, to reduce potential property impacts. Furthermore, the alignment has been deliberately designed to utilise the existing West Moreton System rail corridor for approximately 50 per cent of the length of the alignment. Of the total 488.44 hectares (ha) of land required for the Project permanent disturbance footprint, 86.7 ha or approximately 18 per cent, is within the existing rail corridor.

Where the Project deviates from the existing West Moreton System rail corridor, the Project predominately follows the protected Gowrie to Grandchester future public passenger transport corridor, a greenfield corridor protected for future railway land under the TPC Act. Approximately 80.02 ha, or 16 per cent, of the total area of the Project permanent disturbance footprint is located within the Gowrie to Grandchester future public passenger transport corridor.

1.8.1.2 Civil works

The activities that will be undertaken during Project civil works include:

- Bulk earthworks, such as the construction of embankments and excavating cuttings
  - The construction of the foundation of the railway line will require earthworks and engineering fill to provide a platform designed for the rail construction. The earthworks will predominantly be made up of constructing embankments and excavating cuttings. This work will be carried out using heavy earthmoving plant and equipment.
  - Where required, material stockpiles will be located within the Project temporary disturbance footprint, outside flood prone areas, and will be neatly formed to prevent erosion. Spoil management, reuse and disposal will be addressed in accordance with the Project spoil management strategy. Installation of permanent drainage controls.
  - The proposed rail alignment crosses several drainage features of different catchment areas that contribute flows to the cross drainage structures. Cross drainage structures will be constructed where the rail intercepts existing drainage lines. The type of cross drainage structure depends on various factors such as the natural topography, rail formation levels, design, design flow and soil type. Cuts and embankments will also require drainage treatments such as catch drains, diversion drains and culverts.

- The cross drainage structures will incorporate the installation of permanent drainage controls as they cross floodplain areas and drainage lines. Construction of these drainage structures will require several full-time installation crews throughout the construction period. Longitudinal drainage including embankment drains and catch drains will be constructed to protect the rail formation from surface runoff.

- Permanent drainage controls
  - The proposed rail alignment crosses a number of drainage features of different catchment areas that contribute flows to the cross-drainage structures. Cross drainage structures will be constructed where the rail intercepts existing drainage lines. The type of cross drainage structure depends on various factors such as the natural topography, rail formation levels, design, design flow and soil type. Cuts and embankments will also require drainage treatments such as catch drains, diversion drains and culverts.
  - The cross-drainage structures will incorporate the installation of permanent drainage controls as they cross the floodplain areas and drainage lines. Longitudinal drainage including embankment drains and catch drains will be constructed to protect the rail formation from surface runoff.
  - The construction will be a mix of installation before and after the bulk earthworks, so as not to delay the overall earthmoving program. It will also be necessary to capture overland flow and transfer it to the cross-drainage structures. The sizing of the longitudinal drainage will be dependent upon the hydrology and it is important that these drains are capable of efficiently moving overland flow to dedicated drainage lines to reduce the likelihood of water ingress to the permanent works.
- Bridge construction
  - Bridges are proposed at all major waterway crossings to avoid or minimise disturbance to the existing riverine system. Bridge structures will also be constructed to allow for road, farm track or stock crossings. Design indicates the need to construct 31 bridges of which 19 are over waterways and/or waterways and roads. The remaining are road rail grade separations.
  - Erosion and sediment controls in accordance with the site specific Erosion and Sediment Control Plans will be installed prior to commencement of works,
- Roadworks, including construction of temporary haul roads
  - Due to the location of the rail alignment, there are a high number of road rail interfaces identified that will require consideration. The road owners are either the local council (Lockyer Valley Regional Council or Ipswich City Council) or the DTMR. Construction works on these roads will comply with the asset owner’s approved safety requirements and temporary works procedures. The highest standard to be complied with will be the DTMR Manual of Uniform Traffic Control Devices. For works on, over or adjacent to DTMR roads, such as the railway crossing of the Warrego Highway, the proposed construction methodology and traffic management arrangements will have to be approved by DTMR prior to works commencing.
- Rail corridor works
  - The Project utilises the existing QR West Moreton System rail corridor at several locations along the alignment. The staging of the works, and their associated impacts will be the subject of an interface agreement between Inland Rail and QR. It is currently assumed that proponents can use the existing corridor for short-term rail possessions to carry out rail corridor works. Coordination with QR will be required to maintain access to existing assets for maintenance. Tunnel and portal construction. The proposed tunnel will be constructed through the Little Liverpool Range which is fully located within the Koukandowie Formation (part of the Marburg Subgroup).
  - The rocks are typically moderately to highly weathered, and shale bands weather to clays and commonly undercut the sandstone beds. The current tunnel drive length being 850 m in length and has a maximum cover of approximately 90 m. The tunnel excavated cross section is approximately 142 m², and the internal space requirements are driven by ventilation requirements.

- Two tunnel construction methods could be considered for the tunnel: Roadheader excavation; and/or drill and blast method.

- Track works.
  - Track works construction could be undertaken using two different methods - track laying machine or excavators with 'octopus' attachments. The preferred option for the construction of the Project would be excavators with octopus attachments, however either of the construction methods may be utilised. In this instance the bottom ballast layer would be installed followed by sleepers positioned and spaced to their designed alignment by a tracked excavator using an octopus attachment. This will be closely followed by placement/threading of the rail in 27.5 m shorts or up to 400 m strings. The rail will then be clipped up followed by top ballasting prior to commencing tamping activities.

1.8.1.3 Tunnel construction

The tunnel drive length is approximately 850 m in length and has a maximum cover of approximately 90 m. The tunnel excavated cross section is approximately 142 m², and the internal space requirements are driven by ventilation requirements.

A preliminary hydrogeological investigation has been undertaken for the Little Liverpool Range tunnel and associated portals. There is likely to be little risk of consolidation settlement impacting on existing infrastructure in this environment; however other groundwater drawdown issues such as potential adverse impacts on vegetation, groundwater quality, and any groundwater bores in the area have been investigated.

1.8.1.4 Construction workforce and hours

A preliminary estimate of the workforce required to undertake the construction works for the Project is 410 full time equivalents at peak. The average number of full-time equivalent workforce on site across the full construction period is in the order of 190 people. Primary Project construction hours are shown in Table 1.2.

Table 1.2 Construction hours

Description of works	Hours of work	
Surface works (other than works set out below)	Monday to Friday 6:30 am to 6:00 pm Saturday 6:30 am to 1:00 pm No work on Sundays or public holidays	Monday to Friday 6:00 pm to 10:00 pm Saturday 1.00 pm to 5.00 pm Only if the Project works comply with the defined performance requirements in approved environmental management plans.
Tunnelling activities	24 hours a day, 7 days a week	
Spoil haulage	24 hours a day, 7 days a week	
Transport, assembly or decommissioning of oversized plant, equipment, components or structures	24 hours a day, 7 days a week	
Delivery of "in time" materials such as concrete, hazardous materials, large components and machinery	24 hours a day, 7 days a week	
Works that require continuous construction support, such as continuous concrete pours, pipe-jacking or other forms of ground support necessary to avoid a failure or construction incident	24 hours a day, 7 days a week	
Materials and equipment delivery	24 hours a day, 7 days a week	
Works in a rail corridor (track possessions)	24 hours a day, 7 days a week and in accordance with the hours of work prescribed by the rail infrastructure manager.	

Description of works	Hours of work
Works in a road	In accordance with the hours of work prescribed by the road authority in any permit under a local law (for a local government) or a permission under s.33 of the Transport Infrastructure Act, or if no hours of work are prescribed, then works may be undertaken Monday - Saturday (not public holidays) 6.00 am to 6.00 pm.
Works carried out in an emergency to avoid the loss of life, damage to property or to prevent environmental harm	At any time
Blasting	Monday to Friday 9.00 am to 5.00 pm Saturday 9.00 am to 1.00 pm **No blasting on Sundays or public holidays** Generally blasting will not be conducted outside standard hours. If blasting outside of standard hours is required, approval from the Department of Environment and Science (DES) will be obtained prior to blasting. It is noted that reduced limits may be required to be achieved.

1.8.2 Commissioning and reinstatement phase

Testing and commissioning (checking) of the rail line and communication/signalling systems will be undertaken to ensure that all systems and infrastructure are designed, installed, and operating according to ARTC's operational requirement.

All Project construction sites, compounds and access routes will be rehabilitated. Site reinstatement and rehabilitation management plan will be implemented progressively during the works and will include the following activities:

- Demobilise site compounds and facilities
- Remove all materials, waste and redundant structures from the works sites
- Forming and stabilising of spoil mounds
- Decommission all temporary work site signs
- Establish permanent fencing
- Remove temporary fencing
- Decommission site access roads that are no longer required
- Restoration of disturbed areas as required, including revegetation where required.

Site rehabilitation will be undertaken in accordance with the Project's Reinstatement and Rehabilitation Management Plan and Landscape and Rehabilitation Management Plan.

1.8.3 Operational phase

Operational processes to be carried out during the operational phase will include the use of the railway for freight purposes, potential future use for passenger services, operation and maintenance of tunnel ventilation and safety systems, signalling, and general track and infrastructure maintenance.

An average of 15-20 employees per annum is anticipated over 50 years of operation (expected to be 2026 to 2074).

1.8.3.1 Train operations

The Project will form part of the rail network managed and maintained by ARTC. Train services will be provided by a variety of operators.

Inland Rail will be operational once all 13 sections are complete, which is estimated to be in 2026. The construction completion date is influenced by a number of variables, including the impacts of ongoing community consultation, ongoing design and development work.

The Project will involve operation of a single rail track with crossing loops, to accommodate double stacked freight trains up to 1,800 m long and 6.5 m high. Train design speeds will vary according to axle loads and track geometry ranging from 80 kilometres per hour (km/hr) to a maximum of 115 km/hr. It is estimated that the Project will run an annual average of about 33 train services per day in both directions (northbound and southbound) in 2026. This is then likely to increase to up to 47 per day in both directions in 2040 with current proposed infrastructure.

During the operational phase, tunnel operations will require power and water supplies for ventilation and fire safety. Electricity supply will also be needed for points, signalling and other infrastructure. It is anticipated that the supply of these services will be delivered by relevant providers under the terms of their respective approvals and/or assessment exemptions.

1.8.3.2 Operational maintenance

Standard ARTC maintenance activities will be undertaken during operations. Typically, these activities include minor maintenance works, such as bridge and culvert inspections, sleeper replacement, rail welding, rail grinding, ballast dropping and track tamping, through to major periodic maintenance, such as ballast cleaning and reconditioning of track.

1.8.4 Decommissioning and rehabilitation

The Project is expected to be operational for in excess of 100 years. The design life of structures is 100 years to support the operational objectives. The decommissioning of the Project cannot be foreseen at the date of preparing the Project EIS. If the Project, or elements of it, were subject to plans for decommissioning it is envisaged that the works would be undertaken in accordance with a decommissioning plan, which would be developed in consultation with relevant stakeholders and regulatory authorities.

1.9 Social and economic benefits

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

- **Employment** - The construction workforce is expected to be drawn primarily from communities within the Project region and nearby Local Government Areas, and therefore employment and training benefits would extend to construction industry workers across the region. The availability of long periods of employment in project construction is likely to be a strong positive opportunity for those personnel and their families.

  Employment opportunities in the Project region during the construction stage will have positive mental health benefits for the individuals employed, particularly if they are exiting a period of unemployment or commencing their career. This would be particularly important in communities with high levels of unemployment, and for population groups where unemployment rates are high (such as Indigenous people and young people).

- **Business opportunities** - Local and regional businesses will benefit from the construction phase. Opportunities to supply the project may include supply of fuels, equipment, quarried material, and services including fencing, electrical installation, rehabilitation, landscaping, maintenance and trades services.

Local transport or logistics businesses may also have significant opportunities to service the construction phase.

The Project's local supply arrangements will provide an opportunity to develop and grow local businesses, with some possible benefits in nearby communities, but with regional benefits of greater significance.

The expansion in construction activity in the vicinity of the Project will support additional flow-on demand and additional spending by the construction workforce, and therefore business trading levels in the region.

The Project will improve the connection between local produce such as bulk grain, containerised cotton and other agricultural products, and markets; through to both domestic markets in cities and international markets via the Port of Brisbane.

- **Crash reduction** - Crash cost savings represent the reduced costs associated with fatal and serious injuries resulting from both road and rail incidents.
- **Environmental externalities** - Reduced environmental externality costs represent reductions in air pollution and greenhouse gas emissions due to the Project. Most of these benefits can be attributed to the mode shift from road freight to rail freight.
- **Road decongestion benefits** - As the Project encourages greater movement of freight by rail, the reduced truck movements that are projected upon completion of the Project result in reduced congestion in urban areas.

1.10 Stakeholder engagement

1.10.1 Identification of stakeholders

During the development of the EIS, ARTC has engaged with a wide range of stakeholders across local, regional and national levels as identified in Table 1.3.

Table 1.3 Identified stakeholders associated with the Project

Stakeholder type	Stakeholders
Australian Government	
Elected representatives	▪ Deputy Prime Minister, Minister for Infrastructure, Transport and Regional Development and Member for Riverina—The Hon Michael McCormack MP ▪ Assistant Minister for Road Safety and Freight Transport and Member for Wright—The Hon Scott Buchholz MP ▪ Shadow Minister for Veterans' Affairs and Defence Personnel and Member for Blair—The Hon Shayne Neumann MP
Departments and agencies	▪ Department of Infrastructure, Transport, Regional Development and Communications ▪ DAWE ▪ Regional Development Australia ▪ National Transport Commission
Queensland State Government[1]	
Departmental ministers	▪ Minister for Transport and Main Roads and Member for Miller – The Hon Mark Bailey MP
State elected representatives	▪ Mr. Ian Rickuss (former member for Lockyer) ▪ Mr. Jim McDonald MP (current member for Lockyer, elected 25 November 2017) ▪ Mr. Jim Madden MP (Ipswich West) ▪ Mr. Jon Krause MP (Scenic Rim)

Stakeholder type	Stakeholders
State Government departments	▪ Coordinator-General ▪ Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnerships (formerly Department of Aboriginal and Torres Strait Islander Partnerships) ▪ DAF ▪ Department of Education ▪ Department of Employment, Small Business and Training ▪ DES ▪ Department of Energy and Public Works (formerly Department of Housing and Public Works) ▪ Department of Tourism, Innovation and Sport (formerly Department of State Development, Tourism and Innovation) ▪ Department of Resources (formerly Department of Natural Resources, Mines and Energy (DNRME)) ▪ Queensland Fire and Emergency Services ▪ Queensland Health ▪ Queensland Police ▪ Department of State Development, Infrastructure, Local Government and Planning (DSDILGP) (formerly Department of State Development, Manufacturing, Infrastructure and Planning and the Department of Local Government, Racing and Multicultural Affairs) ▪ DTMR ▪ Economic Development Queensland
Government-owned corporations/ organisations	▪ Queensland Rail ▪ Australia Post
Local government	
Lockyer Valley Regional Council	▪ Cr Tanya Milligan, Mayor ▪ Mr. Ian Church, Chief Executive Officer ▪ Cr Jason Cook, Deputy Mayor ▪ Cr Chris Wilson; Cr Janice Holstein; Cr Rick Vela (elected to Council, 10 February 2018); Cr Kathy McLean (did not contest local government election 28 March 2020); Cr Michael Hagan; Cr Jim McDonald (elected to Queensland Parliament 25 November 2017); Cr Brett Qualischefski (elected to local government 28 March 2020)
Ipswich City Council	▪ Ipswich City Council until 22 August 2018 ▪ Cr Andrew Antoniolli, Mayor ▪ Mr. Greg Kellar, Acting Chief Executive Officer ▪ Cr Paul Tully; Cr David Morrison; Cr Kerry Silver; Cr Kylie Stoneman; Cr Wayne Wendt; Cr Cheryl Bromage; Cr Charlie Pisasale; Cr Sheila Ireland; Cr David Pahlke ▪ Ipswich City Council until 22 August 2018 ▪ Mr. Greg Chemello, Interim Administrator ▪ Mr. Charlie Dill, Acting Chief Executive Officer ▪ Ms. Jan Taylor, Advisor for Community Engagement ▪ Ipswich City Council from Local Government Election 28 March 2020 ▪ Cr Teresa Harding, Mayor ▪ Cr Sheila Ireland; Cr Jacob Madsen; Cr Nicole Kay; Cr Paul Tully; Cr Marnie Doyle; Cr Andrew Fechner; Cr Kate Kunzelmann; Cr Russell Milligan
Local communities	
Directly affected landowners	▪ Landowners located within both the permanent and temporary disturbance footprint
Indirectly affected landowners	▪ Landowners that have the potential for change to existing conditions on their property

Stakeholder type	Stakeholders
Businesses (listed alphabetically)	▪ Advanta Seeds Pty Ltd; AJA Solutions; All Property Real Estate—Gatton; ANZ Tissue Products Pty Ltd as TTE ▪ Bauer's Organic Farm; Best Employment (agency); Boral Resources QLD Pty Ltd; Brandon and Associates Pty Ltd; Branell Homestead; Brooks Earthmoving and Quarries; Bunnings Properties Pty Ltd ▪ Caffe Sorella; CBRE Toowoomba; Clein Excavations & Tipper Hire; Community Care Solutions Inc; Cotton Australia; CR Kennedy, Machine Control; CSY Crushing and Screening PTY LTD ▪ Darling Downs Environment Council; Dyno Nobel ▪ Elders, Gatton ▪ Forest Hill Hotel; Forest Hill Post Office, Café 4342; Franita Pty Ltd (TTE) ▪ Gatton Real Estate; Gehrke Grains and Transport; Gilligrove Pty Ltd; GrainCorp Operations Limited; Grantham Farmworkers Lodge ▪ Harness Energy; High Country Herald; Higher Visibility; Holcim (Sydney Head Office) ▪ ICN Queensland ▪ Jewel Finance ▪ Klucks Investment Pty Ltd ▪ Laidley Better Business; Lake Laurel Pty Ltd; LCR Group; LJ Hooker Commercial Toowoomba; LJ Hooker, Gatton; LMATS Laboratories for Materials Advanced Testing Services; Local agricultural businesses (various); Lockyer Hotel; Lockyer Valley Growers Inc; Lockyer Valley Real Estate; Lockyer Valley Toyota; Lockyer Valley Traffic Management Pty Ltd; Logan Chamber of Commerce; Lockyer Chamber of Commerce and Industry Inc. ▪ Massland—Gatton Caravan Park; Master Hire; MEGT Training ▪ Nexans Olex; Nichols Constructions; Nolan's Interstate Transport ▪ Openville Pty Ltd ▪ Pace SMSF Property Pty Ltd; Patriot Environmental Management; Philip Leach; Property Network Lockyer ▪ Queensland Farmers Federation ▪ Range Crest Realty; RDA Darling Downs and South West; RDA Ipswich & West Moreton; Rocky’s Own Transport; Rugby Farming Group ▪ Sherrin Rentals; Shorehire; Skyreach; Stark Engineering ▪ Toll Mining Services; Toowoomba Surat Basin Enterprise; Top Office Group; Tradeline Site Solutions; Trevor Brooks Earthmoving Pty Ltd ▪ Webbway Pty Ltd
Other key stakeholders	
Emergency and health providers	▪ Gatton Police Station; Helidon Police Station; Laidley Police Station ▪ Queensland Police Service; Queensland Ambulance Service; Queensland Fire and Rescue Services; Queensland Rural Fire Services
Utility service providers	▪ Energex ▪ Powerlink Queensland ▪ Queensland Urban Utilities ▪ Seqwater; SunWater ▪ Telstra ▪ TPG/AAPT/Powertel
Gas and petroleum pipeline owners	▪ APA Transmissions ▪ Santos
Waste and landfill operators	▪ Lockyer Valley Waste Management ▪ Wanless Waste Management ▪ New Hope Group ▪ Ti-Tree Bioenergy ▪ Cleanaway New Chum ▪ Remondis Australia Pty Ltd Swanbank Landfill ▪ Nu Grow ▪ Lantrak Waste Management

Stakeholder type	Stakeholders
Indigenous groups	▪ Yuggera Ugarapul People
Business and Industry Groups	▪ Chamber of Commerce and Industry Queensland ▪ Ipswich Chamber of Commerce and Industry ▪ Regional Development Australia—Ipswich and West Moreton ▪ Lockyer Valley Chamber of Commerce; Laidley Better Business Group (subsequently merged with Lockyer Chamber); Lockyer Valley Tourism ▪ Regional Development Australia—Ipswich and West Moreton; Regional Development Australia—Logan and Redlands
Peak Bodies	▪ Agforce ▪ Australian Trucking Association ▪ National Farmers Federation; National Road Transport Association ▪ Queensland Farmers' Federation; Queensland Resources Council; Queensland Transport and Logistics Council
Community Groups	▪ Btstraps Inc (Bootstraps) ▪ Cahill Park Sports Complex Incorporated; Christian Life Centre Gatton Incorporated; Community Care Solutions Inc ▪ Friends of Lake Apex Inc. ▪ Gatton & District Historical Society; Gatton & District Hospital Auxiliary Inc; Gatton Feather Club Inc; Gatton Jubilee Golf Club Inc.; Gatton Kindergarten; Gatton Lapidary Club Inc; Gatton Meals On Wheels Inc; Gatton Mercury Theatre and Children's & Youth Theatre including Win Davson Art Gallery & Museum Inc.; Gatton RSL Services Club Inc; Gatton Rugby League Football Club Inc; Gatton Show Society; Gatton Soccer Club Inc; Gatton Swimming Club Inc; Gatton Table Tennis Association Inc; Gatton Tennis Association Inc; Grandchester Model Live Steam Association Inc ▪ Helidon and District Progress Association; Helidon Community Shed Association Inc; Helidon Cricket Club Inc; Helidon RSL Sub-Branch Inc ▪ Ipswich Housing and Support Services; Ipswich Railway Museum ▪ Laidley Agricultural and Industrial Society; Laidley and Districts Community Organisation; Laidley and Districts Netball Association Incorporated; Laidley Community Centre; Laidley Crisis Care and Accommodation; Laidley District Cricket Club Inc; Laidley District Historical Society Incorporated; Laidley Golf Club Inc; Laidley Hospital Auxiliary Inc; Laidley Junior Rugby League Club Incorporated; Laidley Kindergarten Association Incorporated; Laidley Meals On Wheels Inc; Laidley Soccer Club Inc; Laidley Swimming Club Inc; Lions Club of Gatton Inc; Lions Club of Laidley; Lions Club of Withcott Helidon; Lockyer Antique Motor Association Inc; Lockyer Classic Cruisers Inc; Lockyer Cricket Association Inc; Lockyer Darts Association Inc; Lockyer District Athletics Inc; Lockyer Equestrian Group Incorporated; Lockyer Information and Neighbourhood Centre Inc; Lockyer Multicultural Association Inc; Lockyer Race Club Inc; Lockyer Reigns Trail Horse Riders Club Inc; Lockyer Valley Aged & Handicapped Association Inc; Lockyer Valley Art Society Inc; Lockyer Valley BMX Club Inc; Lockyer Valley Community Activities Shed Incorporated; Lockyer Valley Community Disability Assoc. Inc.; Lockyer Valley Demons Inc; Lockyer Valley Flying Club Incorporated; Lockyer Valley Growers Inc; Lockyer Valley Islamic Association Inc.; Lockyer Valley Ministers Association; Lockyer Valley Riding For The Disabled Inc.; Lockyer Valley Speedway; Lockyer Valley Water Users Forum; Lockyer Woodcrafters Group Inc.; LVCCC/Lockyer Chamber of Commerce and Industry Inc. ▪ Returned and Services League of Australia (Queensland Branch) Laidley Sub-Branch Inc. (RSL); Rosewood District Protection Organisation Rotary Club of Gatton & Lockyer ▪ Secretary, Gatton Bowls Club; Spirit of the Valley Events Inc; St Albans Anglican Parish of GattonUQ Gatton Past Students Association

Stakeholder type	Stakeholders
Environmental Groups	▪ Australian Rescue and Rehab of Wildlife Association Inc. ▪ Birdlife Australia; Birds Queensland; Birdlife Southern Queensland Branch; Darling Downs Environment Council; Friends of the Escarpment Parks ▪ Greening Australia ▪ Healthy Land and Water; Helidon Hills/Murphys Creek Landcare Group Inc. ▪ Ipswich Koala Protection Society; Ipswich Native Plants Queensland ▪ Koala Foundation ▪ Lockyer Community Action Group; Lockyer Upland Catchments Inc.; Lockyer Valley Landcare Group ▪ Native Plants Queensland ▪ Protect the Bush Alliance ▪ Queensland Conservation Council; Queensland Murray Darling Committee ▪ Return to the Wild ▪ SEQ Catchments ▪ The West Moreton Landcare Group Inc. ▪ Wildlife Queensland
Education and Training	▪ Free Range Kids ▪ Forest Hill State School ▪ Gatton Child Care Centre; Gatton Kindergarten; Gatton State School; Grandchester State School; Grantham State School ▪ Helidon State School ▪ Kates Place Early Education and Child Care, Helidon ▪ Laidley District State School Laidley State High School; Little Angels Kindergarten, Forest Hill; Lockwood Training and Development; Lockyer District State High School; Lockyer Valley Early Education and Pre-school ▪ St Mary's Catholic Primary School, Laidley ▪ TAFE South West; TAFE Queensland ▪ University of Queensland (Gatton Campus); University of Southern Queensland
Churches and Religious Facilities	▪ Baptist Church, Gatton; Baptist Church, Laidley ▪ Christian Life Centre, Gatton; Christian Life Church, Gatton; Churches of Christ Queensland, Gatton ▪ Forest Hill Presbyterian Church, Forest Hill; Forest Hill State School, Forest Hill ▪ New Hope Church, Gatton ▪ Our Lady of the Valley Catholic Parish, Gatton, Forest Hill and Laidley ▪ Peace Lutheran Church, Gatton; Presbyterian Church, Forest Hill ▪ Redeemer Lutheran Church, Laidley ▪ Salvation Army, Gatton; Seventh Day Adventist Church, Gatton; St Albans Anglican Parish, Gatton; St Joseph's Parish ▪ Uniting Church, Laidley
Media	▪ ABC Radio; ABC Southern QLD ▪ Gatton Star ▪ Ipswich Queensland Times ▪ Laidley Plainland Leader ▪ QLD Country Life ▪ Times; The Australian; The Brisbane Times; The Courier-Mail ▪ Queensland Times

1.10.2 Stakeholder engagement activities

Consultation activities have been structured to provide multiple opportunities for both targeted stakeholders and the wider community to participate in the Project. Stakeholders have been engaged using a range of communication channels, including presentations and briefings, newsletters, drop in sessions, web-based material and face-to-face discussions. These were supported by feedback mechanisms, including comment forms, interactive mapping, workshops and project specific contact channels (1800 phone number, email, interactive 'Frequently Asked Questions').

1.10.3 Consultation themes

Table 1.4 provides the key themes of community concern that were identified over the course of consultation activities for the Project's key stakeholders.

Table 1.4 Key themes raised during Project consultation activities

Stakeholder	Key themes raised
DTMR	▪ Future proof for future passenger provision ▪ Consideration of future freight rail corridor in longer term DTMR road network planning ▪ Identification of loading facilities locations
Lockyer Valley Regional Council	▪ Impacts to local road network, road design standards, cycling and connectivity, level crossings and grade separations ▪ Construction impacts to the local road network ▪ Standards for new or reconstructed roads ▪ Flood investigations ▪ Consideration of the project in relation to council's Planning Scheme and Strategic Plans ▪ Impacts to council controlled land and reserves ▪ Consideration of passenger rail ▪ Consideration of natural disasters e.g. bushfire ▪ Tunnel ventilation ▪ Sourcing of construction materials ▪ Impacts to populated communities ▪ Water availability during construction ▪ Local employment base ▪ Impact to the Gatton Caravan Park ▪ Gatton Rail Precinct
Ipswich City Council	▪ Flood investigations ▪ Water availability during construction ▪ Location of haul roads ▪ Noise impacts to community
Landowners	Project alignment ▪ Project adhering to the Gowrie to Grandchester future State transport corridor ▪ Proposed alignment outside of Gowrie to Grandchester future State transport corridor Impacted properties ▪ Potential to impact on farming and grazing properties; impacts to farm infrastructure' impacts from road realignments Traffic, transport and access ▪ Road realignments (Seventeen Mile Road, Helidon; Airforce Road, Helidon; Smithfield Road, Gatton; Chadwick Road, Gatton; Road realignment Laidley Rosewood Road, Grandchester, Gaul Street Level Crossing, Gatton; Hunt Street Level Crossing, Forest Hill; Grandchester Mt Mort Road Level Crossing, Grandchester; Proposed Connors Road Level Crossing, Helidon

Stakeholder	Key themes raised
	Noise and vibration ■ Exceedances and mitigation of noise; potential impact to Forest Hill; potential impact to Gatton; potential impact to Laidley North (Cunningham Crest/Valley Vista Estate) Hydrology ■ Flooding impacts to properties, houses and farmland; debris from flood events impacting the alignment and/or properties; flooding impacts to Forest Hill and Gatton Water resources ■ Impact of alignment on access to ground water for agricultural activities Flora and fauna ■ Protecting Koala habitats; measures addressing the safe passage of fauna; risk and spread of fire ants; Protecting Swamp Tea-tree and Lloyd's Olive Air quality ■ Coal residue in water tanks and local air quality (areas outside townships) Soil ■ Impact to salinity levels where landscape is impacted Hazard and risk ■ Potential impacts to community safety Groundwater ■ Location of groundwater bores; potential uses for construction water
Office of Coordinator-General	■ EIS' compliance with required guidelines ■ Social Impact Assessment methodology – integration of environmental matters, nature of scale of project, identification of impacts and benefits, consideration of vulnerable communities ■ Economic Impact Assessment methodology – review and discussion of ToR and Economic impact assessment guideline (2017) requirements ■ Potential impacts of housing supply and affordability ■ Assessment of impacts and opportunities for local industry to participate in potential procurement and supply opportunities
Queensland Fire and Emergency Services	■ Access to Little Liverpool Range tunnel in case of emergency
Queensland Rail	■ Minimising impacts to existing QR operations (current freight, coal and passenger traffic on the existing line) ■ Maintaining access for maintenance and operation of QR infrastructure ■ Connection details including signalling requirements.
Traditional Owners	■ Provisions for managing accidental discovery of cultural material; contingency planning for finds ■ Clear documentation process and dispute resolution process ■ Development of appropriate cultural heritage awareness training and inductions
Utility companies	■ Clashes with existing utilities and easements

1.10.4 Consultation outcomes

Consultation with individuals and groups at workshops, community consultation sessions, via the interactive online map, community committee meetings and face to face meetings have assisted in highlighting issues and identifying potential impacts and benefits to inform the EIS. These interactions have also helped to shape the project design and inform proposed mitigation measures for implementation in future stages of design, construction, commissioning and operation. In summary, the key issued raised were:

- Predominantly following the West Moreton System rail corridor and the protected Gowrie to Grandchester future State transport corridor
- Project has been designed to accommodate tie-ins to the existing QR network, and with consideration of interface agreements and QR corridor requirements for maintenance and access
- Refinement of the alignment through Grandchester, and testing of options in Forest Hill and Gatton resulting in following the existing rail corridor

- The Project flood modelling has incorporated information from local landowners in validation of flood modelling, as well as:
  - Local Council independent review of flood model, with additional meetings to clarify review comments, updated of flood modelling report to reflect final comments
  - held a series of community information sessions to present the flood study baseline, findings and outcomes and proposed mitigation measures.
  - One-on-one stakeholder consultation with affected/impacted stakeholders, this led to some adjustment of drainage solutions and design updates.
- Confirmation that feasible construction water supply options are available
- Confirmation of feasible waste disposal sites, as well as feasible spoil receiving options are available
- Working with Local Council and the community for alternate road-rail interfaces Identification of the need for careful local traffic management planning at road-rail-interfaces
- Reinstatement or reprovision of local road networks where realignment, grade separation or consolidation of level crossings is proposed to maintain local conditions
- Identification of the need for construction traffic management to account for local business access, local parking, separate construction parking and school travel needs in Forest Hill, Gatton and Laidley.
- While the Project does not currently accommodate passenger transport, the design does not preclude this as a future consideration
- Flora and Fauna workshops with regional conservation groups to clarify the methodologies and process adopted to identify species and impacted habitats. This led to further training sessions workshops to inform concerned groups how to upload their gathered sighting and information into recognised databases.
- The collection of baseline information for the social impact assessment, and the identification of priorities for the social impact management plan
- Stress and anxiety potentially caused by land use change and property acquisition
- Impacts on property values.
- Identification of urban design outcomes and importance of retaining heritage elements through townships—with input from community members and tourism groups
- Commitment to:
  - Deliver the social impact management plan, including local business and industry opportunities, health and community wellbeing and training and employment opportunities
  - Develop a tourism strategy to address property-specific and wider impacts
  - Consider reasonable and practicable (or feasible) operational noise mitigation options and management measures as part of the Project detailed design
  - Further consider potential impacts from the tunnel (for locations directly above the final volumetric take)
  - Work with impacted property owners and communities to address noise mitigation during detailed design stage.

Stakeholder engagement activities have resulted in the following information being considered in the development of the Project design and mitigation measures included during the development of the EIS as identified in Table 1.5.

Table 1.5 Key consultation outcomes

EIS component	Consultation outcome
Flooding and hydrology	Landowner consultation was undertaken to obtain specific photographic records and anecdotal evidence of existing flooding impacts and extents through a series of workshops. Based off primary feedback this information was validated and shared again with landowners to verify the modelling outcomes and findings of the Project's hydrology and flooding assessment.
Traffic, transport and access	Consultation is ongoing with local councils, DTMR and QR about pressure on local roads due to construction and then subsequent operations road network, construction traffic management and expectations with regards to temporary and permanent road network changes. Concerns raised regarding the proposed level crossings in Forest Hill and Gatton. The project has undertaken additional works to explore these road rail interfaces and will continue consultation through the next phase of the Project.
Land use and tenure	Consultation was undertaken to inform residents of Project objectives, proposed timescale, to request land access for field studies, and to also understand their concerns and issues around their land being acquired for the construction and operation of the Project. The Project predominantly follows the West Moreton System rail corridor and the protected Gowrie to Grandchester future State transport corridor Rail alignment along brownfield sections also has fewer potential impacts to agricultural land.
Cultural heritage – Native title claimants	As part of the development of cultural heritage management plans, ARTC engaged with Aboriginal representative group Yuggera Ugarapul. Negotiation and agreement of Cultural Heritage Management Plans (CHMPs) were undertaken with the aim of identifying a process for: ▪ Undertaking cultural heritage surveys for the Project ▪ Including relevant Traditional Owners in assessing Indigenous cultural heritage values and the protection and management of Indigenous cultural heritage Mitigating, managing and protecting identified cultural heritage and objects during both construction and operational phases of the Project.
Landscape and visual amenity	One on one meetings and discussions were held with residents (directly affected and nearby) to understand their concerns about the impact of the project on their views and the visual amenity of the area. A targeted special interest group workshop was held regarding landscape and visual amenity for the Project. Concerns regarding the visual environment have been captured and addressed via the online interactive map, community consultation sessions and CCC meetings.
Waste and spoil management	Consultation with councils was undertaken to ascertain current and forecast landfill capacities and waste transport service providers to appreciate operational capacities and industry processes. ARTC have engaged with other landfill and waste operators to review and confirm the feasibility of the proposed spoil receiving sites. This consultation has identified that there are numerous options, with sufficient capacity to accept the spoil volumes identified in this EIS. These options will be evaluated in future design and construction planning.
Flora and fauna	Consultation with individuals and groups such as Ipswich Koala Protection Society and Native Plants Queensland took place to present project findings, understand key concerns, provide face to face access to EIS technical specialists and provide an opportunity for stakeholder input into mitigation and design. Environmental groups requested the Project team to source a technical specialist to meet with and show them how to use the Wildlife Online database. ARTC sourced an independent facilitator to run Wildlife Online database training in recognition of environmental concerns regarding koalas and other protected fauna. The feedback provided by stakeholders and the community to the project team has continuously reinforced the importance of ecological values to the community and driven the project team to seek opportunities to avoid, minimise and manage impacts to species and their habitats wherever feasible in this stage of project development. ▪ Three fauna crossings are proposed for locations where bridge crossings will be constructed over waterways. ▪ Specific fauna fencing at these locations will be further assessed and determined during detail design.

EIS component	Consultation outcome
	■ Consideration of current distribution of pest species, an assessment of how the Project could influence the spread of these species and the mitigation measures the Project will implement to manage this risk. Chapter 23: Draft Outline Environmental Management Plan nominate proposed mitigation measures to minimise the risk of biosecurity hazards and identify statutory management requirements for fire ant management.
Social	Consultation to inform the SIA was undertaken with various groups including education providers, Aboriginal representative group Yuggera Ugarapul People and community groups. ARTC has a strong commitment to training local and Indigenous people. Training pathways and creation of opportunities for the development of skilled local and Indigenous people through the Project's construction and operation will be achieved by working with: ■ Schools and local training providers, to provide appropriate training ■ Aboriginal community networks, to encourage applications and increase the number of Indigenous people applying for jobs ■ Key partners, to link training and development programs with other projects and local industries to provide the greatest regional benefit ■ Australian Government and Queensland State Government to provide long-term outcomes through training, mentoring and other support programs. ■ Inland Rail has recently established of the Inland Rail Skills Academy, which provides: Scholarship opportunities at the University of Southern Queensland (USQ) for students along the alignment; Science, Technology, Engineering and Mathematics (STEM) programs in local schools ■ Opportunities for student placements or work experience on Inland Rail projects. A partnership with Lifeline was developed to provide key mental health support services in the project area, including a workshop with council members.
Economic	A Workforce Management Action Plan will be prepared as part of the SIMP. The objective of this action plan is to enable residents to access to employment opportunities created by the Project. Engaging local workers from the Project region ensuring that contractors encourage employment, training and skills development opportunities. ARTC will work with tourism associations and local councils to develop a strategy to help mitigate both property-specific and generalised impacts on tourism values.
Amenity (air quality and noise)	Landowners shared concerns about coal dust contaminating water tanks in face to face consultation sessions. Operational noise for landowners and businesses is another concern due to the current rural quietness in the area. Concept noise barriers have been recommended for key locations. A key component in reducing potential noise impacts is expected to be at-property controls such as architectural property treatments and upgrades to property fencing.
Construction water sources	Seqwater has been consulted in relation to construction water estimates, water storage capacities, water access and transportation considerations. Potential water supply options are discussed with hydrology, however discussions with Seqwater will be ongoing as the project progresses. Other landholders may be contacted about the potential use of their bores or other private water sources for construction purposes, if required. Confirmation of private water sources that will be made available to the Project by landholders will be covered under private agreement.
Location of groundwater bores	A number of landholders were consulted as part of the groundwater investigations about property water supply (i.e. bores) to enable the Project team to understand the potential for impacts to current uses if access to bores is affected as a result of construction. Once detailed design has occurred, further consultation will be undertaken with landholders including DTMR to confirm locations, use and quality of bores within the disturbance footprint and to ensure that potential damage to, destruction of, or loss of access to, bores is addressed.

Further detail on consultation activities and outcomes is provided in the EIS Appendix C: Consultation Report.

1.11 Principles of ecologically sustainable development

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

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

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

1.11.1 Precautionary principle

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

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

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

- The assessment of potential impacts is based on best practice, using the best available information. The assessment has involved key stakeholders and the relevant government agencies.
- The impact assessment considered conservative 'worst case' scenarios
- The EIS investigation corridor for the Project was first investigated in 2005. Since 2005, the EIS investigation corridor has been the subject of numerous desktop and field investigations, as well as wide-reaching stakeholder consultation. Knowledge gained over this period will ensure that the Project is designed, constructed and operated in a way that minimises potential impacts.
- The EIS draws attention to aspects of the Project that may cause serious and/or irreversible environmental damage, especially if the nature and extent of the damage is uncertain. Where environmental damage cannot be avoided, mitigation and management measures to protect the receiving environment are proposed. This includes securing offsets for impacts to biodiversity values.
- Lack of full scientific certainty has not been used as a reason for postponing measures to prevent environmental damage. For example, threatened species that could potentially occur but were not observed within the ecology study area during field surveys are still assumed present (rather than absent). Measures to avoid and/or mitigate impacts on threatened species are proposed, on the basis that these threatened species could be present within the MNES study area.
- The detailed design will aim to further minimise impacts and site and species-specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable and the significant adverse residual impacts are offset.
- During development of the Project, the alignment has been refined to:
  - Avoid sensitive vegetation, areas with known threatened flora and fauna populations, and key habitat areas
  - Avoid known items/areas of cultural heritage significance

- Minimise flooding impacts
- Minimise impacts on existing agricultural land and infrastructure, while also considering potential future land uses.

1.11.2 Intergenerational equity

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

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

- When developing the proposed alignment, minimising potential environmental impacts was a key consideration. This will ensure that environmental values (hydrological regimes, water quality, habitat connectivity, cultural heritage sites) are conserved for existing and future generations.
- Climate change projections were factored into flood modelling for the Project, and climate change-specific mitigation measures are proposed
- Sustainability initiatives and measures have been identified and captured in Project designs and proposed mitigation measures where relevant. A Sustainability Management Plan will be developed for the delivery of the design and construction of the Project. Further details are provided in EIS Chapter 7: Sustainability.

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

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

1.11.3 Conservation of biological diversity and ecological integrity

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

Impacts on biological diversity and ecological integrity have been avoided to the greatest extent possible. For example, investigations to verify the presence of threatened species and ecological communities within the MNES study area were completed. The results were used to inform the design and location of fauna crossings, fauna exclusion fencing, and landscaping, revegetation and rehabilitation works.

Other ways in which the Project contributes to the conversation of biological diversity and ecological integrity include:

- A crossing structure hierarchy was adopted during design development. Preference was given to bridges over culverts as, on the whole, bridges result in less severe impacts to fauna passage.
- Close attention was paid to the DAF *Accepted development requirements for operational work that is constructing or raising waterway barrier works* when designing bridges and culverts across mapped Queensland Waterways for Waterway Barriers Works
- A Reinstatement and Rehabilitation Plan will be developed to guide the approach to rehabilitating disturbed areas. Rehabilitation will occur progressively throughout the construction phase.
- Other plans that will be developed to minimise potential impacts on biodiversity during the construction phase include: Erosion and Sediment Control Plan; Biosecurity Management Plan and Flora and Fauna Sub-plans to the CEMP; and Soil Management Sub-plan as part of the CEMP.

Where impacts cannot be avoided (e.g. clearing of regional ecosystems and essential habitat), mitigation and management measures will be implemented. In instances where a significant residual impact as identified by the relevant EPBC Act significant assessment criteria, biodiversity offsets will be secured. An Environmental Offset Delivery Strategy for the Project has been prepared in consultation with the Queensland and Commonwealth Governments and is included as Appendix I.

1.11.4 Improved valuation, pricing and incentive mechanisms

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

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

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

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

- Reasonable steps have been taken to avoid impacts of the project upon biodiversity values including MNES
- The disturbance footprint has been designed to minimise the clearing of native vegetation as far as is reasonably practical. Where required, offsets will be secured to ensure a neutral or net beneficial biodiversity outcome for the region is achieved.
- Where required, offsets will be secured to ensure a neutral or net beneficial biodiversity outcome for the region is achieved
- A range of mitigation measures will be implemented to ensure that, during construction and operation, waste is avoided, reused or recycled wherever possible. Waste mitigation measures will be documented in a Waste Management Sub-plan to the CEMP, including:
  - The management of waste activities associated with the Project will be underpinned by the 2018 *National Waste Policy* and *Waste Reduction and Recycling Act 2011* (Qld) waste and resource management hierarchy, as listed below in the preferred order to be considered:
    - Avoid or reduce
    - Reuse
    - Recycle
    - Recover energy
    - Treat
    - Dispose.

Increased economic growth and reduced freight transport costs as a result of Inland Rail have been recognised. As stated in EIS Chapter 17: Economics, Inland Rail is expected to increase Australia's Gross Domestic Product by $16 billion during construction and the first 50 years of operation, while decreasing freight transport costs by an estimated $10 per tonne.

2 Legislative, policy standards and guidelines

2.1 Commonwealth legislation and policy

This section describes the legislative, policy and management framework for the Project to describe the legislative framework which applies to the assessment of MNES applicable to the Project at the Commonwealth level and to provide the statutory context in which the MNES assessment has been undertaken.

An overview of Commonwealth legislation that is relevant to MNES aspects of the Project, outlining the intent of the legislation and applicability to the Project, is presented in Table 2.1. Post primary approval requirements are outlined in Section 8.1.

In addition, the threatened species survey guidelines for bats, birds, fish, mammals and reptiles were considered during planning for the field assessment. This included survey effort, timing and techniques along with ecological information relevant to a species (refer Section 3).

Table 2.1 Commonwealth legislation and authorities relevant to the Project

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
Commonwealth			
Environment Protection and Biodiversity Conservation Act 1999 (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 DAWE to rely on specified environmental impact assessment processes of Queensland in assessing actions under the EPBC Act. The bilateral agreement specifically aims to achieve the following objectives: ▪ Protect the environment in accordance with the requirements of the EPBC Act ▪ Promote the conservation and sustainable use of natural resources ▪ Ensure an efficient, timely and effective process for environmental assessment and approval of actions.	ARTC submitted an EPBC Act referral to the DotEE in February 2017 (EPBC 2017/7883) The Minister for the Environment determined the Project a 'controlled action' on 17 March 2017. The controlling provisions for the controlled action are: ▪ Listed threatened species and communities. The EPBC Act controlled action will be assessed under the bilateral agreement with the Australian and QLD Governments As required by the ToR, this EIS addresses the relevant sections of Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000.
EPBC Act Environmental Offsets Policy (2012) (EPBC Act Offsets Policy)	Areas subject to the EPBC Act	Developed to support the management and protection of MNES under the EPBC Act and outlines the Australian Government's approach to the use of environmental offsets for impacts to MNES. Eight principles for the use of environmental offset under the EPBC Act have been developed by 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*	The Project will implement avoidance and mitigation measures to minimise the significant adverse residual impacts on the MNES. implementing mitigation measures including offsets will be consistent across Inland Rail. Offsets provided for under the policy include direct offsets, and other compensatory methods (or indirect offsets). It is likely that a combination of methods will be applicable to the Project, based on the extent of the significant adverse residual impacts on MNES. The Project will comply with the EPBC Act Offsets Policy for any significant adverse residual impacts to MNES. A detailed Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction commencement subject to the approval under the EPBC Act.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
		■ *Be in proportion to the level of statutory protection that applies to the protected matter* ■ *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 (DSEWPAC 2012a).* The Australian Government defines offsets as measures that compensate for the significant adverse residual impacts of an action on the environment (DSEWPAC 2012a).	
Matters of National Environmental Significance: *Significant impact guidelines 1.1 – Matters of National Environmental Significance: Environmental Protection and Biodiversity Conservation Act 1999* (DotE 2013a)	MNES	The purpose of the guideline is to assist any person who proposes to take an action to decide whether they should submit a referral to DAWE for a decision by the Commonwealth Minister for the 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 referral may be required. Important terms and phrases are explained.	Assessment of MNES against the MNES significant impact guidelines will facilitate the determination of a significant residual impact to MNES. This has been undertaken in Sections 5.3.3, 5.3.4 and 5.3.5).

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory), (DotE 2014)	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 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 Koala. 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 against the guidelines will facilitate the determination of a significant residual impact to Koala. This has been undertaken in Section 5.3.5.3).
Draft *Guide to nationally protected species significantly impacted by paddock tree removal* (DotEE 2020)	MNES	National environmental law applies to the removal of paddock trees when a 'significant impact' on a nationally protected ecosystem or species is likely to occur. Nationally protected ecosystems include Ramsar wetlands and ecological communities listed in the critically endangered, endangered or vulnerable categories under the EPBC Act. In very rare circumstances, these ecosystems may be significantly impacted by paddock tree removal. Only a very small subset of nationally protected species may be significantly impacted by removing paddock trees. In some cases, undertaking mitigation activities may mean that the removal of paddock trees is lawful and does not require referral under national environmental law. The purpose of the guideline is to assist any person who proposes to clear paddock trees to decide whether or not the action may impact threatened species listed under the EPBC Act and if submission of a referral to the DAWE for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the EPBC Act. These guidelines outline species-specific actions, to assist persons in deciding whether or not referral may be required.	Assessment of MNES against the guideline will facilitate the determination of a significant residual impact to applicable threatened species (such as Koala). This has been undertaken where necessary in Section 5.3. The following species are relevant to the Project and included within the draft guide. The species-specific approval requirements noted in the draft Guideline are identified here with their relevance to the Project. ▪ Regent Honeyeater (*Anthochaera phrygia*): *Removing Ironbark paddock trees within known breeding areas or frequented visitation sites.* The nearest breeding site is over 90 km south-west of the Project. The species occurs sporadically in the Lockyer Valley region (at best) and does not 'frequent' the Project area or surrounds. The approval requirements within the Guideline are not relevant to this species regarding the Project. ▪ Painted Honeyeater (*Grantiella picta*): *Removing old growth eucalyptus paddock trees containing mistletoe within known breeding areas.* The species is not known to breed to the east of the Great Dividing Range and only sporadically occurs in the region. The approval requirements within the Guideline are not relevant to this species regarding the Project. ▪ Coxens fig parrot (*Cyclopsitta diophthalma coxeni*): *Any removal of old growth fig paddock trees in areas of known visitation by this species.* There are no records of the species within 20 km of the Project. There are no records in the region from the year 2000 onwards. As such there are no areas of known visitation associated with the Project. The approval requirements within the Guideline are not relevant to this species regarding the Project.

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
			▪ Swift Parrot (*Lathamus discolor*) – *Removing Tasmanian Blue Gum and Black Gum paddock trees in known breeding areas. These parrots only breed in Tasmania.* The Project is located in south-east Queensland. The approval requirements within the Guideline are not relevant to this species regarding the Project. ▪ Koala (*Phascolarctos cinereus*): *Removing paddock trees where they are habitat critical to the species survival or provide the only movement opportunity / refuge to or between areas of habitat critical to the species survival.* There is *potential habitat* within the Project disturbance footprint and surrounds which is analogous to this description. Addressed further in Section 5.3.5.3 under the significant residual impact assessment for the species.
Species recovery plans	MNES	Recovery plans for listed threatened species and ecological communities have been made or adopted under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). These plans remain in force until and unless the species is removed from the threatened list. A recovery plan is a document stating the research and management actions necessary to stop the decline, support the recovery and enhance the chance of long-term survival in the wild, of a protected community, animal or plant species. It is noted many threatened species do not have recovery plans currently in place.	Species recovery plans (State and Commonwealth) for the following MNES relevant to this project have been considered as part of this assessment: ▪ Brush-tailed Rock-wallaby (*Petrogale penicillata*) ▪ Large-eared pied bat (*Chalinolobus dwyeri*) ▪ Spotted-tail quoll (*Dasyurus maculatus maculatus*) ▪ Black-breasted button-quail (*Turnix melanogaster*) ▪ Red goshawk (*Erythrotriorchis radiatus*) ▪ Regent honeyeater (*Anthochaera phrygia*) ▪ Swift parrot (*Lathamus discolor*) Draft recovery plans awaiting adoption under the EPBC Act and utilised for this report include the following species: ▪ Australian lungfish (*Neoceratodus forsteri*) ▪ Australian painted snipe (*Rostratula australis*) ▪ Australasian bittern (*Botaurus poiciloptilus*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*)

Legislation/ policy	Legislative jurisdiction	Intent	Applicability
Threat abatement plans	MNES	Threat abatement plans provide for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on native species and ecological communities. Implementing the plan should assist the long term survival in the wild of affected native species or ecological communities	Threat abatement plans relevant to MNES associated with the project include: ▪ Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* ▪ Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (*Rhinella marina*) ▪ Threats identified in the Threat abatement plan for competition and land degradation by rabbits ▪ Threat abatement plan for predation by feral cats ▪ Threat abatement plan for predation by the European red fox ▪ Threat abatement plan for competition and land degradation by unmanaged goats Threat abatement plans approved by DAWE are accessible at the at the following location: https://www.environment.gov.au/biodiversity/threatened/threat-abatement-plans/approved

3 Methodology of assessment

3.1 Overview

An overview of the stages involved in the assessment of MNES controlling provision of the Project is provided in Figure 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 MNES (e.g. EPBC Act listed species and threatened ecological communities (TECs)) relevant to the Project. This was undertaken using a combination of desktop-based datasets and validation of predictive, species specific mapping, which was supplemented by targeted field surveys at defined locations (refer Section 3.3.1). Ecological site investigations associated with pre-clearance work for geotechnical investigations (EPBC Referral 2018/8263) were also incorporated into the findings where relevant (refer Section 3.2.2).

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

'… *Alternatives to a dedicated survey may also be appropriate. For example, a desktop analysis of historic data may indicate that a significant impact is not likely. Similarly, a regional habitat analysis may be used to determine the importance of a site to the listed birds. Proponents should also consider the proposals impact in the context of the species' national, regional, district and site importance to establish the most effective survey technique(s)…'* (e.g. DEWHA 2010a; DSEWPAC 2011a)

It should be noted from the outset that detailed onsite surveys for threatened fauna have not necessarily been carried out as per the relevant Commonwealth survey guidelines for each species. Although there are no Commonwealth guidelines regarding threatened flora, surveys for protected flora have been carried out following State guidelines (e.g. Department of Environment and Heritage Protection (DEHP) 2014; 2016). Nevertheless, a range of survey methods have been carried out over a number of years and seasons. This historic survey effort is considered applicable to detecting the potential presence of MNES fauna/flora that may occur in the area. Section 3.3.3.2 outlines the methods used during Project-associated surveys as they apply to MNES fauna species.

The threatened species habitat modelling has been based on a conservative approach to mapping habitat. In the absence of sufficient and robust scientific information to support a species being excluded from the area, the species has been assumed to be present if habitat for the species is present, or there are local records to this species. This is a conservative approach to mapping

The approach is even more conservative as the quality of habitat or the carrying capacity of the habitat has been excluded from the assessment (though this information may be used to determine whether a significant impact is likely when assessed against the MNES Guidelines (refer Sections 5.3.3, 5.3.4 and 5.3.5).

The predictive habitat modelling along with relevant scientific information was used to inform the significant impact assessment (direct and indirect) and where applicable the measures to avoid, minimise and mitigate impacts. This assessment has determined the maximum potential area of disturbance for each MNES using the predictive habitat modelling to provide the total maximum extent of habitat to be cleared irrespective of habitat category (e.g. *Potential habitat, Important habitat* or *Habitat critical to the survival of the species*; refer Section 3.2.5) or quality.

A key outcome of the significant impact assessment is the determination as to whether the maximum clearing extent of the Project will have a significant residual impact on each of the MNES under the MNES Guidelines (refer Sections 5.3.3, 5.3.4 and 5.3.5).

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

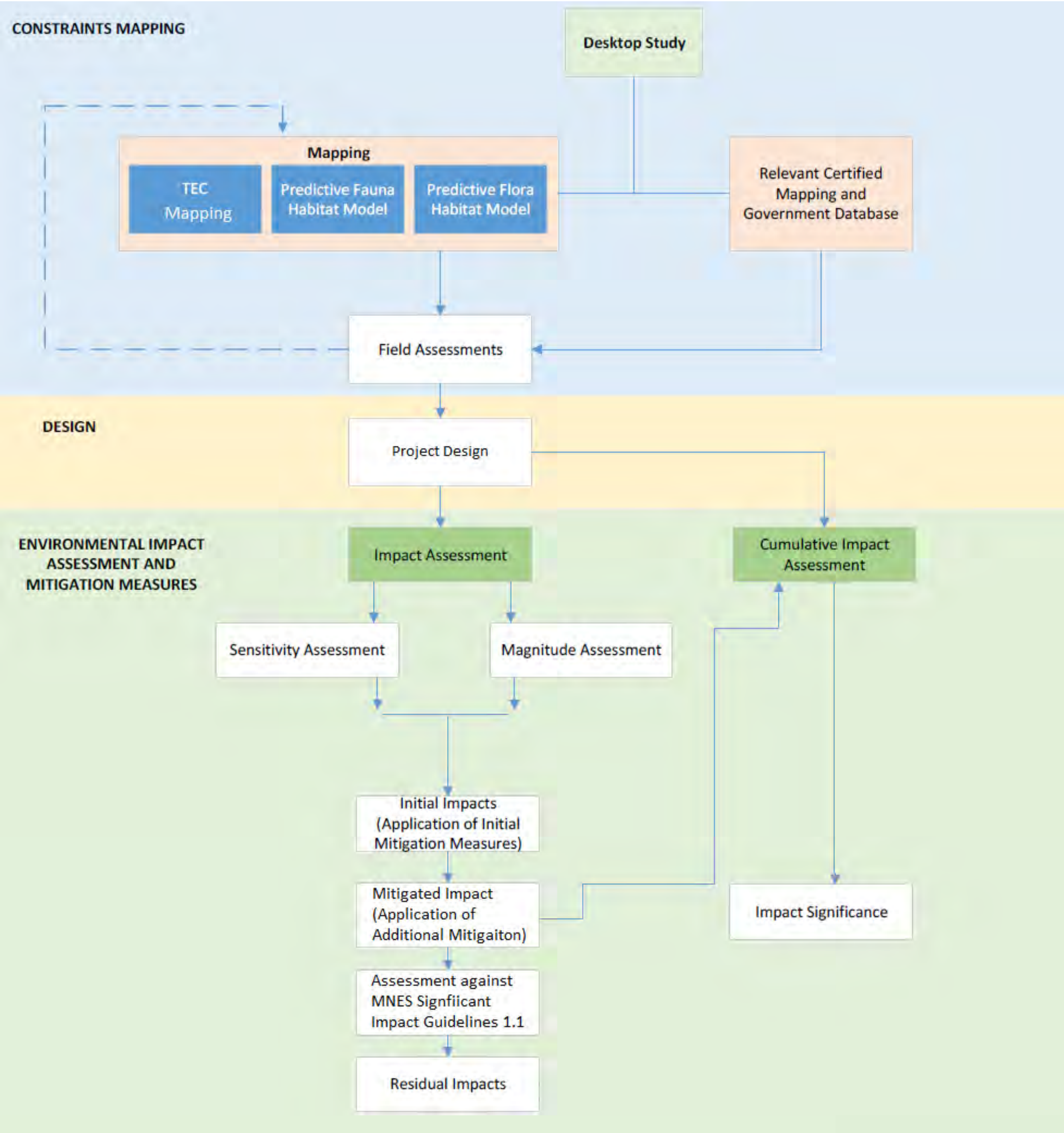


Figure 3.1 Assessment methodology

The approach outlined in Figure 3.1 and documented in this report, is the initial step in the determination of the extent of impacts associated with the Project upon MNES and represents the maximum extent of clearing. During detailed design, the design and construction methodology which will result in refinements to the Project disturbance footprint. The detailed design process will have regard to measures to minimise the Project's impacts and implementation of mitigation measures, approval conditions and additional information on the ecological values of the Project, including the results of additional ecological surveys. It is expected that through the detailed design process, the significance of the impacts on MNES from the project will reduce, in comparison to the conservative assessment that has been presented in this EIS.

3.2 Desktop study

This section details the desktop analysis undertaken to identify MNES located within the MNES study area, and existing gaps in datasets. This analysis included a review of existing field data collected prior to the commencement of the Project EIS and field data collected during the field component of the Project 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 species and ecological communities listed under the EPBC Act within the MNES study area.

3.2.1 Database review

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

Table 3.1 Database review summary

Database/data source name	Database search date	Database search areas	Data type
Atlas of Living Australia	29/03/2020	MNES study area	Ongoing inspection of records of flora and fauna, including threatened species listed under the EPBC Act.
Flying Fox Monitoring Program	24/03/2020	MNES study area	Show the location of flying-fox roosts in Queensland recorded by the department and include monitoring data of continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Flying-fox roost monitoring and locations	04/03/2020	MNES study area	Show the general location of flying-fox roosts in Queensland recorded by the department and include continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Birds Australia	29/03/2019	MNES study area	Records of avian fauna, including threatened and migratory species listed under the EPBC Act.
EPBC Act Protected Matters Search Tool (Australian Government 2020b)	17/03/2020	MNES study area	Provides a “predictive” account of MNES identified within a specific area. Includes: ▪ Threatened species as listed under the EPBC Act ▪ Migratory species listed under the EPBC Act ▪ TECs listed under the EPBC Act ▪ Critical habitats ▪ World Heritage Properties ▪ National Heritage Places ▪ Wetlands of International Importance (i.e. Ramsar) ▪ Great Barrier Reef Marine Park ▪ Commonwealth Marine Area ▪ Nuclear Areas.
Regulated Vegetation Management Map Version 11.1 (DNRME 2020)	04/03/2020	MNES study area	Mapping of regional ecosystems (REs) and High Value Regrowth that provide habitat for TECs and threatened species under the EPBC Act.
Wetland Info database (DES 2020b)	04/03/2020	Impact assessment area	Provides interactive maps, species records, case studies and legislation associated with Queensland wetlands.
MSES Wildlife Habitat Map (Queensland Government 2020)	17/03/2020	MNES study area	Modelled habitat for threatened species listed under the EPBC Act.

Database/data source name	Database search date	Database search areas	Data type
Wildlife Online database (DES 2020) incorporating Wildlife Online and Herbrecs datasets	17/03/2020	MNES study area	Records of flora and vertebrate fauna including threatened species listed under the EPBC Act.
Queensland Springs Database (DES 2018)	04/03/2020	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).

Specifically, data from the sources identified above were used to identify the following MNES contained or predicted to be contained within the MNES study area. MNES are identified as the following:

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

3.2.2 Review of existing literature and previous studies

Ecological assessment reports from the region were identified which presented ecological values of the MNES study area, including species diversity, abundance and seasonal distribution (refer Table 3.2).

In addition, seasonal variation was also captured in the modelling approach (refer Section 3.2.5) which utilised government datasets and historic records that were developed across multiple seasons/years. The results of the modelling and subsequent mapping output provide a measure of the amount of suitable habitat that is present regardless of season as it collates essential “habitat components” required by a species (e.g. vegetation structure, geological features (i.e. surface rocks, cliff faces or boulder piles), and presence of specific hydrology regimes).

In addition to the material identified in Table 3.2, site specific database queries as identified in Section 3.2.1 (refer Table 3.1) have been accessed to produce the predictive habitat mapping related to MNES flora, fauna and TECs (refer Sections 3.2.4 and 3.2.5). 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) and the formulation of the predictive habitat models which are considered to adequately account for seasonal variation and detectability related to threatened species.

The Project EIS ecology team has experience and knowledge in the assessment of MNES including Austral toadflax (*Thesium australe*), Hawkweed (*Picris evae*), Koala (*Phascolarctos cinereus*), Swamp tea-tree (*Melaleuca irbyana*) forest and the Collared delma (*Delma torquata*) which has been utilised during the desktop component of the Project.

As such, there is a high level of confidence in the assessments of MNES undertaken within the MNES study area, including their adequacy for providing a baseline of the terrestrial and aquatic ecology area.

The findings of each of the existing background studies were used to inform this MNES assessment, particularly the likely extent of ecological communities and habitat for threatened species listed under the EPBC Act in the MNES study area. The reports reviewed, in which the alignments largely match that of the Project, include those listed in Table 3.2.

Table 3.2 Project related assessments and reports

Document title	Reference	Summary of significant findings related to MNES
Southern Freight Rail Corridor Study (March 2010) (C2K Project study area adjacent to east of Project)	AECOM (2010)	▪ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ threatened ecological community (TEC) located immediately east of MNES study area ▪ Observations of Koala (*Phascolarctos cinereus*) located immediately east of MNES study area – anecdotally known to occur throughout the study area from community consultation feedback.
Australian Rail Track Corporation/Transport - Land/southwest of Ipswich/Queensland/Inland Rail Helidon to Calvert Project (EPBC referral 2017/7883)	ARTC (2017)	▪ Provides initial details on how the project is likely to impact upon MNES. This includes identification of potential habitat for 15 threatened species and 5 migratory species. Potential for significant residual impacts to Koala (*Phascolarctos cinereus*) are predicted. ▪ Observations of Koala (*Phascolarctos cinereus*) presence (scats) – eight distinct locations along the alignment
Initial Advice Statement: Inland Rail, Helidon to Calvert – 15 February 2017.	ARTC (2017)	▪ Provides initial details on how the project is likely to impact upon MNES. This includes identification of the potential presence of 15 threatened species.
Inland Rail – Gowrie to Kagaru Geotechnical investigations. MNES assessment report – 23 July 2018 Biodiversity Management Plan – 31 October 2018	EMM (2018a, 2018b)	▪ Observations of Koala (*Phascolarctos cinereus*) presence throughout alignment (scats and scratches) ▪ Confirmation of the presence of Lloyd's olive (*Notelaea lloydii*) near Laidley
Inland Rail – Gowrie to Kagaru Geotechnical investigations. Protected plant survey reports (2018 and 2019) Preclearance survey reports (2018 and 2019)	EMM (2018c, 2018d; 2019a, 2019b)	▪ No MNES observed
Inland Rail – Helidon to Calvert Geotechnical investigations. Protected plant survey report – 29 May 2019 Preclearance survey report (30 July 2019)	Eco logical (2019a, 2019b)	▪ No MNES observed

3.2.3 Assessment of the likelihood of occurrence of conservation significant species

The likelihood of threatened species listed under the EPBC Act to occur within the MNES study area was determined based on the results of the desktop study and review of existing literature (refer Appendix B), which was later supplemented with data derived from field assessments (refer Section 4.4, Appendix D, Appendix E, Appendix H and Appendix I) and used to refine the predictive habitat mapping (refer Figure 3.1 and Appendix A). The likelihood of occurrence assessment is central to determining which MNES features were identified as receptors for the Project and were subject to predictive habitat modelling (refer Section 3.2.5, and Appendix A).

Threatened species considered **possibly** or **likely** to occur, or which were later identified in the MNES study area during the field assessment, were assessed as **MNES applicable to the Project**. Threatened species, which were considered **unlikely** to occur within the MNES study area, were not considered further as part of this impact assessment.

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

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

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

- The MNES study area is beyond the current distributional limits for the species
- The species use specific habitat types or resources that are known not to be present in the MNES study area (e.g. altitudinal limits for species such as the Eastern bristlebird (*Dasyornis brachypterus*) and intertidal saltmarshes and estuarine wetlands for the Eastern Curlew (*Numenius madagascariensis*))
- The species are considered locally extinct based on expert knowledge and/or literature (e.g. Southern lack throated finch (*Poephila cincta cincta*) and Northern quoll (*Dasyurus hallucatus*).

Species considered as **possible** include species that fit one or more of the following criteria:

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

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

- Have been recently recorded in the MNES study area (i.e. sightings within the last 10 years within 20 km of the MNES study area)
- Use habitat types or resources that are present in the MNES study area, which are in good condition (with condition based on desktop works, literature review and, where available and possible, supplementary field assessments)
- Are likely to maintain sedentary populations within the MNES study 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 5.3.4 and 5.3.5 and Appendix B.

3.2.4 Mapping of threatened ecological communities

TECs were identified by extrapolation using DAWE conservation listing advice contained on the Species Profile and Threats Database (SPRAT), for each TEC identified during the desktop review phase.

Analogous vegetation communities (i.e. remnant and regrowth regional ecosystems) as regulated by the QLD *Vegetation Management Act 1999* (VM Act) were identified which were then used to spatially map out the extent of each of the identified TEC. Identified TECs and the analogous regional ecosystems (both remnant and high value regrowth) were used to map each of the TECs as stipulated by information provided by the DAWE's SPRAT database and Approved Conservation Advice and is presented in Table 3.3. Additional information regarding QLD Government mapping extent of Swamp Tea-tree (*Melaleuca irbyana)* was also incorporated regarding the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC, although this included some expected error in the actual extent of the TEC within the MNES study area (i.e. the presence of *M. irbyana* does not necessarily mean the TEC is present) (refer Table 3.3).

It is acknowledged that the State-based RE mapping may not accurately delineate the extent of a TEC within the MNES study area, as the threshold size for some TECs are less than 0.5 ha (refer Table 3.3), while remnant patches from the State-based RE mapping (i.e. 1:50,000 mapping) is 2 ha and/or 75 m width limit for linear features. Therefore, the use of RE mapping may not identify the true extent of potential TECs within the Project disturbance footprint (e.g. smaller patches of potential TEC vegetation may not be mapped as remnant or high-value regrowth communities under State-based mapping). In addition, not all patches of analogous RE (remnant or regrowth) may meet the relevant condition thresholds resulting in an overestimation of area until the patches are verified and delineated in the field. Analysis of aerial imagery was used to supplement the mapping, along with targeted field investigations (refer Section 3.3.1 for survey locations). This information was incorporated into the final TEC mapping for the MNES study area (refer Section 4.4.1.3) and as such the extent of TEC within the MNES study area has a confidence level of 90 per cent.

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

TEC name	EPBC Act status	Habitat requirements or analogous REs[1]
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are considered to be analogous to this TEC: 6.4.2, 11.3.1, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6 and 12.12.26 Patches in poor condition can be excluded from the listed Brigalow ecological community. Poor condition of patches can be recognised by one or more of the following attributes: vegetation that has been comprehensively cleared (not just thinned) within the last 15 years; vegetation in which exotic perennial plants have more than 50 per cent cover, assessed in a minimum area of 0.5 ha (100 m by 50 m); and individual patches of Brigalow that are smaller than 0.5 ha.
Coastal Swamp Oak (*Casuarina glauca*) Forest of NSW and SEQ ecological community	Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are analogous to this TEC: 12.1.1 and 12.3.20 The minimum threshold for this community (i.e. meets key diagnostics characteristics) is 0.5 ha.
Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ	Critically Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are analogous to this TEC: 12.9-10.11 and 12.3.18 (formerly 12.3.3.d) It is acknowledged that the QLD government has prepared habitat modelling for the species *Melaleuca irbyana* (listed as Endangered under the Queensland NC Act. This modelling recognises three REs which contain *Melaleuca irbyana* 12.3.19, 12.9-10.27 and 12.5.2x1 but are not listed as analogous under the approved conservation advice for the TEC. In addition, the use of high value regrowth has been incorporated into the mapping assumptions which represent a cautionary approach to mapping this community at the desktop level.
Lowland Rainforest of Subtropical Australia	Critically Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are analogous to this TEC: 12.3.1, 12.3.1a, 12.5.13, 12.5.13a, 12.5.13b, 12.5.13c, 12.8.3, 12.8.4, 12.11.1, 12.11.10, 12.12.1 and 12.12.16 where they meet the following criteria: ▪ Is located at or below 300 m above sea level ▪ Is located at least 2 km from the coastline Note that for remnant patches (which meet the key diagnostic characteristics) the threshold is 0.1 ha or 1 ha for where some residual trees are present , while for non-remnant areas the threshold is 2 ha.

TEC name	EPBC Act status	Habitat requirements or analogous REs[1]
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland)	Critically Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are analogous to this TEC: 12.8.16 (western extent of bioregion) For this community a patch (which meets the key diagnostic characteristics) must be an area that contains five or more trees in which no tree is greater than 75 m from another tree, or the area over which the understorey is predominantly native. Patches must be assessed at a scale of 0.1 ha (1,000 m^2) or greater.

Table note:

1 As regulated under the VM Act (Qld). Obtained from conservation listing advice contained within SPRAT unless otherwise stipulated

3.2.5 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 threatened species and communities listed under the EPBC Act in accordance with the ToR.

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

In addition, to adequately capture known records of threatened species (e.g. historic records and those identified during field assessment), all areas (regardless of existing vegetation communities) within a 1 km radius of the record were 'automatically' assigned as providing habitat for the specific species to which the record belonged. This distance adequately accounts for the potential movement and dispersal for the relevant species and would also mitigate potential issues associated with record precision. If the record occurred on the outside edge of the MNES study area, the 1km buffer area for the record would still be integrated into the predictive habitat mapping where it intersected the MNES study area.

In some instances, the mapped *'potential habitat'* contained areas of agricultural land, grassland and open forest/woodland habitat, as well as scattered trees. With reference to Koala (*Phascolarctos cinereus*) this may provide habitat connectivity to larger forest patches or refuge opportunities between habitat patches considered critical to the survival of the species.

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

Databases and other information that were used to feed into the predictive GIS based model are identified in Table 3.1 (refer Section 3.2.1), Appendix A and Appendix C. Because of the general paucity of information on the distribution of biota over much of the MNES study area, much of the predictive habitat modelling has been undertaken utilising the State-based vegetation mapping (REs) database to delineate potential habitats. Regional ecosystems are an integrated entity derived from landscape pattern, geology and landform, and vegetation. As such, they provide a robust classification for biodiversity planning that incorporates ecological processes at the landscape scale. Regional ecosystems have also been used to define threatened ecological communities within Queensland (refer Section 3.2.4). Aerial imagery was also used to delineate areas of potential habitat located outside of mapped REs which are not captured under the State-based mapping (e.g. vegetated drainage lines).

In addition to database information (e.g. previous ecological survey data and historic records), data collected during Project-associated field-based assessments (such as species records) (refer Section 3.3) was used to verify and ‘fine-tune’ model outputs (refer Figure 3.1).

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

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

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

- Unlikely habitat
- *Potential habitat*
- *Important habitat* (where applicable – refer Section 3.2.5.3)
- *Habitat critical to the survival of the species* (where applicable).

The use of these habitat categories aligns with DAWE’s habitat definitions for species protected under the EPBC Act where they are defined under relevant recovery plans or referral guidelines.

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

3.2.5.1 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.

3.2.5.2 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). *Potential 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 and where this does not completely address the relevant criteria to be mapped as *Important habitat* or *Habitat critical to the survival of the species*. *Potential habitat* may include areas of suboptimal habitat for a species. Species specific assumptions that define the *Potential habitat* category are identified in Appendix A. Impacts to *Potential habitat* are not considered to contribute to significant impact to an MNES as the loss of these areas is not deemed to be significant in accordance with the Commonwealth significant impact criteria. However, impact to *Potential habitat* have been considered in relation to movement of species and the potential to contribute towards fragmentation and barrier effects, rather than the loss of habitat *per se*.

3.2.5.3 Important habitat

In line with DAWE's guidelines, areas of Important habitat are regarded as a surrogate for important populations of Brigalow belt reptiles. Important habitat for Brigalow Belt reptiles is defined in Section 5 of the *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (Department of Sustainability, Environment, Water, Populations and Community (DSEWPaC) 2011e). Relevant to the current investigations, the following species are classified as Brigalow Belt reptiles and Important habitat for these species has been mapped:

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

In addition to the species identified above, the Important habitat has been used to capture 'Priority habitat areas' for the Swift parrot (*Lathamus discolor*) as identified in the *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Saunders and Tzaros 2011). Species specific assumptions that define the Important habitat category for the abovementioned species is provided in Appendix A. Impacts to *Important habitat* are considered to contribute towards significant residual impacts to an MNES.

3.2.5.4 Habitat critical to the survival of the species

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

Impacts to *Habitat critical to the survival of the species* are considered to contribute towards significant residual impacts to an MNES.

3.3 Field assessments

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

- Commonwealth recognised guidelines for threatened species where applicable (refer: http://www.environment.gov.au/epbc/policy-statements). For example:
  - Nationally threatened ecological community information sheet: Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ (DEHP 2005)
- Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland (Neldner et al 2012; Neldner et al 2017)
- Terrestrial vertebrate fauna guidelines for Queensland (V2.0) (Eyre et al 2014)
- Flora survey guidelines - protected plants, *Nature Conservation Act 1992* (DEHP 2016).

There are no Commonwealth guidelines regarding surveys for MNES flora and State guidelines (DEHP 2016) are considered suitable for surveying flora species. For the TECs, there are also no specific Commonwealth survey guidelines. Therefore, Neldner et al 2012 (and subsequent revisions) is considered suitable to verify and delineate the extent of a TEC. This is based on the relevant diagnostic criteria and condition thresholds (where available) in the relevant Approved conservation advice for the TEC.

As noted previously, onsite surveys for threatened fauna have not been carried out in accordance with the relevant Commonwealth survey guidelines. The information within this document is based on desktop information and targeted field-based information from survey activities carried out over a number of years (refer Section 3.3.1). The approach to assessing threatened species presence and habitat modelling for threatened species has adopted a conservative approach. This avoids underestimating the available habitat potentially present within the Project disturbance footprint. For some fauna species the presence of suitable habitat features may be sufficient to consider the species as present (e.g. boulder piles/cliff faces for Brush-tailed rock-wallaby (*Petrogale penicillata*)). As such, it is considered this maintains the intent of the various guidelines. This maintains the intent of the adopted guidelines. During the secondary Project approvals and in parallel with the detailed design, site-based surveys for threatened species will be required as the Project progresses, the disturbance footprint is refined and land access to all areas becomes available.

The extent of fieldwork and predictive flora and fauna modelling undertaken for the Project, when used in conjunction with existing information (refer Table 3.4), are considered sufficient to provide confidence in predictions of potential impacts to MNES. Specific methodologies utilised in assessing MNES attributes are set out below.

The location of terrestrial and aquatic survey sites was dictated by land access agreements with landowners which was provided on a voluntary basis. This significantly reduced the areas that were accessible to ecological investigations. However, where access agreements existed, these locations were surveyed in addition to publicly accessible areas. ARTC is committed to undertaking additional surveys in accordance with relevant guidelines to verify the assumptions used to inform the mapping and address any constraints/limitations.

Whist not specifically detailed within this document, results of previous field work conducted by Arup/SMEC for the Project's EPBC Act referral (2016) and findings associated with ecological investigations to support approval processes for the Gowrie to Kagaru geotechnical program (i.e. undertaken by EMM and ELA) which occurred concurrently with the EIS investigations reported in this document, have been incorporated within the EIS reporting (refer 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, active searches for potential breeding locations and habitat assessments (including breeding and foraging habitat for threatened species), focussing on those listed as threatened (e.g. Koala). This data has been used to assist in the predictive habitat mapping within the MNES study area. Where data from these surveys is considered relevant it has been incorporated throughout this document but specifically in the significant impact assessments associated with TECs (refer Section 5.3.3), threatened flora (refer Section 5.3.4), and threatened fauna (refer Section 5.3.5).

3.3.1 Field assessment locations and timing

A representative sampling approach was employed as part of the Project EIS field sampling methodology. Seasonal sampling, i.e. Spring (mid-September to mid-December) and Autumn (late February to April) are recommended for the SEQ bioregion (Eyre et al. 2014). Targeted surveys were undertaken by the Future Freight Joint Venture (FFJV) EIS team during Spring 2017, with opportunistic surveys extending from February 2018 to October 2018. Additionally, the use of publicly available datasets, surveys undertaken by Arup/SMEC 2016 (i.e. Autumn-Winter 2016) and various surveys undertaken by ELA and EMM as part of geotechnical works fulfil the seasonal survey requirements (refer Table 3.4). The survey timings are considered adequate to measure taxa diversity and their repetition throughout the MNES study area. In addition, when combined with the predictive habitat modelling (refer Section 3.2.5) which has been supplemented with field-based datasets, a highly conservative approach has been adopted to the assessment of threatened species.

3.3.1.1 Previous and concurrent ecological surveys for Project

Table 3.4 presents the survey timing and survey activities associated with previous Project associated ecological investigations, including the Arup/SMEC works in 2016, and geotechnical field investigations undertaken by ELA (2019a, 2019b) and EMM (2018 and 2019). Figure 3.2a-d presents the survey location points. Note, there is substantial overlap in the location of surveys undertaken during programs presented in Figure 3.2a-d with those undertaken as part of targeted surveys associated with the EIS in 2017 (refer Figure 3.3a-d), allowing for seasonal 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 the majority of the Project disturbance footprint has been subject to ecological assessment.

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

Study/investigation	Consultant/ year	Timing of investigations	Season	Methodologies and notes
Initial ecological assessment to support EPBC referral 2017-7883	Arup/SMEC (2016)	30 March to 1 April and 1 June 2016	Autumn, Winter (2016)	Targeted Koala habitat searches – 8 sites Protected plant surveys Fauna habitat assessments - 16 sites
Protected plant surveys associated with geotechnical investigations to support EPBC Referral 2018-8263 and inform the Gowrie to Kagaru Geotechnical Investigations Environmental Management Plan	EMM (2019a, 2019b)	16 May 2018 - 28 June 2018	Autumn, Winter (2018)	Protected plant surveys within/adjacent to alignment (meander surveys – minimum 30 minutes) at 15 sites throughout H2C alignment

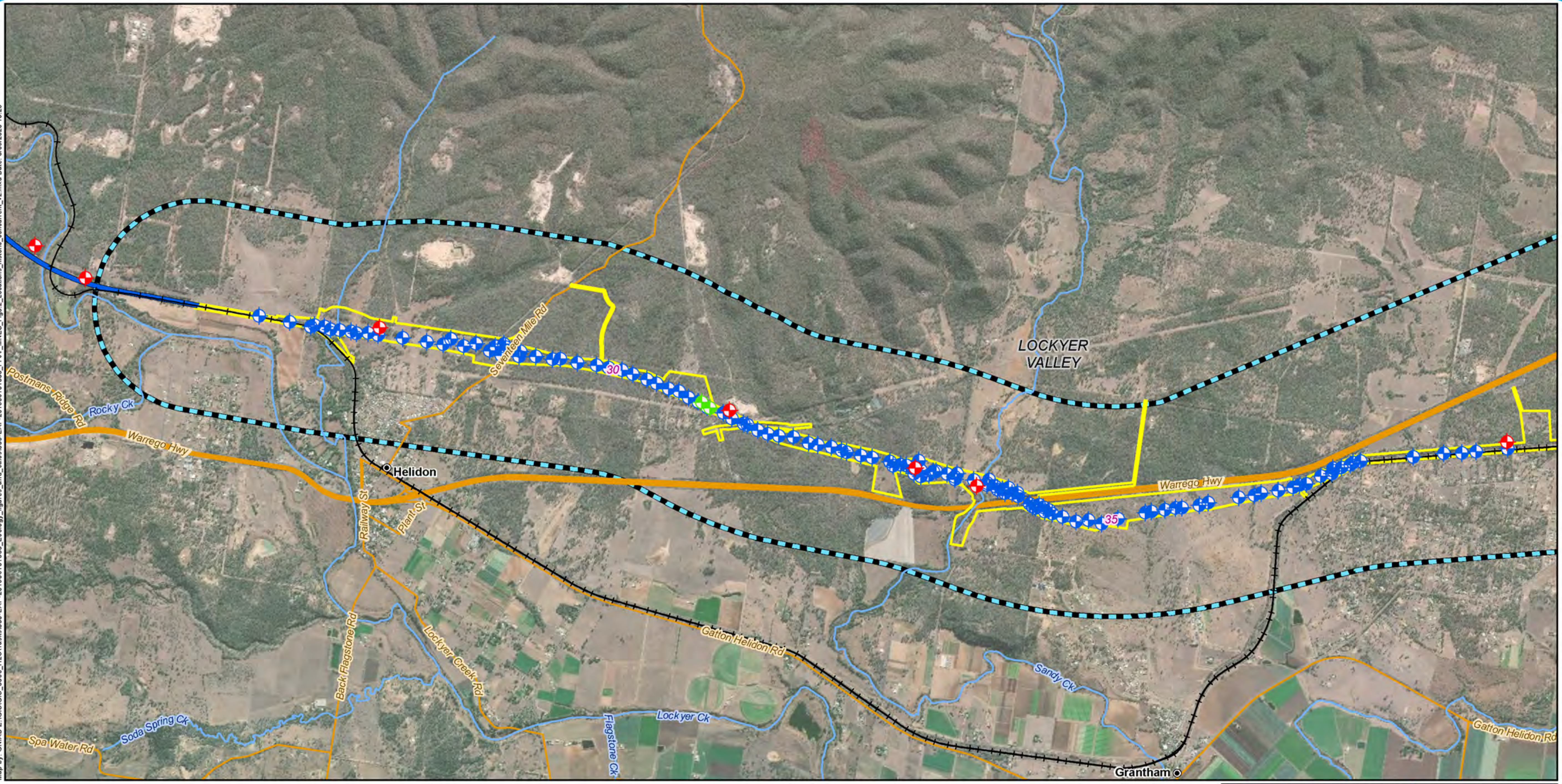
Study/investigation	Consultant/ year	Timing of investigations	Season	Methodologies and notes
Pre-clearing surveys associated with geotechnical investigations to support EPBC Referral 2018-8263 and inform the Gowrie to Kagaru Geotechnical Investigations Environmental Management Plan	EMM (2018c, 2018d, 2019c)	4-14 September 2018 26-28 November 2018 14-29 May 2019	Spring (2018) Autumn (2019)	Threatened fauna habitat assessments within/adjacent to alignment Searches for fauna breeding places TEC confirmation Fauna observations Carried out at 137 sites throughout H2C alignment
Protected plant surveys associated with geotechnical investigations for H2C alignment	ELA (2019a)	December 2018 and February 2019	Summer/Autumn (2018/2019)	Protected plant surveys within/adjacent to alignment (meander surveys – minimum 30 minutes) at 11 sites throughout alignment (covering 24.72 ha)
Pre-clearing surveys associated with geotechnical investigations for H2C alignment	ELA (2019b)	December 2018 and April 2019	Summer/Autumn (2018/2019)	Threatened fauna habitat surveys within/adjacent to alignment Koala habitat assessment Searches for fauna breeding places Fauna observations TEC confirmation Carried out at 269 sites and additional access tracks throughout the MNES study area

Table note:

Methodology regarding aquatic surveys is discussed further in Section 3.3.3.3.

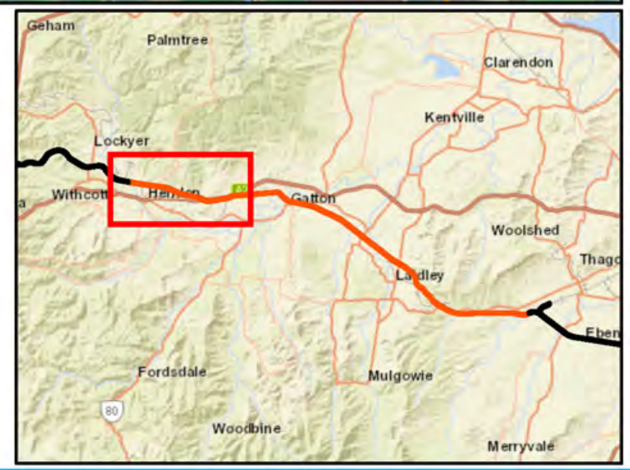
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map by: GN/AD Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig3.2_Locations_historic_concurrent_v2.mxd Date: 8/05/2020 15:29



Legend

- 5 Chainage (km)
- Localities
- Supplementary fauna survey point (ELA)
- Supplementary flora survey point (ELA/EMM)
- Supplementary terrestrial ecology survey point (Arup)
- Existing rail
- G2H project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas



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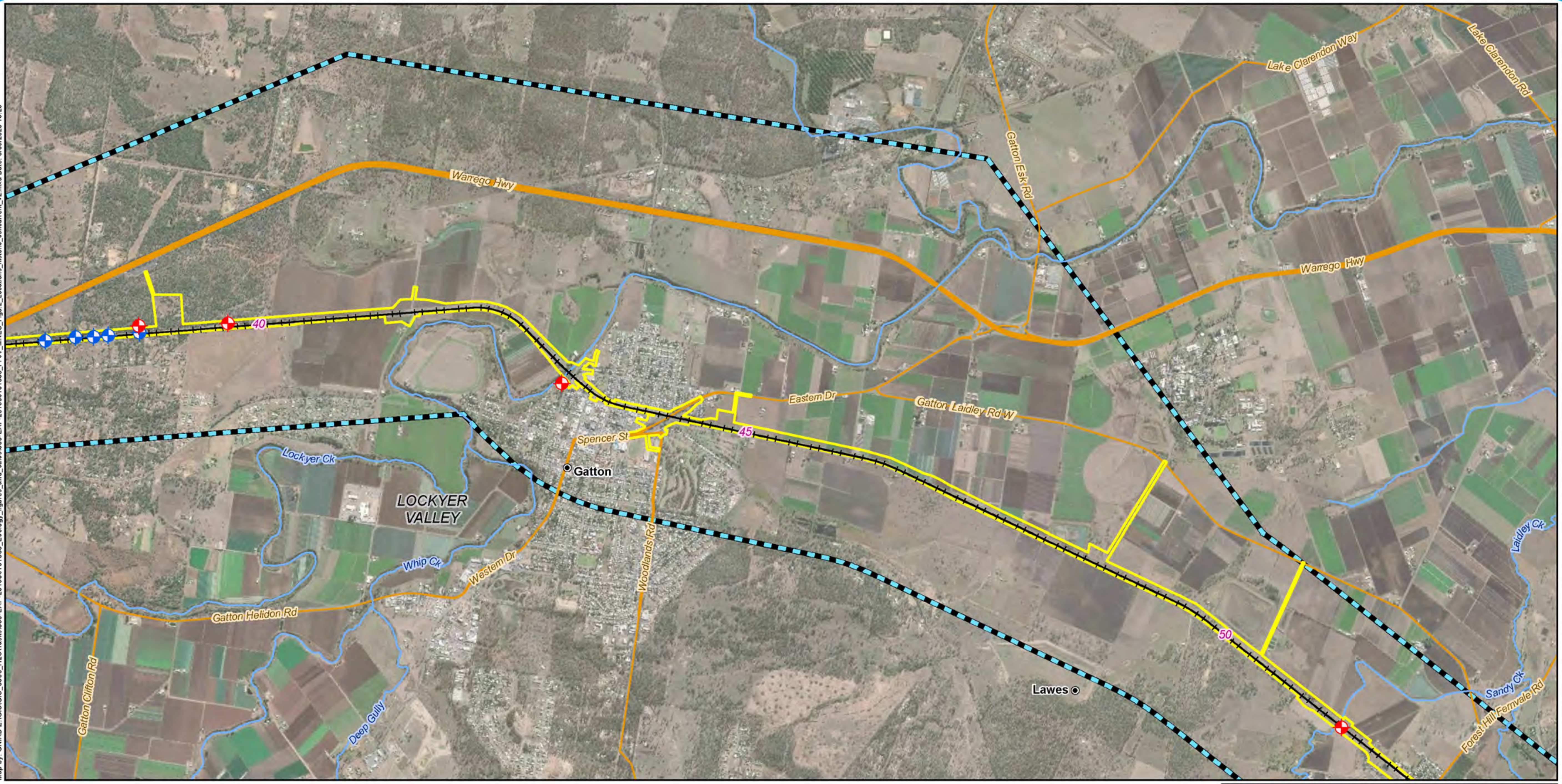
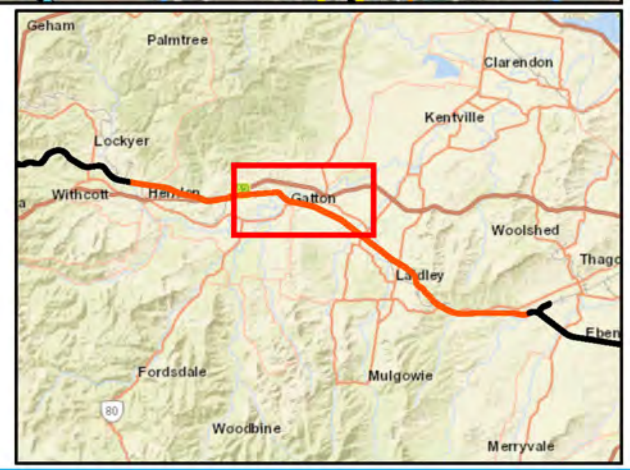
Helidon to Calvert

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

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map by: GN/AD Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig3.2_Locations_historic_concurrent_v2.mxd Date: 8/05/2020 15:29





Legend

- 5 Chainage (km)
- Localities
- Supplementary fauna survey point (ELA)
- Supplementary flora survey point (ELA/EMM)
- Supplementary terrestrial ecology survey point (Arup)
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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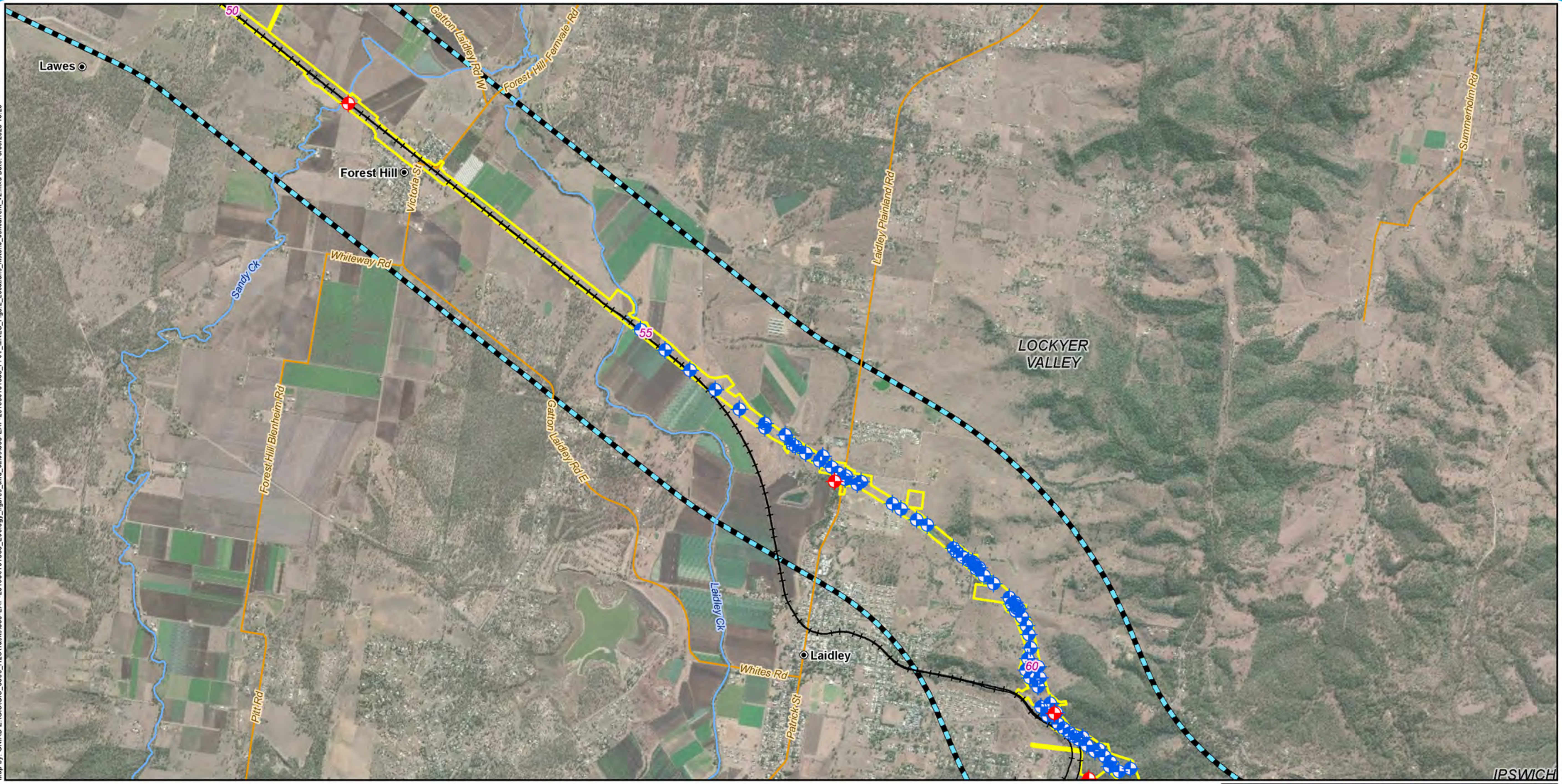
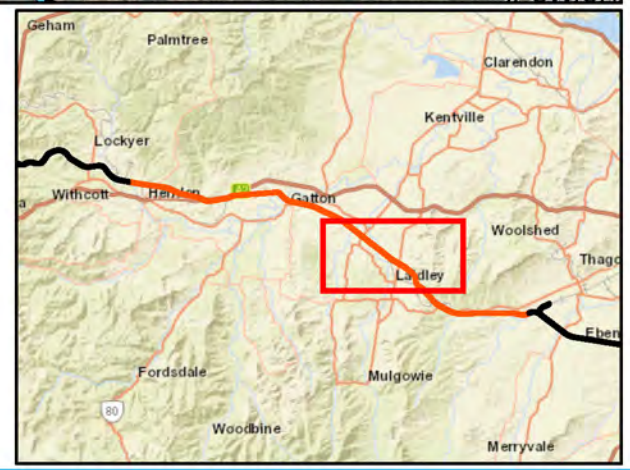
Issue date: 08/05/2020 Version: 2
Coordinate System: GDA 1994 MGA Zone 56

Helidon to Calvert

Figure 3.2b: Location of areas sampled as part of historic and concurrent works

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





Map by: GN/AD Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig3.2_Locations_historic_concurrent_v2.mxd Date: 8/05/2020 15:29

Legend

- 5 Chainage (km)
- Localities
- Supplementary fauna survey point (ELA)
- Supplementary flora survey point (ELA/EMM)
- Supplementary terrestrial ecology survey point (Arup)
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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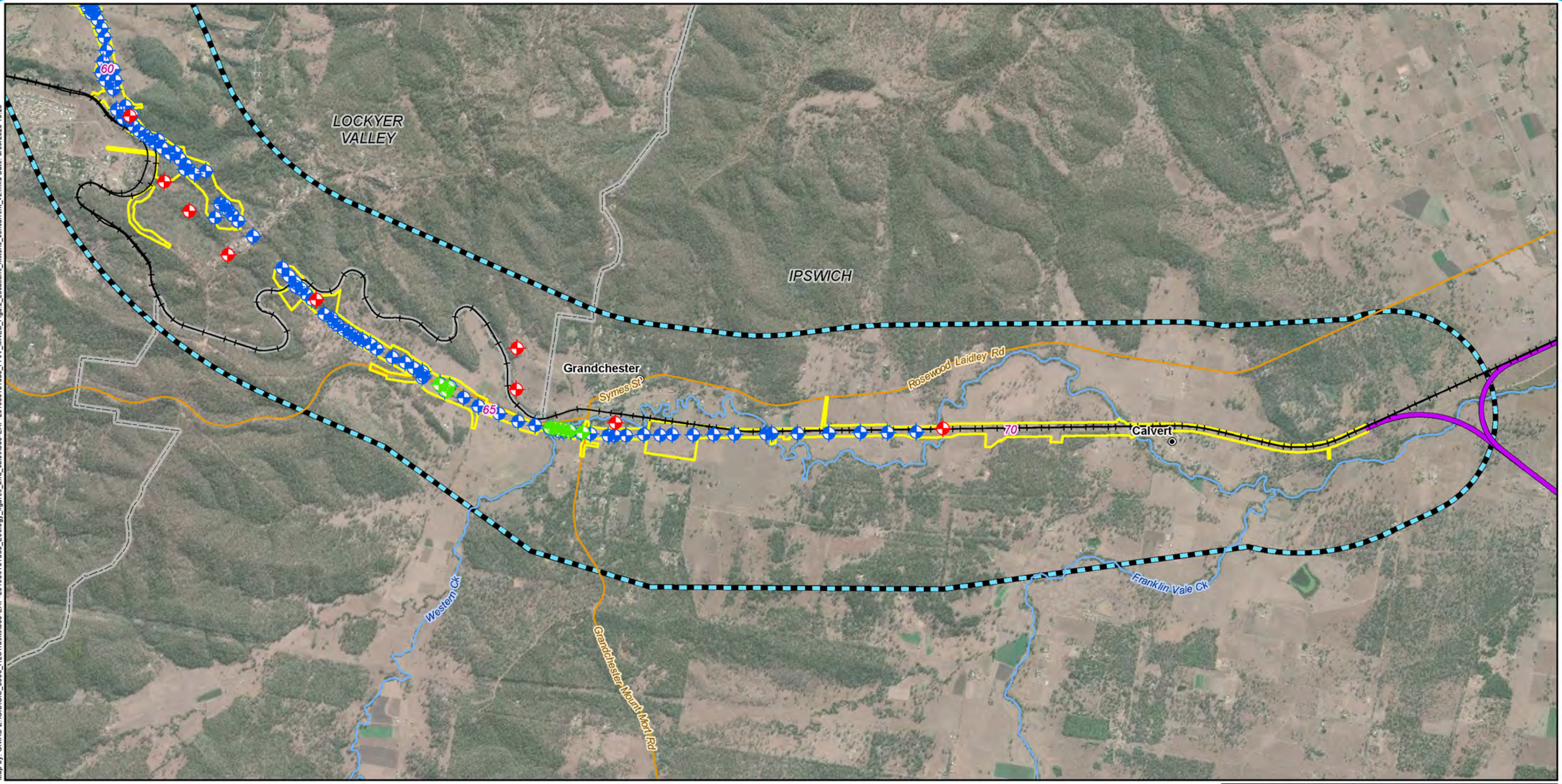
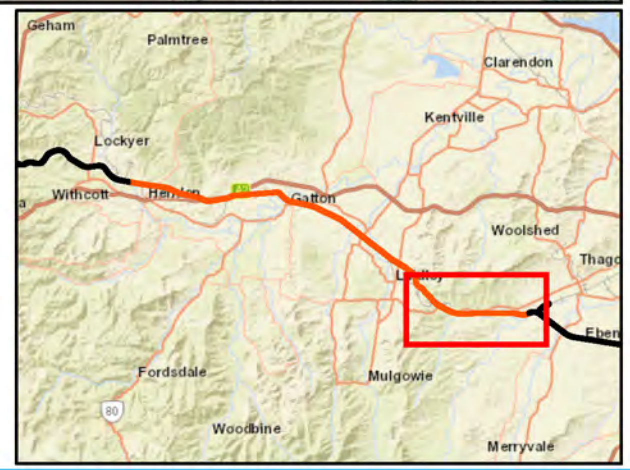
Coordinate System: GDA 1994 MGA Zone 56

Helidon to Calvert

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

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





Legend

- 5 Chainage (km)
- Localities
- Supplementary fauna survey point (ELA)
- Supplementary flora survey point (ELA/EMM)
- Supplementary terrestrial ecology survey point (Arup)
- Existing rail
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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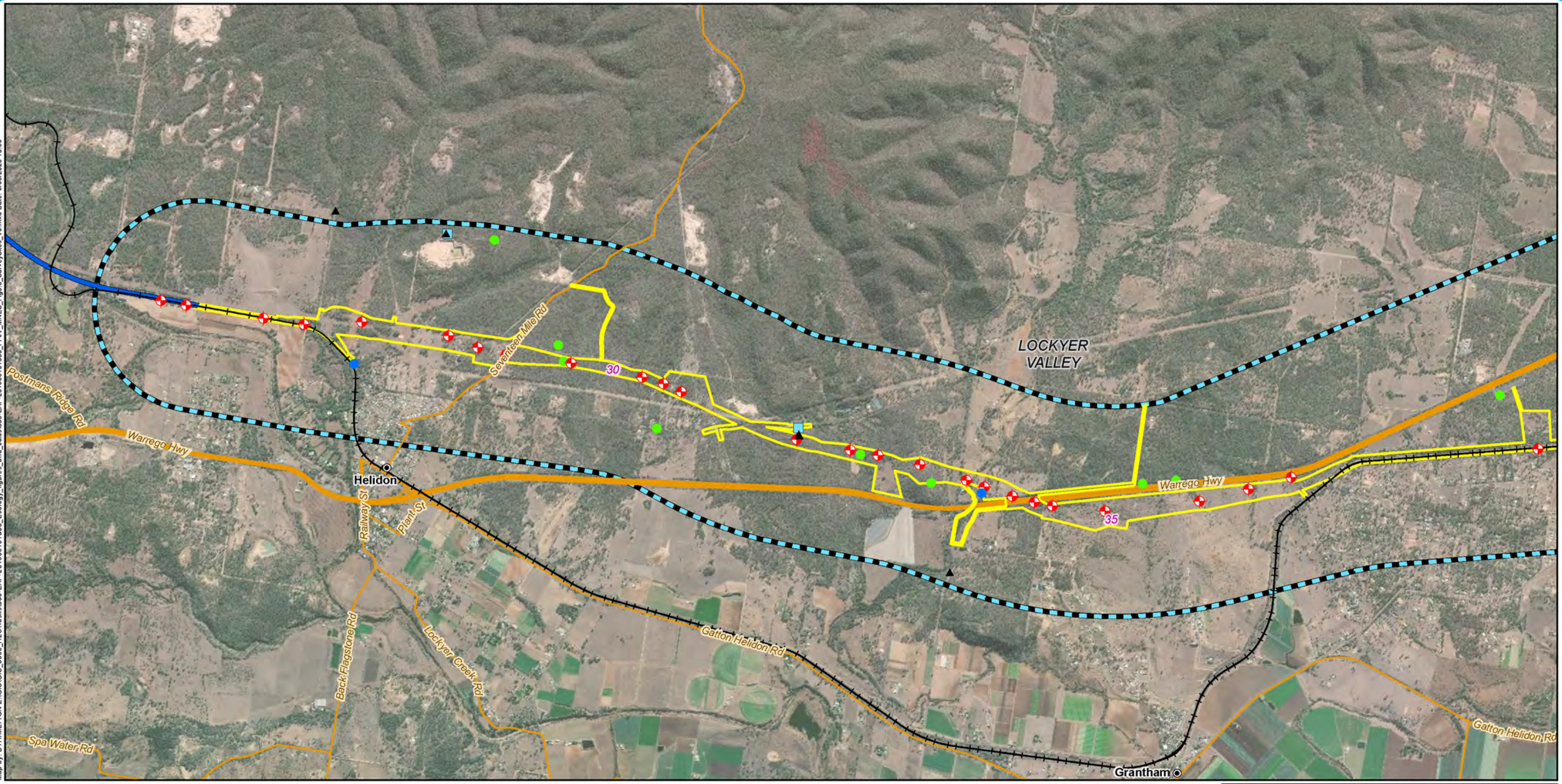
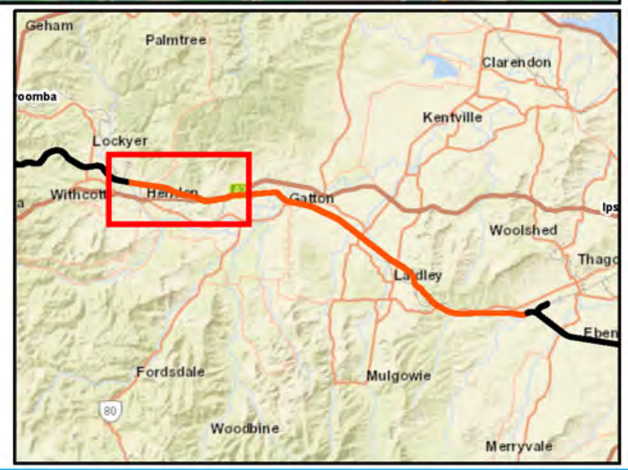
Helidon to Calvert

Figure 3.2d: Location of areas sampled as part of historic and concurrent works

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map by: DTH/MEF/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig3.3_SurveySites_V5.mxd Date: 5/05/2020 13:50





Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Terrestrial sampling sites
- Opportunistic surveys
- Camera sites
- Anabat sites
- Existing rail
- G2H project alignment
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

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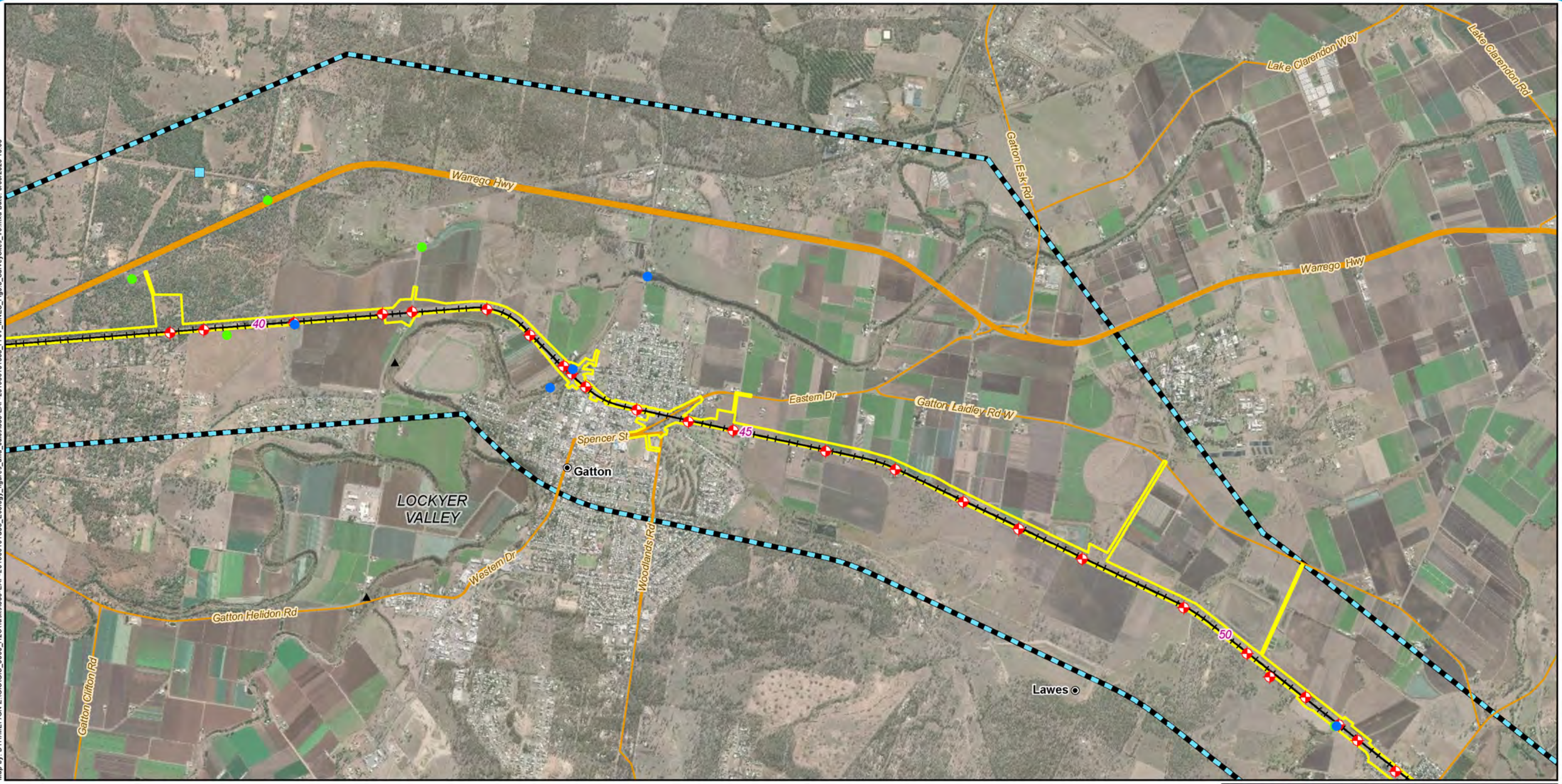
Helidon to Calvert

Figure 3.3a:

Location of sampling locations within the Project MNES study area

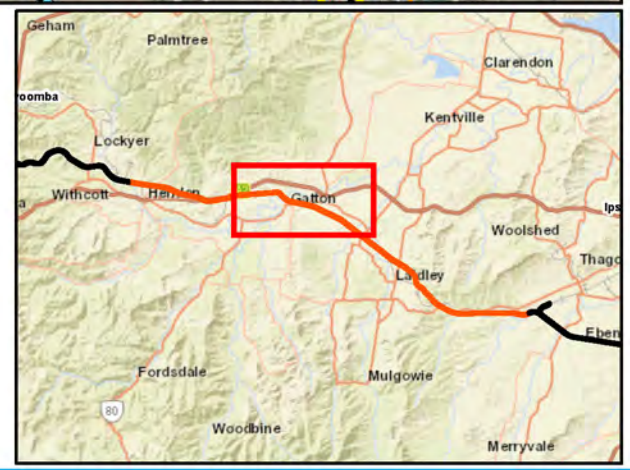
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: DTH/MEF/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_cales\330-EAP-201906101333_FFJV_MNES_Fig3.3_SurveySites_V5.mxd Date: 5/05/2020 13:50

Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Terrestrial sampling sites
- Opportunistic surveys
- Camera sites
- Anabat sites
- Existing rail
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

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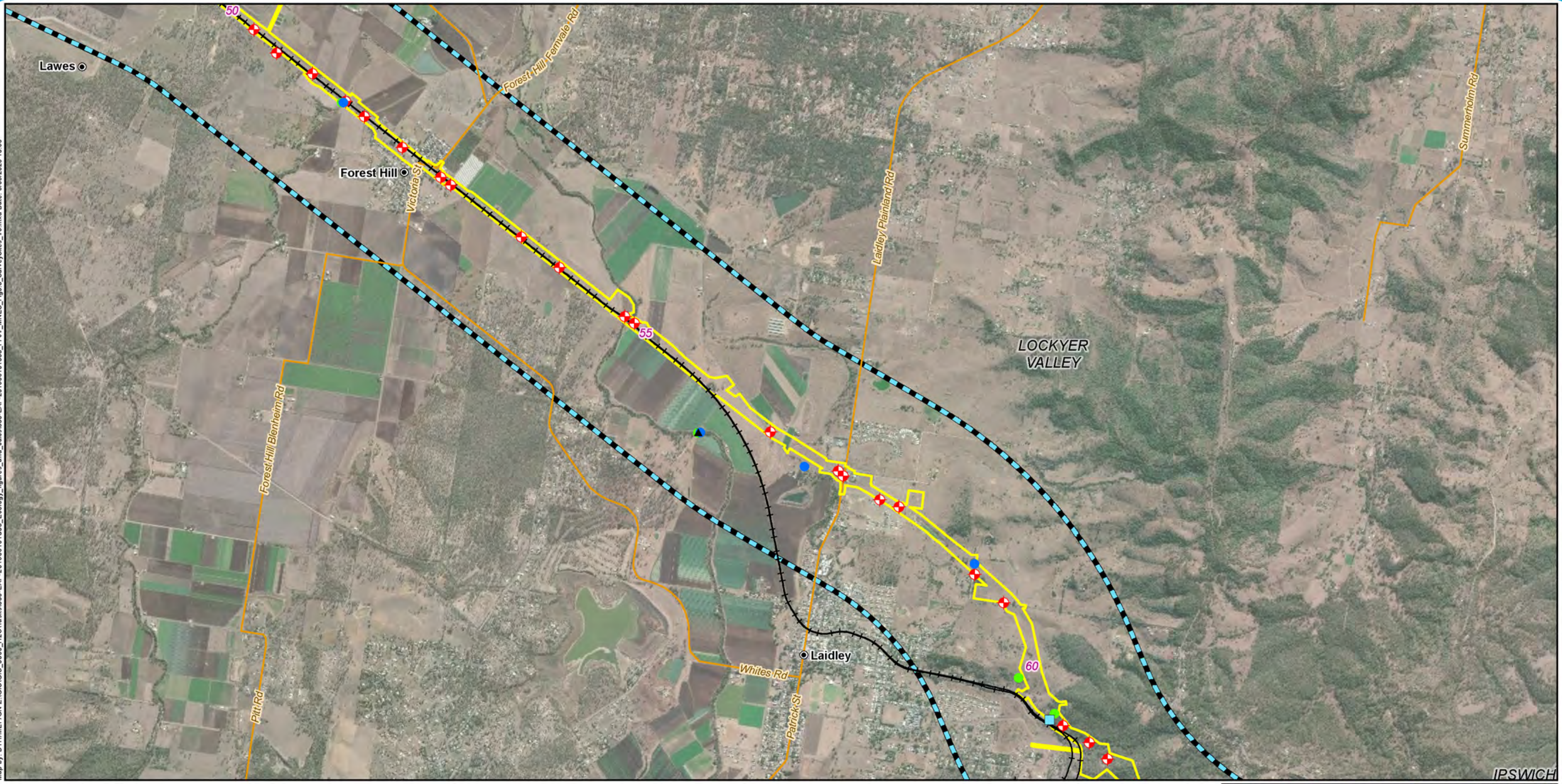
Integrating Community, Environment and Engineering

Issue date: 05/05/2020 Version: 5
Coordinate System: GDA 1994 MGA Zone 56

Helidon to Calvert
Figure 3.3b:
Location of sampling locations within the Project MNES study area

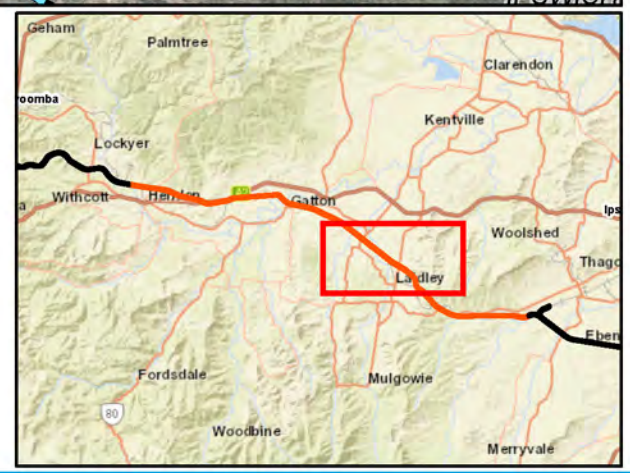
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: DTH/MEF/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_cales\330-EAP-201906101333_FFJV_MNES_Fig3.3_SurveySites_V5.mxd Date: 5/05/2020 13:50

Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Terrestrial sampling sites
- Opportunistic surveys
- Camera sites
- Anabat sites
- Existing rail
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

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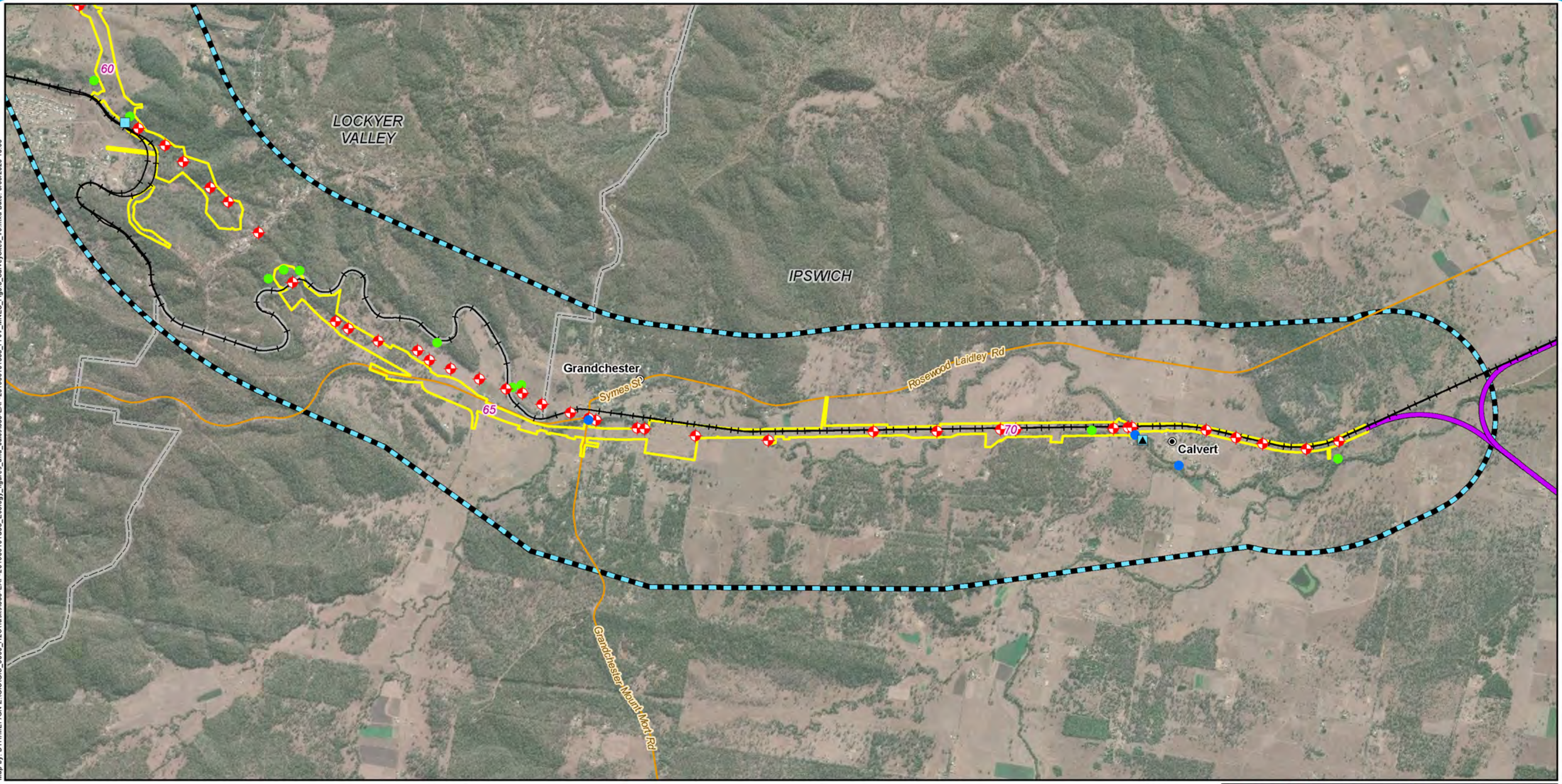
Helidon to Calvert
Figure 3.3c:
Location of sampling locations within the Project MNES study area

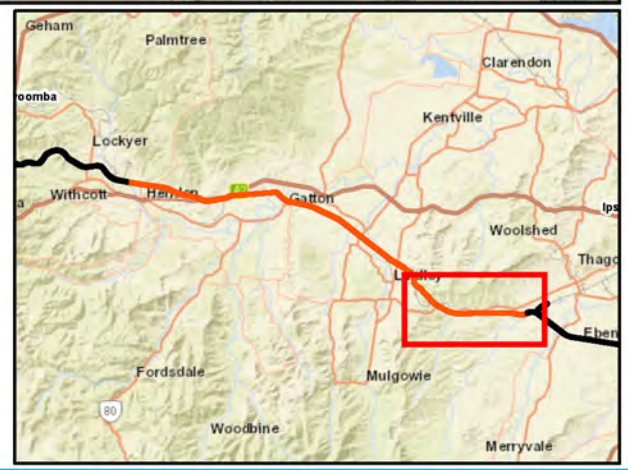
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: DTH/MEF/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig3.3_SurveySites_V5.mxd Date: 5/05/2020 13:50

Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Terrestrial sampling sites
- Opportunistic surveys
- Camera sites
- Anabat sites
- Existing rail
- C2K project alignment
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

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Coordinate System: GDA 1994 MGA Zone 56

Helidon to Calvert
Figure 3.3d:
Location of sampling locations within the Project MNES study area

3.3.2 Project ecological studies

Following the desktop study, sites were selected which were specifically identified as containing features of interest. Terrestrial ecology surveys were carried out at 26 sites and aquatic ecology surveys were carried out at 17 sites. Specifically, the following features were used to target 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)
- Containing landscape features that were considered likely to support threatened species when viewed from aerial photography (i.e. gilgai areas, wetlands and escarpments)
- Known or predicted to support threatened species
- Identified as containing or potentially containing EPBC Act listed TECs
- With waterways which will be potentially impacted by the Project
- 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 (refer Sections 3.3.3.1 and 3.3.3.2 or datasheets in Appendix G and Appendix H). Wetland assessments were carried out in instances where wetland indicators were present (e.g. macrophytes, topography consistent with wetlands or areas mapped as a wetland). The location of terrestrial and aquatic assessment survey sites within the MNES study area, and the date of assessment, are presented in Table 3.5 and shown in Figure 3.3. In addition, opportunistic fauna sampling locations are provided in Figure 3.3.

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

Site ID	Site location (GDA94)		Date assessed
	Latitude	Longitude	
Terrestrial ecology survey sites			
T2	-27.542124	152.261631	22 September 2017
T3	-27.5398618	152.142731	26 September 2017
T4	-27.5412823	152.143247	26 September 2017
T5	-27.5471236	152.152185	26 September 2017
T6	-27.5494628	152.171836	25 September 2017
T7	-27.5519496	152.178633	18 September 2017
T8	-27.5521229	152.199051	24 September 2017
T9	-27.5518616	152.202274	24 September 2017
T10	-27.5446987	152.233621	24 September 2017
T11	-27.5379911	152.246792	24 September 2017
T12	-27.5496055	152.242742	22 September 2017
T14	-27.5837466	152.349497	22 September 2017
T15	-27.6123215	152.383754	22 September 2017
T16	-27.6334983	152.414612	23 September 2017
T17	-27.6366002	152.418062	23 September 2017
T19	-27.650621	152.43138	21 September 2017
T20	-27.6499563	152.434404	21 September 2017
T21	-27.6498777	152.432833	21 September 2017
T23	-27.6562025	152.447643	19 September 2017
T24	-27.660068	152.454903	25 September 2017

Site ID	Site location (GDA94)		Date assessed
	Latitude	Longitude	
T25	-27.6598818	152.455766	25 September 2017
T26	-27.6890756	152.462416	19 September 2017
T27	-27.6640052	152.510872	19 September 2017
T28	-27.6648618	152.515745	19 September 2017
T29	-27.6665154	152.534648	19 September 2017
New E	-27.5307878	152.136645	25 September 2017
Aquatic ecology survey sites			
H2C 1A	-27.5528474	152.183508	10 October 2017
H2C 2A	-27.5487085	152.249294	12 October 2017
H2C 3A	-27.5542918	152.273942	12 October 2017
H2C 4A	-27.5527001	152.276136	9 October 2017
H2C 5A	-27.5837446	152.349692	10 October 2017
H2C 7A	-27.6152834	152.394006	11 October 2017
H2C 8A	-27.623664	152.410394	11 October 2017
H2C 9A	-27.6629196	152.462253	11 October 2017
H2C 10A	-27.664389	152.515044	11 October 2017
H2C 11A	-27.5507779	152.120564	9 October 2017
H2C 12A	-27.5447612	152.283386	10 October 2017
H2C 13A	-27.5814724	152.367306	10 October 2017
H2C 14A	-27.6123168	152.384017	12 October 2017
H2C 15A	-27.541364	152.123031	12 October 2017
H2C 16A	-27.5960112	152.343383	13 October 2017
H2C 17A	-27.6321585	152.386594	13 October 2017
H2C 18A	-27.6670612	152.519272	13 October 2017

3.3.3 Matters of national environmental significance

3.3.3.1 Flora, vegetation community and wetland field assessment

At each survey site targeted for the FFJV EIS studies, a list of all flora species and TECs encountered were recorded and documented. In addition, any wetlands or other notable features relevant to MNES were identified and documented. In addition to specific target areas, opportunistic observations across the MNES study 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 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 (including remnant, regrowth and non-remnant communities) and, wetlands or any other features relevant to MNES identified during the desktop component, was undertaken in the field (refer Section 4.4). The following approach to sampling was applied:

- Within a representative of each different type of vegetation or feature identified from aerial imagery, an intensive survey occurred, which included an assessment of the relative species density and diversity within the emergent, 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. (2012; 2017). Survey transects approximated 100 m in length and 20 m in width. Where applicable (e.g. wetland or spring features were present) spring and wetland verification was undertaken by assessing the presence of wetland features related to floristic communities, wetland indicators, signs of flooding and topography.
- 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. (2012; 2017) (refer Appendix G for site vegetation assessment datasheets)

A representation of the predictive flora habitat modelling for MNES listed species (i.e. flora) (refer Section 3.2.5) was verified where applicable during site field investigations throughout the MNES study area. In addition, where present wetlands and springs were verified, this information fed back into the GIS system and was used to refine the predictive habitat modelling, wetlands and springs mapping as appropriate (refer Figure 3.1) and noting where wetlands and water courses were dry during the surveys.

Where a threatened species was observed, these areas were elevated in status to either *potential habitat* (for areas that were not currently mapped as *potential habitat* for the species), or *Habitat critical to the survival of the species* (for locations that were already included within the *potential habitat* mapping layer) (refer Section 3.2.5 for further detailed information).

Protected plant surveys

In addition to the methodologies presented above, a random meander survey was undertaken at each target and each opportunistic site (regardless of their inclusion/exclusion from 'High Risk' areas identified in the QLD 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 (DEHP 2016)) until no new flora species were identified for 30 minutes following the recording of the last identified flora species. As such, 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 EPBC Act listed flora species encountered, were submitted with the Queensland Herbarium for incorporation into the HERBRECS database, and all flora survey records were submitted to the DES as part of FFJV's scientific purposes licencing commitments.

The random meander survey method was also employed at sites within and adjacent to the Project disturbance footprint associated with vegetation clearing for geotechnical works (largely boreholes and access tracks) (EMM 2018a; 2019a, 2019b; ELA 2019a). As per the QLD protected plant survey guidelines (DEHP 2016), 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).

Survey effort

In addition to the targeted EIS study survey locations identified in Table 3.5 (26 sites within the MNES study area) and initial flora studies carried out by Arup-Smec in 2016 (16 sites within the MNES study area) 100 opportunistic surveys associated with geotechnical investigations were undertaken by FFJV personnel, specifically targeting areas largely within the disturbance footprint. The location of opportunistic surveys is shown in Figure 3.2a-d. With regard to survey effort, a total area of approximately 365 ha was assessed (i.e. 79 ha associated with targeted surveys and 286 ha associated with opportunistic investigations). This represents approximately 3.3 per cent of the MNES study area and more than 50 per cent of the disturbance footprint.

Protected plant surveys were also carried out during 2018 and 2019 (refer Table 3.2) by EMM (2018b, 2018c) and Ecological (2019a). This includes surveys at an additional 26 sites within and adjacent to the Project disturbance footprint. The methods employed are considered to provide an acceptable level of survey effort to sufficiently inform an assessment against the MNES Guidelines for MNES flora species.

3.3.3.2 Fauna field assessments

Assessments for EPBC Act listed species were conducted for the EIS studies (FFJV) with the following objectives:

- Validation of the predictive habitat mapping where applicable
- Use of specific techniques to identify EPBC Act listed species and their habitat where present.

In addition to the techniques identified above, the use of existing datasets, historic records and the formulation of the predictive habitat models for EPBC Act listed species provided a comprehensive assessment of the MNES fauna habitat contained within the MNES study area, that is considered to incorporate seasonal (i.e. temporal) variation and takes a precautionary approach to EPBC Act listed species contained within the MNES study area.

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

Fauna habitat assessments

At each vegetation assessment location (refer 'terrestrial sampling sites' in Figure 3.2a-d), an assessment of fauna habitat features, and a record of all fauna species encountered was undertaken (a total of 26 sites). Fauna habitat assessments were also undertaken within the MNES study area by Arup-Smec (2016) (a total of 16 sites). Fauna habitat features recorded included, but was not limited to:

- Level of disturbance (scale of 0 to nil and 3 to severe) relating to the following:
  - Fire
  - Grazing
  - Clearing
  - Erosion.
- List of threatened fauna species that are likely to utilise the area based on available habitat types (based on database search results and predictive habitat mapping)
- Abundance of tree hollows present in the following categories:
  - > 30 cm diameter
  - >15 cm but < 30 cm diameter
  - >10 cm but <15 cm diameter
  - >5 cm but <10 cm diameter
  - < 5 cm diameter.
- Amount of fallen logs (>10 cm diameter)
- Amount of coarse woody debris (<10 cm diameter)
- Quantity of trees with decorticating bark
- Percentage of groundcover containing the following:
  - Leaf litter
  - Bare ground

- Grasses
- Soil cracks
- Surface rocks
- Non-native flora species (e.g. weeds).

- Presence/quantity of:
  - Soil banks (e.g. river beds/road cuttings)
  - Boulders
  - Wetlands/drainage features.
- Relative abundance of the following:
  - Flowers
  - Fruit.

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

Targeted fauna survey methods

When 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 MNES fauna include the following:

- Anabat devices (Microchiropteran bats) were deployed at five sites (overnight) for a total survey effort of five detector nights (refer Figure 3.3a-d for locations)
- Area searches for nests of the Red goshawk (*Erythrotriorchis radiatus*) in suitable riparian areas during the EIS studies and by EMM (2018c, 2018d, 2019c) and ELA (2019b) during targeted pre-clearance surveys (refer Figure 3.2a-d for locations)
- Active searches for feeding platelets of the Black-breasted button quail (*Turnix melanogaster*) within suitable habitat for the EIS studies and by Arup/SMEC (2016)
- Standardised surveys for all birds which is suitable for all MNES species including the Swift parrot (*Lathamus discolor*), Painted honeyeater (*Grantiella picta*) and Australian painted snipe (*Rostratula australis*) 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 Figure 3.3a-d for locations).
- Active searches for Koala (*Phascolarctos cinereus*) at all EIS assessment sites (refer 'fauna ecology survey site in Figure 3.3a-d for locations), their pellets and scratches were undertaken for the EIS studies and across Project-associated studies by Arup/SMEC (2016) and ELA (2019b) (refer Figure 3.2a-d for locations)
- Active search for latrine sites and dens for the Spotted-tail quoll (*Dasyurus maculatus*) within suitable rocky habitat for the EIS studies and Arup/SMEC (2016)
- Active searches for Brush-tailed rock wallaby (*Petrogale penicillata*) and their pellets which were validated by experts at Queensland Museum for confirmation. Searches for signs and habitat resources are considered an adequate form of survey method for detecting this species, as long as all suitable rocky habitat including mid-level ledges and holes are inspected for signs of activity (DSEWPaC 2011a). Carried out for the EIS studies, Arup/Smec (2016) and ELA (2019b).

- Active searches for reptiles at all EIS assessment sites including the Collared delma (*Delma torquata*). 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 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 F 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 at watering points and/or at baited feeding stations (mammals and birds) – nine sites (overnight) (refer Figure 3.3a-d for locations).

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, 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, defendable and repeatable.

Preclearance habitat surveys

In addition to the fauna survey methods employed for the EIS studies identified above (i.e. surveys carried out by FFJV and Arup in 2016) a large number of 'preclearance surveys' associated with vegetation clearing for geotechnical works (largely boreholes and access tracks) have been carried out 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 137 locations (EMM 2018d, 2018e) and 269 locations (ELA 2019b) throughout the Project disturbance footprint and immediate surrounds.

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
- Assessment of Koala microhabitat incorporating evidence of koalas in the area (e.g. sightings, scratches and scats), food tree abundance, tree species and habitat context (ELA survey locations only)
- Incidental fauna observations recorded.

3.3.3.3 Aquatic surveys

Aquatic habitat assessments

A total of 16 sites were selected for aquatic habitat assessments based on wetland and watercourse mapping and land access (refer Table 3.5). The aquatic habitat assessments described the environmental values of targeted watercourses (to assess existing environmental condition proximal to, and where the Project alignment intersects watercourses) within the MNES study area. The Australian River Assessment System (AUSRIVAS) Physical Assessment Protocol (Parsons et al. 2002) was used in the field assessment of the drainage systems.

The key geomorphological, physical habitat and riparian data which was collected at each assessment site included:

- Valley characteristics, including valley shape and channel slope
- Land use, including catchment land use and local land use
- Physical morphology and bedform of the watercourse, including channel shape and extent and type of bars
- Cross sectional dimensions of the watercourse, including bank full channel width and depth, bank width and height and baseflow stream width and depth
- Substrate characteristics, including bed compaction, sediment angularity, bed stability rating, sediment matrix and substrate composition
- Floodplain characteristics, including floodplain width and features
- Bank characteristics, including bank shape and slope, bank material, bedrock outcrops, factors affecting bank stability and artificial bank protection measures
- Instream vegetation and organic matter, including extent of large woody debris, macrophyte cover and species composition
- Physical condition indicators and habitat assessment
- Riparian vegetation characteristics, including shading of channel, extent of trailing bank vegetation, species compositions, riparian zone width and extent of disturbance.

At each aquatic ecology sampling location, an AUSRIVAS physical assessment protocol was completed to assess the existing physical habitat values of the waterway. Where water was present, a surface water quality sample was collected (refer Section 3.3.3). The habitat value of each aquatic ecology assessment site was assessed to predict the nature of faunal assemblages utilising the watercourse. Due to the locality of the disturbance footprint, the habitat assessment was conducted for low gradient flow watercourses. Habitat scores were produced as a sum of the scores for each of the assessment parameters and were then broadly associated with category thresholds of poor (0 to 25 per cent), fair (25 to 50 per cent), good (50 to 75 per cent), and, excellent (75 to 100 per cent).

In addition, surface water quality sampling was conducted at aquatic habitat assessment sites. Three discrete water sampling events were carried out: one spring (October 2017); and two autumn assessments (March 2018 and 2019). Watercourse flow was limited; however, this was consistent with the highly seasonal, and sporadic flow regimes throughout the water quality study area. Noting the seasonal flow regimes of the watercourses, timing of the assessments was chosen in order to capture dry or wet condition water quality samples.

In-situ water quality field data was collected during each monitoring round in addition to samples collected for laboratory analysis. Sampling could not be undertaken at all habitat assessment sites due to a lack of adequate water (i.e. dry conditions) and land access at the time of the water quality assessments. As such, 12 of the original 18 aquatic habitat sites (refer Table 3.5) were used for the existing water quality assessment. It was not possible to collect water samples at all 12 locations during each of the 3 sample events due to the sites being dry and/or inaccessible at the time of the site visit. The results of the water quality sampling assessments are provided in detail in EIS Chapter 13: Surface Water and Hydrology.

Aquatic fauna surveys

Recordings of incidental fauna species observed during the aquatic field survey were taken at each aquatic ecology assessment site. A sample of aquatic fauna species present at the time of the aquatic sampling was undertaken using two baited traps and dip netting, specifically targeting vertebrate species such as fish and turtles where adequate water was present. Capture and release trapping and netting works associated with fish and turtle assessments was conducted to collect incidental species occurrence data and supplement existing data sets. These works did not exceed two hours at any site to reduce risk of harm to species and minimise field survey effort, whilst dip netting was completed on an incidental basis to address size-specific constraints associated with baited traps.

Field verification of predictive fauna habitat mapping was undertaken by comparing the species-specific habitat assumptions derived from the desktop phase, to characteristics observed in the field. Where site-based field observations significantly deviate from the desktop derived habitat assumptions, these areas were removed from the predictive habitat mapping. In addition, where a threatened species was observed, these areas were elevated in status to either Potential habitat (for areas that were not currently mapped as potential habitat for the species), or Critical habitat (for locations that were already included within the potential habitat mapping layer) (refer Section 3.2.5 and Appendix A for further detailed information).

3.3.4 Permits to conduct works

The ecological field surveys undertaken by FFJV, reported in this document were conducted under the provisions of Aurecon's Scientific Purposes Permit (WISP14453114), General fisheries permit (182654) and Animal ethics approval for General Fish Surveys (CA 2015/01/833) and General Terrestrial Surveys (CA 2015/03/846) and AECOM's Scientific Purposes Permit (WISP16615015) and Animal ethics approval for fauna surveys in Queensland (CA 2015/01/834).

3.3.5 Quality assurance/quality control

Quality assurance/quality control 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 (DEHP 2016) was present within each survey team
- A portion of any potential MNES flora species encountered, or species that could not be confidently identified during field reconnaissance, 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.
- A portion of any potential threatened flora species encountered, or species that could not be confidently identified during field recognisance, was submitted to the Queensland Herbarium for verification/identification
- Scats that were collected in the field were taken to the Queensland Museum for species confirmation
- Any threatened fauna species had to be sighted/confirmed by both member of the field team to produce a confirmed record. Where applicable/possible, proof (e.g. photograph, scat or other evidence) was collected
- Surface water quality sampling was conducted in accordance with industry-accepted standards and quality assured procedures. Field quality control included rigorous sample collection, decontamination procedures (where appropriate), and sample documentation. As each sample was collected it was labelled with a unique sample identifier, the initials of the sampler, the date and the project number. All sample jars were filled leaving no headspace and placed immediately into ice-filled cooler boxes. All samples were transported in ice-filled coolers to prevent degradation of organic compounds. Chain of Custody (CoC) documentation was completed, with data including sample identification, date sampled, matrix type, preservation method, analyses required and name of sampler. Field data monitoring equipment was fully serviced and calibrated prior to use.

3.3.6 Nomenclature

3.3.6.1 Flora

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

3.3.6.2 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 (2017) for reptiles
- Pizzey and Knight (2012) for birds
- Menkhorst and Knight (2010) for mammals
- Pusey, Kennard and Arthington (2004) for freshwater fish.

3.4 Impact assessment

The MNES assessment of the Project uses a significance-based impact assessment framework to identify and assess potential Project related impacts in relation to MNES. Initial impact assessment was undertaken to identify MNES where they may be subject to significant impacts (refer Section 3.4.3). Where impacts were identified as potentially significant, these were subject to assessment against the MNES significant impact assessment guidelines 1.1 (refer Sections 5.3.3, 5.3.4 and 5.3.5).

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

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

3.4.1 Magnitude of impacts

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

Table 3.6 Criteria for magnitude

Magnitude	Description
Major	An impact that is widespread, permanent and results in substantial irreversible change to the MNES. Avoidance through appropriate design responses or the implementation of environmental management controls are required to address the impact (e.g. greater than 50 per cent 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 MNES. 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 per cent of the habitat within the greater area disturbed).

Magnitude	Description
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 per cent 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 per cent 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 per cent of the habitat within the greater area disturbed).

Table note:

* 'Greater area disturbed' refers to the wider area within which the proposed impact is situated and compared against (e.g. the MNES study area).

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

Table 3.7 Timeframes for predicted Project activity impact duration

Duration term	Timeframe – to be defined for each activity type (refer Table 5.1)
Temporary	Days to months (e.g. 1 to 2 seasons; 3 to 6 months)
Short term	Up to 2 years (i.e. 6 to 24 months)
Medium term	From 2 to 10 years[1]
Long term/long lasting	From 11 to 20 years[2]
Permanent or irreversible	More than 21 years[3]

Table notes:

1 Derived from the term 'moderate' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)
2 Derived from the term 'major' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)
3 Derived from the term 'catastrophic' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)

3.4.2 Sensitivity

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

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

Each particular environmental value assessed (MNES in this case) is treated individually (i.e. MNES are not treated collectively). In the case where there are conflicting classes, the "worst-case" is taken.

Table 3.8 Sensitivity criteria for sensitive matters of national environmental significance within the study area

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

Table note:

Low and negligible sensitivity criteria shown in Table 3.9: Significance assessment matrix are not included in this table as they are not considered applicable to MNES.

3.4.3 Initial assessment of the significance of total impact

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

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

Table 3.9 Significance assessment matrix

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

Table 3.10 Significance classifications

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

Significance ratings of Low, Moderate, High and Major constitute a potential significant residual impact to an MNES and are assessed against the *MNES Significant impact guidelines 1.1* (DotE 2013a) Guidelines to confirm the initial impact assessment results (refer Sections 5.3.3, 5.3.4 and 5.3.5).

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

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

- Construction
- Commissioning and reinstatement
- Operation

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

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

Following the initial assessment of significance (refer Section 3.4.3), assessment of impacts to MNES that returned a mitigated initial significance rating of Major, High, Moderate or Low was undertaken. MNES that returned a rating of Negligible, or those MNES for which habitat had not been identified within the MNES study area, were omitted from assessment against the MNES Guidelines. Relevant MNES were assessed against the following guidelines as applicable:

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

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

- TECs – Section 5.3.3
- Threatened flora species – Section 5.3.4
- Threatened fauna species – Section 5.3.5.

3.5 Cumulative impact assessment

3.5.1 Introduction

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

The sections below outline the selected projects to be used in the cumulative impact assessment and the methodology to be applied in undertaking the assessment.

3.5.2 Project selection

Projects for inclusion in the cumulative impact assessment are all those within the Project region meet the following criteria:

- 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 (IAS) is available on the Queensland DSDILGP website
- Are currently being assessed under Part 1 of the Chapter 3 of the Qld *Environmental Protection Act 1994* as per DES website
- 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 Project
- Could potentially compound residual impacts that the Project may have on environmental or social values.

Table 3.11 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 3.11 include infrastructure development projects located in proximity to the Project. It is noted that the Remondis Waste-To-Energy Power Station project (Remondis) located at Swanbank Industrial Estate has not been included as part of the cumulative impact assess as the project is located in a highly disturbed environment and initial investigations indicate the this project will not contribute towards impacts to MNES as identified within this document.

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 assessment 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.

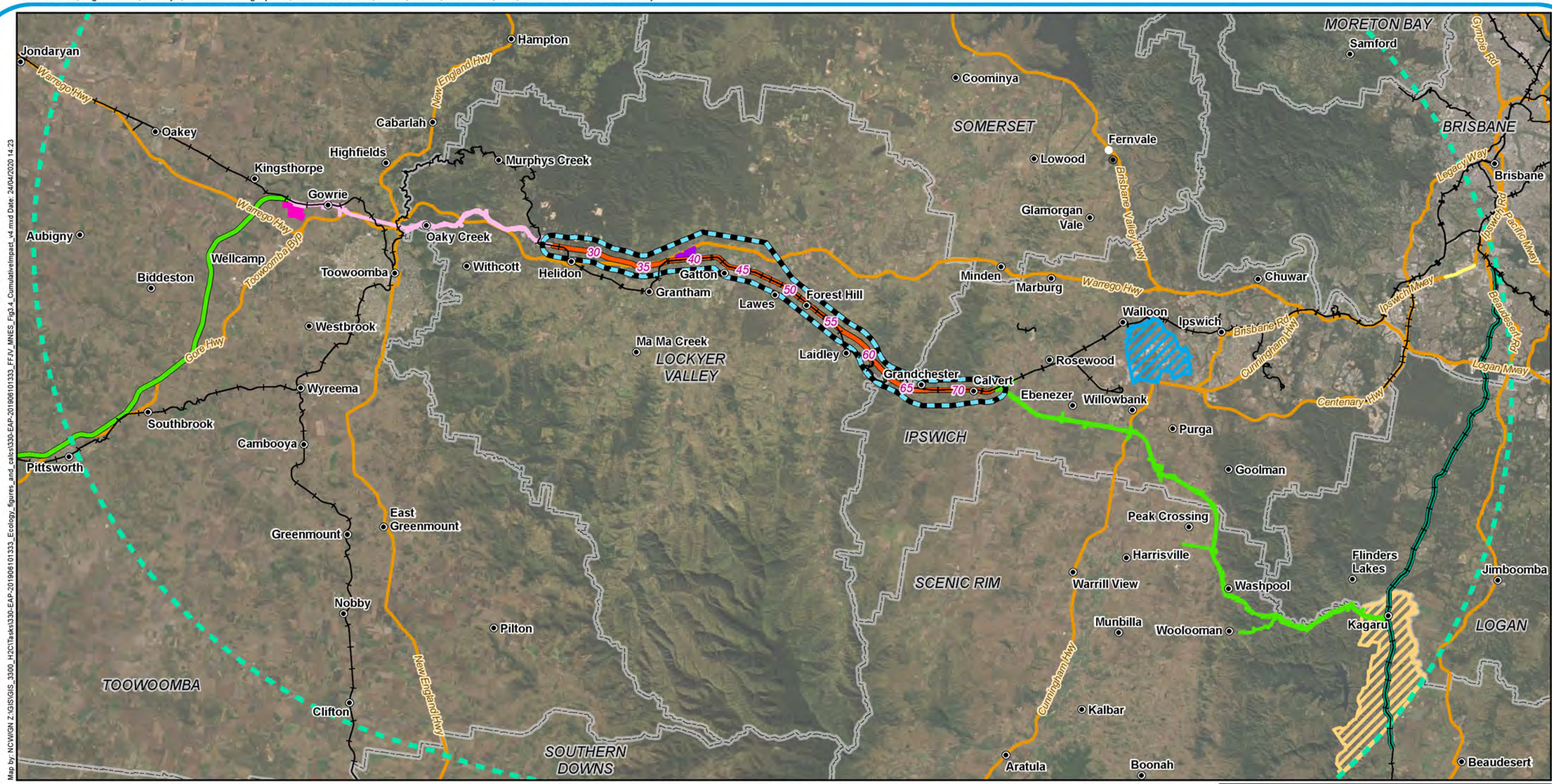
Table 3.11 **Projects to be included in cumulative assessment**

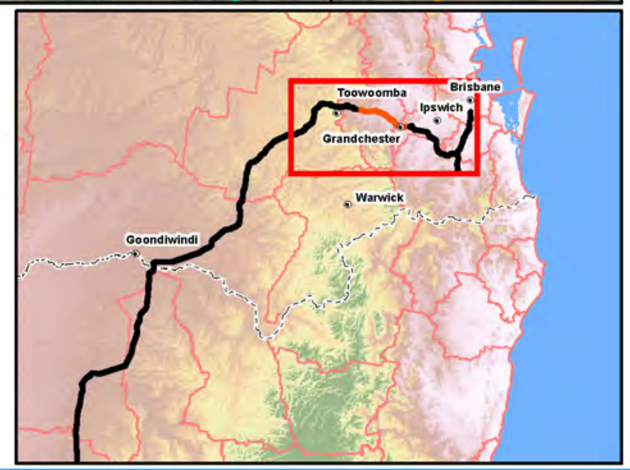
Project and proponent	Location	Description	Source	Project status	Construction dates and jobs	Operation years and jobs	Selection criteria	Relationship to the Project
Gowrie to Helidon (ARTC)	Rail alignment from Gowrie to Helidon	26 km single-track dual-gauge freight railway as part of Inland Rail	http://eisdocs.dsdip.qld.gov.au/Inland%20Rail%20Gowrie%20to%20Helidon/IAS/inlandrail-G2H-final-ias.pdf	ARTC currently preparing EIS Declared a 'controlled action by DotEE – 17/03/2017	2021 to 2026 Jobs: 600	>50 years Jobs: 15 - 20	a), b) & c)	Overlap of construction with H2C and G2H.
Calvert to Kagaru (ARTC)	Rail alignment from Calvert to Kagaru	53 km single-track dual-gauge freight railway as part of Inland Rail	http://eisdocs.dsdip.qld.gov.au/Inland%20Rail%20Calvert%20to%20Kagaru/IAS/initial-advice-statement.pdf	ARTC currently preparing EIS Declared a 'controlled action by DotEE – 21/06/2017	2021 to 2026 Jobs: 620	>50 years Jobs: 15 - 20	a), b) & c)	Overlap of construction for H2C and C2K.
Bromelton State Development Area (QLD Government)	Bromelton, QLD	Delivery of critical infrastructure within the Bromelton SDA will support future development and economic growth. This includes a trunk water main and the Beaudesert Town Centre Bypass. This infrastructure provides opportunities to build on the momentum of current development activities by major landowners in the SDA.	https://www.statedevelopment.qld.gov.au/resources/project/bromelton/bromelton-sda-development-scheme-dec-2017.pdf	The current version of the Bromelton SDA Development Scheme was approved by Governor in Council, December 2017 The Development Scheme is managed by the Coordinator-General	2016 to 2031 Jobs TBA	TBA	c) & d)	Ongoing development at the Bromelton SDA could require deconfliction of construction resources. There may also be an increase of heavy vehicles using the surrounding highways during both construction and operation.
Ipswich Motorway Upgrade Rocklea to Darra (Remaining sections) (DTMR)	Western Brisbane, QLD	Addressing congestion and extensive delays in the Ipswich Motorway corridor by a range of road upgrades along 7 km of Ipswich Motorway between Rocklea and Darra.	https://www.infrastructureaustralia.gov.au/map/ipswich-motorway-upgrade-rocklea-darra-remaining-sections	Project listed on QLD Infrastructure Initiative List – Proponent to complete business case development (Stage 3 of Infrastructure Australia's Assessment Framework)	2016/17 to 2020/21 Jobs: TBA	TBA Jobs: TBA	c)	Construction periods may overlap resulting in conflict in demand for construction resources and traffic volumes on highways.

Project and proponent	Location	Description	Source	Project status	Construction dates and jobs	Operation years and jobs	Selection criteria	Relationship to the Project
RAAF Base Amberley future works (Department of Defence)	RAAF Base Amberley	White paper dedicated future upgrades to RAAF Base Amberley at a cost of $1 billion	http://www.defence.gov.au/id/_Master/docs/Economic/KPMGRAAFAmberleyReport.pdf	N/A	2016 to 2022 7,000 jobs	TBA	c)	Ongoing development at RAAF Base Amberley may see increase in road traffic with heavy vehicles and further increase as the H2C construction occurs
Gatton West Industrial Zone (GWIZ) (Lockyer Valley Regional Council)	3km north west Gatton	Industrial development including a transport and logistics hub on the Warrego highway	https://www.lockyervalley.qld.gov.au/our-region/economic-and-regional-development/Documents/Economic%20and%20Development/Lockyer%20Economic%20Development%20Plan%202018%20-2023.pdf	N/A	2019 to 2024 Jobs: 13.5 FTE	- Jobs: 36.3 FTA	c)	May increase road traffic. Need for rail resources,
InterLinkSQ (InterLinkSQ)	13km west of Toowoomba	200ha of new transport, logistics and business hubs. Located on the narrow-gauge regional rail network and interstate network. Located at the junction of the Gore, Warrego and New England Highways.	https://www.interlinksq.com.au/	N/A	2017 to 2037	Jobs 1,500	c)	Ongoing development could require deconfliction of construction resources. There may also be an increase of heavy vehicles using the surrounding highways

Project and proponent	Location	Description	Source	Project status	Construction dates and jobs	Operation years and jobs	Selection criteria	Relationship to the Project
Cross River Rail (CRR) (Queensland Government)	Brisbane City	A new north-south rail line connecting Dutton Park to Bowen Hills under the Brisbane River and CBD.	http://www.statedevelopment.qld.gov.au/assessments-and-approvals/cross-river-rail-project.html	Declared as 'not a controlled action' – 28/0/2010 EIS Complete New lapse date for the Coordinator-General's EIA evaluation report on 31 December 2025 at the time of writing.	2019 to 2025 1,547 jobs	> 50 years 576 jobs	c) and d)	CRR is unlikely to result in material cumulative environmental impacts; however, depending on timing there may be competition for construction workers.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





Legend

- 5 Chainage (km)
- Localities
- Existing rail
- B2G project alignment
- H2C project alignment
- K2ARB project alignment
- Major roads
- MNES study area
- Cumulative impact study area
- Local Government Areas

Cumulative Projects

- Bromelton State Development Area
- Calvert to Kagaru
- Gatton West Industrial Zone (GWIZ)
- Gowrie to Helidon
- Interlink SQ - Global Logistics Centre
- Ipswich Motorway Upgrade
- RAAF Amberley

A3 scale: 1:400,000

0 6 12 18 24 30km

Future Freight
Integrating Community, Environment and Engineering

Issue date: 21/04/2020 Version: 4
Coordinate System: GDA 1994 MGA Zone 56

Helidon to Calvert

Figure 3.4: Location of projects that have been included in the cumulative impacts assessment

3.5.3 Approach

Each of the technical chapters within this EIS has undertaken a cumulative impact assessment for that aspect. The approach used to identify and assess potential cumulative impacts of this Project provided within this technical report and the technical chapters is summarised below and projects considered within the assessment are shown in Figure 3.4.

- A review of the potential impacts identified within the EIS assessments
  - The environment at the time of the EIS ToR is the baseline, prior impacts from past land use has not be considered
- A register of assessable projects has been collated with timelines to demonstrate the temporal relationship between projects. This has included:
  - Identification of projects outside of Inland Rail:
    - Only State projects that are in the public domain as being planned, constructed or operated at the time of the EIS ToR have been considered
    - Where additional relevant projects have arisen after the finalisation of the EIS ToR, the Coordinator-General has been consulted to determine if assessment is required
  - The Inland Rail projects immediately adjacent to the project within the assessment:
    - For this Project, the Gowrie to Helidon and the Calvert to Kagaru Inland Rail projects have been considered
- Identification and mapping of the assessable projects and the areas of influence of the aspect being considered:
  - Current operational projects and commercial or agricultural operations that are in the areas of influence around the Project are accounted for in the corresponding technical baseline studies (e.g. air, noise, social, economic)
- Where there is a potential overlap in impacts (either spatially or temporally), a cumulative impact assessment has been undertaken to determine the nature of the cumulative impact. This includes:
  - Where possible, the assessment method has been quantitative in nature (e.g. calculation of impact areas which inform magnitudes) but qualitative assessment has also been undertaken
  - Where quantitative assessment is possible, the significance of impact has been assessed in comparison to the same criteria or guidelines as adopted by the relevant technical impact assessments
  - Where the impacts are expressed qualitatively, the probability, duration, and magnitude/intensity of the impacts should be considered as well as the sensitivity and value of the receiving environmental conditions
- An assessment matrix method (further detailed within Section 3.5.4) has been used to determine the significance of cumulative impacts with respect to beneficial or detrimental effects
- Where cumulative impacts are determined to be of ‘medium’ or ‘high’ significance, additional mitigation measures are proposed, beyond those already proposed by the relevant technical impact assessments.

3.5.4 Assessment matrix

Following the identification of each potential cumulative impact, a relevance factor score of low, medium or high has been determined in consideration of the impacts, in accordance with the assessment matrix given in Table 3.12.

The significance of the impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 3.12 and summing the relevance factors. The sum of the relevance factors determines the impact significance and consequence which are summarised in Table 3.13. For example, if an environmental value such as groundwater 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 3.12 Assessment matrix

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

Table 3.13 Impact significance

Impact significance	Sum of relevant factors	Consequence
Low	1 to 6	Negative impacts need to be managed by standard environmental management practices. Special approval conditions unlikely to be necessary. 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. Specific approval conditions are likely. Targeted monitoring program required, where appropriate.
High	10 to 12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Specific approval conditions required. Targeted monitoring program necessary, where appropriate.

4 Description of environmental values

4.1 Content of this section

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

The following sections present the environmental values associated with the regional setting in which the Project occurs in order to provide a broader context for the observed values within the MNES study area.

4.2 Regional and local context

The Project is located within the Moreton Basin subregion, one of the 12 subregions of the SEQ bioregion. The Project disturbance footprint is located close to the boundary of the Brigalow Belt South bioregion located to the west which encompasses Toowoomba and the Great Dividing Range. The SEQ bioregion has a sub-tropical climate with warm and wet summers and mild winters. The region contains the most urbanised areas in QLD and is subject to a range of land uses including grazing, agriculture, residential and industrial urban areas, and rural residential. The Bioregion also comprises extensive areas set aside for conservation including the Gondwana Rainforests of Australia World Heritage Area located to the south of the MNES study area.

Within the wider area low lying alluvial river and creek flats have been extensively cleared and remnant patches of open forest woodlands on floodplains are typically confined to constrained gullies with limited access and creek channels. These fringing woodlands are typically comprised of Blue gum (*Eucalyptus tereticornis*), River she-oak (*Casuarina cunninghamiana*) and Paperbark (*Melaleuca spp.*), with Grey box (*E. moluccana*) and Narrow-leaved ironbark (*E. crebra*) sometimes present in more elevated areas of the floodplain.

Undulating landscapes and foothills such as in the Helidon and Little Liverpool Range areas are dominated by open eucalypt forests on sedimentary rocks, typically comprised of Brown bloodwood (*Corymbia trachyphloia subsp. trachyphloia*), Lemon-scented gum (*Corymbia citriodora subsp. variegata*), Narrow-leaved ironbark (*E. crebra*), Red ironbark (*E. fibrosa subsp. fibrosa).* Within elevated parts of the Great Dividing Range, there are remnant pockets of Narrow-leaved ironbark woodland, which contains Narrow-leaved ironbark (*E. crebra*), Blue gum (*Eucalyptus tereticornis*), Moreton Bay ash (*Corymbia tessellaris*), Smooth-barked apple (*Angophora spp.*), Silver-leaved ironbark (*E. melanophloia*).

The western section of the alignment passes to the north of the township of Helidon intersecting the lower slopes of the Helidon Hills. The area to the north encompasses a rugged landscape dominated by sandstone formations with extensive tracts of remnant vegetation and several sandstone quarries. A large portion of the remnant vegetation is protected including Lockyer National Park, Lockyer Resources Reserve and Lockyer State Forest. The area comprises habitat for a number of threatened fauna species ((including Brush-tailed rock-wallaby (*Petrogale penicillata*) and Collared delma (*Delma torquata*)) and several plants with a restricted range such as Four-tailed grevillea (*Grevillea quadricauda*) and Blunt-leaved leionema (*Leionema obtusifolium*). The alignment itself passes through a mosaic of cleared grazing lands, rural residential properties and remnant and regrowth vegetation as far east as the Warrego Highway.

The alignment crosses to the south of the highway and heads east to Gatton, the largest town in the Lockyer valley. Here the landscape becomes progressively more degraded being dominated by grazing, rural residential properties and irrigated agriculture. Scattered patches of remnant and regrowth vegetation occur largely to the north and outside of the alignment. Large trees occur as scattered paddock trees and along the existing West Moreton System rail line which the alignment follows for much of this section. The alignment crosses Lockyer Creek before entering Gatton itself. Creek line vegetation is highly degraded along the creek with little native tree cover in the vicinity of the crossing point.

From Gatton east to Forest Hill and then Laidley the landscape is relatively flat and highly modified being dominated by irrigated agriculture and grazing lands. There are scattered patches of remnant and regrowth vegetation in the landscape, largely to the south of the alignment. No mapped vegetation communities occur within this section of the alignment with large trees only occurring as scattered paddock trees and as a thin strip along Laidley Creek.

The area of the Little Liverpool Range to the north and east of the Project alignment (between Laidley and Grandchester) is part of a volcanic shield system of Tertiary age which includes Main Range to the south. The Little Liverpool Range is considered a regionally important corridor under State mapping of biodiversity values. The peak elevation of the land intersected by the Project is reached as the alignment intersects Little Liverpool Range at an approximate elevation of 240 m. While the slopes of the range in this area remain vegetated with a mixture of remnant and regrowth vegetation, rural housing occupies the ridge line where the proposed tunnel is to be constructed.

The landscape within the Grandchester-Calvert area (east of the Little Liverpool Range) is characterised by very high levels of anthropogenic disturbance in the vicinity of Western Creek with most extant remnant and regrowth vegetation located on higher ground outside of the Project disturbance footprint. This presents a highly fragmented environment dominated primarily by pasture grasses, isolated trees and areas of woody regrowth. Whilst much of the area is subject to grazing and other agricultural practices, Western Creek retains a thin but relatively continuous strip of riparian vegetation and has a limited potential to act as local fauna movement conduit.

Catchment values

The majority of the Project is located in the Lockyer Creek catchment which extends east to Laidley where the Little Liverpool Range forms the boundary of the catchment. The western portion of the alignment (from Helidon to Gatton) runs roughly parallel to the creek and the Project intersects Lockyer Creek on the north-west edge of Gatton township. The project intersects a number of waterways within the catchment including Laidley Creek and Sandy Creek and their associated floodplains west of the Little Liverpool Range. To the east of the Little Liverpool Range (Grandchester to Calvert) the Project is located within the upper reach of Western Creek which is within the Bremer River catchment. The alignment crosses Western Creek in four locations. There are no large dams located upstream of the Project. There are a number of smaller dams in the area including Lake Dyer near Laidley.

Both catchments are considered to be in poor health, with freshwater health continuing to decline, being in very poor condition due to a decrease across most indicators, particularly water quality, fish and macroinvertebrate community health (Healthy Land and Water 2019). Site investigations indicate that watercourses that intersect the project are in relatively very poor condition. Laidley Creek in particular was considered to be in very poor condition and noted as being dry for the first time since sampling at this site had begun (Healthy Land and Water 2019a).

Groundwater values

There are numerous moderate and low potential aquatic groundwater dependent ecosystems (GDEs) (from regional studies) within the study area, including Lockyer Creek, Laidley Creek and Western Creek (and their tributaries). These are generally described as wetlands associated with alluvial aquifers on the Bureau of Meteorology GDE Atlas. There are no registered groundwater springs within the study area based on a review of the QLD Globe website, with the nearest being Helidon Spring located 4 km south of Ch 26.00 km.

There are no World heritage areas, National heritage areas, Commonwealth marine areas or Great Barrier Reef Marine Park areas located within or in close proximity to the MNES study area and these areas are sufficiently displaced from the Project that downstream impacts will be negligible. For example, the Project is located over 65 km upstream of Moreton Bay, a wetland of international importance (Ramsar wetland).

4.3 Results of desktop study

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

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.

4.3.1 Flora

4.3.1.1 Threatened flora species

A total of 18 threatened terrestrial and aquatic flora species identified under the provisions of the EPBC Act are predicted or are known to occur within the MNES study area (refer Table 4.1; refer Appendix C for species profiles). Of these, nine species have been identified exclusively from the EPBC Act protected matters search report (DAWE 2020b) which is a predictive search tool that does not rely on specimen backed records. The location of specimen backed records for conservation significant flora species, derived from database sources (e.g. Herbrecs and Atlas of Living Australia (AoLA)) is provided in Figure 4.1.

A total of two species listed under the provisions of the EPBC Act are considered likely to occur within the MNES study area based on specimen-backed records in the Wildlife Online, and AoLA databases and/or the presence of suitable habitat (refer Table 4.1).

A total of eight species listed under the provisions of the EPBC Act are considered possible to occur within the MNES study area based on the presence of suitable habitat (refer Table 4.1).

Eight species listed under the provisions of the EPBC Act were considered unlikely to occur within the MNES study area based on the absence of specimen-backed records in the Wildlife Online and AoLA databases and/or the absence of suitable habitat (refer Table 4.1).

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

Table 4.1 Threatened flora species identified in the matters of national environmental significance study area from database searches

Family	Species name	Common name	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Poaceae	*Arthraxon hispidus*	Hairy-joint grass	V				✓	Possible
Orchidaceae	*Bulbophyllum globuliforme*	Miniature moss-orchid	V				✓	Unlikely. No suitable rainforest habitat likely present and no records within 50 km of Project
Surianaceae	*Cadellia pentastylis*	Ooline	V		✓			Unlikely, this species is out of its known distribution in the region.
Poaceae	*Dichanthium setosum*	Bluegrass	V		✓		✓	Possible

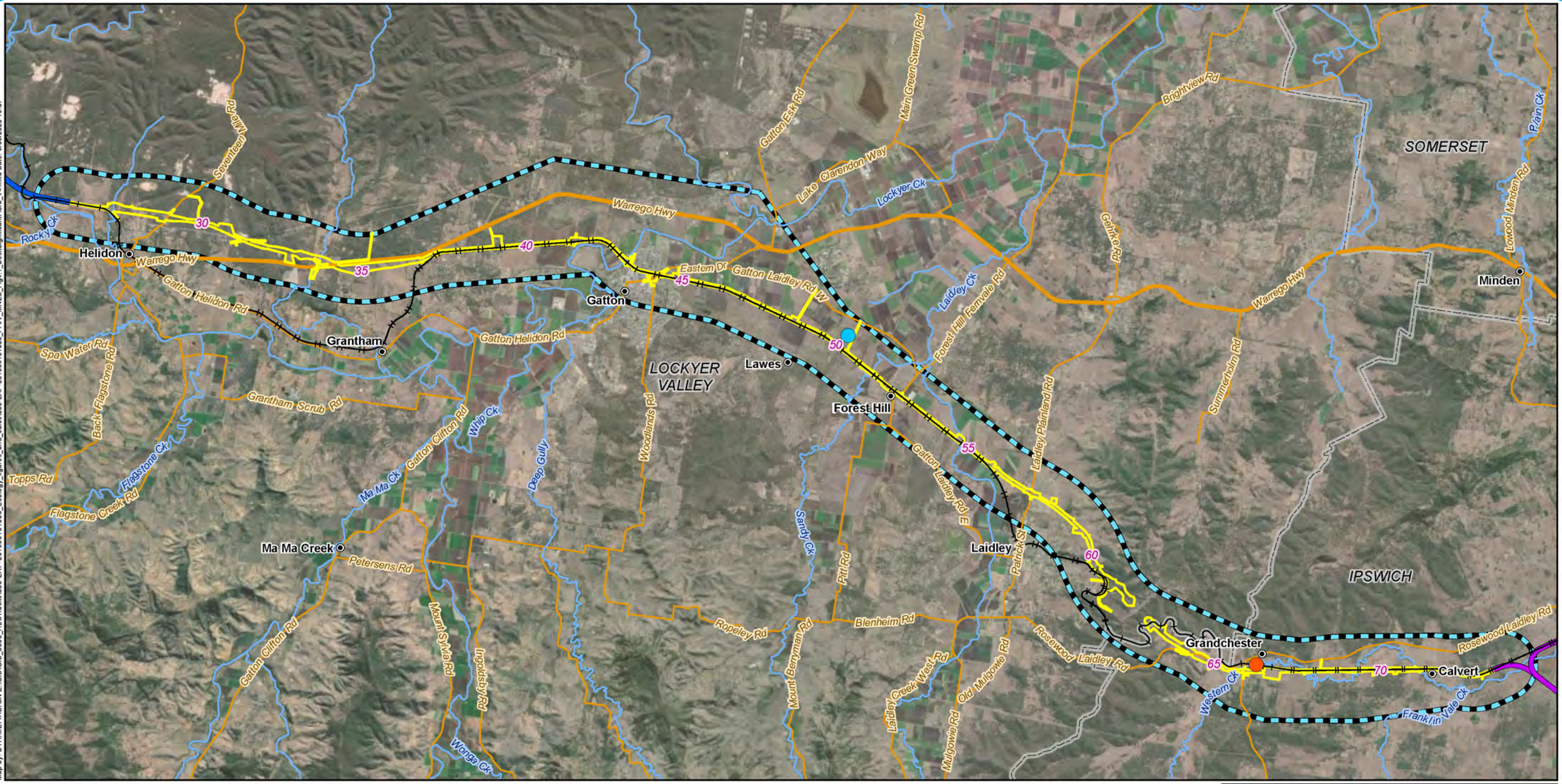
Family	Species name	Common name	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Euphorbiaceae	*Fontainea venosa*	Bahrs Scrub Fontainea	V		✓			Unlikely. Species only known from small populations in Beenleigh, Gympie and Kilcoy
Proteacaea	*Grevillea quadricauda*	Four-tailed grevillea	V	✓	✓	✓	✓	Possible
Haloragaceae	*Haloragis exalata velutina*	Tall velvet sea-berry	V		✓		✓	Unlikely. No suitable habitat present for this species.
Rutaceae	*Leionema obtusifolium*	Blunt-leaved leionema	V				✓	Possible
Brassicaceae	*Lepidium peregrinum*	Wandering pepper-cress	E				✓	Possible
Characeae	*Lychnothamnus barbatus*	A green algae	E		✓			Unlikely. Known only from Warrill Creek and Wallace Creek in the Boonah area. Project does not intersect these waterways.
Proteceae	*Macadamia integrifolia*	Macadamia nut	V		✓		✓	Unlikely. No suitable rainforest habitat likely present and no nearby records. Planted specimens (i.e. not in the wild) may be present but these are considered beyond the intent of the EPBC Act listing
Oleaceae	*Notelaea lloydii*	Lloyd's native olive	V	✓	✓	✓	✓	Likely
Poaceae	*Paspalidium grandispiculatum*	A grass	V		✓		✓	Possible
Rutaceae	*Phebalium distans*	Mt Berryman phebalium	CE		✓		✓	Possible
Asteraceae	*Rhaponticum australe*	Austral cornflower	V	✓	✓	✓	✓	Unlikely, potential habitat for this species is marginal and no recent historic records close to the Project (all nearby records are pre-1950)
Simaroubaceae	*Samadera bidwillii*	Quassia	V		✓		✓	Unlikely. No records in wider area and species occurs between Mackay and Gympie (DAWE 2020b)
Fabaceae	*Sophora fraseri*	Brush sophora	V				✓	Possible
Santalaceae	*Thesium australe*	Austral toadflax	V	✓	✓	✓	✓	Likely

Table notes:

Status: CE = Critically Endangered E = Endangered V = Vulnerable
Data source: PMST = Protected Matters Search Tool AoLA = Atlas of Living Australia ToR = Terms of reference
✓ = species present within database record within the MNES study area

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map by: DTH/MEF/AD/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig4.1_DeskSignificantFlora_V4.mxd Date: 5/05/2020 15:37



Legend

- 5 Chainage (km)
- Localities
- *Notelaea lloydii*
- *Thesium australe*
- Existing rail
- G2H project alignment
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas

A3 scale: 1:125,000

0 1 2 3 4 5km

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Coordinate system: MGA56

Helidon to Calvert

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

4.3.1.2 Threatened ecological communities

The following TECs listed under the provisions of the EPBC Act were identified as potentially occurring within the MNES study area as provided by the PMST database (DAWE 2020b):

- Brigalow (*Acacia harpophylla* dominant and co dominant) ecological community – Endangered. The MNES study area between Forest Hill and Laidley encompasses several heterogeneous polygons (south of the Project disturbance footprint) comprising high-value regrowth communities including RE 12.9-10.6 which are analogous to the Brigalow TEC. Does not occur within the disturbance footprint with the nearest known occurrence located approximately 30 m south of the Project disturbance footprint (Ch 54 km to Ch 55 km) with the proposed rail alignment to the north of the existing QR West Moreton System rail corridor.
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and SEQ ecological community – Endangered. The MNES study area does not intersect any area where the community may occur (i.e. waterways which are tidal) and no REs present within the MNES study area are analogous with this community (refer Table 3.3). Known patches of this TEC are significantly displaced from the Project, while the community's distribution extends downstream along Western Creek from Calvert.
- Lowland Rainforest of Subtropical Australia – Critically Endangered. The MNES study area does not intersect any area where the community may occur and none of the REs present (remnant or regrowth) within the MNES study area are analogous with this community (refer Table 3.3).
- Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ - Critically Endangered. Mapped as occurring in the MNES study area south-west of Calvert on the south side of Hiddenvale Road (south of the Project disturbance footprint). Remnant and high-value regrowth communities mapped as RE 12.3.18 are considered analogous to the Swamp tea-tree TEC. This is the westernmost extent of this TEC relevant to the Project with the community occurring more widely to the south-east of Calvert. Noting there are records at College View approximately 1.5 km to the north-east of the Project disturbance footprint (Ch 49 km). Does not occur within the disturbance footprint, with the community identified approximately 530 m south of the Project disturbance footprint, where the proposed alignment is to the south of the existing QR West Moreton System rail corridor.
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland - Critically Endangered. The MNES study area does not intersect an area where the community may occur. No REs (remnant or regrowth) analogous with this TEC were identified within the MNES study area. This community is predominantly known from west of the Great Dividing Range. Based on the RE mapping the nearest occurrence of vegetation which is analogous with this community (mapped as RE12.8.16) lies approximately 2 km north of the Project in the Little Liverpool Range. This encompasses a substantial area and is flanked by adjacent patches of mixed regrowth communities which may also comprise the TEC. The nearest occurrence to the south lies 7 km away from the Project (also in the Little Liverpool Range area).

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

These communities are also known to provide habitat for a number of threatened flora and fauna species, including some of the species listed in Table 4.1 and Table 4.3. The amount of each community occurring within the MNES study area based on vegetation community mapping at a desktop level is detailed in Table 4.2 and is depicted in Section 4.4.1.3.

Table 4.2 Threatened ecological communities identified within the matters of national environmental significance study area based on desktop mapping

TEC Name	EPBC Act status*	Extent (ha)	
		MNES study area	Disturbance footprint
Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ	CE	**5.77**	**0**
Brigalow (*Acacia harpophylla* dominant and co dominant) ecological community	E	**4.53**	**0**

4.3.2 Fauna

4.3.2.1 Threatened fauna species

A total of 30 conservation significant fauna species (terrestrial and aquatic) identified under the provisions of the EPBC Act are predicted or are known to occur within the MNES study area (refer Table 4.3). Of these, 16 species have been identified exclusively from the EPBC Act PMST report (DAWE 2020b) which is a predictive search tool that does not rely on specimen backed records. The location of specimen backed records for threatened fauna species that have been identified within the past 30 years, derived from database sources (e.g. Birds Australia, Wildlife Online and AoLA) is provided in Figure 4.2.

Of the threatened species identified above (refer Table 4.3):

- Four are considered likely to occur within the MNES study area based on specimen-backed records in the Wildlife Online and the AoLA databases and/or the presence of suitable habitat
- Seventeen are considered as possible to occur within the MNES study area based on the presence of suitable habitat
- Nine are considered unlikely to occur within the MNES study area based on their current distributional limits.

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

Table 4.3 Threatened fauna species identified in the matters of national environmental significance study area from database searches

Family	Species name	Common name	EPBC Act	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Birds								
Accipitridae	*Erythrotriorchis radiatus*	Red goshawk	V	✓	✓		✓	Possible
Apodidae	*Hirundapus caudacutus*	White-throated needletail	V, M		✓		✓	Likely
Ardeidae	*Botaurus poiciloptilus*	Australasian bittern	E		✓		✓	Possible
Columbidae	*Geophaps scripta scripta*	Squatter pigeon (southern subspecies)	V	✓	✓	✓	✓	Unlikely. The species is typically associated with the westerns slopes of the Great Dividing Range. While there are several records of this species within the broader project context, the majority of these are older and there are no recent records (>1980s) within 5 km of the project disturbance footprint (AoLA 2020)
Dasyornithidae	*Dasyornis brachypterus*	Eastern bristlebird	E				✓	Unlikely, species occurs in montane areas in eucalypt forests with a dense tussock grass layer (DAWE 2020b). Habitat does not occur and the species has never occurred in or near the MNES study area.
Falconidae	*Falco hypoleucos*	Grey falcon	V			✓		Possible

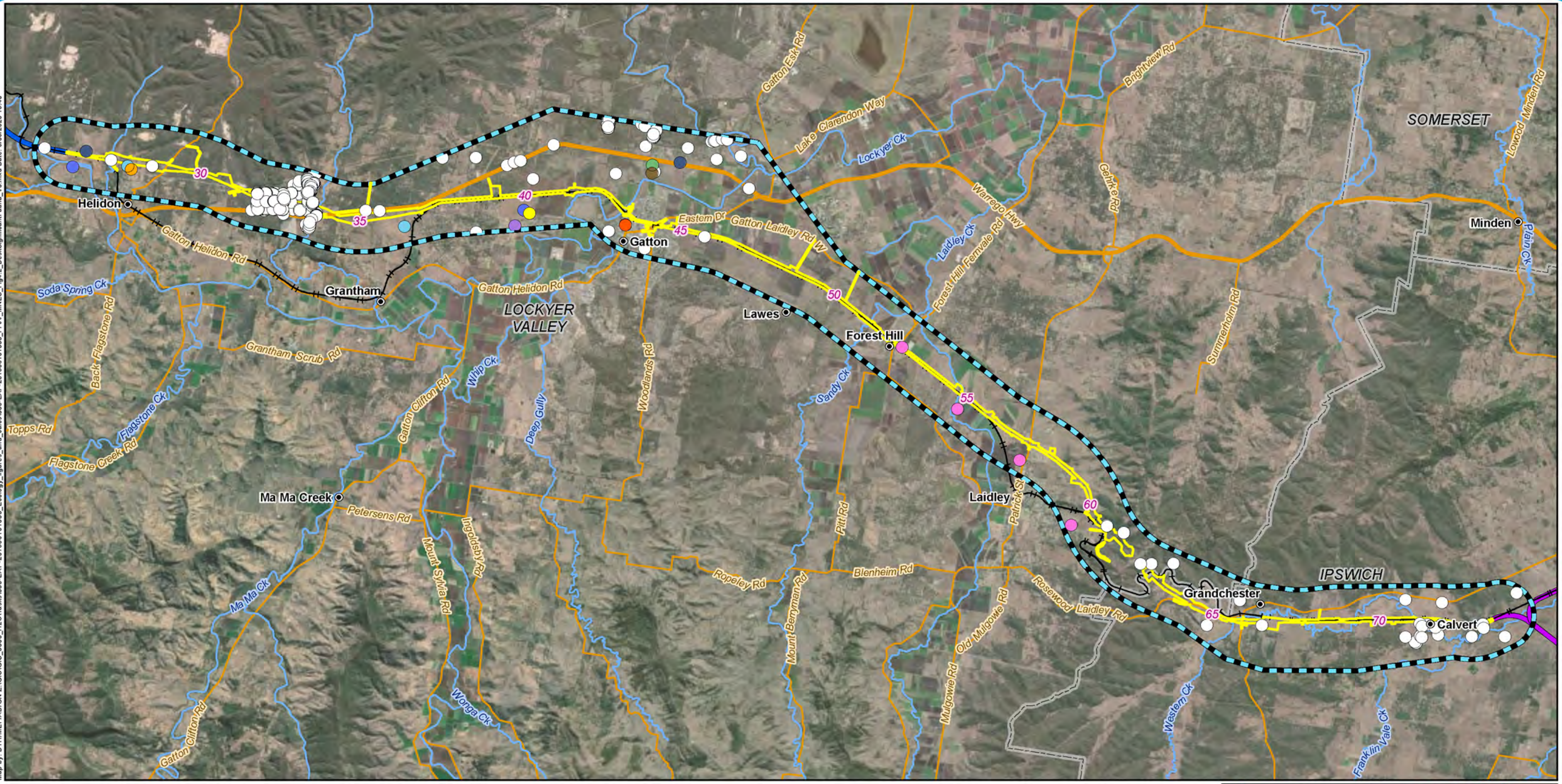
Family	Species name	Common name	EPBC Act	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Meliphagidae	*Anthochaera phrygia*	Regent honeyeater	CE		✓		✓	Possible
Meliphagidae	*Grantiella picta*	Painted honeyeater	V		✓		✓	Possible
Passeridae	*Poephila cincta cincta*	Southern black-throated finch	E		✓		✓	Unlikely. Expert advice indicates that this species is locally extinct within SEQ (DAWE 2020b)
Psittacidae	*Cyclopsitta diophthalma coxeni*	Coxen's fig-parrot	E				✓	Unlikely. No records close to MNES study area and no reliable records of the species from the year 2000 onwards. Preferred habitats featuring fig trees (lowland rainforest, warm and cold subtropical as well as cool temperate rainforests) (Birdlife International 2018c) do not occur within or near the MNES study area.
Psittacidae	*Lathamus discolor*	Swift parrot	CE		✓	✓	✓	Possible
Rostratulidae	*Rostratula australis*	Australian painted snipe	E	✓	✓	✓	✓	Possible
Scolopacidae	*Calidris ferruginea*	Curlew sandpiper	CE, M	✓	✓		✓	Possible
Scolopacidae	*Numenius madagascariensis*	Eastern curlew	CE, M		✓		✓	Unlikely. Species is essentially a coastal specialist
Turnicidae	*Turnix melanogaster*	Black-breasted button-quail	V		✓		✓	Possible
Mammals								
Dasyuridae	*Dasyurus hallucatus*	Northern quoll	E		✓			Unlikely, the species has never been recorded in the greater Brisbane region. Nearest records in the Toowoomba Range are older (<1986) (AoLA 2020) and the species likely no longer occurs in the area.
Dasyuridae	*Dasyurus maculatus maculatus*	Spotted-tail quoll	E		✓		✓	Possible
Macropodidae	*Petrogale penicillata*	Brush-tailed rock-wallaby	V	✓	✓	✓	✓	Possible
Muridae	*Pseudomys novaehollandiae*	New Holland mouse	V		✓		✓	Possible
Petauridae	*Petauroides volans volans*	Greater glider	V	✓	✓		✓	Possible
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	✓	✓	✓	✓	Likely
Potoroidae	*Potorous tridactylus tridactylus*	Long-nosed potoroo	V		✓		✓	Possible

Family	Species name	Common name	EPBC Act	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Pteropodidae	*Pteropus poliocephalus*	Grey-headed flying-fox	V	✓	✓		✓	Likely
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared pied bat	V				✓	Unlikely. No nearby database records (AoLA 2020) and habitat is unlikely to be present. Nearest record is older (1994) and from Main Range National Park.
Reptiles								
Pygopodidae	*Delma torquata*	Collared delma	V		✓		✓	Likely
Elapidae	*Furina dunmalli*	Dunmall's snake	V		✓		✓	Possible
Scincidae	*Anomalopus mackayi*	Five-clawed worm-skink	V		✓		✓	Possible
Scincidae	*Coeranoscincus reticulatus*	Three-toed snake-tooth skink	V				✓	Unlikely. Largely occurs in wet rainforest and wet sclerophyll forest habitats (DAWE 2020a) which does not occur within or near the footprint. Nearest record is from Mount Tamborine (AoLA 2020).
Fish								
Pericichthyidae	*Maccullochella mariensis**	Mary River cod	E		✓		✓	Unlikely. Whilst it is acknowledged the Mary River cod may have potential to occur within the broader region, these individuals are likely to have resulted from fish stocking activities and are considered to be outside of areas considered to be within their natural distribution. There are no database records of the species in the Brisbane/Logan River catchments. Habitat critical to the survival of this species is restricted to the Mary River drainage system and therefore this species has been excluded from the impact assessment
Protopteridae	*Neoceratodus forsteri*	Australian lungfish	V	✓	✓		✓	Possible

Table notes:

Status: CE = Critically Endangered E = Endangered V = Vulnerable
Data source: PMST = Protected Matters Search Tool AoLA = Atlas of Living Australia ToR = Terms of reference
✓ = species present within database record within the MNES study area
PMST = Protected Matters Search Tool
* = Fish species have been actively stocked/translocated in a number of the project catchments

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

- 5 Chainage (km)
- Localities
- *Calidris ferruginea*
- *Dasyurus maculatus maculatus*
- *Erythrotriorchis radiatus*
- *Geophaps scripta scripta*
- *Hirundapus caudacutus*
- *Neoceratodus forsteri*
- *Petauroides volans volans*
- *Petrogale penicillata*
- *Pteropus poliocephalus*
- *Rostratula australis*
- *Phascolarctos cinereus*
- Existing rail
- G2H project alignment
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas

A3 scale: 1:125,000

0 1 2 3 4 5km

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Coordinate system: MGA56

Helidon to Calvert

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

4.4 Existing environment

The following subsections provide a description of the existing ecological values of the Project MNES area based on the results of the field assessments. The results presented in this section detail the known existing flora and fauna species (including weeds and pests), habitats, vegetation communities, and MNES.

4.4.1 Flora

4.4.1.1 Species richness

A total of 421 plant species were identified within the MNES study area during the Project EIS field investigations, including 287 native species (68.2 per cent) and 134 non-native species (31.8 per cent) (refer Appendix D).

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 montividensis*) 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 at aquatic survey sites throughout the MNES study area.

4.4.1.2 Threatened flora species

Two specimens of Lloyd's native olive (*Notelaea lloydii*) (listed as vulnerable under the EPBC Act) were recorded within the Project disturbance footprint during preliminary pre-clearance ecology surveys (EMM 2018b). The specimens were found east of Laidley in a road reserve on the western edge of the Little Liverpool Range (refer Figure 4.3). The habitat comprised regrowth Spotted gum (*Corymbia citriodora*) woodland on sedimentary soils (refer Photograph 4.1). There have been a number of other records of this species within the Little Liverpool Range area (refer Section 5.3.4.2).

Photograph 4.1 Lloyd's native olive– Laidley area (2018)

The field investigations also confirmed habitat for a number of other flora species within the MNES study area comprising the following:

- Four-tailed grevillea (*Grevillea quadricauda*) – Helidon Hills area
- *Paspalidium grandispiculatum* (a grass) - Helidon Hills area

This information was used to inform the predictive habitat modelling for each of the MNES flora species. Predictive habitat mapping within the MNES study area for those species considered to have habitat potentially impacted by the Project are presented in Appendix F. Potential habitat for threatened flora species is largely associated with remnant vegetation associated with Helidon Hills area (north of Helidon) and the Little Liverpool Range (between Laidley and Grandchester).

It is noted that whilst not all areas of the project were accessible for the EIS (FFJV) surveys, information derived from historic and concurrent surveys (refer Table 3.4) was used to inform the predictive mapping for MNES flora species where applicable.

4.4.1.3 Threatened ecological communities

A single Critically Endangered TEC identified in the desktop study (Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ) and a single Endangered TEC Brigalow (*Acacia harpophylla* dominant and co dominant) ecological community (refer Section 4.3.1.2) have not been confirmed as present during field investigations within the MNES study area. Nevertheless, the EIS-associated surveys and protected plants surveys (EMM 2018a; EMM 2019a, 2019b; Ecological 2019a) carried out in the Calvert area (refer Figure 3.2 and Figure 3.3) confirm that no TEC occurs within the Project disturbance footprint.

Queensland State RE mapping indicates that polygons of remnant and regrowth RE 12.3.18 (analogous to the Swamp tea-tree TEC) and heterogeneous polygons of HVR including RE 12.9-10.6 (analogous to the Brigalow TEC) occur within the MNES study area. The location and extent of mapped TECs within the MNES study area is presented in Figure 4.3.

The estimated extent of Swamp Tea-tree TEC identified covers 5.77 ha in two discrete patches located south of Calvert (eastern extent of Project) comprising 4.59 ha of remnant vegetation and 1.18 ha of regrowth. The nearest of the two patches is 530 m south of the Project disturbance footprint (refer Figure 4.4).

The estimated extent of Brigalow TEC comprises 4.53 ha of regrowth with the nearest occurrence located 30 m south of the Project disturbance footprint (refer Figure 4.4).

Further surveys are required as part of the post-EIS process to identify the accuracy of the vegetation mapping and the extent to which the TEC actually occurs within the vicinity of the Project boundary.

4.4.2 Fauna

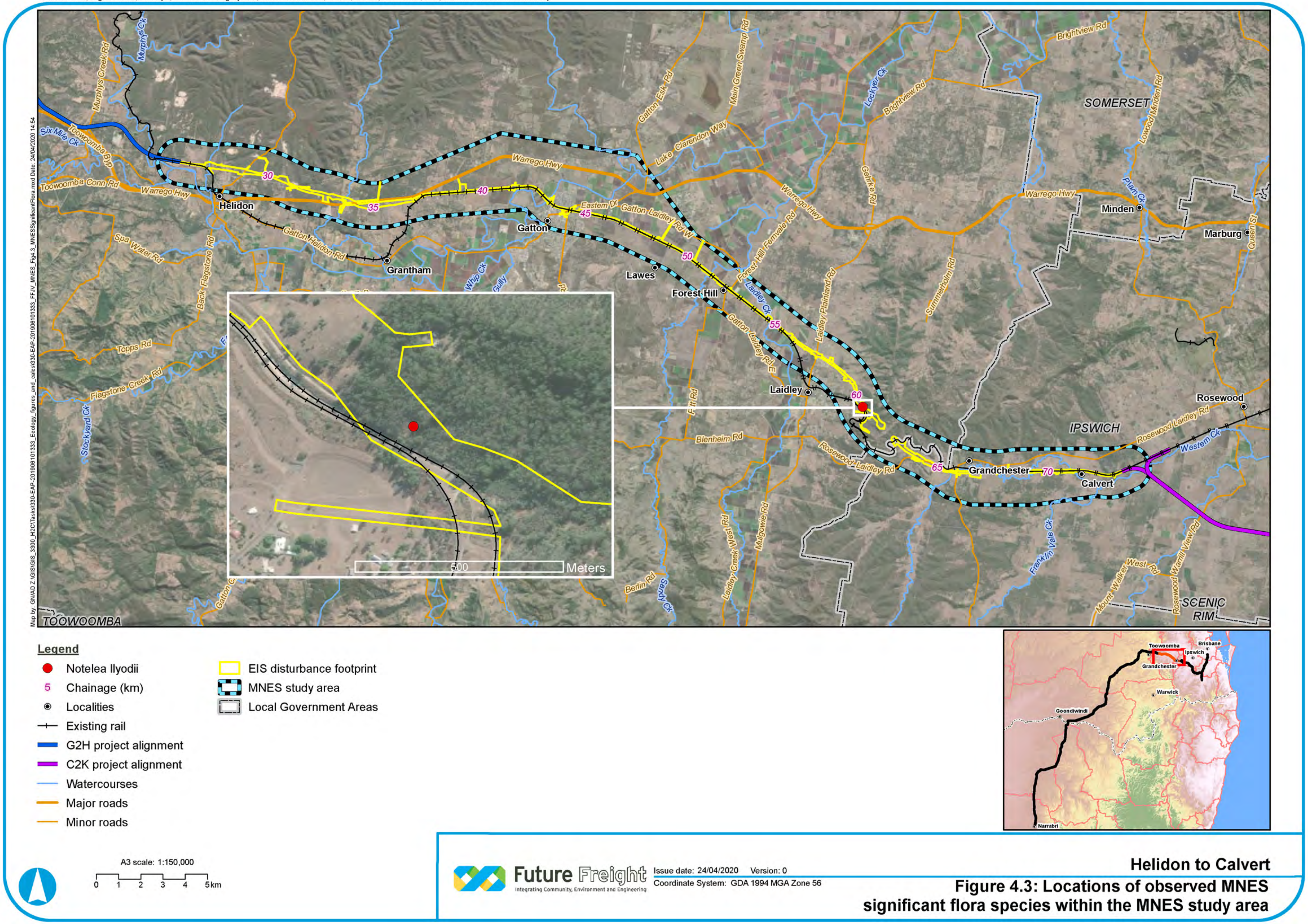
This section outlines the fauna species richness observed within the MNES study area. This section also provides the threatened species listed under the provisions of the EPBC Act that were recorded within the MNES study area.

4.4.2.1 Species richness

The Project EIS field investigations identified a total of 173 fauna species (refer Appendix E), including 160 native species (92.4%) and 13 non-native species (7.6%) from within the MNES study area. Recorded species consisted of 120 (69.36%) birds, 32 (18.5%) mammals (16 of which are microbat species), 12 (6.94%) reptiles, four (2.31%) amphibians and five (2.89%) fish species.

Given the fragmented nature of bushland areas within the MNES study 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.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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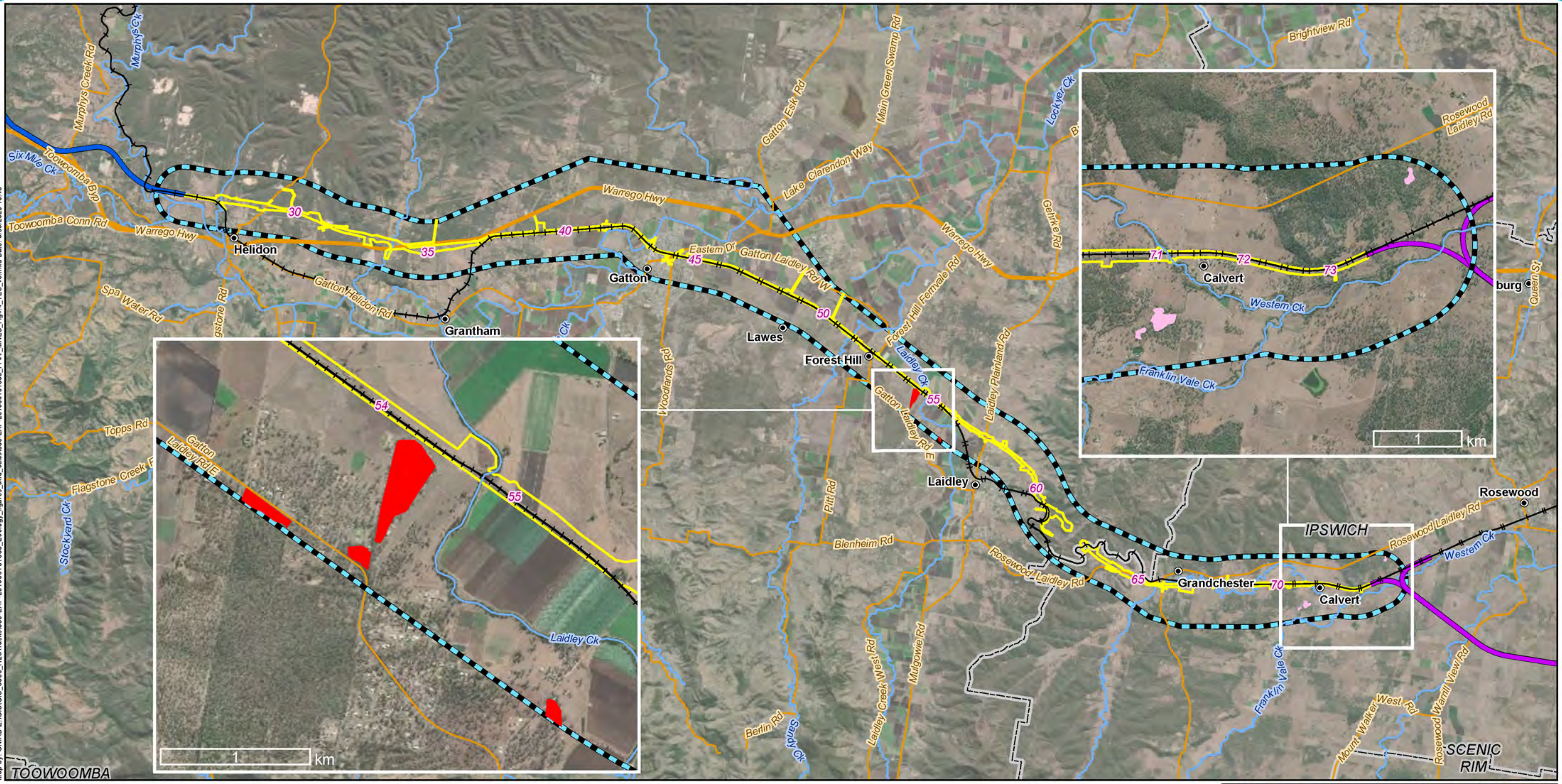
Helidon to Calvert

Figure 4.3: Locations of observed MNES significant flora species within the MNES study area

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- C2K project alignment
- Defined watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas
- Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC
- Swamp Tea-tree *Melaleuca irbyana* (EPBC Act) forest TEC

A3 scale: 1:150,000

0 1 2 3 4 5km

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Coordinate System: GDA 1994 MGA Zone 56

Helidon to Calvert

Figure 4.4: Extent of Threatened Ecological Communities within the MNES study area

4.4.2.2 Threatened fauna species

As noted in Section 4.3.2.1, there is the potential for several threatened fauna species to occur throughout the MNES study area.

Three threatened fauna species were recorded within the MNES study area during the Project-associated field investigations:

- Grey falcon (*Falco hypoleucos*) was observed within the Gatton area, associated with Lockyer Creek (refer Photograph 4.2)
- Grey-headed flying fox (*Pteropus poliocephalus*) was observed outside of the MNES study area within the vicinity of a known flying-fox camp in the Gatton area located 1.5 km south of the Project disturbance footprint
- Signs of Koala (*Phascolarctos cinereus*) presence (scratches and scats) have been observed at several locations along the alignment during EIS surveys and surveys by Arup/SMEC (2016). Along the alignment these records are located between Helidon and Gatton and Laidley to Calvert. In particular, records are concentrated around forested areas in the Little Liverpool Range and the Helidon Hills.

Photograph 4.2 Lockyer Creek catchment illustrating areas downstream of known Grey falcon habitat (FFJV 2017)

The locations of threatened fauna records are displayed in Figure 4.5.

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

- In the Helidon Hills and Little Liverpool Range areas habitat features known to support the Collared delma (*Delma torquata*) were observed. This include microhabitats such as coarse woody debris and loose rocky outcrops.
- Confirmed habitat (primarily in areas containing eucalypt open forest/woodland communities) for the following species:
  - Regent honeyeater (*Anthochaera phrygia*) - box-ironbark woodlands
  - Spotted-tail quoll (*Dasyurus maculatus maculatus*) – rocky habitat within the Helidon Hills
  - Red goshawk (*Erythrotriorchis radiatus*) – extensive intact habitat within Helidon Hills and Little Liverpool Range

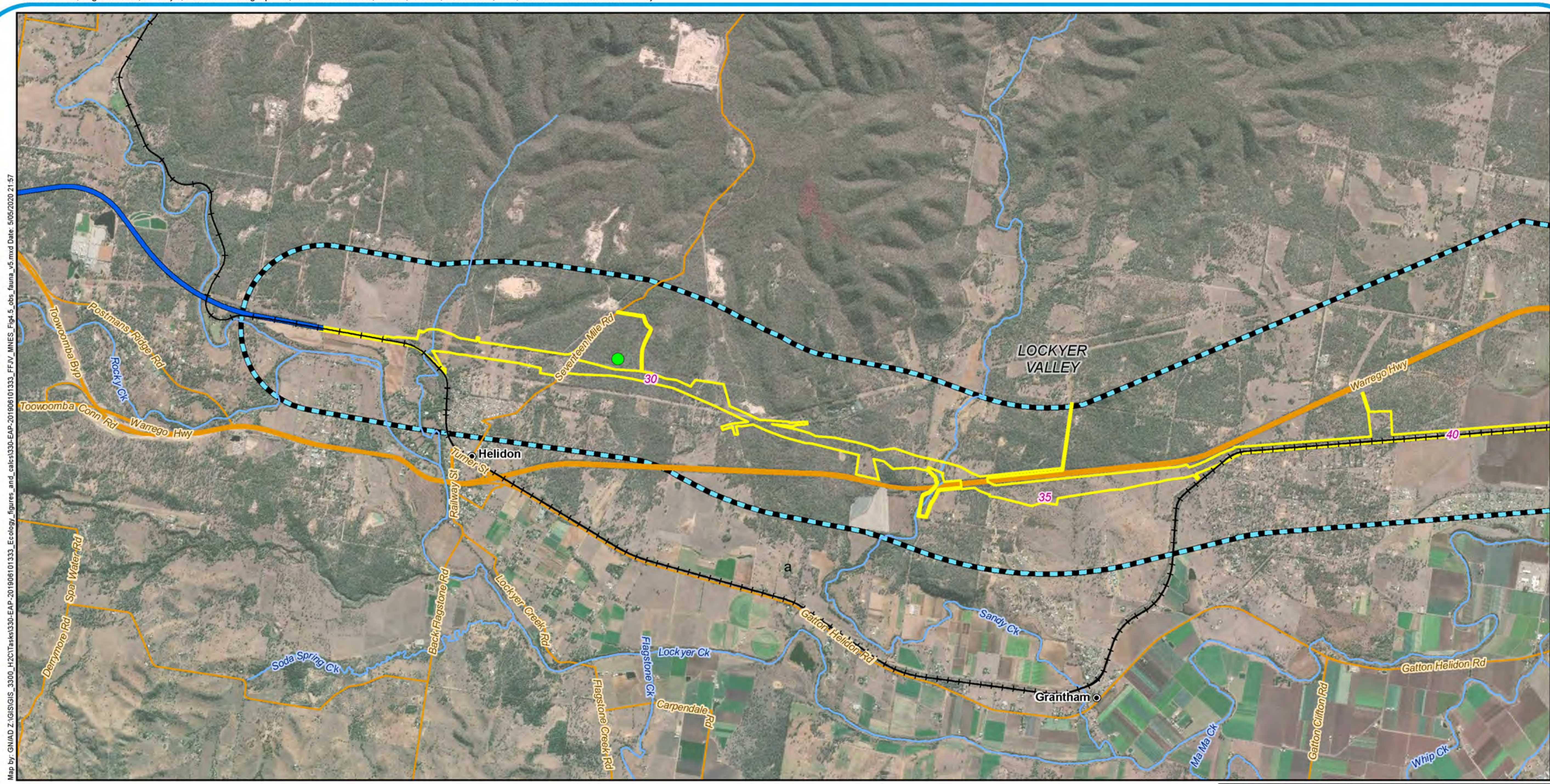
- Painted honeyeater (*Grantiella picta*) - eucalypt/*Acacia* woodlands
- Swift parrot (*Lathamus discolour*) – eucalypt woodlands
- Greater glider (*Petauroides volans*) – eucalypt woodlands with large hollows present
- Koala (*Phascolarctos cinereus*) - eucalypt woodlands throughout
- New Holland mouse (*Pseudomys novaehollandiae*) – habitat within the Helidon Hills/Helidon Hills
- Grey-headed flying-fox (*Pteropus poliocephalus*) – foraging habitat throughout.

The availability of habitat types and their relevance to MNES fauna and flora are discussed further in Section 4.4.4.

This information was used, in addition to that contained within relevant recovery plans and conservation listing advice, to inform the predictive habitat modelling for each of the MNES fauna species. Predictive habitat mapping within the MNES study area for those species considered to have habitat potentially impacted by the Project are presented in Appendix F. Potential habitat for threatened fauna species is largely associated with remnant vegetation associated with the Helidon Hills area (north of Helidon), the Little Liverpool Range (between Laidley and Grandchester) and some areas of watercourse vegetation (although creek line vegetation in much of the MNES study area is generally in poor condition).

It is noted that whilst all areas of the project were not accessible, information derived from historic and concurrent surveys (refer Table 3.4) was used to inform the predictive mapping for MNES fauna species where applicable.

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

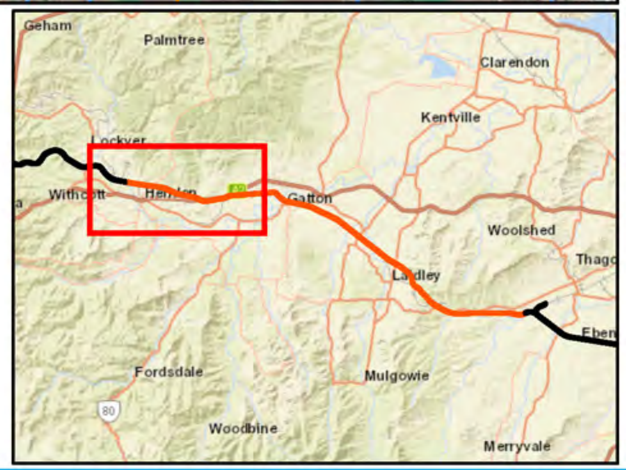


Legend

5 Chainage (km)
Localities
Fauna observations
Koala (*Phascolarctos cinereus*)

Existing rail
G2H project alignment
Watercourses
Major roads
Minor roads

EIS disturbance footprint
MNES study area
Local Government Areas



A3 scale: 1:50,000
0 0.5 1 1.5 2 km

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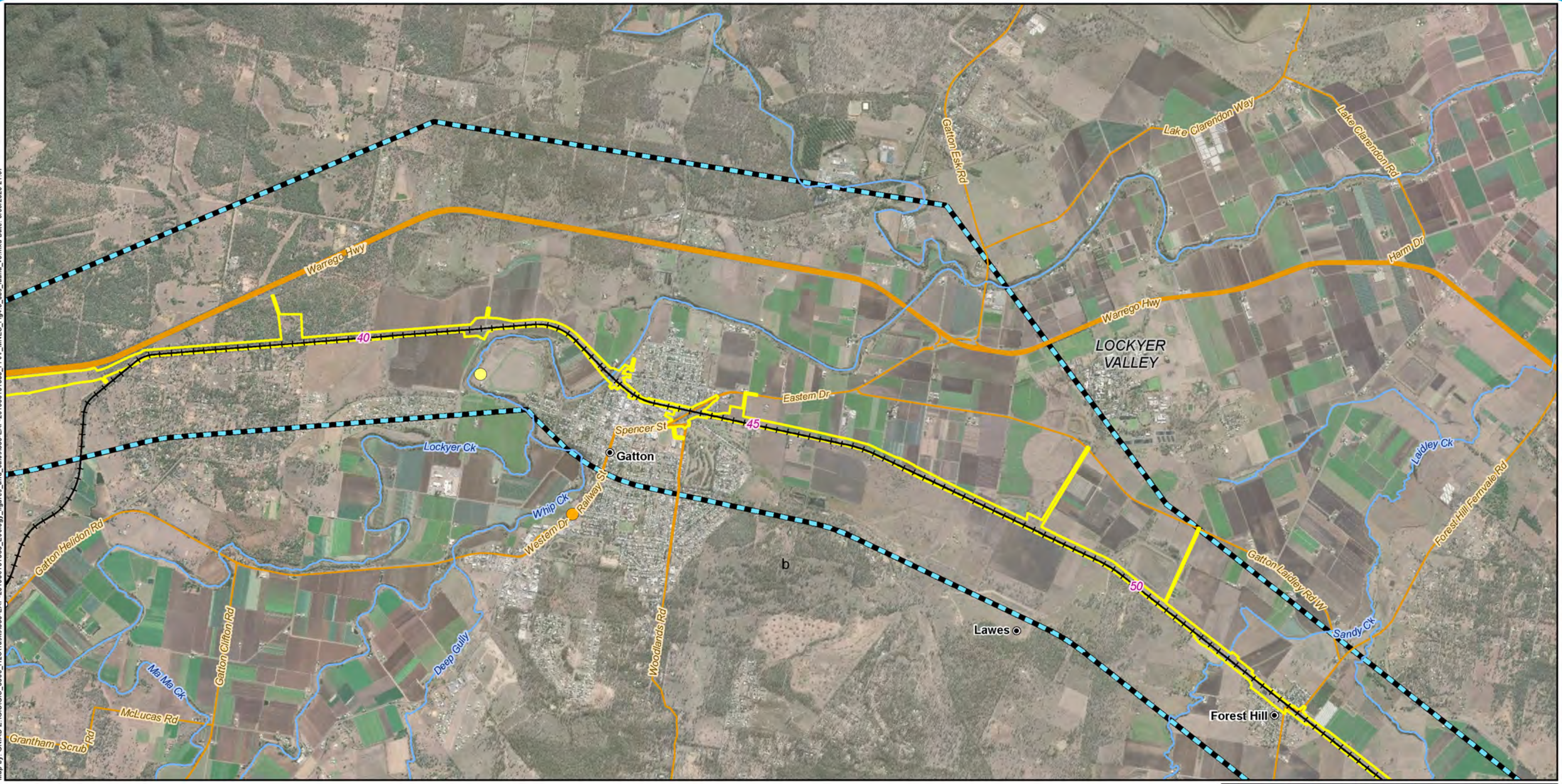
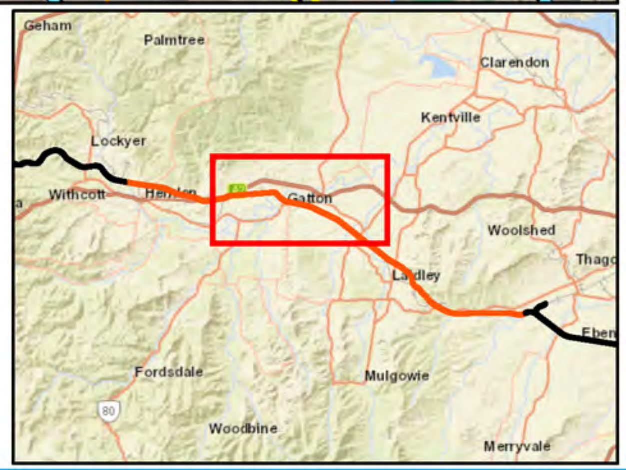
Helidon to Calvert
Figure 4.5a: Locations of threatened fauna observed within the MNES study area

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: GN/AD Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig4-5_obs_fauna_v5.mxd Date: 5/05/2020 21:57



Legend

- 5 Chainage (km)
- Localities

Fauna observations

- Grey falcon (*Falco hypoleucos*)
- Grey-headed flying fox (*Pteropus poliocephalus*)

- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas

A3 scale: 1:50,000

0 0.5 1 1.5 2 km

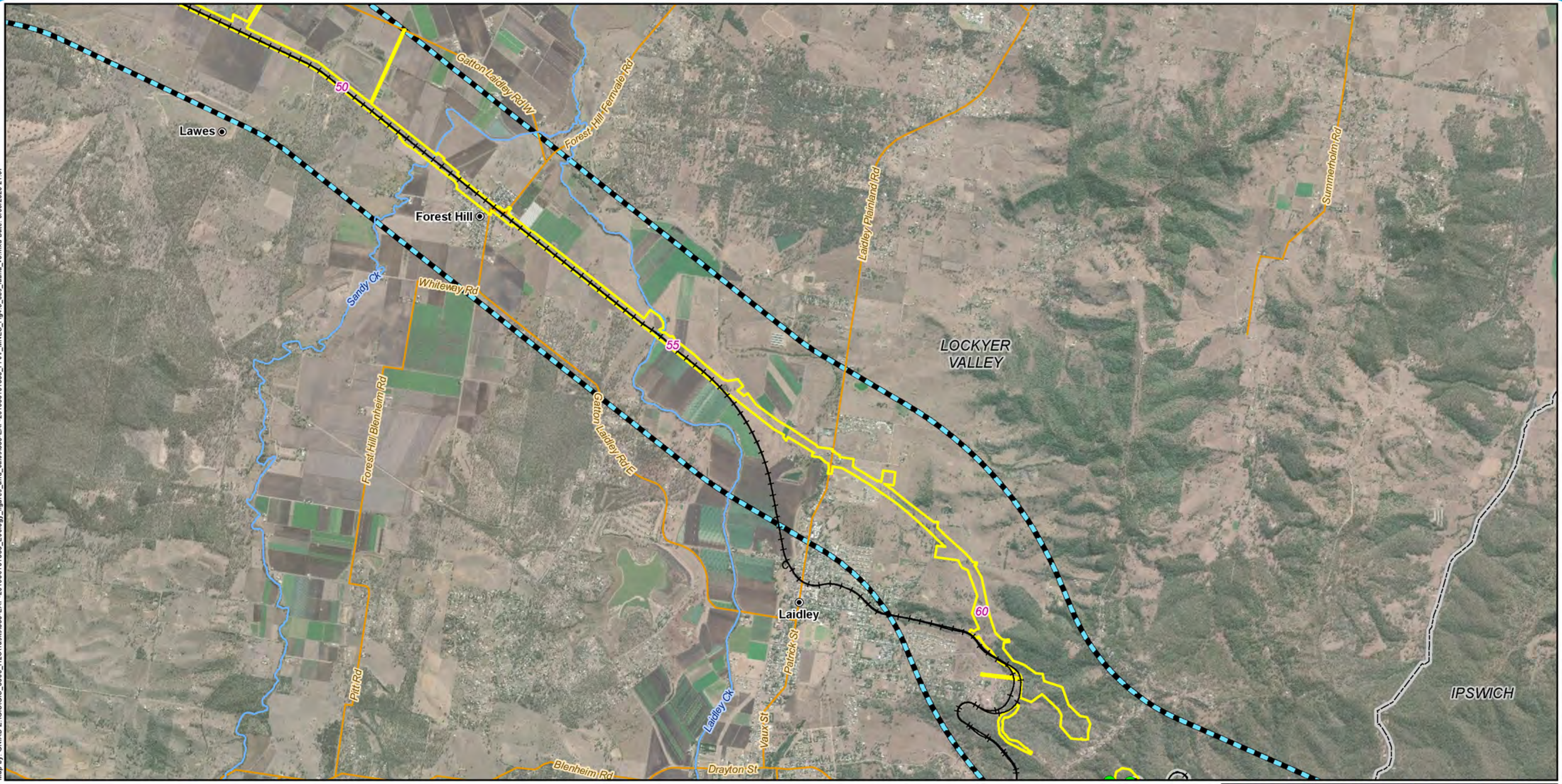
Future Freight
Integrating Community, Environment and Engineering

Issue date: 05/05/2020 Version: 5
Coordinate System: GDA 1994 MGA Zone 56

Helidon to Calvert

Figure 4.5b: Locations of threatened fauna observed within the MNES study area

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



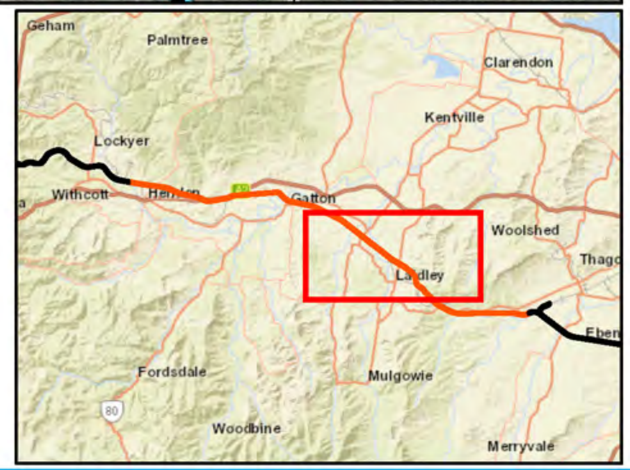
Map by: GN/AD Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig4-5_obs_fauna_v5.mxd Date: 5/05/2020 21:57

Legend

- 5 Chainage (km)
- Localities

Fauna observations

- Koala (*Phascolarctos cinereus*)
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Local Government Areas



A3 scale: 1:50,000

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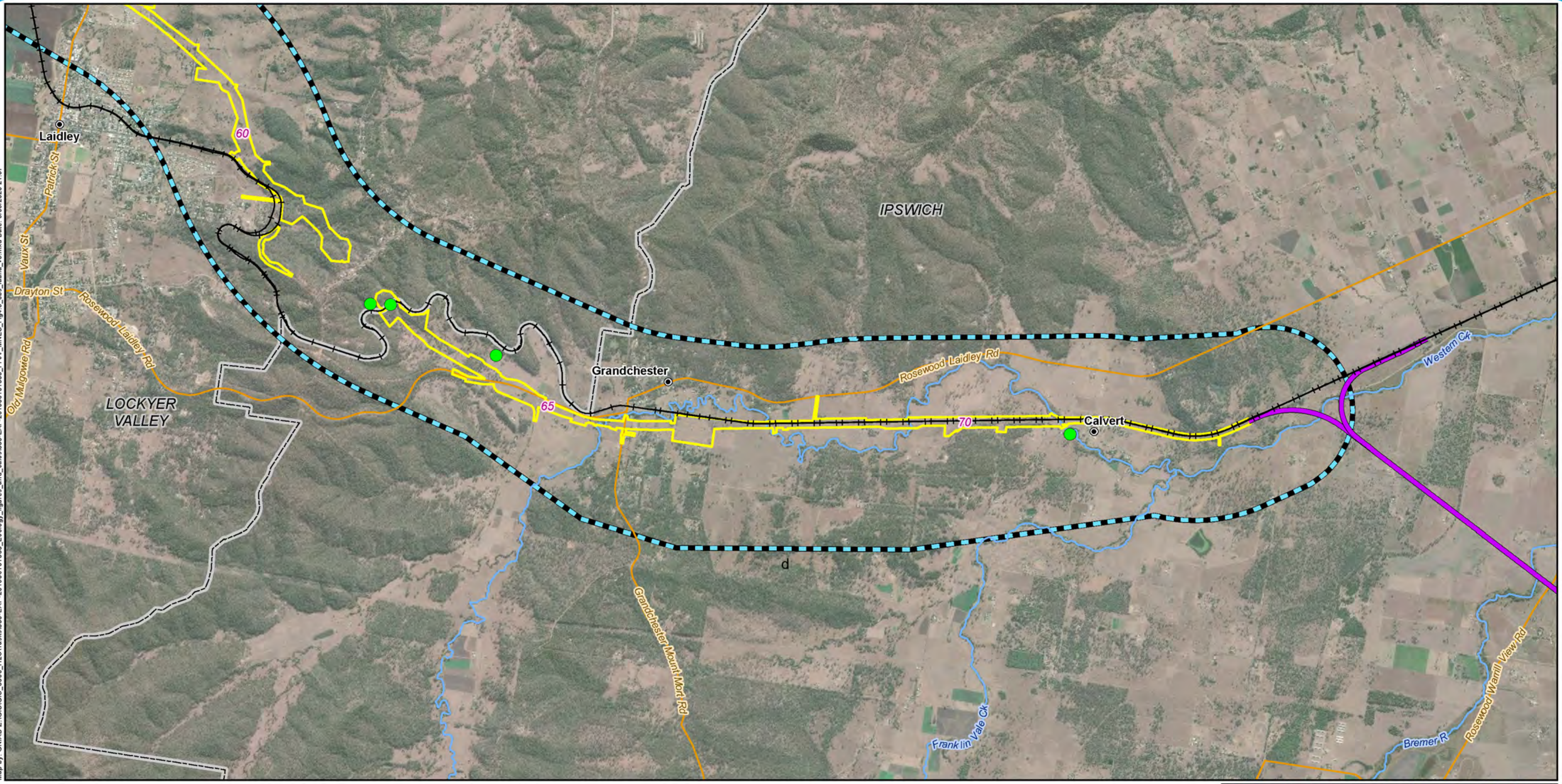
Helidon to Calvert

Figure 4.5c: Locations of threatened fauna observed within the MNES study area

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: GN/AD Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig4-5_obs_fauna_v5.mxd Date: 5/05/2020 21:57

Legend

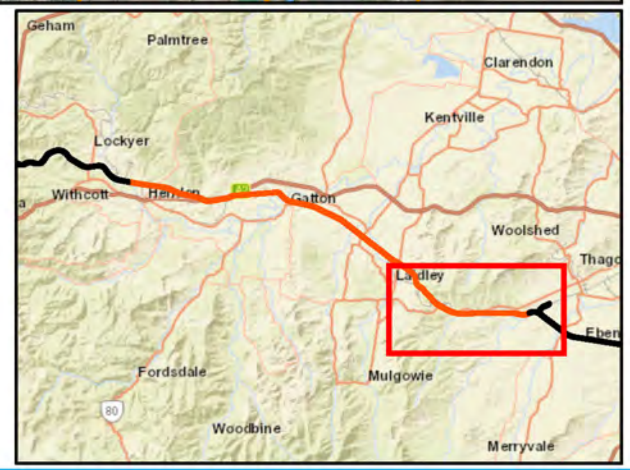
- 5 Chainage (km)
- Localities

Fauna observations

- Koala (*Phascolarctos cinereus*)

- Existing rail
- C2K project alignment
- Watercourses
- Major roads
- Minor roads

- EIS disturbance footprint
- MNES study area
- Local Government Areas



A3 scale: 1:50,000

0 0.5 1 1.5 2 km

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Helidon to Calvert

Figure 4.5d: Locations of threatened fauna observed within the MNES study area

4.4.2.3 Aquatic species

As noted in Table 4.3, two threatened aquatic species (Mary River cod and Australian lungfish) have the potential to inhabit the watercourses associated with the MNES study area.

As noted in the draft *National recovery plan for the Australian lungfish (Neoceratodus forsteri)* (DoEE 2019a) known habitat for this species relevant to the Project is associated with Lockyer Creek. Furthermore, under the plan Habitat critical for the survival of the species is:

- Any breeding or foraging habitat in areas where the species occurs
- Any newly discovered breeding or foraging locations.

This species was not encountered during opportunistic fish surveys, though suitable habitat in the form of a large permanent pool was noted where the alignment crosses Lockyer Creek. As such, this site may be considered as critical habitat for the species and has been included within the predictive habitat mapping to ensure that a conservative approach to impact assessment occurs. Other waterways intersected by the Project, such as two tributaries immediately south of Laidley Creek, appear highly ephemeral and would not appear to provide suitable breeding or foraging habitat for the species.

The Mary River cod (*Maccullochella mariensis*) was also possibly (formerly) present within the Brisbane-Stanley catchment. This species has been subject to restocking activities into a number of impoundments including Lockyer Creek. The *Mary River cod research and recovery plan* (Simpson and Jackson 1996) notes the species distribution as currently restricted to the Mary River and the species is not considered as present for the purposes of this assessment.

4.4.3 Predicted habitat for threatened flora and fauna species

Predictive habitat mapping for threatened flora and fauna (refer Section 3.2.4 and Appendix A) indicates that potential habitat for 26 threatened species (7 flora and 19 fauna species) occurs within the MNES study area (refer Appendix F). Areas of habitat for these species are presented in Table 4.4 and mapped areas of habitat are provided in Appendix F.

The predictive habitat mapping also indicates that there is no habitat within the Project disturbance footprint for the following seven species: Hairy joint-grass (*Arthraxon hispidus*), Bluegrass (*Dichanthium setosum*), Wandering pepper-cress (*Lepidium peregrinum*), Mount Berryman phebalium (*Phebalium distans*), Black-breasted button-quail (*Turnix melanogaster*), Five-clawed worm-skink (*Anomalopus mackayi*) and Dunmall's snake (*Furina dunmalli*).

The predictive habitat mapping is based on a range of considerations including desktop and ground-truthed vegetation mapping, database search results for species records and the results of field surveys for the Project. The Project disturbance footprint encompasses a total of 634.58 ha. Under current QLD Government (DES) vegetation mapping this comprises 32.26 ha of remnant vegetation and 66.39 ha of high-value regrowth vegetation (HVR) (refer EIS Appendix I: Terrestrial and Aquatic Ecology Report). The remaining 535.93 ha (84.5 per cent of the Project disturbance footprint) has been heavily modified (clearing for agriculture, cattle grazing and urban development) and is very unlikely to provide habitat for most MNES fauna and flora apart from scattered ephemeral flooded areas (for wetland birds) and small areas that are less impacted as associated with road reserves which may act as minor refuge areas.

The predictive estimation of habitat provided in Table 4.4 represents a highly conservative approach, accounting for MNES movement patterns, and where doubt existed regarding the potential of an area to provided habitat for a specific MNES, these areas were incorporated into the predicted estimation. The values provided in Table 4.4 are considered to represent the upper limit of available habitat within the MNES study area for each MNES.

It is noted the predictive estimate of *Potential habitat* for Koala encompasses 205.29 ha within the project disturbance footprint (in addition to 98.66 ha of *Habitat critical to the survival of the species*).

For the purposes of this assessment *Habitat critical to the survival of the species* (i.e. koala habitat) has been identified using the MNES Guidelines and includes all mapped remnant and regrowth vegetation communities containing eucalypt species and includes drainage lines which may provide suitable riparian habitat trees located outside of known vegetation mapping (e.g. Lockyer Creek). As can be observed in Figure 4.2 and Figure 4.5 most records for koala were from eucalypt woodlands (remnant and regrowth) in the Helidon Hills and Little Liverpool Range areas. These areas were considered to be *Habitat critical for the survival of the species* (refer Appendix F).

Potential habitat for the species is based on a 1 km buffer placed on recent species records (refer Figure 4.2) located outside of mapped vegetation communities (remnant or regrowth) and aims to consider potential movement patterns on a local scale outside of *Habitat critical for the survival of the species* (refer Appendix A for methodology). *Potential habitat* encompasses habitat comprising scattered trees in grazing paddocks (in which the species has been known to use but do not provide the only movement opportunity / refuge to or between areas of habitat critical to the species survival) and grazing and cropped areas which do not feature trees at all (e.g. Lockyer Creek and Laidley Creek floodplain).

As such, *Potential habitat* mapped for Koala is likely a significantly over-estimate with the main risk to the species in these areas being the barrier effect/fragmentation (i.e. generally north south movement, there is weak connectivity east to west across the Laidley Creek floodplain). A study by Barth et al (2019) noted that koalas use paddock trees and roadside vegetation during both breeding and non-breeding seasons, with these areas utilised significantly more than expected based on their availability within the landscape.

Habitat determination will be subject to further refinement through additional studies during the final design stage of the Project.

It should also be noted while there is large habitat area values associated with White-throated needletail (*Hirundapus caudacutus*) (constituting the entire MNES study area) this is an aerial foraging species which may forage over any habitat including heavily disturbed areas. As such, all 'air-space' above the Project may be considered habitat. Given this habitat (i.e. above the Project) will not be impacted by the Project construction/operation activities the species is not subject to further impact assessment.

Table 4.4 Predicted habitat for threatened flora and fauna species within the matters of national environmental significance study area

Species name	Common name	EPBC Act status*	Predicted habitat within the Project MNES study area (ha)* (11,866.54 ha)				Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha)			
			Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species	Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species
Threatened flora										
Arthraxon hispidus	Hairy-joint grass	V	1.16	1.16	0.00	0.00	0.00	0.00	0.00	0.00
Dichanthium setosum	Bluegrass	V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grevillea quadricauda	Four-tailed grevillea	V	476.49	476.49	0.00	0.00	26.06	26.06	0.00	0.00
Leionema obtusifolium	Blunt-leaved leionema	V	888.11	888.11	0.00	0.00	29.26	29.26	0.00	0.00
Lepidium peregrinum	Wandering pepper-cress	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Notelaea lloydii	Lloyd's native olive	V	2,593.56	2,417.14	0.00	176.42	134.03	112.77	0.00	21.26
Paspalidium grandispiculatum	a grass	V	2,359.53	2,359.53	0.00	0.00	84.58	84.58	0.00	0.00
Phebalium distans	Mt Berryman phebalium	CE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sophora fraseri	Brush sophora	V	414.52	414.52	0.00	0.00	39.98	39.98	0.00	0.00
Thesium australe	Toadflax	V	653.22	653.22	0.00	0.00	94.77	94.77	0.00	0.00
Threatened fauna										
Anthochaera Phrygia	Regent honeyeater	CE	2,259.21	2,259.21	0.00	0.00	84.58	84.58	0.00	0.00
Botaurus poiciloptilus	Australasian bittern	E	446.51	415.42	0.00	31.09	15.43	15.43	0.00	0.00
Calidris ferruginea	Curlew sandpiper	CE, M	818.13	812.98	0.00	5.15	15.43	15.43	0.00	0.00
Erythrotriorchis radiatus	Red goshawk	V	2,426.17	1,380.34	0.00	955.83	88.82	71.08	0.00	17.74
Falco hypoleucos	Grey falcon	V	6,425.19	6,425.19	0.00	0.00	351.97	351.97	0.00	0.00
Grantiella picta	Painted honeyeater	V	683.72	681.05	0.00	2.67	13.34	13.34	0.00	0.00
Hirundapus caudacutus	White-throated needletail^	M, V	11,866.54	9,057.47	2,809.07	0.00	634.56	535.12	99.46	0.00
Lathamus discolor	Swift parrot	CE	2,773.66	2,411.00	0.00	362.66	98.67	85.33	0.00	13.34
Rostratula australis	Australian painted snipe	E	790.96	344.45	0.00	446.51	33.38	17.95	0.00	15.43

Species name	Common name	EPBC Act status*	Predicted habitat within the Project MNES study area (ha)* (11,866.54 ha)				Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha)			
			Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species	Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species
Turnix melanogaster	Black-breasted button-quail	V	0.09	0.00	0.00	0.09	0.00	0.00	0.00	0.00
Dasyurus maculatus maculatus	Spotted-tail quoll (Southern subspecies)	E	2,126.47	1,807.43	0.00	319.04	77.07	75.48	0.00	1.59
Petauroides volans volans	Greater glider	V	1,527.84	1,527.84	0.00	0.00	30.64	30.64	0.00	0.00
Petrogale penicillata	Brush-tailed rock-wallaby	V	297.73	235.89	0.00	61.84	41.25	36.37	0.00	4.88
Phascolarctos cinereus	Koala	V	6,467.86	3,782.28	0.00	2,685.58	303.95	205.29	0.00	98.66
Potorous tridactylus tridactylus	Long-nosed potoroo	V	2,253.93	2,253.93	0.00	0.00	84.58	84.58	0.00	0.00
Pseudomys novaehollandiae	New Holland mouse	V	2,401.31	2,400.63	0.00	0.68	88.12	88.12	0.00	0.00
Pteropus poliocephalus	Grey-headed flying-fox	V	2,812.21	26.30	0.00	2,785.91	99.46	0.00	0.00	99.46
Anomalopus mackayi	Five-clawed worm-skink	V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delma torquata	Collared delma	V	2,326.15	0.00	2,326.15	0.00	85.33	0.00	85.33	0.00
Furina dunmalli	Dunmall's snake	V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neoceratodus forsteri	Australian lungfish	V	462.87	338.88	0.00	123.99	2.24	0.28	0.00	1.96

Table notes:

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

^ Aerial species, all "air-space" above the Project may be considered habitat. However, these areas will remain unimpacted by the project. This species has not been subject to impact assessment.

* No value (i.e. 0) represent areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. For species where no habitat is present within the MNES study area, impact assessment has not occurred although their habitat requirements and ecology has been considered through the modelling process (refer Appendix A and Appendix B).

4.4.4 Flora and fauna habitat within the matters of the national environmental significance study area

A total of eight broad fauna habitat types have been identified within the MNES study 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 MNES study area.

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

The majority of remnant and non-remnant native vegetation is clustered around the eastern and western extremities of the MNES study area (i.e. Helidon and Calvert), in areas of higher elevation. The central portion of the MNES study area (i.e. Gatton-Forest Hill) is extensively cleared and subject to high intensity irrigated horticulture. 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. Drainage lines, waterways and wetlands are also important features in regards for the provision of habitat for MNES and are present within the MNES study area.

Each broad habitat type is discussed in further detail below and spatially represented in Figure 4.6a-d. The following sections denote the State-based vegetation communities (REs) associated with the broad habitat types discussed. For detailed descriptions of the REs please refer to Appendix A within Appendix A of this report: Predictive habitat modelling methodology. An analysis of the quantity of fauna habitat contained within the MNES study area and within the Project disturbance footprint is presented in Table 4.5.

Table 4.5 Extent of fauna habitat located within the matters of national environmental significance study area

Fauna habitat type* (refer Figure 4.6)	Extent (ha)	
	Project MNES study area	**Project disturbance footprint**
Mature eucalypt open forest and woodland	1,529.81	29.63
Mature eucalypt riparian woodland	87.33	1.87
Regrowth eucalypt communities	879.76	49.03
Melaleuca irbyana low open forest	5.77	0.00
Acacia harpophylla-Casuarina cristata open forest to woodland	6.11	0.00
Riparian zones	521.81	19.79
Wetlands	22.77	0.00
Grassland	6,986.46	490.70
Cultivated land	1,826.72	43.56
Total	**11,866.54**	**634.58**

Table note:

* Includes communities currently mapped as regrowth communities under State-based vegetation mapping

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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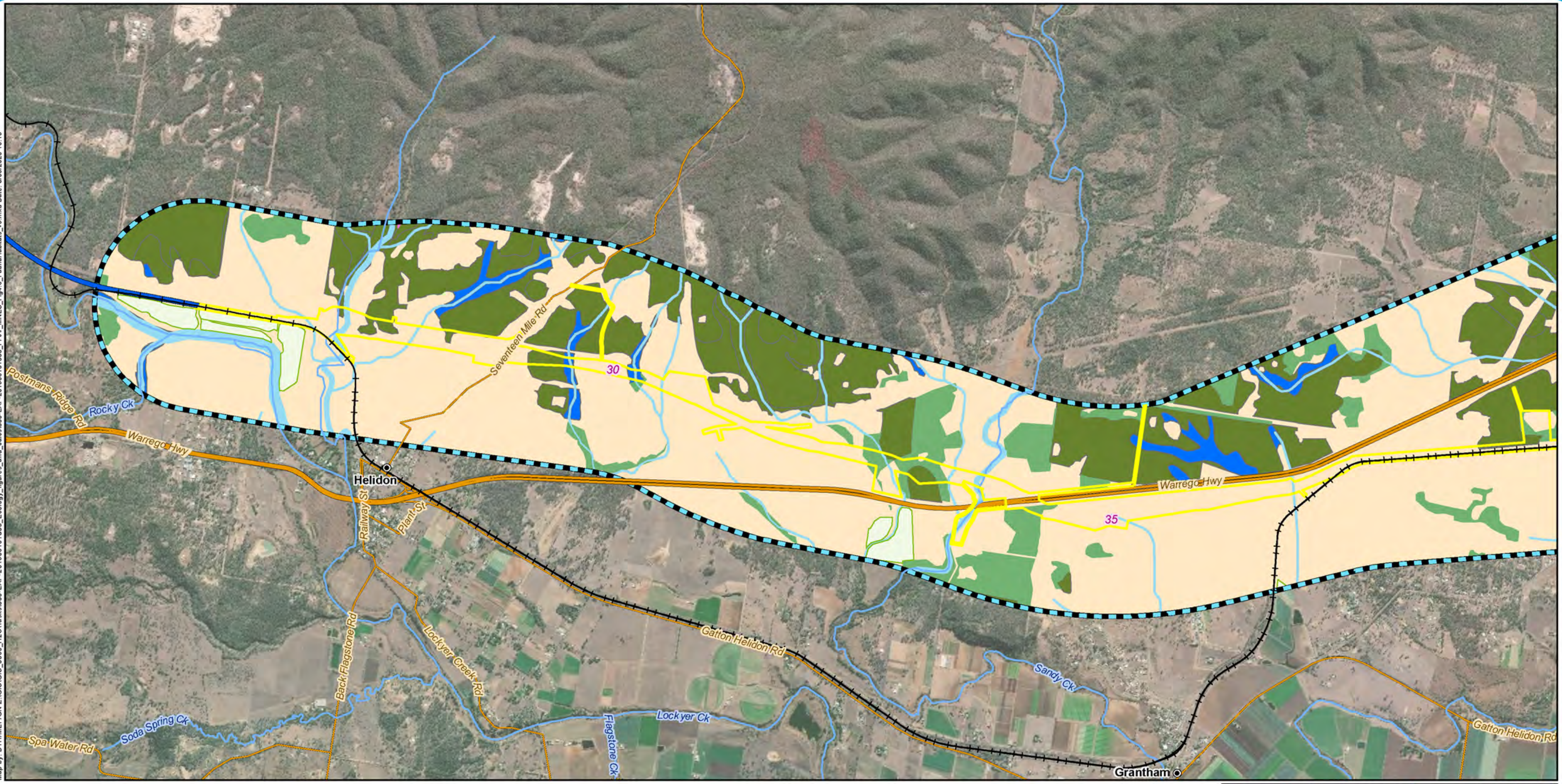

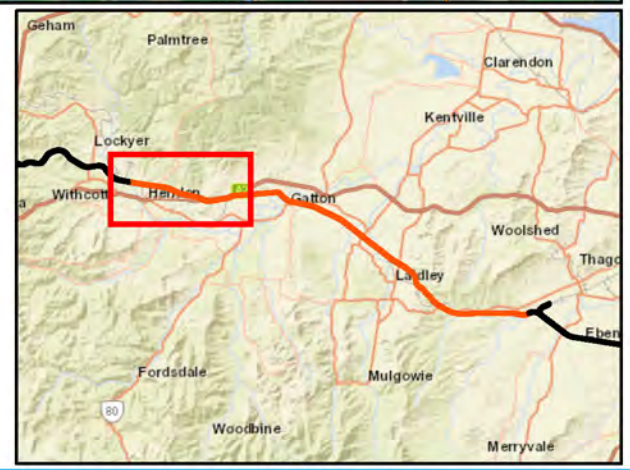

Legend

- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Cultivated land
- Grassland
- Regrowth communities
- Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
- Mature eucalypt riparian open forest and woodland
- Riparian zones / waterways
- Wetlands

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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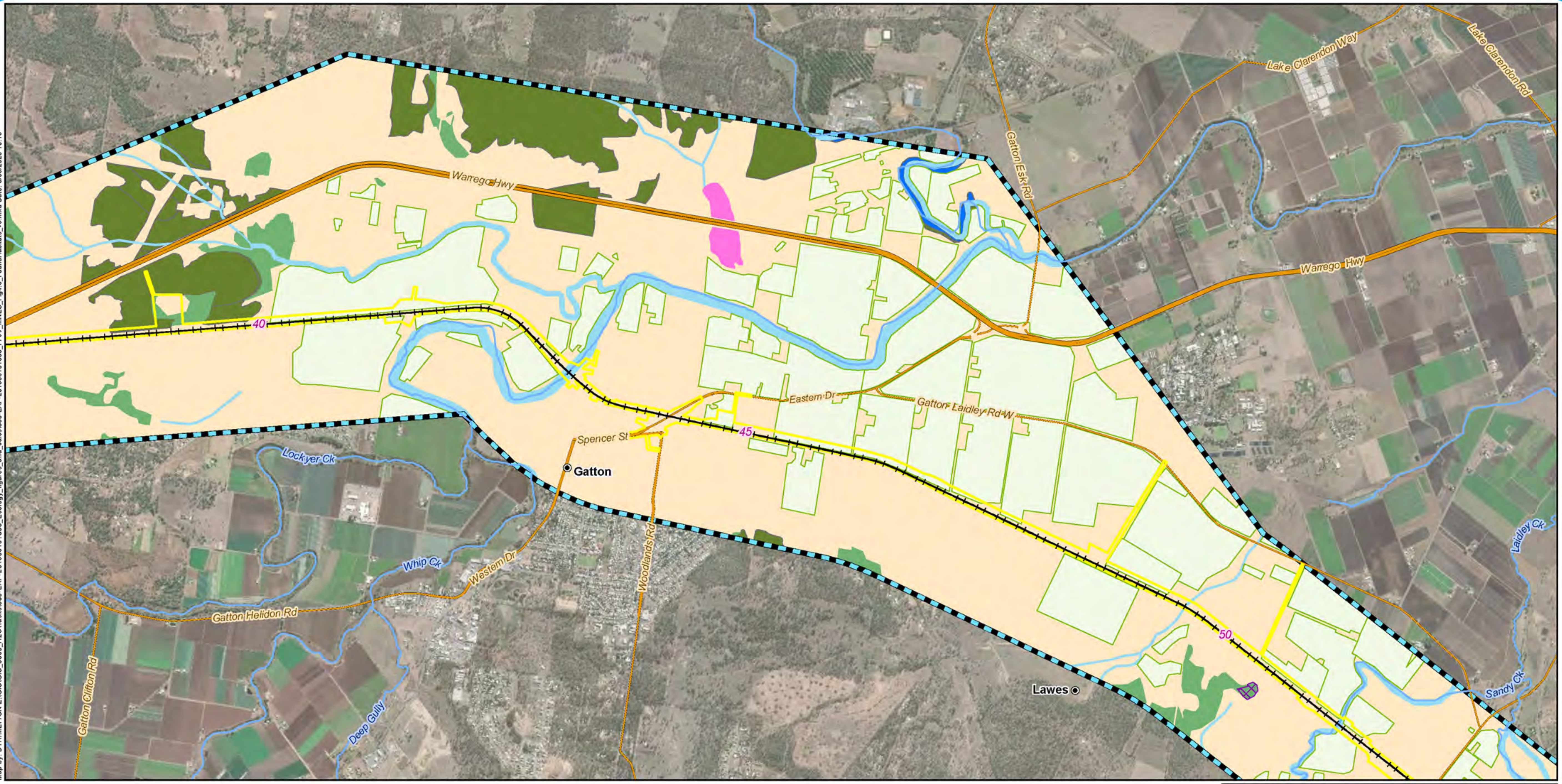
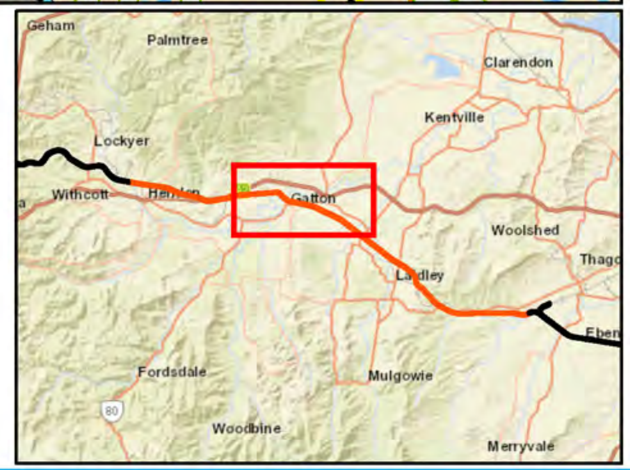
Helidon to Calvert

Figure 4.6a: Location of habitat types contained within the MNES study area

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: DTH/MEF/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_cales\330-EAP-201906101333_FFJV_MNES_Fig4-6_FaunaHabitats_v5.mxd Date: 8/05/2020 10:15



Legend

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Cultivated land
- Grassland
- Regrowth communities
- Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
- Mature eucalypt riparian open forest and woodland
- Riparian zones / waterways
- Wetlands
- *Acacia harpophylla-Casuarina cristata* open forest sub-dominant community

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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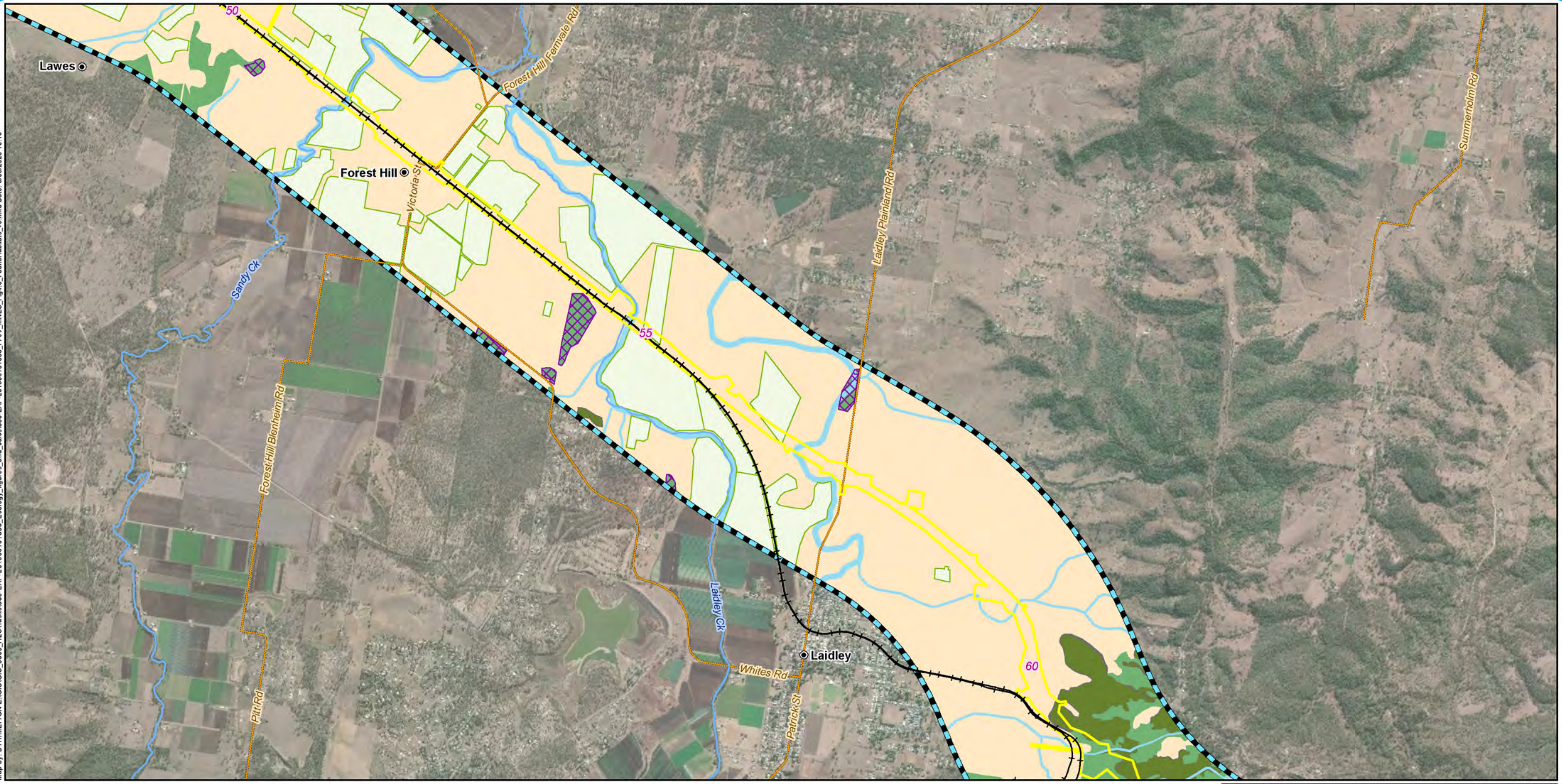
Helidon to Calvert

Figure 4.6b: Location of habitat types contained within the MNES study area

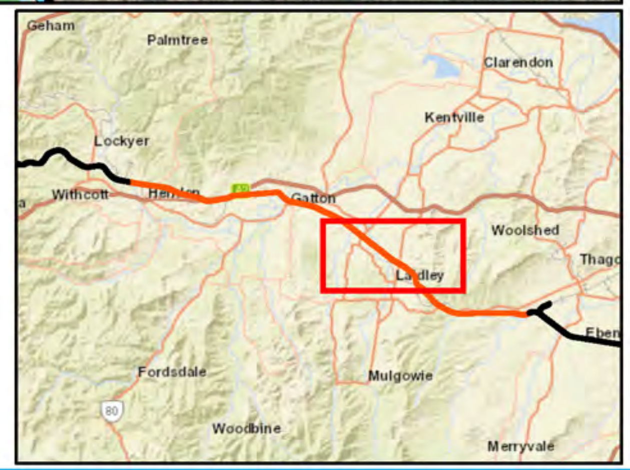
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map by: DTH/MEF/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_FFJV_MNES_Fig4-6_FaunaHabitats_v5.mxd Date: 8/05/2020 10:15



Legend

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- MNES study area
- Cultivated land
- Grassland
- Regrowth communities
- Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
- Riparian zones / waterways
- *Acacia harpophylla-Casuarina cristata* open forest sub-dominant community



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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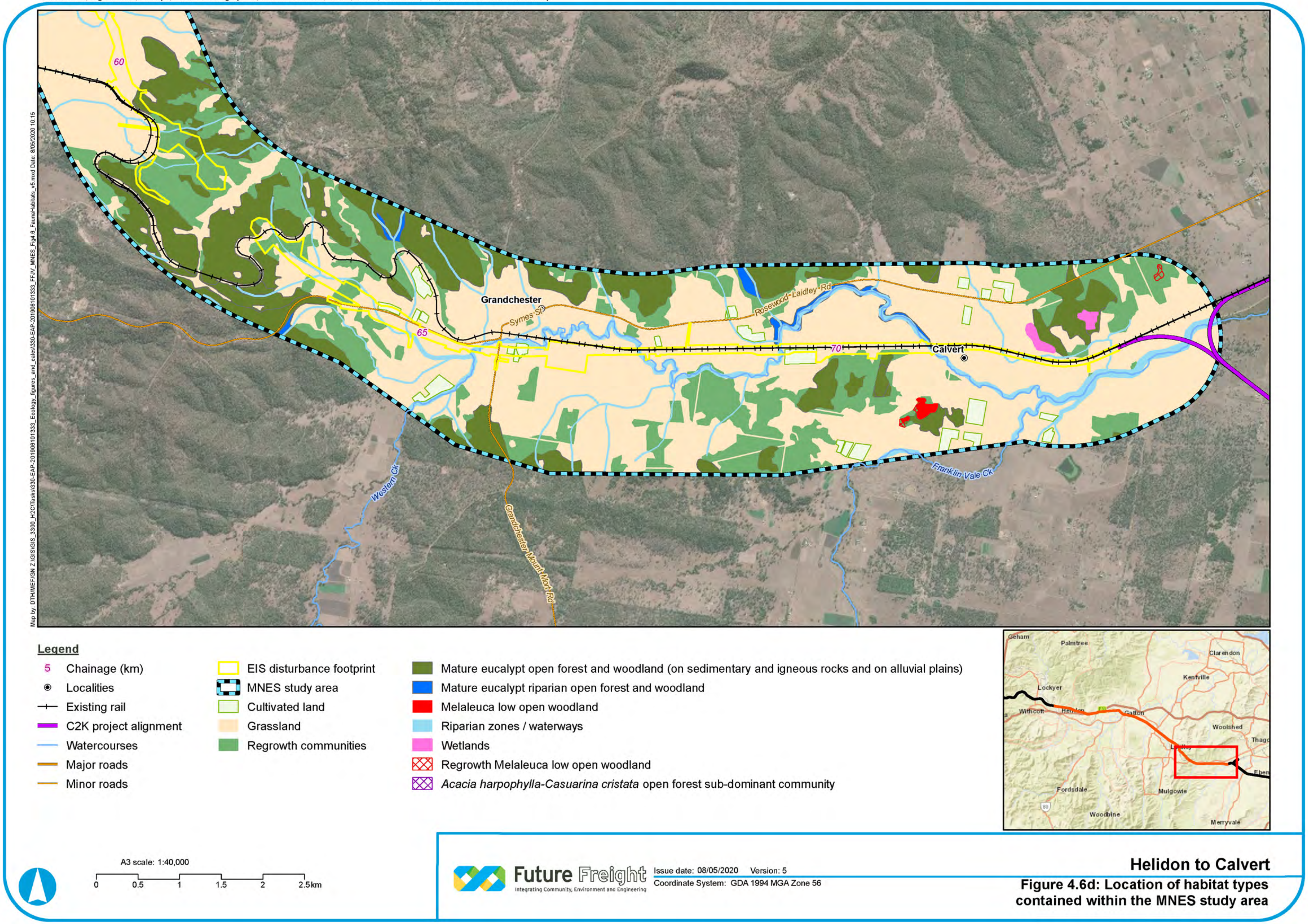
Helidon to Calvert

Figure 4.6c: Location of habitat types contained within the MNES study area

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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Helidon to Calvert

Figure 4.6d: Location of habitat types contained within the MNES study area

4.4.4.1 Mature eucalypt open forest and woodland

On sedimentary rocks

This habitat is dominant in the Helidon Hills west to the Warrego Highway in the western portion of the MNES study area and the elevated areas associated with the Little Liverpool Range in the east. These communities are dominated by Spotted gum (*Corymbia citriodora*) (refer Photograph 4.3), Narrow-leaved ironbark (*Eucalyptus crebra*), Queensland bluegum (*Eucalyptus tereticornis*), Moreton Bay ash (*Corymbia tessellaris*), Silver-leaved ironbark (*Eucalyptus melanophloia*), Broad-leaved ironbark (*Eucalyptus fibrosa*), Gum-topped box (*Eucalyptus moluccana*) and *Angophora* spp. Many of these species provide foraging habitat for Koala (*Phascolarctos cinereus*), although Queensland bluegum is particularly preferred. Spotted gum dominates the woodland in the Little Liverpool Range due to the poor soils in this area (refer Photograph 4.3), while woodlands in the Helidon Hills were more diverse. Areas of remnant, mature eucalypt open forest and woodland within the MNES study area are represented by REs 12.9-10.2, 12.9-10.3, 12.9-10.7 and 12.9-10.19.

The condition and structure of these habitats varies greatly across the MNES study area, ranging from a simplified structure with sparse shrub and/or ground strata reflective of past land use and current management practices (e.g. logging, cattle grazing and vegetation thinning), to a complex vegetation structure with all strata (i.e. canopy, mid-storey and understorey) essentially intact. Invasive weeds including Lantana (*Lantana camara* and *L. montevidensis*), and Prickly pear (*Opuntia)* species were noted as commonly occurring in this habitat with dense infestations of *Lantana camara* observed in some areas. Important microhabitat refugia provided by this habitat type includes tree hollows, hollow logs and termitaria (arboreal and terrestrial).

Canopy species present in this habitat type provide a range of trunk and limb hollows (of a variety of size classes) which potentially provide suitable habitat for Microchiropteran bats, gliders, possums, birds (including parrots, cockatoos and owls), arboreal snakes and monitors. Eucalypt flowering events may provide seasonal foraging resources for a number of dispersive MNES bird species including the Swift parrot (*Lathamus* discolour) and the Regent honeyeater (*Anthochaera phrygia*). Standing dead trees (stags) also provide roosting sites, nesting dens and breeding locations for a similar range of species. Where mature eucalypt open forest and woodlands occur as fragmented/isolated patches in largely cleared agricultural landscapes, they are somewhat restricted in their capacity to support woodland and forest species and are more likely to offer habitat value to transitional species and support mammal and bird species typical of disturbed areas. Canopy arthropods are relatively abundant in eucalypt forest and woodlands and provide a valuable foraging resource to birds and mammals. Eucalypt forests and woodlands also provide an important source of nectar for Grey-headed flying-fox (*Pteropus poliocephalus*). Red goshawk (*Erythrotriorchis radiatus*) may occur where there are extensive woodlands supporting an abundance of birds such as the Helidon Hills and Little Liverpool Range areas.

Areas of mature eucalypt open forest and woodland (on sedimentary and igneous rock) within the MNES study area may provide suitable habitat for a range of MNES fauna species where appropriate habitat values are present for the species. The required habitat elements to support MNES species (e.g. large tree hollows, large fallen timber) are not present throughout. Suitable habitat for MNES fauna may include Collared delma (*Delma torquata*), Greater glider (*Petauroides volans volans*) and Koala (*Phascolarctos cinereus*). Suitable habitat for Collared delma (*Delma torquata*) was identified in the Little Liverpool Range. Large tree hollows were generally observed to be scarce in the surveyed areas of the Little Liverpool Range reducing the suitability of this habitat for arboreal species such as Greater glider (*Petauroides volans*). Long-nosed potoroo (*Potorous tridactylus tridactylus*) may occur where a dense understorey and ground layer is present. Lloyd's native olive (*Notelaea lloydii*) is also known to occur in this habitat within the Project disturbance footprint.

The presence of large rocks/cliffs may support habitat for Spotted-tail quoll (*Dasyurus maculatus maculatus*) and Brush-tailed rock wallaby (*Petrogale penicillata*) (refer Photograph 4.5) although no such habitat areas were observed within or near the Project disturbance footprint. Lloyd's native olive (*Notelaea lloydii*) is also known to occur in this habitat within the Project disturbance footprint. Long-nosed potoroo (*Potorous tridactylus tridactylus*) may occur where a dense understorey and ground layer is present.

Photograph 4.3 **Spotted gum dominated woodland in Little Liverpool Range (2017)**

Photograph 4.4 **Rocky habitat in Helidon Hills area (2017)**

On alluvial plains

Areas of mature eucalypt open forest and woodland on alluvial plains within the MNES study area include areas dominated by Queensland bluegum (*Eucalyptus tereticornis*) and Gum-topped box (*Eucalyptus moluccana*). Areas of remnant eucalypt open forest and woodland (on alluvial plains) within the MNES study area are represented by RE 12.3.3 and 12.3.19.

This habitat type exists on floodplains and creek flats within the MNES study area and generally exhibits low structural complexity, particularly at lower strata levels. Ground cover is typically low due to the impacts of livestock use, and the understorey is also generally very sparse with an open canopy of large Queensland bluegum (refer Photograph 4.5). However, mature eucalypt trees on alluvial plains are known to provide important habitat, such as food and shelter (in the form of large tree hollows) (refer Photograph 4.6), for a range of fauna species, including birds, mammals, and reptiles. MNES fauna species that may occur in mature eucalypt open forests and woodland include Regent honeyeater (*Anthochaera phrygia*), Swift parrot (*Lathamus discolor*), Greater glider (*Petauroides volans*), Koala (*Phascolarctos cinereus*), Grey-headed flying-fox (*Pteropus poliocephalus*). In particular, Queensland blue gum (*Eucalyptus tereticornis*) is a favoured forage species for Koala.

Furthermore, during heavy rainfall periods this habitat type may flood 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, crakes, rails, egrets, and herons. MNES fauna species that may occasionally utilise flooded eucalypt open forest and woodland on alluvial plains include Australian painted snipe (*Rostratula australis*) where suitable cover may occur.

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.

Photograph 4.5 **Degraded floodplain woodland in Gatton area (2017)**

Photograph 4.6 **Example of large habitat tree (Queensland bluegum) in matters of national environmental significance study area (2017)**

4.4.4.2 Mature eucalypt riparian woodland

Eucalypt riparian open forest and woodlands within the MNES study area include open forests and woodlands dominated by Queensland bluegum (*Eucalyptus tereticornis*) fringing drainage lines with associated species, including *Melaleuca* spp., Moreton Bay ash (*Corymbia tessellaris*), *Angophora* spp., and River she-oak (*Casuarina cunninghamiana*). Areas of remnant *Eucalypt* riparian open forest and woodland within the MNES study area are represented by RE 12.3.7. This habitat type occurs exclusively along the edge of rivers, creeks and vegetated drainage lines within the MNES study area. Mature eucalypt riparian open forest and woodlands within the MNES study area is generally in poor condition having been heavily impacted by adjacent land use. In most areas this habitat has been subject to clearing with few large trees present and substantial weed invasion (such as Laidley Creek and the mid-reaches of Lockyer Creek). Western Creek retains a narrow (although disturbed) line of riparian vegetation along its length within the MNES study area (refer Photograph 4.7), as does the upper reaches of Lockyer Creek (in the Helidon area).

Riparian vegetation also contributes to in-stream habitat (e.g. large woody debris) considered important for MNES fish species. Within these zones, threatened aquatic fauna are considered to have potential to occur where large permanent waterholes occur, specifically Australian lungfish (*Neoceratodus forsteri*).

A range of fauna, including birds, mammals, and reptiles, may utilise this habitat type for foraging, breeding, and dispersal. The movement corridors provided by this habitat type are important for structural connectivity, in otherwise fragmented landscapes, although as noted, this connectivity is generally impaired within the MNES study area. MNES fauna species that may occur in mature eucalypt riparian open forests and woodland include Regent honeyeater (*Anthochaera phrygia*), Red goshawk (*Erythrotriorchis radiatus*) where it occurs within extensive tracts of remnant vegetation, Swift parrot (*Lathamus discolor*) and Koala (*Phascolarctos cinereus*). Greater glider (*Petauroides volans*) may occur where riparian woodland remains adjacent to tracts of floodplain woodland.

Photograph 4.7 **Western Creek in Grandchester area (2017)**

Photograph 4.8 **Regrowth *Acacia* woodland with *Lantana camara* dominant understorey (2017)**

4.4.4.3 Regrowth eucalypt communities

Areas of regrowth vegetation, largely represented by the Department of Resources HVR vegetation mapping, are present throughout the MNES study area. A total of 1,093.72 ha of HVR is mapped within the MNES study area. The patches of regrowth vegetation within the MNES study area are generally in poor condition, suffering from extensive weed invasion (refer Photograph 4.8) and disturbance from cattle grazing practices. 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 in floodplain areas. Transitional fauna species include migratory terrestrial bird species, moving between habitats.

4.4.4.4 *Melaleuca irbyana* low open forest

Melaleuca low open woodland within the eastern extent of the MNES study area includes small mapped areas of low open woodland and tall shrubland dominated by *Melaleuca irbyana* (Swamp tea-tree) (it is noted these areas have not been surveyed and the community confirmed as present). Areas of remnant *Melaleuca* low open woodland within the MNES study area are represented by RE 12.3.18 on alluvial plains and are represented by three small patches in the western extent of the alignment. Within this habitat type *Melaleuca irbyana* forms a closed shrub layer or sub-canopy with a sparse understorey. An open canopy of emergent eucalypts (e.g. *Eucalyptus tereticornis*) is sometimes present. RE 12.3.18 is considered to be analogous to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC.

This habitat type may provide foraging and nesting habitat for a limited range of bird and mammal species. Melaleuca low open woodland occurs on Mesozoic sediments where drainage is impeded, such as lower slopes and elevated flats. Ephemeral pools commonly occur, provided suitable breeding habitat for a range of frog species. During the wet season this habitat type commonly forms a palustrine wetland when flooded. Where Queensland bluegum (*Eucalyptus tereticornis*) is present, *M. irbyana* low open forest may provide abundant seasonal nectar resources. Threatened fauna species that may utilise *Melaleuca* low open woodland within the MNES study area include Painted honeyeater (*Grantiella picta*) and Grey-headed flying fox (*Pteropus poliocephalus*).

4.4.4.5 *Acacia harpophylla-Casuarina cristata* open forest to woodland

Acacia harpophylla-Casuarina cristata open forest on sedimentary rocks within the MNES study area is represented by mapped patches of mixed regrowth partially comprising RE 12.9-10.6. This habitat type is dominated by Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*), with a semi-evergreen vine thicket understorey. A prominent low tree or tall shrub layer may be present including species such as *Geijera parviflora* and *Eremophila mitchellii.* Vine thicket species potentially present include *Carissa ovata, Owenia acidula, Croton insularis, Denhamia oleaster* and *Notelaea microcarpa*. This habitat type typically occurs on cracking clays that are usually black or grey to brown or reddish-brown in colour and occurs in the Lockyer Valley and Boonah areas. RE 12.9-10.6 is considered to meet the conservation listing advice criteria for the Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC.

Brigalow open forest/woodland on alluvial plains within the impact assessment area is represented by RE 11.3.10a. This habitat type is dominated by *Acacia harpophylla* forming a fairly continuous canopy with *Eucalyptus* spp. including *E. populnea and E. tereticornis* sometimes scattered through the canopy or occurring as emergents. This community occurs on Quaternary alluvial plains in the Lockyer Valley where small areas of cracking clay soils occur. This community does not meet the conservation listing advice criteria for the Brigalow TEC.

In the region both communities have been heavily impacted by land use activities associated with agriculture and cattle grazing. Within the MNES study area these communities may provide habitat for MNES species including Painted honeyeater (*Grantiella picta*) and Dunmall's snake (*Furina dunmalli*). It is noted the areas where these communities are mapped as occurring are outside the Project disturbance footprint and have not been surveyed and confirmed as present.

4.4.4.6 Riparian zones/waterways

Riparian zones are an interface between terrestrial and aquatic ecosystems and also play a vital role supporting biodiversity. Healthy, native riparian vegetation reduces the water temperature of aquatic habitats by shading (as a buffer to thermal radiation). When water temperature increases poikilothermic aquatic organisms will experience physiological stress (Guschina and Harwood 2006), with expected reduced resilience to additional stressors (such as further degraded water quality parameters). More sunlight in the riparian zone also increases the growth of soft leaved vigorous weeds and algae that can choke the stream channel, reducing fish passage at lower hydrological flow.

In general, riparian zones within the MNES study area are in poor condition with little taller vegetation present and heavy weed infestation in the shrub and ground layers (refer Photograph 4.7 and Photograph 4.9). Where present, riparian forests dominated by Queensland bluegum (*Eucalyptus tereticornis*) provide seasonal nectar resources for birds and flying-foxes and mature specimens have large tree hollows suitable as shelter nesting sites for arboreal mammals and some bird species (particularly parrots). Proximity to permanent water sources also increases the importance of these areas as habitat. Riparian vegetation also contributes to in-stream habitat (e.g. large woody debris) considered important for MNES fish species. Within these zones, threatened aquatic fauna are considered to have potential to occur where large permanent waterholes occur, specifically Australian lungfish (*Neoceratodus forsteri*). Australian lungfish is known to occur in Lockyer Creek. Riparian vegetation at the alignment crossing at this point is heavily degraded with few overstorey trees present (refer Photograph 4.9).

Within the MNES study area, habitats with permanent water are likely to support the most diverse and abundant aquatic communities, however areas with seasonal water provide periodically available habitat and act as pathways for fauna. Lockyer Creek was noted as retaining a large pool at the alignment crossing area during Project assessments despite dry conditions occurring at the time (refer Photograph 4.9). These crossings (and associated works within the riparian vegetation communities) coincide with medium aquatic conservation assessment scores indicating the value of riverine wetlands and associated habitat importance to MNES within the MNES study area.

Aquatic habitat values were assessed across a 100 m assessment reach at 17 riparian sites within the MNES study area including Lockyer Creek, Laidley Creek, Western Creek and various small tributaries. The habitat assessment scores noted that most of the aquatic habitat across the ecology study area was typically poor to fair. Typically, the un-named tributaries demonstrated the poorest physical habitat site condition while higher physical habitat site condition was noted from Western Creek and Laidley Creek. Further information regarding riverine habitat values is provided in EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report.

Vegetation associated with intact riparian zones provides an important role in facilitating fauna movement in otherwise fragmented environments and as such are pivotal in the movement of genetic material within populations and ecosystems and ensure correct ecosystem function and processes are maintained.

Photograph 4.9 Lockyer Creek at alignment crossing point (2017)

Photograph 4.10 Lake Dyer (Bill Gunn Dam) near Laidley (2017)

4.4.4.7 Wetlands

Wetland habitats within the MNES study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine), and vegetated swamps (palustrine). It is noted no wetlands are mapped as occurring within the Project disturbance footprint (refer Table 4.5). Artificially created wetlands (i.e. farm and public dams (refer Photograph 4.10)), which are abundant across agricultural landscapes, are included as they potentially provide suitable wetland alternatives for vertebrate fauna. Artificial wetlands include typically small farm dams and much larger turkey-nest dams associated with irrigated cropping, as well as drinking water supply reservoirs. Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants, and Queensland bluegum (*Eucalyptus tereticornis*). All of the aquatic ecology monitoring sites at non-riverine wetlands had Aquascores (under ACA AquaBAMM assessment) of High to Very High indicating good conditions across the MNES study area.

Palustrine wetlands within the MNES study area typically occur on alluvial floodplains and are dominated by *Poaceae* (grasses), *Restionaceae* (rushes) and *Cyperaceae* (sedges). Areas of remnant Palustrine wetland within the MNES study area are represented (partially) by the presence of RE 12.3.8 (specifically described as a swamp community), although these areas are highly ephemeral in nature. None occur within the Project disturbance footprint. Riverine wetlands are represented by RE 12.3.7.

Wetland habitats within the MNES study area are considered to provide suitable habitat for a variety of fish, amphibian, reptile (incl. turtles) and bird species. Larger palustrine-wetlands potentially provide important refuge habitat for many bird species, including dispersive species. MNES fauna species that may utilise wetland habitats within the MNES study area include the Australasian bittern (*Botaurus poiciloptilus)* and Australian painted snipe (*Rostratula australis*) although both of these species are reliant on the presence of dense vegetation either aquatic (in the case of the bittern) or as nearby cover (for snipe). It is noted farm dams are less likely to provide these habitat elements and floodplain wetlands are highly ephemeral. At the time of the EIS field surveys the study region had undergone an extended dry period with no water available on floodplain wetlands. Curlew sandpiper (*Calidris ferruginea*) may occasionally occur on larger dams with shallow muddy areas (such as Lake Dyer near Laidley).

In Queensland 'high ecological significance' (HES) wetlands are defined by modelling using the Aquatic Biodiversity Assessment and Mapping Methodology (AquaBAMM) to identify important wetland areas as 'matters of state environmental significance' under State legislation. These wetlands are typically of a 'high' or 'very high' conservation value under the criteria used for AquaBAMM mapping. There are 22.77 ha of State mapped wetlands (as mapped by DES) considered as 'high ecological significance' (HES) wetlands that occur within the MNES study area, of which none lies within the current Project disturbance footprint. In addition, the identified wetlands are also up-gradient of the Project and unlikely to be impacted from Project activities. Two HES wetlands are located at the eastern end of the MNES study area, associated with the local hydrological catchment of Western Creek (Ch 72.40 km). Refer to the EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for a detailed description on these areas and their locations.

Other wetland values within the MNES study area are represented through aquatic conservation assessment modelling. The catchment aquatic conservation assessment indicates a skew towards higher value riverine wetlands throughout both the Lockyer Creek and Bremer River (including Western Creek in the MNES study area) catchments, indicating the presence of sensitive wetlands throughout both catchments. Noting this, aquatic assessment within the MNES study area indicated areas of very low value (i.e. portions of Lockyer Creek catchment) and medium value (i.e. Lockyer Creek, Laidley Creek and Western Creek) (DEHP 2015). No spring fed wetlands mapped on the QLD wetland mapping layer (DES 2020a) were identified within the MNES study area. Further information regarding wetland values are provided in EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report.

4.4.4.8 Grassland

Grassland habitats within the MNES study area include non-native grasslands and derived native grasslands. Non-native grasslands are dominated by exotic pasture grasses and are represented by areas of non-remnant vegetation (excluding cultivated land), previously cleared of native-vegetation for agriculture. Dominant pasture grasses include Rhodes grass (*Chloris gayana*), Pigeon grass (*Setaria sphacelate*), Green panic (*Megathyrsus maximus*), and Sabi grass (*Urochloa mosambicensis*). However, native grass species also occur, including Native rats-tail grass (*Sporobolus creber*), Forest bluegrass (*Bothriochloa bladhii*), Blue grass (*Dichanthium sericeum*), and Blady grass (*Imperata cylindrica*).

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*), Forest bluegrass), Blue grass, Digitaria (*Digitaria divaricatissima*), and Pitted bluegrass (*Bothriochloa decipiens*). However, exotic pasture grasses sometimes occur, such as Rhodes grass.

Non-native and native derived grasslands are considered as one fauna habitat due to similarities in structure and floristics. Grassland within the MNES study area is typically located on alluvial floodplains and creek flats. These grassland habitats are commonly utilised for agricultural purposes including livestock grazing and fodder harvesting and are often in poor condition. Better grassland habitat condition may be found in road and rail reserves which are not impacted by grazing (refer Photograph 4.11).

Grassland within the MNES study area provides foraging habitat for granivorous bird species such as finches, parrots and pigeons. Grassland habitats also provide important microhabitat refugia (i.e. soil cracks) for small ground fauna such as native rodents, skinks, and snakes. Scattered paddock trees occur across many grassland habitats, providing fauna habitat and connectivity in otherwise cleared and fragmented landscapes. In general, the grasslands that dominate the Project disturbance footprint provide poor habitat value for MNES fauna species potentially occurring in the area, although grasslands may provide temporary habitat for wetland bird species when flooded.

Photograph 4.11 Grasslands in road/rail reserve in Laidley area (2017)

Photograph 4.12 Cultivated lands near Laidley (2017)

4.4.4.9 Cultivated land

Cultivated land within the MNES study area is extensive dominating the landscape between Gatton Laidley. This includes irrigated and dryland crops, stubble fields and fallow fields. Common crops include winter cereals, vegetables and legumes. The availability of soil cracks and other microhabitat refugia is greatly reduced by soil cultivation. Cultivated land typically occurs in low-lying areas on fertile clays and provides habitat for generalist bird species such as Torresian crow (*Corvus orru*), Australian magpie (*Gymnorhina tibicen*), and Little corella (*Cacatua sanguinea*). Non-native fauna species are typically abundant in cultivated land habitats, including restricted matters (Category 3 invasive animals) such as European red fox (*Vulpes vulpes*), Domestic dog (*Canis familiaris*), and Feral pig (*Sus scrofa*).

4.5 Ecological values and matters of national environmental significance

4.5.1 Ecological values

Consistent with the relevant legislation as stated in Section 2 of this report, the overarching ecological values adopted for the MNES study area, include:

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

4.5.2 Matters of national environmental significance

For the identified MNES, predictive habitat mapping has been used to assess the species potential to occur within the MNES study area (refer Appendix A). Based on this mapping there is the potential for 25 threatened species under the EPBC Act to inhabit the MNES study area including seven species of plants, nine species of birds, seven species of mammals, a species of reptile and a species of fish. Mapping associated with this process is presented in Appendix F and the area of predicted habitat contained within the MNES study area and within the Project disturbance footprint is provided in Table 4.4. In instances where species/communities did not have *Potential habitat* contained within the MNES study area, these species were not subject to impact assessment and were no longer considered to constitute receptors as the risk of impacts to any of these species are considered low. The MNES identified within the MNES study area are identified in Table 4.6 along with their assigned sensitivity value as determined by Table 3.8.

Table 4.6 Identified terrestrial and aquatic ecology receptors within the matters of national environmental significance study area

Associated ecological value	Identified MNES	Assigned sensitivity (refer Table 3.8)	Justification
▪ Australia's natural environment and native flora and fauna ▪ Biodiversity	EPBC Act listed TECs: ▪ Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC ▪ Brigalow (*Acacia harpophylla* dominant and codominant) TEC	High	▪ Protected by Commonwealth legislation ▪ Important for biodiversity ▪ Rare ▪ High sensitivity, high exposure to impacts
	Threatened terrestrial and aquatic flora and fauna species listed under the provisions of the EPBC Act (including habitat): **Flora** ▪ Hairy-joint grass (*Arthraxon hispidus*) ▪ Four-tailed grevillea (*Grevillea quadricauda*) ▪ Blunt-leaved leionema (*Leionema obtusifolium*) ▪ Lloyd's native olive (*Notelaea lloydii*) ▪ *Paspalidium grandispiculatum* (a grass) ▪ Brush sophora (*Sophora fraseri*) ▪ Austral toadflax (*Thesium australe*) **Fauna** ▪ Red goshawk (*Erythrotriorchis radiatus*) ▪ Grey falcon (*Falco hypoleucos*) ▪ Australasian bittern (*Botaurus poiciloptilus*) ▪ Australian lungfish (*Neoceratodus forsteri*) ▪ Spotted-tail quoll (southern subspecies) (*Dasyurus maculatus maculatus*) ▪ Brush-tailed rock-wallaby (*Petrogale penicillata*) ▪ Regent honeyeater (*Anthochaera phrygia*) ▪ Painted honeyeater (*Grantiella picta*) ▪ New Holland mouse (*Pseudomys novaehollandiae*) ▪ Koala (*Phascolarctos cinereus*) ▪ Long-nosed potoroo (*Potorous tridactylus tridactylus*) ▪ Greater glider (*Petauroides volans volans*) ▪ Swift parrot (*Lathamus discolor*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*) ▪ Collared delma (*Delma torquata*)	High	▪ Protected by Commonwealth legislation ▪ Rare ▪ High sensitivity, high vulnerability

Associated ecological value	Identified MNES	Assigned sensitivity (refer Table 3.8)	Justification
	■ Australian painted snipe (*Rostratula australis*) ■ Curlew sandpiper (*Calidris ferruginea*) ■ Black-breasted button-quail (*Turnix melanogaster*)		

5 Potential impacts and impact mitigation

Potential Project related impacts are described in the sections below. These impacts are then assessed against the identified MNES, 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 residual risk of impact with all mitigation in place.

Through information gathered during the Project EIS process, MNES 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 environmental value being assessed, are described in Section 5.1.3.

5.1 Description of potential impacts

5.1.1 Project activities

Infrastructure activities proposed as part of the Project have been categorised into three phases; construction, commissioning and reinstatement, and operation. 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 reinstatement, and operation phase

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.7 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	Medium term
		Installation of offices, hardstands	Medium term
		Stockpiling	Medium term
		Artificial impoundment dewatering	Permanent
	Utility diversions	Excavation	Permanent
		Trenching	Short term
		Modification, diversion and realignment of utilities and associated infrastructure	Short term/Medium term
	Drainage	Culvert installation	Medium term
	Structures	Construction of bridges over main waterways	Medium term
		Road/rail bridge construction	Medium term
	Civil works	Cutting construction	Medium term
		Embankment construction using cut to fill from rail alignment and borrow to fill from external borrow sources, where required	Medium term
		Construction of temporary haul roads	Medium term
		Drainage controls	Medium term
	Road works	Road realignment	Permanent
		Construction of permanent rail maintenance access roads	Permanent

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.7 for definitions)
	Rail logistics	Sleeper stockpiling	Medium term
		Rail stockpiling	Medium term
	Rail construction	Drilling	Temporary
		Blasting	Temporary
		Ballast installation	Short term
		Sleeper placement	Short term
		Rail placement	Short term
		Installation of train signals and communications infrastructure	Short term
		Demobilising site compounds	Short term
	Tunnel construction	Removal of construction material and waste	Temporary
		Roadheader excavation	Short term
		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 and reinstatement	Demobilisation/ Decommissioning	Establish permanent fencing	Temporary
		Restoration of disturbed areas, including revegetation where required	Short term
	Spoil mounds	Conversion of haul roads and construction access roads into permanent roads	Medium term
	Fencing	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
Operation	Train operations	Train movement along rail	Permanent
	Operational maintenance	Ongoing vehicle movement within rail corridor	Permanent

5.1.2 Potential impacts to matters of national environmental significance

5.1.2.1 Habitat loss and degradation from vegetation clearing/removal

The Project disturbance footprint encompasses a total of 634.58 ha. Under current QLD Government (DNRME) vegetation mapping this comprises 32.26 ha of remnant vegetation and 66.39 ha of regrowth vegetation (HVR). The remaining 535.93 ha (84.5 per cent of the Project disturbance footprint) has been largely heavily modified (clearing for agriculture/cattle grazing).

The removal of vegetation and construction of linear infrastructure resulting in habitat loss is likely to pose the largest risk of adverse impacts for biodiversity arising from the Project. The impact may be direct in the form of vegetation and habitat removal, or indirect, as fauna and flora diversity may become reduced due to shortages in available habitat resources. Habitat loss and degradation can also occur due to the increased risk of fire during construction and maintenance activities. 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. Habitat loss and degradation has the potential to impact upon all MNES (including their associated habitats) identified in this assessment (refer Table 5.4). Of the MNES identified, the greatest amount of predicted habitat to be removed (refer Table 4.4) is to the following species:

- Lloyd's native olive (*Notelaea lloydii*) - 134.03 ha including 21.26 ha of *Habitat critical to the survival of the species*
- Austral toadflax (*Thesium australe*) – 94.77 ha of *Potential habitat*
- Grey falcon (*Falco hypoleucos*) – 351.97 ha of *Potential habitat*
- Swift parrot (*Lathamus discolour*) – 13.34 ha of *Habitat critical to the survival of the species*
- Koala (*Phascolarctos cinereus*) - 98.66 ha of *Habitat critical to the survival of the species*
- New Holland mouse (*Pseudomys novaehollandiae*) – 88.12 ha of *Potential habitat*
- Grey-headed flying-fox (*Pteropus poliocephalus*) – 99.46 ha of *Habitat critical to the survival of the species*
- Collared delma (*Delma torquata*) – 85.33 ha of *Important habitat*
- Spotted-tail quoll (Southern subspecies) (*Dasyurus maculatus maculatus*) – 75.45 ha of *Potential habitat* (including 1.59 ha of *Habitat Critical to the survival of the species*)
- Red goshawk (*Erythrotriorchis radiatus*) – 71.08 ha of *Potential habitat* (including 17.74 ha of *Habitat critical to the survival of the species*)
- Regent Honeyeater (*Anthochaera phrygia*) – 84.58 ha of *Potential habitat*
- Long-nosed potoroo (*Potorous tridactylus tridactylus*) – 84.58 ha of *Potential habitat*

Whilst it is acknowledged that the SEQ 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 Koala (*Phascolarctos cinereus*) (i.e. K-selected species) and is less pronounces in those that are R-selected (e.g. those species with high fecundity and shorter lifespans) (Oli 2004).

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

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

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

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

In addition, entrapment of wildlife in utility diversions (e.g. trenches) or other excavations associated with the Project may also cause physical trauma to fauna. For example, open trenches for underground utilities, or other pits are known to be effective at trapping a wide variety of wildlife and often result in mortality (Ayres and Wallace 1997; Doody et al. 2003; Woinarski et al. 2006). Species most likely to become trapped in pits or other excavations during construction of the Project are ground dwelling species that can move across modified areas (e.g. Collared delma (*Delma torquata*), Long-nosed potoroo (*Potorous tridactylus tridactylus*) and the New Holland mouse (*Pseudomys novaehollandiae*)) and arboreal species which ascend to the ground to disperse such as the Koala (*Phascolarctos cinereus*).

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

Aquatic fauna may be injured or killed during construction within waterways, such as the construction of culverts and bridges and associated temporary impoundments required during construction. Species most susceptible to death or injury include smaller and/or sessile species such as freshwater invertebrates. Species such as Australian lungfish are less likely to be at risk to direct mortality where appropriate mitigation measures are applied (e.g. fish salvage activities as part of dewatering events).

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

5.1.2.3 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 consistence (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 threatened flora such as Hairy-joint grass (*Arthaxon hispidus*), Four-tailed grevillea (*Grevillea quadricauda*), Lloyd's olive (*Notelaea lloydii*) and *Paspalidium grandispiculatum* (a grass). Impacts to soil may also have flow on effects to MNES fauna though 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 2005). 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 and compaction may impact upon the growth of fungi that are a potential food source for threatened species such as the Long-nosed potoroo *(Potorous tridactylus tridactylus)*. In addition, water infiltration and percolation are slower in compacted soils, thereby inhibiting root growth, leading to the potential reduced uptake of immobile nutrients such as phosphorus and potassium; and increased nitrogen losses can be expected because of prolonged periods of saturated conditions in compacted soils.

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

5.1.2.4 Displacement of threatened 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. In addition, weeds may result in impacts to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC through competitive processes and displacement, altering nutrient cycling and outcompeting for limited resources.

Pest species can also damage native vegetation by grazing and trampling (Adair and Groves 1998; Clarke et al 2001; Thorp and Lynch 2011) or though direction competition/predation (e.g. *Gambusia holbrooki* within aquatic ecosystems). Therefore, weed and pest species may reduce the extent or quality of available habitat and hence population size for a specific threatened species. This may have the effect of increasing mortality and reducing the size and viability of population sizes though 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, act in conjunction to increase the chances of weed and pest proliferation throughout the Project disturbance footprint and adjoining areas. Proliferation of weed and pest species has the potential to occur during all phases of the Project, especially during the construction phase, however the highest likelihood of weed and pest species occurring is from vegetation clearing and soil disturbance from local agricultural land practices.

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

Non-native species comprised over 30 per cent of the flora species recorded in the MNES study area (refer Appendix E). Of these, 17 flora species (as well as six pest fauna species) were ‘restricted matters’, listed under the provisions of the Queensland *Biosecurity Act 2014* (some of which are also listed as Weeds of National Significance (WoNS)). Weed species such as *Lantana camara* (listed as a WoNS) are noted as a potential threat to a number of MNES species (e.g. *Grevillea quadricauda* and *Notelaea lloydii*) and were identified as common throughout the MNES study area, particularly in regrowth areas and along waterways. Without appropriate management strategies, the Project activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited or are occur in low densities or have high specific habitat requirements where weed encroachment has been identified as a threatening process (e.g. Collared delma *(Delma torquata*)). However, pest and weed invasion may benefit some species of MNES by supply an abundant food source which would otherwise be unavailable (non-native plants as a food source for the Brush-tailed rock-wallaby (*Petrogale penicillata*)).

Project activities also have the potential to introduce new weed species into the MNES study 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 those occupied by the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC (refer Appendix B).

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

Unmitigated Project activities have the potential to disperse pest (animal) species from the MNES study area into the surrounding landscape, due to habitat removal, noise disturbance, and human presence during the construction and operation phases of the Project. This may include the introduced fire ant (*Solenopsis invicta*) though not recognised as a threatening process for any threatened species under the EPBC Act, the species is known to be very aggressive and voracious feeders on small ground fauna and also eat or damage seeds which could affect local vegetation communities or threatened flora. The eastern extent of the Project (from Forest Hill to Calvert) is located within ‘zone 2’ of fire ant biosecurity zone mapping for SEQ (as mapped by DAF). This zoning restricts the movement of soils and identified ‘fire ant carriers’ within the mapped area.

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 (Catling and Burt 1995). Nevertheless, Project surveys noted several pest species as being present in the area including feral cats and dogs. Therefore, unmitigated potential impacts of the displacement of native species through the invasion of non-native species may be temporary or irreversible (refer Table 3.7 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. Fragmentation of such corridors have been identified as important threatening process to MNES such as Spotted-tail quoll (*Dasyurus maculatus maculatus*) and Koala (*Phascolarctos cinereus*) (refer Appendix B).

The Queensland corridor mapping for SEQ Biodiversity Planning Assessments (Version 4.1, 2016) depicts regional corridors within the MNES study area along the Little Liverpool Range, which portrays vegetation that is significant for the spread and movement of flora and fauna, including MNES. Connectivity is present north and south of the MNES study area in the range, and is evident in areas associated with steep topography.

The potential impacts of linear infrastructure traversing this biodiversity corridor includes 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.

Nevertheless, most of the Project disturbance footprint exists in a very fragmented environment. In particular, the landscape is highly impacted from Gatton to the Laidley with few trees present. Functional connectivity across the MNES study area is retained somewhat through local linkages of remnant and regrowth vegetation, associated with roadside and riparian corridors linking larger patches of vegetation on private land. These linkages may provide landscape permeability for mobile MNES such as birds and bats.

The Project is co-located with the QR West Moreton System rail corridor for approximately 24 km, minimising the potential for further impacts to landscape connectivity. The western portion of the alignment is located adjacent to the north of the Warrego Highway which is also an existing movement barrier for fauna. The tunnel through the Little Liverpool Range will allow continued fauna movement associated with the regional corridor in the Little Liverpool Range. Given the highly disturbed nature of the landscape surrounding the Project the unmitigated potential impacts to biodiversity corridors resulting from the Project are likely to be relatively minor.

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 MNES study area, the Project largely avoids patches of vegetation that are small, irregularly shaped, and fragmented, and as such are already subject to considerable edge effects. The Project will impact some larger habitat patches with low edge to area ratios, in the Helidon area and the Little Liverpool Range. Project activities (vegetation clearing, temporary and permanent) may create edge effects resulting in habitat degradation and a reduction of the habitat available for a range of species.

Edge effects have the potential to impact on the range of flora and fauna species identified as potentially occurring in the MNES study area, especially upon the species with specific micro-habitat requirements that are less tolerant to disturbance (e.g. some ground-dwelling reptiles and mammals, smaller birds and some plants). Conversely, some threatened flora species appear to respond positively to edge effects, particularly ground disturbance, and colonise these edge areas reasonably quickly (e.g. *Paspalidium grandispiculatum* and *Thesium australe*).

It is anticipated that MNES involving threatened species and wetland and waterway habitat (including habitat for Spotted-tail quoll (*Dasyurus maculatus maculatus*), Collared delma (*Delma torquata*), Greater glider (*Petauroides volans*) and New Holland mouse (*Pseudomys novaehollandiae*)) 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 short term and irreversible (refer Table 3.7 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 (i.e. Noisy miners) (Loyn et al. 1983) which further decreases population levels of other species remaining in the fragments. Fragmentation reduces patch size, thereby increases edge effects within a patch and reducing the area of undisturbed 'core' habitat for the fauna species present in an area.

The landscape in which the Project is situated is highly fragmented with most vegetation occurring as small fragments due to agricultural practices such as pasture, cropping and horticulture. The Project activities will contribute to further fragmentation along with the associated edge effects and reduction in habitat. This effect will largely occur in the area in the Helidon Hills area where the Project disturbance footprint will fragment patches of remnant and regrowth vegetation communities that occur in the area. Habitat within the Little Liverpool Range will not be fragmented where the tunnel passes underneath the range, though fragmentation will occur due to the tunnel portals. In addition, this area is already subject to fragmentation due to the existing road and rail infrastructure located to the south of the alignment. Habitat fragmentation has been identified as important threatening process to MNES such as Spotted-tail quoll (*Dasyurus maculatus maculatus*) and Koala (*Phascolarctos cinereus*) (refer Appendix B). This is due to the importance of connectivity, dispersal opportunities and habitat quality for species at a local scale and the cumulative impacts at a regional scale. In some instances the Project may not result in significant fragmentation of populations identified as relevant to the area (refer to species-specific population information in Section 5.3.4 and Section 5.3.5) given the capacity of the species to disperse widely across the landscape (e.g. Koala (*Phascolarctos cinereus*)).

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

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

5.1.2.8 Barrier effects

Barrier effects (permanent and/or temporary) occur where species are either unable or are unwilling to move between suitable areas of habitat due to the imposition of a barrier. This can include a habitat type that has become unsuitable (e.g. cleared areas devoid of vegetation or structure) or a physical barrier such as a fence, alteration to a waterway or a culvert that that does not provide movement opportunities ((particularly important to aquatic MNES such as the Australian lungfish (*Neoceratodus forsteri*)). As noted in the previous section (fragmentation) this is only considered a potential impact in the Helidon area due to the highly modified nature of much of the landscape and the use of the tunnel through the Little Liverpool Range.

Species most vulnerable to barrier effects include uncommon species, smaller ground-dwelling species, and relatively sessile species with smaller home ranges. Terrestrial MNES most vulnerable to barrier effects include the Collared delma (*Delma torquata*), Greater glider (*Petauroides volans volans*), Brush-tailed rock-wallaby (*Petrogale penicillata*), Koala (*Phascolarctos cinereus*) Long-nosed potoroo (*Potorous tridactylus tridactylus*) and the New Holland mouse (*Pseudomys novaehollandiae*).

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). This impact may affect MNES species such as Collared delma (*Delma torquata*) and the New Holland mouse (*Pseudomys novaehollandiae*). Mobile species such as larger mammals, birds, and bats may not be affected to the same extent. However, in some instances the Project infrastructure/works may not present a barrier to populations identified as relevant to the area (refer to species-specific population information in Section 5.3.4 and Section 5.3.5) given the capacity of the species to disperse widely across the landscape (including heavily disturbed areas) and utilise Project infrastructure (such as culverts) (e.g. Koala (*Phascolarctos cinereus*)).

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

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

Nevertheless, much of the corridor is located adjacent to an existing rail line (QR West Moreton System rail corridor) which already presents an existing barrier in the landscape. The unmitigated potential impacts of barrier effects resulting from the Project are considered to be in most cases short term and temporary (i.e. in instances where fauna passage measures are provided) but may in some cases be long term and irreversible (refer Table 3.7 for definitions associated with timeframes).

5.1.2.9 Noise, dust, and light impacts

Noise, dust, and light are direct impacts that have the potential to occur as a result from the Project activities during all phases and may also have cumulative effects. Understanding of the impacts of 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 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).

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).

The likelihood of potential impacts is anticipated to be greatest where Project activities take place near vegetated areas and known habitat, during construction, decommissioning and rehabilitation phases. Operating rail lines will generate noise and vibration and it is likely that many species will habituate as a result of the regularity of generated noise.

The Project will result in minor light spill (i.e. 'warm light' at level crossings and around the tunnel portals) into adjacent receiving environments (e.g. fauna habitat) due to the operation of plant and equipment throughout the construction phase of the Project and installation of lighting on infrastructure required for the operation of the Project. Impacts associated with light spill may include direct impacts (e.g. increased susceptibility to predation from increased light) or indirect impacts related to altered foraging and habituation in areas exposed to increased lighting. Light impacts associated with construction will be temporary in nature, however operational lighting impacts will be long term and localised (e.g. infrastructure) or transient in nature (i.e. vehicle movement). Whist light spill may impact negatively on many species, it may positively impact upon species such as microbats by attracting nocturnally flying insects upon which this species feeds.

Ecological MNES affected from these potential impacts include all threatened flora (impact associated with dust) and terrestrial fauna species (impact associated with noise and vibration) listed under the provisions of the EPBC Act. The Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC is likely to impacted to a lesser extent and these impacts are likely to be associated with dust alone (i.e. reducing photosynthetic processes following settlement of dust on the leaves of components of the TEC), although it is noted the nearest occurrence of this TEC is located approximately 100 m from the Project disturbance footprint. These types of impacts are likely to be short-term in duration and localised.

5.1.2.10 Increase in litter (waste)

The act of littering has the potential to impact the surrounding environment (by causing injury to wildlife), poses threats to human health and is aesthetically displeasing. When discarded as litter, human-made materials such as plastic, glass and aluminium have the potential to cause external injury to wildlife, entanglement, and if accidentally ingested, may cause starvation or suffocation and as such negatively impact species such as the Australian lungfish (*Neoceratodus forsteri*). Littered objects may also provide suitable habitat for disease-spreading insects, such as flies and mosquitoes (Healthy Land and Water 2019b).

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 2019b).

Ecological MNES affected from this potential impact include all threatened flora (through alterations in recruitment and nutrient cycles) and fauna species (direct consumption, declines in habitat suitability and entanglement). This type of impact has the potential to be long in duration due to the varying times of decomposition; however, it is likely to be localised and manageable.

5.1.2.11 Aquatic habitat degradation

Activities related to the construction and operation of the Project are likely to impact water quality, thereby degrading habitats for aquatic fauna and flora. Erosion and sedimentation (refer Section 5.1.2.12), contamination and an increase in litter (refer Section 5.1.2.10) are all potential mechanisms that will adversely impact aquatic habitat. In addition, direct loss of waterway habitat may occur though activities associated with waterway crossings during construction and operation.

Physical habitat modification due to hydrological regime change may degrade current habitat morphological features including substrate composition, channel form and bank stability which may reduce aquatic ecological values. Further loss of ecological services may occur from a removal of riparian vegetation required for both watercourse and drainage feature infrastructure (within construction and operation phases), which may compound physical habitat modification from any changes to hydrological regimes. It is noted most waterways intersected by the Project are already subject to significant habitat modification due to adjacent land use.

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. Transported sediments from the terrestrial environment 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 5.1.2.8).

There is potential for contaminants and pollutants associated with construction and operation of the Project to enter aquatic environments, resulting in the alteration or loss of potential habitat for terrestrial and aquatic species. Concrete, oil and grease and other chemicals associated with construction and operation may result in localised run-off into adjacent watercourses and waterbodies following rainfall events.

The disturbance and modification of some riparian zones and works within watercourses/wetlands during the construction phase of the project has the potential to reduce the ecological integrity of the watercourse thereby impacting on structural aspects that support breeding and foraging requirements of aquatic species.

Aquatic habitat degradation is considered a ‘high ranking’ threatening process contributing to Australian Lungfish (*Neoceratodus forsteri*) population declines (DotEE 2019a) although this largely occurs at the catchment scale, as a result of land clearing, pesticide use and irrigation abstraction which influence water quality. The Lungfish is restricted to areas of permanent water and is known to complete their lifecycle entirely within freshwater habitats (i.e. potamodromous). The species is known to occur in impounded waters on rivers as well and has successful populations where it has been introduced to dams. The temporary impoundment of watercourses intersected by the Project in which the species may occur (Lockyer Creek) is not expected to pose a risk to the species. Potential threats are more likely to be realised through impacted water quality (e.g. increased turbidity) at the site localised to construction works although this is only expected to be temporary in nature.

5.1.2.12 Erosion and sedimentation

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.

5.1.2.13 Tunnelling impacts – Little Liverpool Range

The construction and operation of the proposed tunnel through the Little Liverpool Range may have potential to cause a number of localised impacts to habitats located above the tunnel such as subsidence, groundwater drawdown, and vibrations caused by the tunnel construction. Lloyd's olive (*Notelaea lloydii*) was identified as present to the north of the tunnel area and habitat for the species is present above the tunnel. There are no other MNES flora or TECs identified as present in the tunnel area. The tunnel is proposed to be 850 m long with an excavated cross-section of approximately 142 m² (internal space dimensions are driven by ventilation requirements). At the highest elevation point in the Little Liverpool Range the tunnel will be approximately 85 m below ground level.

The tunnel intersects the Koukandowie Formation (part of the Marburg Subgroup), which is a sedimentary rock comprising cross bedded sandstone and shale layers of weak to medium strength (refer EIS Chapter 9: Land resources for further detail). Aboveground subsidence may result from both the tunnelling process itself, or as a result of settlement caused by subsequent groundwater drawdown processes caused by the tunnel. Impacts to native vegetation from potential subsidence will be localised and are therefore difficult to predict beforehand. Potential impacts on remnant vegetation may include the following: trees may become destabilised by surface movement causing tree falls and slumping; surface or tension cracking may sever or damage vegetation root systems causing tree death; ground fracturing and surface cracking may cause localised changes to soil hydrology with follow-on adverse impacts to surface vegetation.

Geotechnical survey works within the tunnel area have so far been limited (refer Golder 2019). Nevertheless, initial interpretation of results indicate the potential for minimal settlement and therefore damage to vegetation communities due to subsidence from the tunnel appears to be low. However, ongoing geotechnical investigations will assess the potential for settlement/subsidence and will inform the final design of the tunnel.

Groundwater monitoring in the Little Liverpool Range area indicates groundwater levels range from 13 metres below ground level (mgbl) (east of the east portal of the tunnel), 15 mgbl (west of the west portal) and up to 82 mgbl along the ridgeline (at Ch 62.2) (Golder 2020). The vegetation in the range at the tunnel area comprises eucalypt open forest dominated by species such as Spotted gum (*Corymbia citriodora*), Grey gum (*Eucalyptus major*), and Narrow-leaf ironbark (*E. crebra*). None of these species are known to require access to groundwater. Indeed, the depth to groundwater in the higher elevations of the range preclude vegetation accessing this water source. Lloyd's olive is the only MNES flora species potentially occurring in the Little Liverpool Range and is not groundwater dependent.

Lowered groundwater levels due to long-term seepage into the tunnel has the potential to impact groundwater users and vegetation such as deep-rooted trees (GDEs). Mapping of GDEs (from the BoM GDE Atlas) indicates the potential presence of 'low potential' GDEs associated with local gully lines in the range area, the nearest of which lies adjacent to the north side of the east portal of the tunnel. It is noted the mapped GDEs have not been confirmed as present. Vegetation in these areas includes Queensland blue gum (*E. tereticornis*) which may access groundwater. Preliminary predictive numerical modelling of the drained tunnel through the Little Liverpool Range was carried out to estimate potential groundwater drawdown impacts (Golder 2020). Drawdown is assumed to be ongoing and long-term. Under the base case scenario (estimated typical groundwater levels and no structural features) drawdown impacts were limited in magnitude and lateral extent, and no potential GDEs were within the predicted 1 m drawdown extent and no unacceptable adverse impacts would be anticipated (refer EIS Chapter 14: Groundwater for further information).

Potential ground-borne vibration and associated ground-borne noise due to tunnel construction works has been assessed in a conservative fashion relying on technical assumptions for the vibration emitted by the excavation activity and the surrounding geotechnical conditions (refer EIS Chapter 15: Noise and Vibration for further information). The assessment considered the closest 70 sensitive (human) receivers to the tunnel as properties beyond this distance were not expected to experience vibration levels that could trigger the assessment criteria. It is noted there are no guidelines regarding potential impacts to fauna. A tunnelling Project in New Zealand adopted human vibration limit criteria to identify potential impact zones on wetland bird species and thereby informing fauna relocation activities (NDY 2020). Vibration levels are predicted to be above the lower guideline limit for dwellings during non-standard working criteria (0.3 mm/s) at approximately 10 properties along the top of the range above the tunnel. Vibration impacts are very likely to be similar to those described for noise (refer EIS Chapter 15: Noise and vibration). Following the completion of construction, vibration will be restricted to train movements (i.e. regular events of relatively short duration). As such, any potential impact on MNES fauna is likely to be minor at worst and temporary.

5.1.3 Assessment of potential impacts to matters of national environmental significance associated with air quality, surface water and hydrology, groundwater, and noise and vibration

An assessment of potential project related impacts associated with air quality, surface water and hydrology, groundwater, and noise and vibration were undertaken for the identified MNES. This assessment is summarised in Table 5.2. Potential impacts identified within Table 5.2 were incorporated into the assessment of initial impact magnitude as shown in Table 5.5.

Specific impacts associated with the relevant MNES are discussed in Sections 5.3.2, 5.3.3, 5.3.4 and 5.3.5.

Table 5.2 Assessment of potential impacts related to air quality, surface water and hydrology, groundwater, and noise and vibration upon the identified matters of national environmental significance

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
Threatened Ecological Communities	Air quality	Construction	Air quality has not been identified as a threatening process to TECs (i.e. Swamp Tea-tree forests and Brigalow) (refer Appendix C) and is not likely to impact upon TECs identified within the MNES study area	▪ EIS Chapter 12: Air Quality ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.3 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement		
		Operation		
	Surface water and hydrology	Construction	One identified TEC (i.e. Swamp Tea-tree) is highly susceptible to alterations to hydrology (refer Appendix B). Whilst not listed as a threatening process, significant alterations to hydrology may impact upon this TEC. However, significant deviations in hydrological process are not considered likely to occur as a result of the project. The nearest instance of this TEC to the Project is approximately 500 m from the Project disturbance footprint.	▪ EIS Chapter 13: Surface water and hydrology ▪ EIS Appendix M: Hydrology and Flooding Technical Report ▪ Section 5.2– Impact mitigation ▪ Section 5.3.3 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	Significant deviations in hydrological process (e.g. time of submergence, area of inundation and peak levels) between the base/existing case and the developed case are not predicted to occur. It is also noted that the communities are generally up-gradient and located away from the alignment where flood conditions align with the existing conditions.	
	Groundwater	Construction	One identified TEC (i.e. Swamp Tea-tree) is highly susceptible to alterations to hydrology (refer Appendix B). However, there are no significant impacts expected to occur to ground water that are likely to impact upon the identified Swamp Tea-tree TEC.	▪ EIS Chapter 14: Groundwater; ▪ Section 5.2– Impact mitigation ▪ Section 5.3.3 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement		
		Operation		
	Noise and vibration	Construction	Noise and vibration have not been identified as a threatening process to the identified TECs (i.e. Swamp Tea-tree forests and Brigalow) (refer Appendix C) and is not likely to impact upon TECs identified within the MNES study area.	▪ EIS Chapter 15: Noise and vibration ▪ Section 5.2– Impact mitigation ▪ Section 5.3.3 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement		
		Operation		

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
Threatened flora species	Air quality	Construction	Air quality has not been identified as a threatening process to any of the Flora MNES identified (refer Appendix C). Whilst it is acknowledged that particulate matter (e.g. dust during the construction period) has the potential to settle on foliage, this is not expected that this will significantly impede photosynthetic processes. Impact associated with air quality are not likely to result in an impact to MNES flora species within the MNES study area.	▪ EIS Chapter 12: Air quality; ▪ Section 5.2– Impact mitigation ▪ Section 5.3.4 - significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement		
		Operation		
	Surface water and hydrology	Construction	None of the identified flora MNES likely to be associated with the Project are highly susceptible to alterations to hydrology (refer Appendix B). Whilst listed as a threatening process, significant alterations to hydrology are not likely to occur as part of the project.	▪ EIS Chapter 13: Surface water and hydrology; ▪ Section 5.2– Impact mitigation ▪ Section 5.3.4 - significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	No significant impact expected during this stage	
	Groundwater	Construction	No MNES flora species associated with the Project is considered groundwater dependent. There are no significant impacts expected to occur to groundwater that are likely to impact upon any of the identified flora MNES as a result of Project activities (also refer tunnel impacts in Section 5.1.2.13).	▪ EIS Chapter 14: Groundwater; ▪ Section 5.2– Impact mitigation ▪ Section 5.3.4 - significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	No significant impact expected during this stage	
	Noise and vibration	Construction	Noise and vibration have not been identified as a threatening process to any of the identified MNES flora species (refer Appendix B) and are not likely to impact upon flora MNES identified within the MNES study area.	▪ EIS Chapter 15: Noise and vibration ▪ Section 5.2– Impact mitigation ▪ Section 5.3.4 - significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement		
		Operation		
Threatened fauna species	Air quality	Construction	The greatest Impacts associated with air quality (i.e. dust) will be during the construction period. Whilst not identified as a threatening process to MNES fauna species *per se*, particulate matter (e.g. dust) may settle on plants and in waterways. Once in waterways it may result in declining water quality. However, despite these potential impacts, significant impacts to MNES fauna species are not expected to occur as a result of Air quality.	▪ EIS Chapter 12: Air quality; ▪ Section 5.2– Impact mitigation ▪ Section 5.3.5 - significant impact assessment ▪ Appendix B – species information and threatening processes

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	No significant impact expected during this stage	
	Surface water and hydrology	Construction	One identified MNES fauna species (e.g. Australian lungfish) is aquatic (refer Appendix B). Whilst these species are susceptible to declines in water quality, any impact associated with construction is considered to be short-term and temporary. It is not expected that water quality will decline to the point at which these aquatic species will be adversely impacted.	▪ EIS Chapter 13: Surface water and hydrology; ▪ Section 5.2– Impact mitigation ▪ Section 5.3.5 - significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	Significant deviations in hydrological (flooding) processes (e.g. time of submergence, area of inundation and peak levels) between the base/existing case and the developed case are not predicted to occur. This includes the floodplain areas of Lockyer Creek. During operation, the tunnel will require the release of groundwater draining into the tunnel. The release of water is not predicted to be of a quantity to impact surface water or MNES values.	
	Groundwater	Construction Commissioning and reinstatement Operation	One identified MNES fauna species (e.g. Australian lungfish) is aquatic (refer Appendix B). Whilst this species is susceptible to declines in water quality, any impact associated with construction is considered to be short-term and temporary. It is not expected that water quality will decline to the point to which these aquatic species will be adversely impacted.	▪ EIS Chapter 14: Groundwater; ▪ Section 5.2– Impact mitigation ▪ Section 5.3.5 - significant impact assessment ▪ Appendix B – species information and threatening processes
	Noise and vibration	Construction Commissioning and reinstatement	Whilst noise and vibration have not been identified as a specific threatening process for MNES fauna species that have potential to occur within the MNES study area, animals typically show avoidance behaviours to foreign stimuli, including noise and vibration. Whilst such stimuli may result in little impact to vagile species such as the Grey-headed flying-fox and the Swift parrot, other less vagile species such as the Koala, Brush-tailed rock-wallaby and Spotted-tail quoll may avoid areas that are subject to acute noise and vibration events. Avoidance of areas subject to such stimuli is likely to occur during the construction phase and may result in a reduction in foraging efficiency.	▪ EIS Chapter 15: Noise and vibration ▪ Section 5.2– Impact mitigation ▪ Section 5.3.5 - significant impact assessment ▪ Appendix B – species information and threatening processes

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
		Operation	Whilst acute noise and vibration are known to result in avoidance behaviours in animals, chronic noise and vibration, particularly when applied at regular intervals, are less likely to illicit a response. It is therefore likely that once operational, impacts associated with noise and vibration will not adversely impact upon MNES fauna species	

5.2 Impact mitigation

This section outlines both the flora and fauna impact mitigation measures included as part of the Project design and the mitigation measures that are proposed for the Project to manage predicted environmental impacts. The impacts are initially assessed with consideration of the design mitigation measures and then reassessed to determine residual risk after the inclusion of the proposed mitigation measures.

5.2.1 Design considerations

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

Mitigation measures and controls that have been factored into the design for the Project are as follows:

- The Project is partially located within the existing QR West Moreton System rail corridor, as well as within the Gowrie to Grandchester future State transport corridor. As noted previously, the Gowrie to Grandchester rail corridor was assessed in detail in 2003 (refer Section 1.6.1) with analysis of the potential environmental impacts posed by the Project. The Project design has been developed to utilise the existing rail corridor system and minimise land severance and impacts to natural and rural landscapes to the greatest extent possible.
- The Project disturbance 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.
- Avoidance of natural movement corridors will maintain connectivity for species such as the Brush-tailed rock-wallaby, Koala and Greater glider which have potential habitat with the broader region. For example, the rail tunnel (approximately 850 m in length) occurs where the alignment crosses a higher point in the mapped regional corridor in the Little Liverpool Range. Fauna will be able to utilise the unimpacted section of the range over the tunnel as a movement corridor.
- The Project has avoided direct impacts on nationally or regionally protected areas such as the Lockyer Resources Reserve, Lockyer State Forest or Lockyer National Park. The Project has also avoided direct impacts to sections of the Little Liverpool Range subject to Little Liverpool Range Initiative.
- Clearing of 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
  - Critically endangered and endangered TECs
  - Riparian vegetation
  - Steep slopes and
  - Instream habitats.
- Watercourse crossing structures (including culverts and bridges) have been designed to maintain aquatic fauna passage and minimise the risk of blockages in reference to the accepted development requirements for operational work that is constructing or raising waterway barrier works (1 October 2018; DAF 2018)
- The Project incorporates bridge and culvert structures to maintain existing flow paths and flood flow distributions. These have been located and sized to minimise increases in peak water levels, velocities and duration of inundation
- Bridges have been designed to minimise impacts to the bed, banks and environmental flows of watercourses in accordance with requirements of the *Fisheries Act 1994* (Qld)

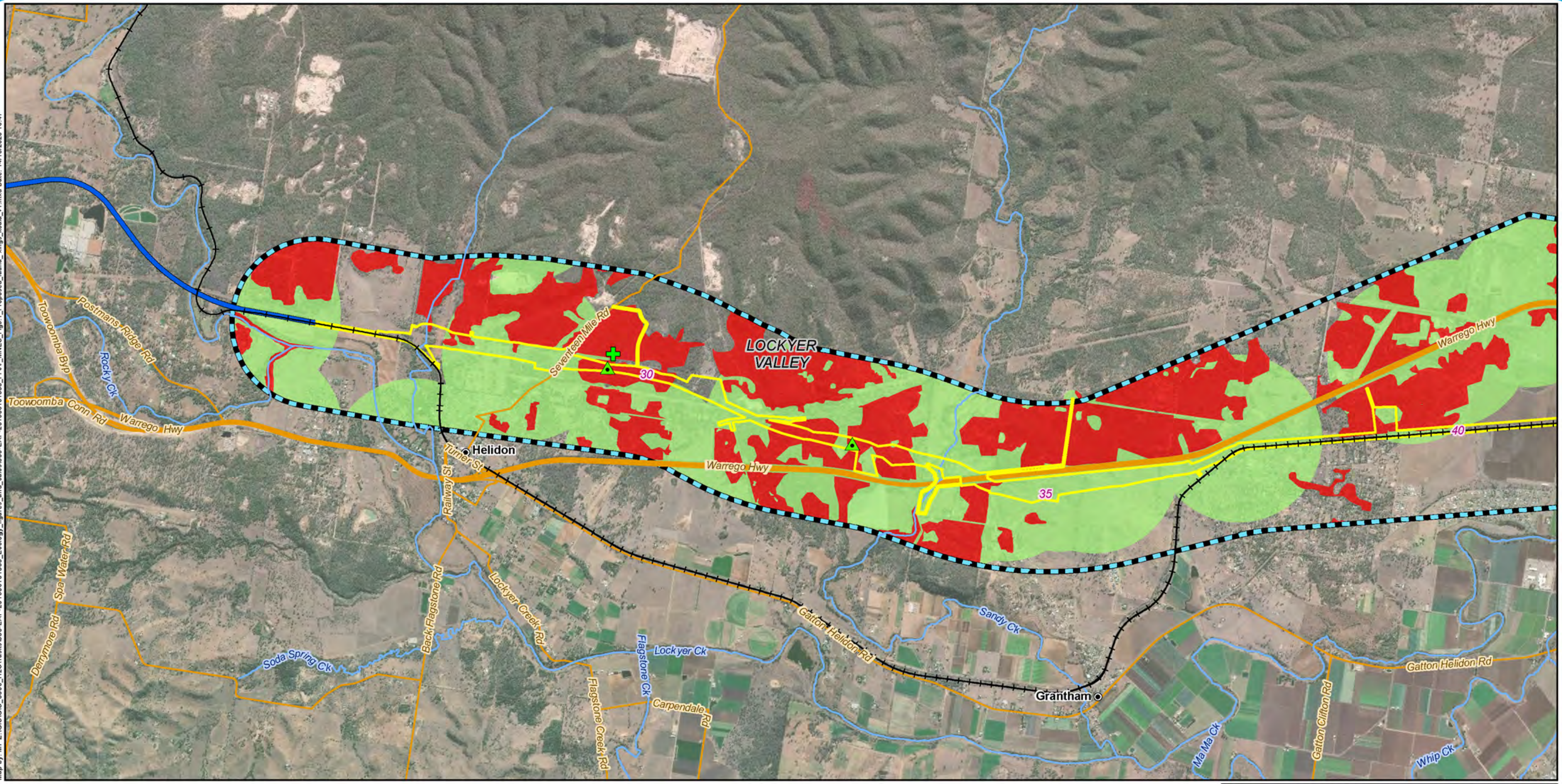
- The Project has been developed to minimise impacts to watercourses, riparian vegetation and instream flora and habitats by adopting a crossing structure hierarchy where bridges are preferred to culverts to maintain connectivity for MNES species such as Australian lungfish and riparian fauna conduits that are important to MNES species
- Scour and erosion protection measures have been incorporated into the design in areas determined to be at risk, such as around culvert headwalls, drainage discharge pathways and bridge abutments
- The nominated rail corridor has been restricted to the land required to accommodate permanent infrastructure components of the railway, including earthworks, cross drainage and rail maintenance access roads. Habitat for MNES species has been avoided wherever possible.
- Fauna crossing opportunities for species such as Koala, have been located to align with mapped regionally significant fauna movement corridors and areas of important fauna habitat. Crossing one (Ch 29.7 km) is at natural ground level north-west of Helidon and represents a likely choice for fauna to cross with minimal guidance. Crossings two and three (Ch 32.6 km and Ch 65.7 km) are located with bridge crossings south of the Helidon Hills area and east of Grandchester respectively (Figure 5.1a-e). The three locations have been 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 detailed design.
- Opportunities for the provision of fauna exclusion fencing and fauna movement solutions have been identified. These include fencing strategies to guide species such as Koalas to safe movement opportunities including the proposed fauna crossing locations. These opportunities will be refined through the detailed design process and incorporated where appropriate.
- Avoidance of natural movement corridors (e.g. Little Liverpool Range associated with the tunnel) will maintain connectivity for species such as the Koala which has habitat within the broader region. For example, the rail tunnel (850 m long) occurs where the alignment crosses a higher point in the range. Fauna will be able to utilise the unimpacted section of the range over the tunnel as a movement corridor.

5.2.2 Proposed mitigation measures

To manage Project risks, several mitigation measures have been proposed for implementation in future phases of Project delivery, as presented in Table 5.3. Further detail regarding species specific mitigation measures is provided in Table 5.6 and Table 5.7 and should be considered in conjunction with the measures detailed in this section.

Mitigation measures have been recommended to address Project specific issues and opportunities, legislative requirements and accepted government plans, policy and practice. Information related to government threat abatement plans and recovery plans has been incorporated into the identified mitigation measures wherever applicable. Mitigation measures have been selected based on the best available information including government guidelines (e.g. DTMR's Fauna Sensitive Road Design Manual (DTMR 2010)) and mitigation measures used on similar projects that have been subject to legislative approval (refer footnotes to Table 5.3). It is acknowledged the effectiveness of these measures may not be subject to rigorous peer-reviewed analysis.

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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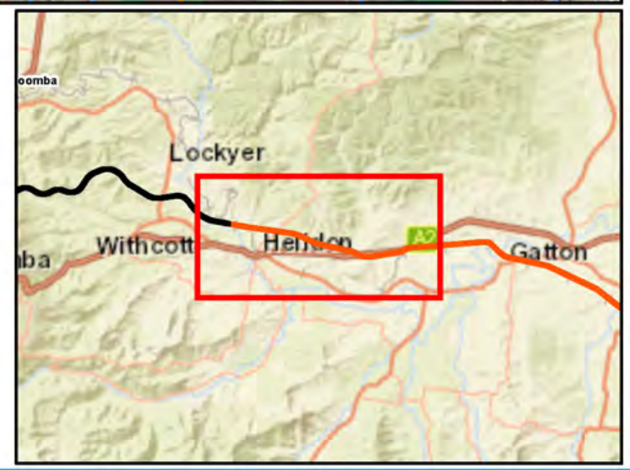

Legend

- 5 Chainage (km)
- Localities
- Fauna crossings
- Koala observations
- Existing rail
- G2H project alignment
- Major roads
- Minor roads
- Watercourses
- EIS disturbance footprint
- MNES study area
- Local Government Areas

Koala

- Habitat critical to the survival of the species
- Potential habitat

A3 scale: 1:50,000

0 0.4 0.8 1.2 1.6 2km

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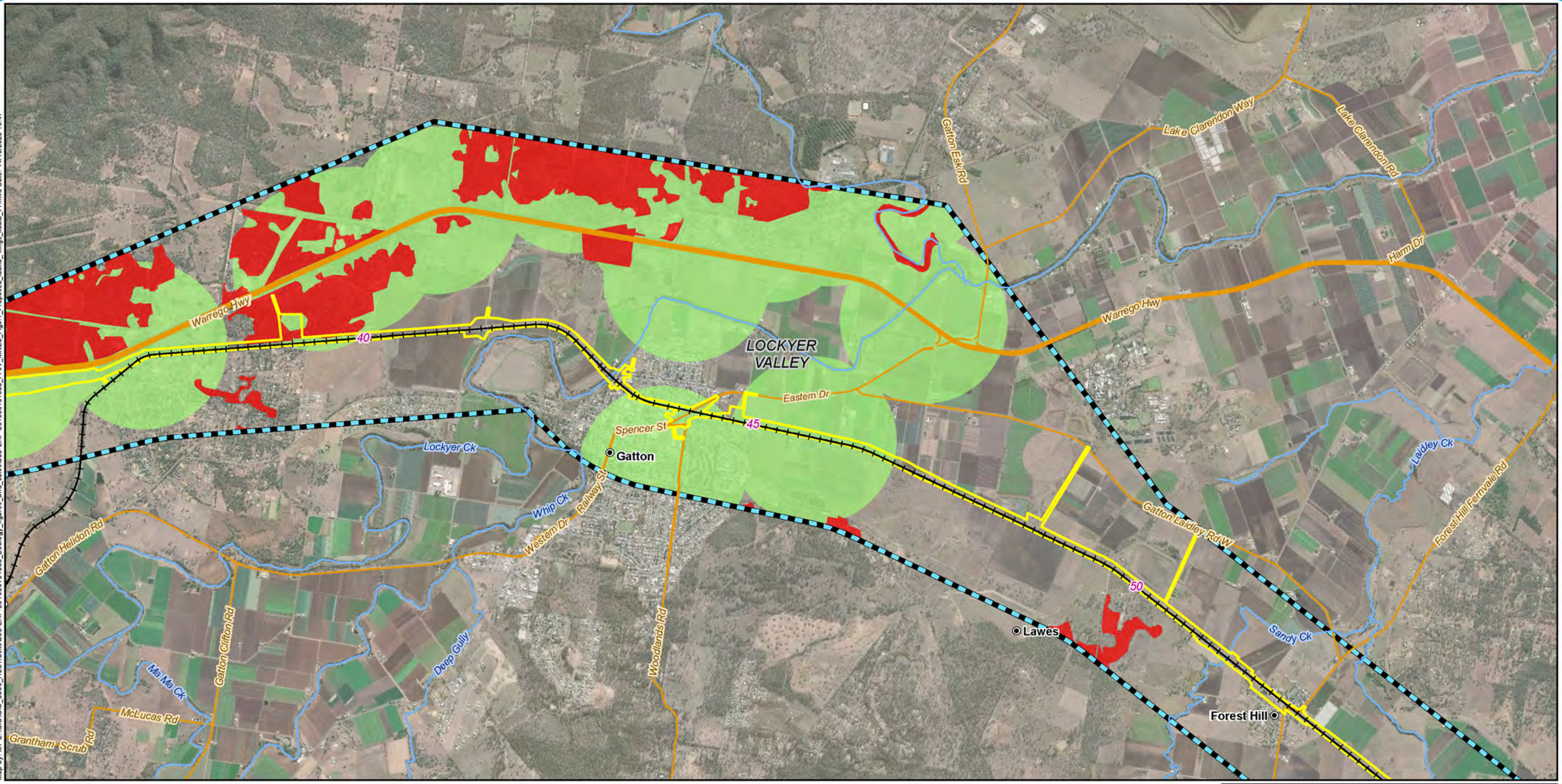
Helidon to Calvert

Figure 5.1a: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- 5 Chainage (km)
- Localities
- Fauna crossings
- Koala observations
- Existing rail
- Major roads
- Minor roads
- Watercourses
- EIS disturbance footprint
- MNES study area
- Local Government Areas

Koala

- Habitat critical to the survival of the species
- Potential habitat

A3 scale: 1:50,000

0 0.4 0.8 1.2 1.6 2km

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Helidon to Calvert

Figure 5.1b: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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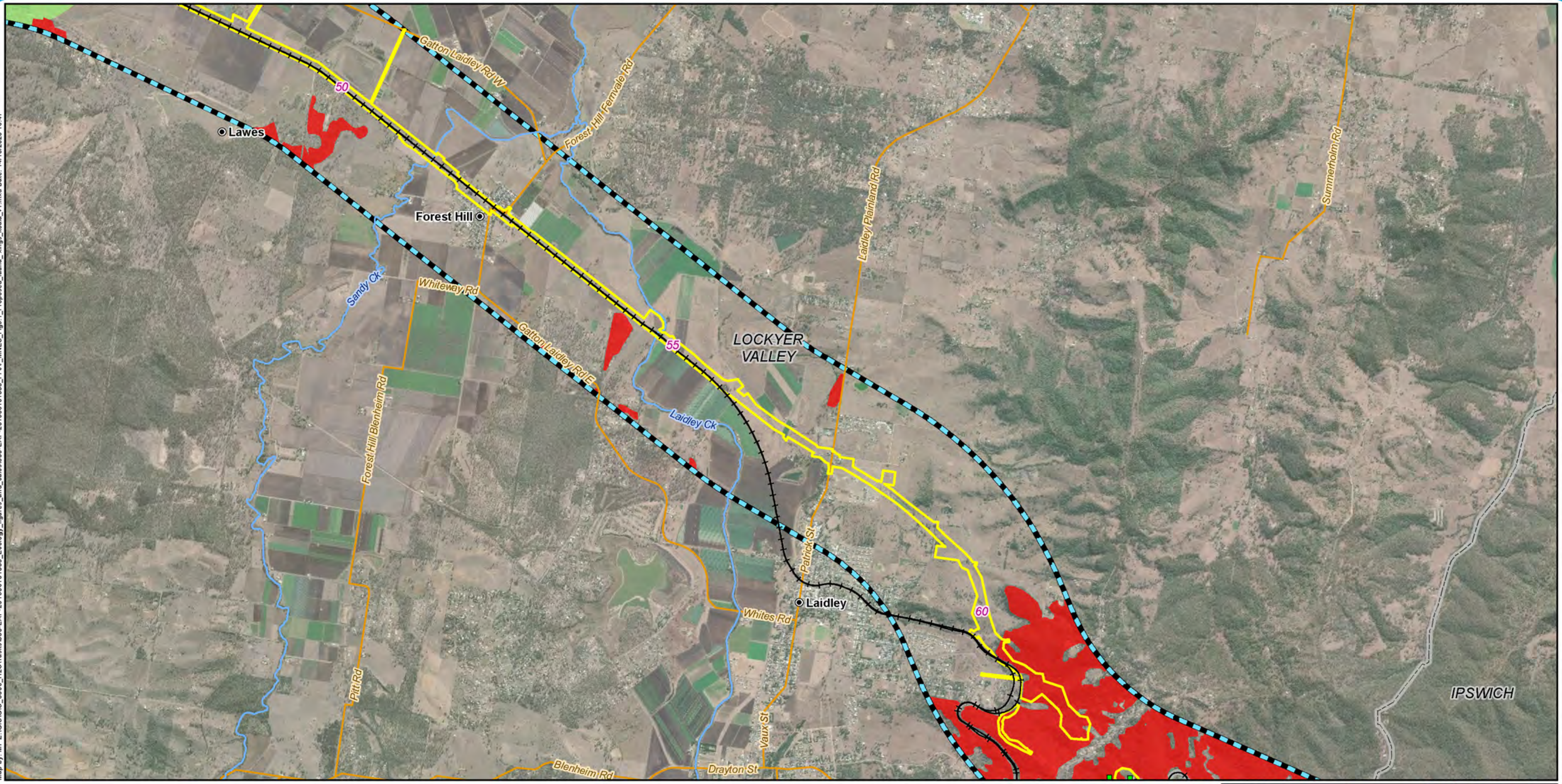
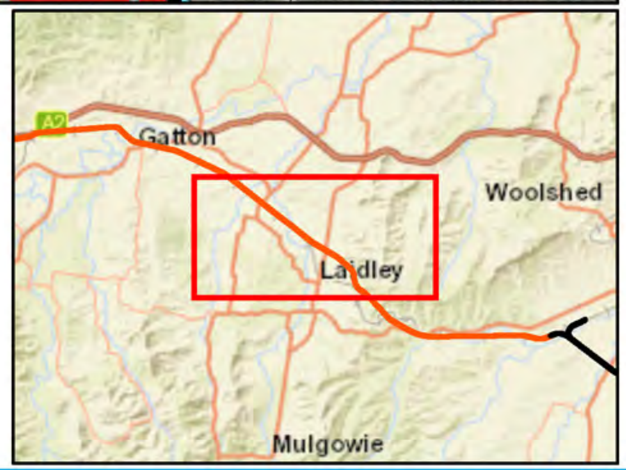


Legend

5 Chainage (km)	Major roads	**Koala**
Localities	Minor roads	Habitat critical to the survival of the species
Fauna crossings	Watercourses	Potential habitat
Koala observations	EIS disturbance footprint	
Existing rail	MNES study area	
	Local Government Areas	



A3 scale: 1:50,000

0 0.4 0.8 1.2 1.6 2km

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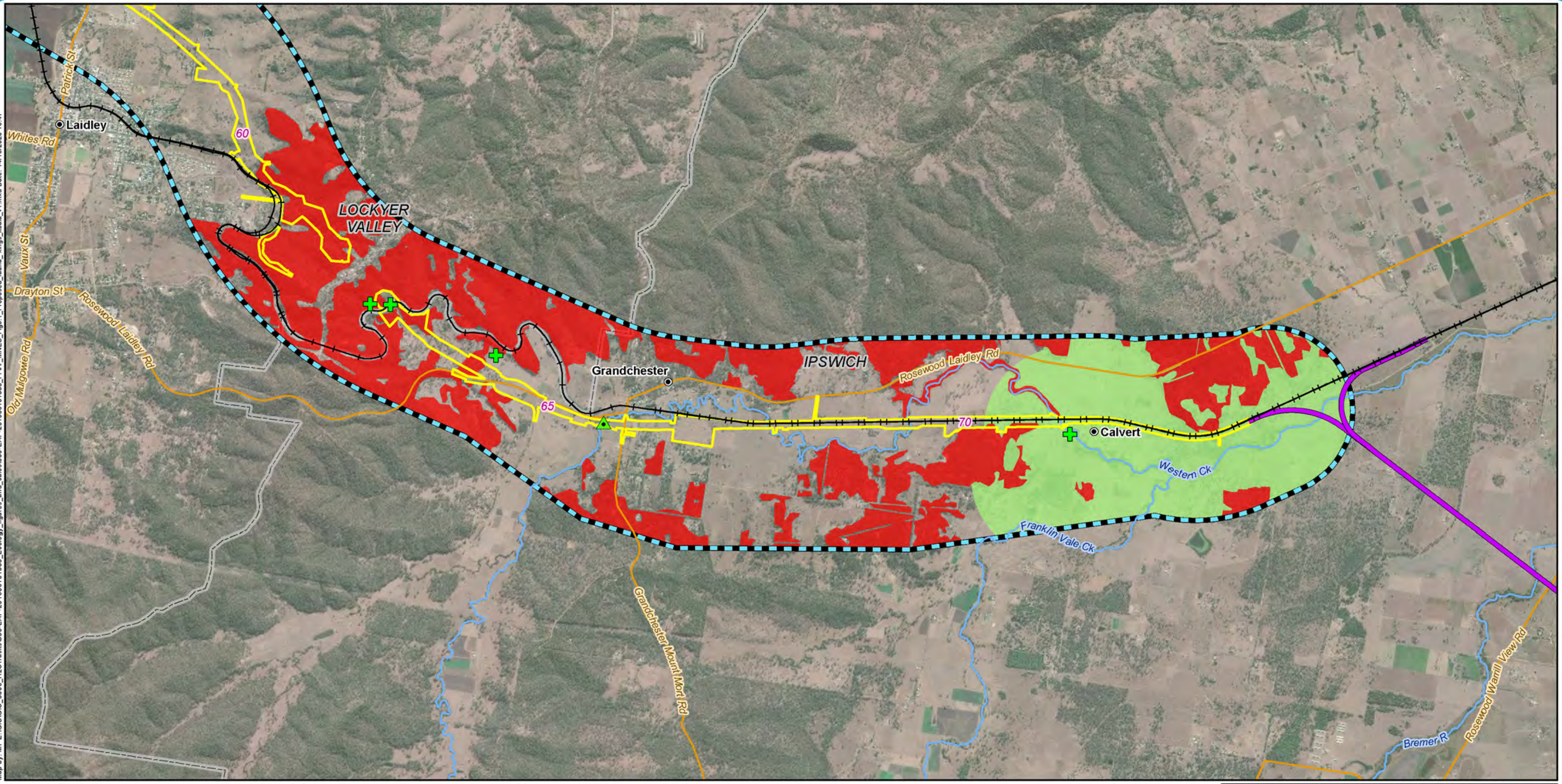
Helidon to Calvert

Figure 5.1c: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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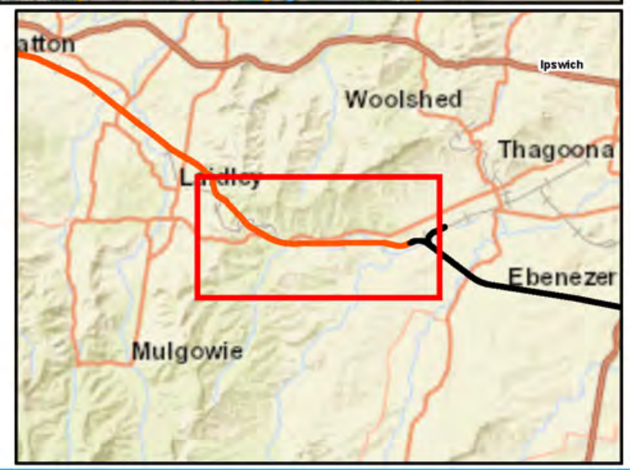
Legend

- 5 Chainage (km)
- Localities
- Fauna crossings
- Koala observations
- Existing rail
- C2K project alignment
- Minor roads
- Watercourses
- EIS disturbance footprint
- MNES study area
- Local Government Areas

Koala

- Habitat critical to the survival of the species
- Potential habitat



A3 scale: 1:50,000

0 0.4 0.8 1.2 1.6 2km

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Helidon to Calvert

Figure 5.1d: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

ARTC has reviewed a cross-section of available published literature on effectiveness of mitigation measures used on linear infrastructure. There is significant literature which corroborates ARTC's proposed mitigation measures as being effective:

- Installation and regular maintenance of fauna exclusion fences can help reduce wildlife mortality during construction. Wildlife crossing structures (underpasses and overpasses) have been constructed around the world and are used by many species to safely cross linear infrastructure (Bond and Jones 2008; VicRoads 2012; van der Grift et al. 2015; van der Ree et al. 2015a; Weller 2015)
- Wildlife crossing structures also improve traffic safety and contribute to the conservation of biodiversity by allowing animals to move safely across roads, thereby reducing the risk of collision (Smith et al. 2015)
- Wildlife crossing structures are the most effective approach to mitigate the barrier effect of linear infrastructure on wildlife movement (Taylor and Goldingay 2010; Smith et al. 2015)
- The combination of exclusion fencing with wildlife passes are complementary, with the ability to avoid animal collisions and maintain infrastructure permeability (VicRoads 2012; Carvalho et al. 2017; Ghent 2018; Barrientos et al. 2019).
- VicRoads (2012) corroborates the use of bridge underpasses for the effective use of koala crossings
- The most effective stream crossings for fish, when long-span bridges are not an option, are culverts or shorter span bridges that simulate the natural channel (Ottburg and Blank 2015)
- Use of planting native species to the region was validated by Milton, et al. (2015).

ARTC is committed to implementing ongoing monitoring of the effectiveness of the measures with contingency (under an adaptive management framework) to change/improve management strategies where deleterious impacts to the identified environmental values are observed, or are not minimised, as per the objectives of the proposed measures.

Literature is in agreement that monitoring is a critical component of quantifying effectiveness of a specific mitigation measure (van der Ree et al. 2008; van der Grift et al. 2015). This is because the success of mitigation measures are heavily reliant on factors such as existing environment, potential habitat, species, climate, design components of the linear infrastructure, and operational frequency of the transport; due to these factors it is not feasible to be able to provide a quantification of effectiveness of the Project's mitigation measures (Ghent 2018).

For example, a comprehensive evaluation of the effectiveness of wildlife crossing structures requires a clear definition of success. Effectiveness is defined as the extent to which the goals of mitigation are reached. However, it is difficult to assess effectiveness without a specific and measurable goal. Therefore, ARTC recommends the SMART approach, that is, goals that are Specific, Measurable, Achievable, Realistic and Time framed (van der Ree et al. 2008; van der Ree et al. 2015b and 2015c; van der Grift et al. 2015). Van der Ree et al. (2007) proposed that the overall objective of wildlife crossing structures is to 'increase the permeability of a road corridor'. Criteria that can be used to measure effectiveness include:

- Rates of road-kill
- Habitat connectivity
- Biological requirements are met
- Allowance for dispersal and re-colonisation
- Maintenance of meta-population processes and ecosystem services.

It is also recommended that goals should be set for individual projects that are specific to species, location and the nature of the conflict. For example, a specific goal might be to ensure more than 90 per cent of individuals that approach a crossing structure successfully cross it, or to maintain the risk of extinction of a population to less than 5 per cent over the next 100 years.

Additional strategies as identified by the relevant threat abatement plan/recovery plans will be incorporated into the Project's mitigation strategies following the primary approval phase of the Project as part of detailed design. A summary of threat abatement plans and recovery plans applicable to the identified MNES is provided in Appendix B and Sections 5.3.4 and 5.3.5.

Proposed mitigation measures have been grouped by Project delivery phase with implementation during:

- Detailed design
- Pre-construction
- Construction
- Operation.

Table 5.3 identifies the relevant delivery phase, the aspect to be managed, and the proposed mitigation measure, which is then factored into the initial impact assessment (refer Section 5.3.2).

In addition, it is recognised that targeted surveys for most MNES flora and fauna species have not been carried out within the Project disturbance footprint as part of Project surveys detailed in this report. ARTC will undertake additional ecological surveys in accordance with relevant Commonwealth and/or State survey guidelines to verify and further refine the habitat mapping and extent of local populations (where applicable). These additional works will inform relevant approvals and management plans, along with necessary offset requirements and disturbance limits. These surveys will be a part of the Project Flora and Fauna Sub-plan as identified in Section 5.3.2.

EIS Chapter 23: Draft outline environmental management plan provides further context and the framework for implementation of these proposed mitigation and management measures.

Table 5.3 Project impact mitigation and management measures

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design	MNES	While the assessment assumes the entire Project disturbance footprint will be cleared, the disturbance footprint will be refined through detailed design as far as practical, to that required to safely and efficiently construct and operate the Project and avoid unnecessary clearing. This will involve inputs from the design team, construction contractor and where applicable, the constructing authority.
		Flora and fauna surveys will be undertaken within and immediately adjacent to the Project footprint where they are required to verify prior surveys and assessments, refine potential offsets, inform micro-siting of infrastructure, support secondary approvals and establish baseline conditions against which relevant outcomes of the Reinstatement and Rehabilitation Plan and monitoring activities can be compared. Methods and sequencing of surveys, including seasonal timing, will be in accordance with the relevant published State and Commonwealth survey guidelines and conservation advices for each target species (e.g. *Survey guidelines for Australia's threatened birds* (DEWHA 2010b)) or Queensland guidelines where Commonwealth guidelines do not exist (e.g. *Protected Plants Survey Guidelines* (DES 2020b)) Flora species to be targeted through these surveys include, but are not limited to the following: ▪ Hairy-joint grass (*Arthraxon hispidus*) ▪ Four-tailed grevillea (*Grevillea quadricauda*) ▪ Blunt-leaved leionema (*Leionema obtusifolium*) ▪ Lloyd's olive (*Notelaea lloydii*) ▪ *Paspalidium grandispiculatum* (a grass) ▪ Brush sophora (*Sophora fraseri*) ▪ Austral toadflax (*Thesium australe*) Fauna surveys, including terrestrial, aquatic habitats and breeding habitats (including burrows and hollow bearing trees/logs, wetlands, existing culverts and structures) will target, but not be limited to the following species: ▪ Regent honeyeater (*Anthochaera phrygia*) ▪ Australasian bittern (*Botaurus poiciloptilus*) ▪ Curlew sandpiper (*Calidris ferruginea*) ▪ Spotted-tail quoll (*Dasyurus maculatus maculatus*) ▪ Collared delma (*Delma torquata*) ▪ Red goshawk (*Erythrotriorchis radiatus*) ▪ Grey falcon (*Falco hypoleucos*) ▪ Painted honeyeater (*Grantiella picta*) ▪ Swift parrot (*Lathamus discolor*) ▪ Australian lungfish (*Neoceratodus forsteri*) ▪ Greater glider (*Petauroides volans*) ▪ Brush-tailed rock-wallaby (*Petrogale penicillata*) ▪ Koala (*Phascolarctos cinereus*)

Delivery phase	Environmental value impacted	Mitigation and management measures
		■ Long-nosed potoroo (*Potorous tridactylus tridactylus*) ■ New Holland mouse (*Pseudomys novaehollandiae*) ■ Grey-headed flying-fox (*Pteropus poliocephalus*) ■ Australian painted snipe (*Rostratula australis*) ■ Black-breasted button-quail (*Turnix melanogaster*) Where a species is detected this will be reported to the relevant agencies along with information on the species habit, habitat in which the species was identified and where possible, population size and local threatening processes. The information will be used to refine the predictive habitat mapping, significant residual impact assessment, disturbance limits, mitigation measures and offsets. Surveys of representative MNES habitat that will be impacted by the Project will be undertaken in accordance with the *Guide to determining terrestrial habitat quality - methods for assessing habitat quality under the Queensland Environmental Offsets Policy. Version 1.3* (DES 2020c) and the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC, 2012a) to enable a condition assessment of vegetation communities that require offset for the Project.
		Based on the outcome of flora, fauna and MNES habitat surveys: ■ Work with the design team and construction team to implement measures to avoid and/or further minimise the extent of impacts (i.e. designate no-go zones, reduce the construction or operational footprint within or adjacent to communities or habitat for MNES, define clearing limits) ■ This information will inform staged and sequential clearing (i.e. clearing of non-habitat trees in area, then a wait period and then the clearing of the remaining habitat) ■ Identify suitable locations for the release of fauna that may be encountered during pre-clearing or clearing or for the salvaging of microhabitats.
		For any threatened flora species identified through surveys within the disturbance footprint, consult with relevant specialist to determine the feasibility of translocating or propagating specimens in accordance with relevant guidelines (e.g. *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018)), including the collection of seed. Feasibility will be assessed noting that not all species can be translocated or propagated and that for the majority of the species identified as potentially occurring with the Project disturbance footprint there is limited evidence of these species being successfully translocated, even though some are used in the horticultural industry.
		The following species-specific measures for Hairy-joint grass (*Arthraxon hispidus*), Four-tailed grevillea (*Grevillea quadricauda*), Blunt-leaved leionema (*Leionema obtusifolium*), Lloyd's olive (*Notelaea lloydii*), *Paspalidium grandispiculatum* (a grass), Brush sophora (*Sophora fraseri*) and Austral toadflax (*Thesium australe*): ■ Avoid works in areas that may support an important population of the species ■ Undertake protected flora surveys as per *Protected Plants Survey Guidelines* (DES 2020b) with a particular focus within areas suspected of supporting the species (refer species habitat mapping in Appendix F).

Delivery phase	Environmental value impacted	Mitigation and management measures
		The following species-specific measures for Australian Lungfish (*Neoceratodus forsteri*) will also be implemented: - Avoid clearing within and along major watercourses, through the use of bridge structures and the placement of pylons away from bed and banks - Pre-construction surveys of waterways identified as *potential habitat* of species to identify whether Australian lungfish occurs. Surveys will follow the Survey guidelines for Australia's threatened fish (DSEWPaC 2011c) - Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, the Flora and Fauna Sub-plan will include requirements for an appropriately qualified person to be consulted to make an assessment on the method of recovery, transport and release of fish. The Flora and Fauna Sub-plan will include requirements for the application of follow relevant State (DAF) fish salvage guidelines during construction activities. - The Biosecurity Management Sub-plan will include measures to manage the risk of translocating non-endemic flora and fauna through dewatering and fish salvage activities - The Surface Water Sub-plan will be developed to include measures to maintain low flows during drought conditions and avoid fluctuations to water levels downstream during spawning period (i.e. Bremer River) - The Reinstatement and Rehabilitation Plan will establish requirements for instream and riparian habitats impacted by Project works. This includes restoration of natural riparian vegetation and where possible, reinstatement of instream habitat to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and allow fish passage).
		The following species-specific measures for Spotted-tail quoll (*Dasyurus maculatus maculatus*) Long-nosed potoroo (*Potorous tridactylus tridactylus*), New Holland mouse (*Pseudomys novaehollandiae*) and Brush-tailed rock-wallaby (*Petrogale penicillata*) will also be implemented: - Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project - Targeted surveys for identified mammal species will follow the *Survey guidelines for Australia's threatened mammals* (DSEWPaC 2011b) and include the identification of species-specific habitat (refer species habitat mapping in Appendix F) and habitat features considered suitable for species presence (e.g. cliff faces/boulder piles for Brush-tailed rock-wallaby and Spotted-tail quoll) - As part of the MNES monitoring plan, establish camera traps above the tunnel areas to monitor fauna movement across this area during construction - The Flora and Fauna Sub-plan will include restricted works measures for implementation if the above mentioned species are observed within or adjacent to disturbance footprint to allow safe movement away from works area. These measures may include, but are not limited to the following: Measures to remove carrion from the Project disturbance footprint (and the rail corridor), along with waste management measures Pest control measures in known or potential habitat for the above mentioned species to consider risks to the species (e.g. use of baiting to control wild dogs. predation) Salvage hollow logs and rocky outcrops removed from the Project disturbance footprint into adjoining habitat Establish buffer zones around known key habitat and den sites Where possible avoid clearing within the known habitat) during the breeding season where possible Measures to manage the clearing of hollow logs and hollow bearing trees (e.g. tapping of tree prior to clearing, removal of hollows prior to clearing and grubbing activities).

Delivery phase	Environmental value impacted	Mitigation and management measures
		The following species-specific measures for Swift parrot (*Lathamus discolor*) will also be implemented: ▪ Where possible through design, reduce the disturbance footprint in winter foraging habitat, including avoiding clearing for ancillary works ▪ Incorporate winter foraging species into the landscape design and Reinstatement and Rehabilitation Plan.
		The following species-specific measures for Australian painted snipe (*Rostratula australis*), Curlew sandpiper (*Calidris ferruginea*) and Australasian bittern (*Botaurus poiciloptilus*) will also be implemented: ▪ Targeted surveys to be undertaken of potential habitat following the *Survey guidelines for Australia's threatened birds* (DEWHA 2010b) where applicable ▪ Should the above mentioned species or other target wetland species be found to occur, the CEMP Flora and Fauna sub-plan will include: Clearing/construction works in potential habitat areas will be timed where possible to avoid wet conditions where habitat is likely to be most suitable Restricted works/avoidance measures in place should nesting be detected. ▪ The CEMP will include measures to minimise noise as much as feasible and the Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods ▪ The Biosecurity Management Sub-plan will include site hygiene and waste management measures to ensure pest predator fauna are not attracted to works areas or utilising Project disturbance footprint.
		The following species-specific measures for Collared delma (*Delma torquata*) will also be implemented: ▪ Targeted surveys to be undertaken as per *Survey guidelines for Australia's threatened reptiles* (DSEWPaC 2011e) where suitable habitat is identified (refer species habitat mapping in Appendix F) ▪ The Flora and Fauna Sub-plan will include restricted works measures for implementation if the Collared delma is observed within or adjacent to disturbance footprint to allow safe movement away from works area. Other measures may include, but are not limited to the following: Measures to ensure retrieval of potential habitat elements (e.g. loose surface rock, large fallen timber) during vegetation clearing and placement in adjacent unimpacted habitat Erosion and sediment control measures in steep slopes (and known *important habitat* for this species) to avoid/minimise slippages Measures to allow safe handling of fauna (where required) and repatriation in a suitable habitat away from site.
		The following species-specific measures for Red goshawk (*Erythrotriorchis radiatus*), Regent honeyeater (*Anthochaera phrygia*), Painted honeyeater (*Grantiella picta*), Black-breasted button-quail (*Turnix melanogaster*) and Grey falcon (*Falco hypoleucos*) will also be implemented: ▪ Pre-clearing surveys of woodlands identified as potential habitat for the above mentioned species (refer species habitat mapping in Appendix F) will be undertaken to identify whether individuals occur and potentially nest (Red goshawk only) within the disturbance footprint. Surveys for nest sites within or near the disturbance footprint will be as per MNES guidelines where suitable nesting habitat (i.e. large emergent trees near water) are identified.

Delivery phase	Environmental value impacted	Mitigation and management measures
		■ Where nesting is identified in pre-clearing surveys, the Flora and Fauna Sub-plan will include restricted works measures for construction to allow nesting to continue undisturbed (e.g. micro siting of works to avoid nests or maximise separation distance, 100 m buffer and signage around nests, no disturbance to nests until after breeding season (being until fledglings/offspring no longer use the nest/roost for habitat). Some limited works may occur in the buffer zone during this period (e.g. cultural heritage surveys).
		The following species-specific measures for Koala (*Phascolarctos cinereus*) will also be implemented: ■ Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project ■ Pre-clearing surveys to be undertaken of woodlands (and other relevant habitats) identified as potential habitat of species (refer species habitat mapping in Appendix F) to identify whether individuals occur within disturbance footprint ■ Project design to incorporate fauna crossing structures to allow fauna movement across alignment. The location and frequency of the passages will be based on an understanding of local Koala movements and in consultation with relevant stakeholders (e.g. DTMR and local councils. ■ Fauna and fencing in accordance with ARTC guidelines and DTMR’s Fauna Sensitive Road Design Manual (DTMR 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. ■ Viaducts and the bridge structures will assist in the retention of corridor(s) of at least 100 m width. While the tunnel will ensure a corridor over 850 m wide is maintained through the Little Liverpool Range. ■ The Flora and Fauna Sub-plan will include restricted works measures for implementation within or adjacent koala habitat to allow safe movement away from works area. These measures may include, but are not limited to the following: Staged and sequential clearing within koala habitat in areas where koala have been identified as being present (e.g. undertake pre-clearing koala searches on the morning prior to clearing commencing) Measures to allow safe handling of koalas (where required) and repatriation in suitable habitat away from site Requirements for koalas subject to handling to be examined and if suspected of Chlamydia infection will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release A procedure to guide koala interactions, including any translocations Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk Incorporation of koala trees in landscape design and rehabilitation works, especially along existing corridors which are to be retained (e.g. riparian corridors).
		The following species-specific measures for Greater glider (*Petauroides volans volans*) will also be implemented: ■ Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project ■ Pre-clearing surveys to be undertaken of woodlands (and other relevant habitats) identified as potential habitat for the species (refer species habitat mapping in Appendix F) to identify whether individuals occur within disturbance footprint, including potential movement pathways, nest sites (i.e. hollow bearing trees) and feeder trees ■ Project design to incorporate fauna crossing structures to allow fauna movement across alignment. The location and frequency of the passages will be based on an understanding of local Greater glider movements and in consultation with relevant stakeholders (e.g. DTMR and local councils.

Delivery phase	Environmental value impacted	Mitigation and management measures
		■ Fauna fencing in accordance with ARTC guidelines and DTMR's Fauna Sensitive Road Design Manual (DTMR 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Also, where possible, avoid the use of barb wire particularly on the top strand, to prevent threatened species (particularly Greater glider, flying-foxes and microbats) from becoming entangled. Fauna friendly fencing must be used, whilst being in accordance with landowner and/or structural requirements. ■ The Flora and Fauna sub-plan will include: Pre-clearing surveys to identify and map out hollow bearing trees, feeder trees and potential movement pathways Consultation with the project team and construction team to determine whether key microhabitats can be avoided Where key microhabitats cannot be avoided developed protocols/procedures to manage these features, including relocating hollow bearing trees into adjacent habitat and the use of nest boxes, tapping of hollows bearing trees or where possible by lowering trees slowly with a claw extension.
		The following species-specific measures for Grey-headed flying-fox (*Pteropus poliocephalus*) will also be implemented: ■ Pre-clearing surveys to be undertaken of riparian habitat identified as potential roost sites of species to identify whether camps occur within or near the disturbance footprint. It is noted known roost sites have been identified approximately 600 m (Laidley area) and 1.2 km (Gatton) from the Project. ■ Where possible, reduce the disturbance footprint in winter foraging species, including avoiding clearing for ancillary works ■ Incorporate winter foraging species into the landscape design and Reinstatement and Rehabilitation Plan ■ Work with the design team and property team to incorporate fencing which minimises the risk of entanglement (e.g. avoid the use of barbed wire fencing with a high tensile wire strand as the top wire) ■ The Flora and Fauna Sub-plan will include measures to be implemented should a roost site be found to occur. These will incorporate the mitigation standards detailed in the *Commonwealth's Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE 2015a).
		For other MNES species included in the initial impact assessments for MNES flora and MNES fauna, review the outcome of additional flora and fauna surveys, and ensure the species-specific measures are appropriately implemented for survey, landscape design, the Reinstatement and Rehabilitation Plan or the Flora and Fauna Sub-plan.
		Develop a post-construction MNES monitoring plan. The MNES monitoring plan will be informed by the survey results and developed in consultation with relevant stakeholders. The MNES monitoring plan will define the TEC or other MNES habitat location, reference condition, assessment framework, infrastructure elements (e.g. erosion and sediment control devices, fauna crossing structures), corrective actions, completion criteria and monitoring timeframes.
		Project design to incorporate minimum lighting requirements feasible for Project safety.
		The potential for Project works to impact MNES through erosion, soil loss, land degradation, sedimentation or decreased surface water or groundwater quality or availability will be managed through the following: ■ Soil surveys to further characterise soil conditions across the disturbance footprint at a suitable scale to inform detailed design, including appropriate design responses where reactive or problem soils are present or suspected ■ Contaminated land surveys to inform detailed design and subsequent contaminated land strategy ■ A Soil Management Plan will be developed to provide the framework for the stripping, storage, treatment and reuse of topsoil

Delivery phase	Environmental value impacted	Mitigation and management measures
		▪ An Erosion and Sediment Control Plan (ESCP) will be developed as part of the CEMP, in accordance with the International Erosion Control Association's *Best Practice Erosion and Sediment Control* (IECA, 2008). It will include: Soil/land conservation objectives for the Project Management of problem soils Temporary/permanent drainage, erosion and sediment control measures Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material Vehicle, machinery and imported fill hygiene protocols and documentation Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction Where practical and or in accordance with specific flora and fauna management plans, vegetation clearing and ground disturbing works will be staged sequentially across the Project to minimise areas exposed to erosion and sediment risk of receiving waterways and drainage lines in accordance with the general environmental duty of the *Environmental Protection Act 1994* (Qld) Measures for minimising the exposure time of unprotected materials to prevent sedimentation of receiving waterways and subsequent impacts to ecological receptors A process for site- and activity-specific preparation when forecast large or high-intensity wet weather events are predicted. This may include, but not be limited to, removing equipment out of riparian zones, stabilising/covering live work areas, additional application of soil binders/veneers and pre event treatment, and dewatering of sediment basins. Process for the continuous review of effectiveness of erosion and sediment controls Water quality monitoring requirements as defined in the Surface Water Sub-plan to assess the effectiveness of erosion and sediment controls and reinstatement and rehabilitation programs The ESCP will align with the Reinstatement and Rehabilitation Plan and will include progressive stabilisation of earth materials and soil consolidation to prevent erosion and sedimentation in areas within the disturbance footprint that do not form part of the permanent works (e.g. temporary construction compounds, temporary waterway barrier works and laydown areas etc.) ▪ A surface water monitoring framework, which will inform the development of the Surface Water Sub-plan and construction water quality monitoring program. It will identify monitoring locations including upstream, downstream and at the intersection of the Project disturbance footprint and watercourse. It will include the relevant water quality objectives, parameters, criteria and specific monitoring locations, frequency and duration identified in consultation with relevant regulators to reduce impacts to surface water quality. ▪ The Surface Water Sub-plan will establish the construction water quality monitoring program which will include (as a minimum): Analysis of the representative background monitoring dataset Identification of Project works and activities during construction and operation, including runoff, emergencies and spill events, that have the potential to impact on surface water quality of potentially affected waterways and riparian land (via discharge points) A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment, including definition of impacts that trigger contingency and ameliorative measures. ▪ Potential aquatic and terrestrial Groundwater Dependent Ecosystems will be field-truthed to confirm presence ▪ Further geotechnical investigations will be undertaken at deep cut sections to inform design and location-specific construction management of groundwater.

Delivery phase	Environmental value impacted	Mitigation and management measures
		▪ Risks associated with dewatering (i.e. water table lowering) and environmental management requirements during construction will be identified through appropriate baseline groundwater monitoring, modelling and analysis, and incorporated into the CEMP.
	Riparian vegetation and aquatic habitats	Project design minimises impacts to waterways, riparian vegetation and in-stream flora and habitats by: ▪ Adopting a waterway crossing structure hierarchy: bridges preferred to culverts, to maintain infrastructure permeability for fauna at identified habitat connectivity points, however local conditions and constructability impacts must be considered when determining the preferred environmental solution ▪ Avoiding, then minimising the extent and duration of temporary waterway diversions. Where unavoidable, implement water quality, erosion and sediment control measures to minimise impacts to downstream environments and water users. ▪ Continuing to refine Project design in response to hydraulic modelling outcomes. This includes addressing flood impact objectives which include consideration of peak water levels, flow distribution, velocities, and duration of inundation, and implications for fish passage. This will confirm bridge lengths, culvert sizing and numbers, localised scour and erosion protection measures for both rail, road and other permanent Project infrastructure. ▪ Avoiding, then minimising the extent of permanent waterway diversions. Where unavoidable, waterway diversion design to include simulation of natural features e.g. meanders, pools, riffles, shaded and open sections, deep and shallow sections and different types of sub-strata, depending on the pre-disturbance environmental values, as per requirements of relevant and applicable conditions of approval, legislation, regulations and industry guidelines. Maintenance activity locations, construction compounds and storage areas will be defined as part of Project detailed design and positioned away from waterways. ▪ Stormwater controls, such as scour protection, are to be further developed and incorporated where necessary to achieve compliance with established water quality objectives. Temporary and permanent measures must be appropriate to the site conditions, responding to the erosion risk assessment, environmental receptors, climatic zone and seasonal factors. The ESCP will establish and specify the monitoring and performance objectives for handover to operational management on completion of construction. ▪ Ensuring the disturbance footprint extents allow sufficient space for provision of the required temporary and permanent erosion and sediment control measures/pollution control measures defined during detailed design ▪ Undertaking rehabilitation of temporary waterway crossings in accordance with the Reinstatement and Rehabilitation Plan ▪ Developing ESCPs for implementation during pre-construction, construction and commissioning
	Fauna passage[1,2]	Refine fauna passage locations and associated rehabilitation areas in the design to maintain infrastructure permeability, particularly at the key locations identified as part of the EIS assessment process to maintain and/or re-establish habitat connectivity. Design of fauna passage structures and associated rehabilitation areas will respond to local topographical and hydrological context, with consideration of safety requirements for the rail corridor and adjoining properties. Design bridges and culverts to accommodate terrestrial fauna passage where assessed as appropriate, in addition to fish passage design requirements. Fauna passage design will be consistent with the intent of DTMR's Fauna Sensitive Road Design Manual (DTMR 2010) and where applicable species-specific requirements.

Delivery phase	Environmental value impacted	Mitigation and management measures
	Fauna fencing[1,2]	Fauna fencing opportunities will be further assessed and, where appropriate, developed during detailed design to limit fauna strike and fauna mortality risk and/or maintain habitat connectivity. This will include: ▪ Assessment of the compatibility of each approach for the targeted local species with the general fencing principles at each proposed fencing location ▪ Consideration of safety requirements for the rail corridor and adjoining properties ▪ Consultation with adjoining landholders ▪ Requirements for maintaining an appropriate clearance buffer between adjacent vegetation and fauna fences ▪ Consideration for maintenance constraints and responsibilities that a fauna connectivity or fencing opportunity may introduce to operations. Fauna fencing will be designed with reference to DTMR's Fauna Sensitive Road Design Manual (DTMR 2010). Additional expert guidance in relation to specific design features will be sought during the detailed design process. The design will aim to maximise infrastructure permeability by connecting fauna fencing with safe crossing opportunities.
	Aquatic fauna	Design watercourse crossing structures (including culverts and bridges) to maintain fish passage where applicable in accordance with *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works. The design will aim to minimise the need for ongoing maintenance and inspection to maintain fish passage. Develop a dewatering strategy in accordance with the *Biosecurity Act 2014* (Qld), providing reasonable measures to avoid the spread of pest species and in accordance with any required aquatic fauna species management plans and water quality objectives defined in the outline CEMP. Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, the Flora and Fauna Sub-plan will include requirements for an appropriately qualified person to be consulted to make an assessment on the method of recovery, transport and release of fish. The Flora and Fauna Sub-plan will include requirements for the application of follow relevant State (DAF) fish salvage guidelines during construction activities. The Biosecurity Management Sub-plan will include measures to manage the risk of translocating non-endemic flora and fauna through dewatering and fish salvage activities.
	Flora	Where feasible and practicable, locate construction areas including compounds, stockpiles, fuel storage, laydown areas and staff parking outside the tree protection zone as defined in *AS4970-2009 Protection of trees on development sites*. Where practical, existing tracks will be used and the design for new access tracks (permanent and temporary) will be undertaken with the aim of minimising disturbance of substrate and vegetation.

Delivery phase	Environmental value impacted	Mitigation and management measures
	Landscape, rehabilitation and stabilisation	Landscape design establishes the requirements for rehabilitation of disturbed areas for habitat re-creation, landscaping and stabilisation, including for riparian zones and informs the development of the Reinstatement and Rehabilitation Plan and the Landscape and Rehabilitation Management Plan[1,3]. This will also include criteria for retrieval of potential habitat elements (loose surface rock, large fallen timber) during vegetation clearing for habitat recreation where appropriate. Develop a Reinstatement and Rehabilitation Plan for areas within the disturbance footprint that do not form part of the permanent works (e.g. construction compounds, laydown areas, temporary access tracks etc). The Plan will include and clearly identify: ▪ Location of areas subject to rehabilitation and/or reinstatement/stabilisation, in accordance with the landscape and rehabilitation design developed during detailed design, including operational rail safety considerations ▪ 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, the plan describes 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, consistent with the Reinstatement and Rehabilitation Plan objectives ▪ Native flora species endemic to the Scenic Rim and Ipswich regions or other suitable species appropriate to the landscape context and nursery/seed stock sources. Where possible (i.e. propagated material is available) include MNES species (e.g. Lloyd's olive) in rehabilitation activities. ▪ Incorporate koala trees in landscape design and rehabilitation works, especially along existing corridors which are to be retained (e.g. riparian corridors) ▪ Procedures, timeframes, measurable performance objectives and responsibilities for monitoring the success of rehabilitation and/or reinstatement/stabilisation areas ▪ Corrective actions if the outcomes of rehabilitation and/or reinstatement/stabilisation are not achieved. A Landscape and Rehabilitation Management Plan will be developed to define post construction maintenance requirements, monitoring requirements and completion criteria for areas defined in the landscape design and/or identified in the Reinstatement and Rehabilitation Plan.
	Offsets[1,2]	Restriction of the Project disturbance 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 requirements based on the outcomes of the Flora, fauna and MNES habitat surveys. A Project offset delivery plan and Offsets management plans 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 Appendix I of this Report: Environmental Offset Delivery Strategy QLD).

Delivery phase	Environmental value impacted	Mitigation and management measures
	Flora and fauna	Develop the Flora and Fauna Sub-plan to include appropriate criteria, directives and procedures in relation to: ▪ Pre-clearing surveys, including terrestrial, aquatic and wetland habitats, protected plants, breeding habitats (including burrows and hollow bearing trees/logs, existing culverts and structures, riparian habitat identified as potential roost sites) for both threatened and non-threatened species by suitably qualified persons ▪ Staged and sequential clearing protocols ▪ Signage requirements for the delineation of no-go areas and clearing extents, including avoiding works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the project ▪ Animal handling protocols, including relocation and emergency care. For example, koalas subject to handling will be examined and if suspected of Chlamydia infection will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release ▪ Restricted works/avoidance measures should nesting of Australian painted snipe or Australasian bittern be detected ▪ Works protocols should an active Red goshawk nest site be identified, to allow nesting to continue undisturbed ▪ Works protocols should a grey headed flying fox roost site be found, in accordance with the Commonwealth's *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE 2015a) ▪ Works protocols to allow safe movement away from works area, should other fauna be observed within or adjacent to the works area ▪ Relocation of habitat features (such as hollow bearing logs or rocks for the Collared delma) where applicable ▪ Requirements for inspections and corrective actions during construction and rehabilitation activities ▪ Requirements for 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.
	Weeds and pests	Develop the Biosecurity Management Sub-plan[1,2,3] to include: ▪ Requirements for pre-clearing surveys in areas immediately adjacent to the Project disturbance footprint to determine the risk of environmental weeds and pests including prohibited and restricted matters prescribed under the *Biosecurity Act 2014* (Qld) and Biosecurity Regulation 2016 being present ▪ Relevant guidelines to control potential deleterious pathogens including *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities both of which may impact Melaleuca and eucalypt species. ▪ Revegetation species to be obtained from source certified free of *Phytophthora cinnamomi* ▪ Mapping of the existing extent and severity of any weed infestation and weed management requirements in the disturbance footprint or on adjacent land, (restricted matters including mother of millions, Opuntioid cactus, Lantana and Giant rats tail grass) ▪ Pest animal management, including Red imported fire ants management within the Biosecurity Zones 1 and 2 as per current DAF advice ▪ Weed surveillance and treatment during construction and rehabilitation activities ▪ Vehicle and plant washdown protocols when traversing properties via temporary access tracks or if any high risk areas are identified during the Project construction

Delivery phase	Environmental value impacted	Mitigation and management measures
		▪ Requirements in relation to pesticide and herbicide use and documentation, recognising ACDC Act requirements including any limitations on use, such as, restrictions on use in sensitive environmental areas, drainage lines that flow to waterways and aquatic habitats, and ensuring that broad scale use does not result in an increased erosion and sediment risk ▪ Vehicle and plant equipment and imported fill hygiene protocols and documentation ▪ Erosion and sediment control risks associated with broad scale weed removal or treatment ▪ Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material ▪ Consideration of local government Biosecurity Plans (City of Ipswich Biosecurity Plan 2018-2023 and City of Logan Biosecurity Plan 2017-2022) ▪ Dewatering and fish salvage requirements to manage the risk of translocating non-endemic flora and fauna ▪ Requirements for monitoring the effectiveness of weed hygiene measures.
		Develop the Community Engagement Sub-plan in the CEMP, to enable members of the public to assist with weed surveillance in the vicinity of Project works.
Pre-construction	Flora and fauna	Implement the Flora and Fauna Sub-plan. Undertake pre-clearing surveys in any areas to be cleared to enable pre-construction activities and confirm the species-specific works protocols to be implemented. Document the area and type of vegetation cleared in a post clearance summary, including MNES for offsetting and compliance purposes.
	Landscape, rehabilitation and stabilisation	The Reinstatement and Rehabilitation Plan will guide the approach to rehabilitation and be implemented progressively during pre-construction and construction phase activities.
	Weeds and pests	Implement the Biosecurity Management Sub-plan during pre-construction to reduce the potential for the spread of weeds and pests into the surrounding environments and land uses.
	Erosion and sediment control	Implement appropriate site stabilisation treatments, including seeding and planting requirements, in accordance with the ESCPs and Reinstatement and Rehabilitation Plan.
Construction and commissioning (including reinstatement)	Flora and fauna (including MNES)	Project clearing extents are limited to that which is required to safely construct, operate and maintain the Project, in accordance with the approved disturbance footprint. Locate temporary construction facilities compounds, stockpiles, fuel storage, laydown areas, temporary access roads and staff parking to minimise the extent of disturbance on existing habitat and significant vegetation (i.e. undertake micro-siting of these temporary activities and facilities). Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. Clearly define clearing boundaries associated with the construction disturbance footprint with flagging or marking tape, signage or other suitable means to delineate no go areas. Undertake this delineation and marking process in a manner that is consistent with the Project flagging/marking tape process and specifications, to ensure that it is consistent with the wider Project control processes and does not conflict or contradict any other demarcation practices.

Delivery phase	Environmental value impacted	Mitigation and management measures
		Staged and sequential clearing where feasible to minimise the extent of exposed areas. Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species[1]. A qualified Fauna Spotter Catcher will undertake pre-clearance surveys of habitats and vegetation, including where applicable fauna reduction activities. The Fauna Spotter Catcher will supervise the subsequent clearing. The area and type of vegetation cleared will be documented where required for compliance with secondary approvals and offset purposes[1,2,3]. Implement the post-construction MNES Monitoring Plan. Continue monitoring each nominated MNES against initial assessment values, until completion criteria are achieved. Corrective actions to be implemented where Project-associated impacts are identified. Implement Air Quality Sub-plan to minimise dust impacts including dust monitoring and suppression methods.
	Riparian vegetation and aquatic habitats	Locate construction areas including compounds, stockpiles, fuel storage, laydown areas, temporary and permanent access roads within the disturbance footprint. Undertake a flood/drainage assessment to inform the siting and scale of temporary construction areas (including stockpiles, construction compounds, fuel storage and laydown areas etc). Locate these areas on land that is not subject to flooding to the extent possible. Siting of plant and equipment and refuelling facilities to be undertaken in accordance with *AS1940:2017 The storage and handling of flammable and combustible liquids*. Implement the site-specific ESCPs. Works within or adjacent to watercourses will be conducted in accordance with relevant secondary approvals including: ▪ *Riverine protection permit exemption requirements* (WSS/2013/726) or conditions of a riverine protection permit issued for the Project ▪ *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works. Dewatering/extraction of water from artificial impoundments will be undertaken after consultation with relevant stakeholders. Dewatering strategies will be required to comply with the *Biosecurity Act 2014* (Qld) to take reasonable measures to avoid the spread of pest species (with capacity to affect water quality) and in accordance with any required aquatic fauna species management plans. The salvage and relocation of fish within isolated aquatic environments will be managed in accordance with DAF Guidelines for Fish Salvage. 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 required. 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 undertaken[1].
	Fauna passage	Prioritise bridge structures/culverts construction where practical and feasible, particularly in the three key locations identified as part of the EIS assessment process to maintain and/or re-establish habitat connectivity as soon as possible and minimise the disruption to waterways. Stage the implementation of the Reinstatement and Rehabilitation Plan in locations associated with fauna passage structures.

Delivery phase	Environmental value impacted	Mitigation and management measures
	Flora	Minimise clearance of remnant vegetation to that necessary for safe and efficient construction and operation[1,2,3]. Where practicable and feasible, locate construction areas including compounds, stockpiles, fuel storage, laydown areas, staff parking outside the tree protection zone as defined in *AS4970-2009 Protection of trees on development sites*. Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species. Implement a Soil Management Plan as part of the CEMP, guiding the stripping, stockpiling and management of topsoil where it has the potential to contain seedbank or weed material. Topsoil stockpiles will be managed to maintain the viability of soil seed banks for threatened flora Plan and implement revegetation and rehabilitation works so that they do not create safety, maintenance or performance issues e.g. vegetation does not grow and obscure signals or impact longevity of rail infrastructure.
	Aquatic fauna	Construct temporary and permanent watercourse crossing structures in accordance with the detailed design and *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier. This is required to minimise impacts to aquatic fauna (i.e. fish passage) and hydrology during construction and operation.
	Fauna fencing	Install fauna exclusion fencing in accordance with detailed design and fencing hierarchy especially in conjunction with the identified fauna passages/creek crossing locations for the Project to maintain permeability in the alignment[1,2].
	Weeds and pests	Implement the Biosecurity Management Sub-plan during construction to reduce the potential for the spread of weeds and pests into the surrounding environments and land uses. 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] Implement the Community Engagement Sub-plan in the CEMP, to enable members of the public to assist with weed surveillance in the vicinity of Project works.
	Landscape, rehabilitation and stabilisation	Construct landscaping treatments in accordance with the landscape design. Implement the Soil Management Plan to protect MNES species (e.g. soil seedbanks and habitat). Undertake progressive rehabilitation and reinstatement of disturbed areas in accordance with the Reinstatement and Rehabilitation Plan and the Landscape and Rehabilitation Management Plan to minimise threatening process to MNES such as weed invasion.
	Erosion and sediment control	Vegetation clearing and ground disturbing activities will be supplemented by the progressive installation of erosion and sediment controls including stabilisation works to minimise areas exposed to erosion and sediment risk. Implement site stabilisation treatments in accordance with: ▪ ESCP ▪ Air Quality Sub-plan ▪ Reinstatement and Rehabilitation Plan.

Delivery phase	Environmental value impacted	Mitigation and management measures
		Assess the suitability of cleared vegetation for mulching/erosion protection on a case by case basis. Any vegetated material containing or with the potential to contain weed seed material will not be used for on-site mulching or erosion protection without prior treatment. For any unsuitable material i.e. noxious weeds etc, the cleared and grubbed material shall be removed from the site and disposed of in accordance with relevant statutory requirements and the Biosecurity Management Sub-plan. Re-use suitable mulch generated by construction of the Project within appropriate timeframes and manner as specified in the ESCP and the Reinstatement and Rehabilitation Plan.
Operation	Riparian vegetation and aquatic habitats	▪ Undertake maintenance activities and refuelling facilities in accordance with *AS1940:2017 The storage and handling of flammable and combustible liquids*. ▪ Where maintenance activities within or adjacent to watercourses are required these will be undertaken in accordance with: – *Riverine protection permit exemption requirements* (WSS/2013/726) or conditions of a riverine protection permit issued for the works – *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (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 Qld *Biosecurity Act 2014, ARTC operation and maintenance procedures and policies* 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. ARTC's Enviroline will be advertised for the Project to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.
	Fauna passage	Cross drainage structures (including culverts and bridges) will be inspected to assess physical condition and performance, structural integrity and corrective measures in accordance with ARTC's *Structures Inspection Engineering Code of Practice* (ETE-09-01) [1,2]. Inspection of cross drainage structures will ensure fish passage/flow hydrology is being maintained where applicable (i.e. watercourses) Fauna passages will be maintained and where applicable monitored during the operational life of the Project (design life of 100-years)

Delivery phase	Environmental value impacted	Mitigation and management measures
	Fauna fencing	Inspect and maintain fauna fencing in accordance with ARTC *Engineering (Track and Civil) Code of Practice – Section 17 Right of Way: Inspection and Assessment*[1,2]. Fauna fencing will be maintained and where applicable monitored during the operational life of the Project (design life of 100-years). Record vehicle strikes with Koalas and Greater gliders and investigate potential source of the issue Where applicable implement corrective measures (e.g. erect fauna friendly fencing, glider poles etc)

Table notes:

1 Mitigation measure successfully implemented as part of the Toowoomba Second Range Crossing Project.

2 Mitigation measure approved by the Commonwealth as part of the rail component for the Carmichael Coal Mine and Rail Project (EPBC 2013/6885) (refer measures within *Species Management Plans. Carmichael Rail Project* (CRN 2019)).

3 Mitigation measure commonly applied across other projects as approved by the Commonwealth in central and southern Queensland e.g. *Santos Significant Species Management Plan – GFD Project* (Santos 2016), *Anya Significant Species Management Plans* (Shell 2017), *Species Management Plans - Carmichael Rail Project* (CRN 2019).

5.3 Significant impact assessment

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

Potential impacts to environmental values due to construction of the Project are summarised in Section 5.3.2 and are assessed in Sections 5.3.3, 5.3.4 and 5.3.5. For the purposes of impact assessment, the maximum potential direct disturbance to each MNES (i.e. areas identified using the predictive habitat mapping) have been used. This mapping assumes the presence of species if habitat has been identified as being present (i.e. habitat has been used as a proxy for species presence). This represents an application of the precautionary approach and represents a highly conservative estimate of Project impacts. Given the highly conservative approach adopted, impacts identified represent the maximum potential impact and assume a “worst-case” scenario in relation to the Project’s disturbance. The clearing extents identified during this assessment will be reduced during the Project stages following the primary approval phase.

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 5.3. This has been split into consideration of the construction phase, the commissioning and reinstatement phase, and operations. Environmental offsets in response to significant residual impacts are discussed in Section 5.4.

5.3.1 Quantification of potential magnitude of direct impacts

Estimations of the potential magnitude of disturbance (i.e. clearing as a result of the Project) was undertaken for each MNES, using the total quantity of habitat as identified in Table 5.4. (i.e. combines the habitat categories to identify the maximum potential habitat loss). Note that the different habitat categories were considered in relation to the MNES significant impact criteria as described in Section 3.2.5.

The table also provides an estimate of the total extent of habitat within the MNES study area for each MNES and the percentage of this habitat being disturbed as a result of the Project.

Table 5.4 Estimation of potential magnitude of disturbance for each of the matters of national environmental significance identified for the Project

Receptor	Total coverage of ecological receptor within the MNES study area (ha). Study area size = 11,866.54 ha[1]	Total unmitigated potential disturbance area associated with the Project (ha). disturbance area size = 634.56 ha[1]	Percentage (%) disturbance to receptors within the MNES study area based on the unmitigated potential disturbance	Magnitude of disturbance area (refer Table 3.6 for magnitude criteria)
Threatened ecological communities (EPBC Act)				
Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC	5.77	0.00	0.00	Negligible
Brigalow (*Acacia harpophylla* dominant and codominant)	4.53	0.00	0.00	Negligible
Threatened flora habitat * (EPBC Act):				
Hairy-joint grass (*Arthraxon hispidus*)	1.16	0.00	0.00	Negligible
Four-tailed grevillea (*Grevillea quadricauda*)	476.49	26.06	5.47	Moderate
Blunt-leaved leionema (*Leionema obtusifolium*)	888.11	29.26	3.29	Moderate
Lloyd's olive (*Notelaea lloydii*)	2,593.56	134.03	5.17	Moderate
Paspalidium grandispiculatum (a grass)	2,359.56	84.58	3.75	Moderate
Brush sophora (*Sophora fraseri*)	414.52	39.98	9.64	Moderate

Receptor	Total coverage of ecological receptor within the MNES study area (ha). Study area size = 11,866.54 ha[1]	Total unmitigated potential disturbance area associated with the Project (ha). disturbance area size = 634.56 ha[1]	Percentage (%) disturbance to receptors within the MNES study area based on the unmitigated potential disturbance	Magnitude of disturbance area (refer Table 3.6 for magnitude criteria)
Austral toadflax (*Thesium australe*)	653.22	94.77	14.51	High
Threatened fauna habitat * (EPBC Act):				
Birds				
Regent honeyeater (*Anthocharea phrygia*)	2,259.21	84.58	3.74	Moderate
Australasian bittern (*Botaurus poiciloptilus*)	446.51	15.43	3.46	Moderate
Curlew sandpiper (*Calidris ferruginea*)	818.13	15.43	1.89	Negligible
Red goshawk (*Erythrotriorchis radiatus*)	2,426.17	88.82	3.66	Moderate
Grey falcon (*Falco hypoleucos*)	6,425.19	351.97	5.48	Moderate
Painted honeyeater (*Grantiella picta*)	683.72	13.34	1.95	Low
Swift parrot (*Lathamus discolor*)	2,773.66	98.67	3.56	Moderate
Australian painted snipe (*Rostratula australis*)	790.96	33.38	4.22	Moderate
Black-breasted button-quail (*Turnix melanogaster*)	0.09	0.00	0.00	Negligible
Mammals				
Spotted-tail quoll (*Dasyurus maculatus maculatus*)	2,126.47	77.07	3.62	Moderate
Greater glider (*Petauroides volans volans*)	1,527.84	30.64	2.01	Moderate
Brush-tailed rock-wallaby (*Petrogale penicillata)*	297.73	41.25	13.85	High
Koala (*Phascolarctos cinereus*)	6,467.86	303.95	4.70	Moderate
Long-nosed potoroo (*Potorous tridactylus tridactylus*)	2,253.93	84.58	3.75	Moderate
New Holland mouse (*Pseudomys novaehollandiae*)	2,401.31	88.12	3.67	Moderate
Grey-headed flying-fox (*Pteropus poliocephalus*)	2,812.21	99.46	3.54	Moderate
Reptiles				
Collared delma (*Delma torquata*)	2,326.15	85.33	3.67	Moderate
Fish				
Australian lungfish (*Neoceratodus forsteri*)	462.87	2.24	0.46	Negligible

Table note:

* There is potential for each of the 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 disturbance footprint.

5.3.2 Initial assessment of impacts and mitigation measures

Following the assessment of the sensitivity of MNES values, identification of the potential impacts to these values and the assessment of the magnitude of impact, an initial outline of the assessment of the impact of the Project on each MNES value was undertaken.

The magnitude of impacts presented in Table 5.4, takes into consideration direct impacts associated with the direct removal of habitat and also considers indirect impacts associated with air quality (refer EIS Chapter 12: Air Quality), surface water and hydrology (refer EIS Chapter 13: Surface Water and Hydrology), groundwater (refer EIS Chapter 14: Groundwater) and noise and vibration (refer EIS Chapter 15: Noise and Vibration). The initial assessment of potential impacts from the Project on MNES values is provided in the following section for TECs (refer Table 5.5), threatened flora (refer Table 5.6) and threatened fauna (refer Table 5.7). The assessments present an initial assessment significance of those impacts detailed in Section 5.1.2 considered appropriate to the MNES species or species groups assessed (i.e. application of mitigation measures already incorporated into the design), an outline of the mitigation measures detailed in Table 5.3 which are most appropriate to the species or species groups (further species-specific information is added where required), and an assessment of the reduction of impact following the application of Project's mitigation measures. The assessment provides a more targeted focus on those Project impacts most likely to affect individual MNES.

The initial assessment of impacts has taken a conservative approach and those MNES that returned an impact rating of Major, High, Moderate or Low are assessed using MNES Guidelines (refer Sections 5.3.3, 5.3.4 and 5.3.5).

Table 5.5 Initial impact assessment of the Project upon identified matters of national environmental significance – threatened ecological communities

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
TECs	**Swamp Tea tree (*Melaleuca irbyana*) Forest of Southeast Queensland and Brigalow (*Acacia harpophylla* dominant and codominant)**						
High	Pre-construction and construction	Displacement of flora and fauna species from invasion of weed and pest species Dust impacts Erosion and sedimentation	Low	**Moderate**	The nearest mapped instance of the Swamp tea-tree TEC to the Project is over 500 m from the Project disturbance footprint. The nearest mapped instance of Brigalow TEC is 30 m from the Project disturbance footprint. Neither community has been confirmed as present. These areas will be marked as a no-go zone on relevant design and construction plans, and were applicable barrier fencing or signage installed. ▪ Flora (detailed design, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) Flora and Fauna Sub-plan developed and in place prior to construction. Pre-construction surveys will be carried out to confirm whether TECs occur in the immediate vicinity (within 50 m) of the Project disturbance footprint where mapped occurrences currently occur. Where TECs are found to occur condition assessment will be carried (using Biocondition assessment) with regular monitoring against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified. Soil Management Sub-plan developed and in place prior to construction. To include soil conservation measures and erosion and sediment controls with specific reference/controls to identified TEC areas Biosecurity Management Plan developed and in place prior to construction. To include at a minimum ▪ Pre-construction weed assessment in TEC areas intersected or directly adjacent to Project disturbance footprint ▪ Construction vehicle weed certification and wash down procedures in place	Negligible	**Low** (refer to Section 5.3.3 for assessment against MNES Impact guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					▪ Weed monitoring within TEC in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified ▪ Control protocols will be designed so as to reduce the risk of herbicides/chemicals entering the TEC Project Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods		
	Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation	Low	**Moderate**	▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) Soil Management Sub-plan – continued maintenance of erosion and sediment controls with specific reference/controls to identified TEC areas Biosecurity Management Plan ongoing: ▪ Construction vehicle weed certification and wash down procedures in place ▪ Continued weed monitoring within TEC in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified In accordance with the MNES Monitoring Plan, regular monitoring and maintenance of erosion and sediment devices/infrastructure with specific reference/controls to identified TEC areas. Landscape, rehabilitation and stabilisation – rehabilitation of temporary construction areas	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation	Negligible	**Low**	Soil Management Sub-plan – ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure with specific reference/controls to identified TEC areas Biosecurity Management Plan ongoing: ▪ Ongoing weed monitoring within TEC in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified In accordance with the MNES Monitoring Plan, regular monitoring and maintenance of erosion and sediment devices/infrastructure with specific reference/controls to identified TEC areas.	Negligible	**Low**

Table notes:

1 Refer Table 3.8 for 'sensitivity' and 'magnitude' criteria.

2 Potential impacts to MNES in the above table are based upon those presented in Section 5.1.

3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for information relating to the use of offsets to compensate Project related impacts that are not sufficiently reduced in the above table.

Table 5.6 Initial impact assessment of the Project upon identified matters of national environmental significance – threatened flora

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
Four tailed grevillea (*Grevillea quadricauda*), Lloyd's olive (*Notelaea lloydii*), *Paspalidium grandispiculatum* (a grass), Blunt leaved leionema (*Leionema obtusifolium*) and Austral toadflax (*Thesium australe*)							
High	Construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation	High	**Major**	▪ MNES (detailed design), flora and fauna (pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) **Species-specific** Flora and Fauna Sub-plan developed and in place prior to construction. Pre-construction protected flora surveys as per DES guidelines (2020c) throughout identified habitat (refer species habitat mapping in Appendix F) within alignment to identify whether protected species occur. Focus on the following: ▪ Lloyd's olive which has been recorded during project surveys within Project disturbance footprint near Laidley and suitable habitat identified within Little Liverpool Range ▪ Suitable habitat in Helidon area for Four-tailed grevillea and *Paspalidium grandispiculatum* This includes assessing the condition and health of any identified population prior to construction and monitoring the population during construction to determine if any changes to the population occur as a result of the Project or due to natural attrition. Potential criteria may include recruitment and presence of fertile material, plus signs of water stress.	Moderate	**High** (refer to Section 5.3.3 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Where a threatened flora species is found to occur - pre-construction condition assessment of species habitat in vicinity of Project disturbance footprint (using Biocondition assessment) with regular monitoring against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified Where a threatened species population is detected and impacts from the Project are likely, specific measures will be developed in consultation with relevant specialists, the project team and the construction team. Vegetation clearing to include at a minimum: ▪ All vegetation outside of construction footprint will be appropriately marked as a No-Go Zone to site workers ▪ Vegetation clearance will be approved and carried out under ecological supervision ▪ All workers will be briefed on the importance of threatened flora species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them Soil Management Sub-plan developed and in place prior to construction. 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) Biosecurity Management Plan developed and in place prior to construction. To include at a minimum ▪ Pre-construction weed assessment of threatened flora species habitat (where found to occur) in areas adjacent to construction footprint ▪ Construction vehicle weed certification and wash down procedures in place ▪ Weed monitoring within threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Develop Air Quality Sub-plan (refer EIS Chapter 12: Air quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods.		
	Commissioning and reinstatement	Displacement of flora species from invasion of weed species Edge effects Erosion and sedimentation	Negligible	**Low**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) In accordance with the MNES Monitoring Plan, undertake regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas. Biosecurity Management Plan ongoing: ▪ Construction vehicle weed certification and wash down procedures in place ▪ Weed monitoring within identified threatened species habitat in accordance with the MNES Monitoring Plan, with required control protocols in place where weed invasion is identified. Where previously identified continued threatened flora habitat monitoring against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas Soil Management Sub-plan – continued maintenance of erosion and sediment controls with specific reference/controls to identified threatened flora habitat areas	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation	Negligible	**Low**	Soil Management Plan – ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas Biosecurity Management Plan ongoing: ▪ Ongoing annual weed monitoring within identified threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified Ongoing monitoring of any identified threatened species population in accordance with the MNES Monitoring Plan. Corrective actions to be implemented where Project-associated impacts are identified.	Negligible	**Low**
Hairy joint grass (*Arthraxon hispidus*) and Brush sophora (*Sophora fraseri*)							
High	Construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation	Low	**Moderate**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species specific** Pre-construction protected flora surveys as per DES guidelines (2020c) targeting potential habitat within and adjacent the Project disturbance footprint (refer species habitat mapping in Appendix F). Where a species is detected, specific measures will be developed in consultation with relevant specialists, the project team and the construction team (e.g. micro-siting to avoid population or minimise impacts, ensuring ancillary works avoid these areas, collection of seed and other fertile material).	Negligible	**Low** (refer to Section 5.3.3 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Vegetation clearing to include at a minimum: ▪ All vegetation outside of construction footprint will be appropriately marked as a 'No-Go' Zone to site workers ▪ Vegetation clearance will be approved and carried out under ecological supervision ▪ All workers will be briefed on the importance of threatened flora species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them Soil Management Sub-plan developed and in place prior to construction. 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) Biosecurity Management Plan developed and in place prior to construction. To include at a minimum ▪ Pre-construction weed assessment of threatened flora species habitat (where found to occur) in areas adjacent to construction footprint ▪ Construction vehicle weed certification and wash down procedures in place ▪ Weed monitoring within threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified Develop Air Quality Sub-plan (refer EIS Chapter 12: Air quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods.		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Commissioning and reinstatement	Displacement of flora species from invasion of weed species Edge effects Erosion and sedimentation	Negligible	**Low**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) In accordance with the MNES monitoring plan, undertake regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas. Biosecurity Management Plan ongoing: ▪ Construction vehicle weed certification and wash down procedures in place ▪ Continued weed monitoring within threatened flora habitat in vicinity of Project disturbance footprint in accordance with the MNES monitoring plan with required control protocols in place where weed invasion is identified. Where previously identified annual threatened flora habitat monitoring against initial assessment values in accordance with the MNES monitoring plan. Corrective actions to be implemented where Project-associated impacts are identified. Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas Soil Management Sub-plan – continued maintenance of erosion and sediment controls with specific reference/controls to identified threatened flora habitat areas	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation	Negligible	**Low**	Soil Management Plan – ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas Biosecurity Management Plan ongoing: ▪ Ongoing annual weed monitoring within identified threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified	Negligible	**Low**

Table notes:

1 Refer Table 3.8 for 'sensitivity' and 'magnitude' criteria.
2 Potential impacts to MNES in the above table are based upon those presented in Section 5.1.
3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for information relating to the use of offsets to compensate Project related impacts that are not sufficiently reduced in the above table.

Table 5.7 Initial impact assessment of the Project upon identified matters of national environmental significance – threatened fauna

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	**Significance**		**Magnitude**	**Significance**
Australian lungfish							
High	Pre-construction and construction	Habitat loss from temporary waterway impoundment Displacement of fauna species from invasion of weed and pest species Barrier effects Dust impacts Aquatic habitat degradation Erosion and sedimentation	High	**Major**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▪ Aquatic fauna (detailed design, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) **Species-specific:** Pre-construction surveys of waterways identified as potential habitat of species (e.g. Lockyer Creek) to identify whether Australian lungfish occurs. Surveys will follow the *Survey guidelines for Australia's threatened fish* (DSEWPaC 2011b). Avoid clearing within and along major watercourses, in particular Lockyer Creek and Laidley Creek, through the use of bridge structures and the placement of pylons away from bed and banks. Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, an appropriately qualified person will be consulted to make an assessment on the method of recovery, transport and release of fish and will follow relevant State (DAF) fish salvage guidelines during construction activities. Dewatering and fish salvage activities to include measures to manage the risk of translocating non-endemic flora and fauna (i.e. Biosecurity Management Sub-Plan)	Moderate	**High** (refer to Table 5.26 for assessment against MNES Impact guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Maintain low flows during drought conditions and avoid fluctuations to water levels downstream during spawning period (i.e. Lockyer Creek) Project CEMP Biosecurity Management Plan developed and in place prior to construction. To include at a minimum ▪ Pre-construction aquatic and riparian weed and pest fish assessment of waterways identified as potential habitat of species ▪ Construction vehicle weed certification and wash down procedures in place ▪ Weed monitoring within identified waterways in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified Develop Air Quality Sub-plan (refer EIS Chapter 12: Air quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods. Through final Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Surface Water Management Sub-plan developed and in place prior to construction. To include at a minimum: ▪ Watercourse-specific water quality criteria based on baseline data ▪ A surface water quality sampling monitoring detailing water quality parameters and schedule ▪ Response framework where water quality impacts identified from Project activities Project Soil Management Plan developed and in place prior to construction. To include soil conservation measures and erosion and sediment controls with specific reference/controls to all waterways		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Aquatic habitat degradation Erosion and sedimentation	Low	**Moderate**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Aquatic fauna (detailed design, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) Where possible, instream habitat will be reinstated to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and allow fish passage). Biosecurity Management Plan ongoing: ▪ Construction vehicle weed certification and wash down procedures in place ▪ Continued aquatic weed monitoring within waterways with required control protocols in place where weed invasion is identified Soil Management Plan – continued maintenance of erosion and sediment controls associated with all waterways Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas including instream and riparian habitat features. Surface Water Management Sub-plan monitoring and evaluation ongoing.	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Erosion and sedimentation	Negligible	**Low**	▪ Weeds and pests (operation) ▪ Fauna passage (operation) including ongoing maintenance of fish passage structures ▪ Riparian vegetation and aquatic habitats (operation) ▪ Soil Management Plan – ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure associated with all waterways.	Negligible	**Low**
Wetland birds: Australian painted snipe, Australasian bittern and Curlew sandpiper							
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation	Moderate	**High**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▪ Aquatic fauna (detailed design, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species specific** Flora and Fauna Sub-plan developed and in place prior to construction. Will detail pre-construction surveys of wetlands identified as potential habitat of species to identify whether habitat and/or any of these species occurs. Surveys will follow the *Survey guidelines for Australia's threatened birds* (DEWHA 2010a). Clearing/construction works in potential habitat areas will be timed where possible to avoid wet conditions where habitat is likely to be most suitable.	Low	**Moderate** (refer to Section 5.3.5.1 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Should the species be found to occur Plan to include the following for further pre-clearance activities: ▪ Engagement of a qualified fauna spotter/ecologist for further pre-clearance surveys and measures to ensure safe movement of species away from works area should the species still be found to occur ▪ Restricted works/avoidance measures in place should nesting of Australian painted snipe or Australasian bittern be detected Measures to minimise habitat loss during vegetation clearing to include at a minimum: ▪ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers ▪ Vegetation clearance will be approved and carried out under ecological supervision ▪ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them Project CEMP Biosecurity Management Plan developed and in place prior to construction. To include at a minimum: ▪ Pre-construction wetland and riparian weed assessment of wetlands identified as potential habitat of species ▪ Construction vehicle weed certification and wash down procedures in place ▪ Weed monitoring within identified wetlands in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified ▪ Measures to ensure pest predator fauna are not attracted to works areas or utilising Project disturbance footprint for shelter		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Project CEMP to include measures to minimise noise as much as feasible and Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods Project design to incorporate minimum lighting requirements feasible for Project safety Through final Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact *potential habitat* for the species. Surface Water Management Sub-plan developed and in place prior to construction. To include at a minimum: ▪ Wetland and watercourse-specific water quality criteria based on baseline data ▪ A surface water quality sampling monitoring detailing water quality parameters and schedule ▪ Response framework where water quality impacts identified from Project activities Project Soil Management Plan developed and in place prior to construction. To include soil conservation measures and erosion and sediment controls with specific reference/controls to all waterways and wetland habitat		
High	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation	Low	**Moderate**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▪ Aquatic fauna (detailed design, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning)	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					In accordance with the MNES Monitoring Plan, undertake regular monitoring and maintenance of erosion and sediment devices/infrastructure associated with all waterways. Biosecurity Management Plan ongoing: ▪ Construction vehicle weed certification and wash down procedures in place ▪ Ongoing annual weed monitoring within wetland habitat in vicinity in accordance with the MNES Monitoring Plan, with required control protocols in place where weed invasion is identified ▪ Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter Noise and Air Quality Management Sub-plan measures ongoing Project design to incorporate minimum lighting requirements feasible for Project safety Soil Management Plan – continued maintenance of erosion and sediment controls associated with all waterways and wetland habitats Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas including riparian habitat Surface Water Management Sub-plan monitoring and evaluation ongoing		
	Operation	Displacement of fauna species from invasion of weed and pest species Light impacts Erosion and sedimentation	Negligible	**Low**	Biosecurity Management Plan ongoing: ▪ Ongoing annual weed monitoring within wetland habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified Project design to incorporate minimum lighting requirements feasible for Project safety Soil Management Plan – ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure associated with all waterways	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
Koala and Greater glider							
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	High	**Major**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) **Species-specific:** Flora and Fauna Sub-plan developed and in place prior to construction. Will detail pre-construction surveys of woodlands identified as potential habitat of species to identify whether individuals occur within Project disturbance footprint. Plan to include at a minimum: ▪ Engagement of a qualified fauna spotter/ecologist for pre-construction Koala/Greater glider surveys and tree hollow inspections ▪ Measures to ensure safe retrieval of tree hollows during vegetation clearing and allow safe movement of species away from works area ▪ Restricted works measures in place should Koala be observed within Project disturbance footprint to allow safe movement safe away from works area ▪ Vegetation clearing within the Project disturbance footprint in Koala habitat will be carried out in a manner to minimise stress on potential individuals as much as is practicably possible (e.g. sequential clearing and minimising time of disturbance to animals) ▪ Measures to allow safe handling of fauna (where required) and repatriation in suitable habitat away from site ▪ Measures to responsibly handle injured fauna	Moderate	**High** (refer to Section 5.3.5 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					▪ Koalas subject to handling will be examined and if suspected of Chlamydia infection will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release ▪ Measures to control vehicle speed limits onsite to no more than 40 km/hr ▪ Fauna management and incident register Measures to minimise habitat loss during vegetation clearing to include at a minimum: ▪ All vegetation outside of construction footprint will be appropriately marked as a No-Go Zone to site workers ▪ Vegetation clearance will be approved and carried out under ecological supervision ▪ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them Project Biosecurity Management Plan developed prior to construction. Weed species are not considered to be more than a minor impact on these species. The MNES study area is already subject to significant weed invasion. The Plan will consider relevant guidelines to control potential deleterious pathogens including *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities both of which may impact eucalypt species. General measures to include: ▪ Pre-construction weed assessment of potential habitat of species ▪ Construction vehicle weed certification and wash down procedures in place ▪ Contractor education on the requirements for site access regarding identified habitat (including procedures regarding		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					▪ Weed monitoring within in immediate vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified ▪ Measures to ensure pest predator fauna are not attracted to works areas or utilising Project area for shelter. Project design to incorporate fauna crossing structures to allow fauna movement across alignment. The location and frequency of the passages will be based on an understanding of local Koala and Greater glider movements and in consultation with relevant stakeholders (e.g. DTMR and local councils). Fauna fencing in accordance with ARTC guidelines and DTMR's Fauna Sensitive Road Design Manual (DTMR 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Also, where possible, avoid the use of barb wire particularly on the top strand, to prevent threatened species (particularly Greater glider, flying-foxes and microbats) from becoming entangled. Fauna friendly fencing must be used, whilst being in accordance with landowner and/or structural requirements. Viaducts and the bridge structures will assist in the retention of corridor(s) of at least 100 m width. While the tunnel will ensure a corridor 850 wide is maintained through the Little Liverpool Range. Project CEMP to include measures to minimise noise as much as feasible and Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods Project design to incorporate minimum lighting requirements feasible for Project safety		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Low	**Moderate**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) Flora and Fauna Sub-plan activities ongoing: ▪ Measures to control vehicle speed limits onsite to no more than 40 km/hr ▪ Fauna management and incident register. Biosecurity Management Plan ongoing: ▪ Construction vehicle weed certification and wash down procedures in place ▪ Contractor education on the requirements for site access regarding identified habitat (including procedures regarding clean clothing/footwear) ▪ Continued weed monitoring with required control protocols in place where weed invasion is identified ▪ Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter. Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out for at least two consecutive years within two years of Project completion. Noise and Air Quality Management Sub-plan measures ongoing. Project design to incorporate minimum lighting requirements feasible for Project safety.	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas where woodland habitat has been cleared. Aligned with Biosecurity Management Plan revegetation plant species will be obtained from a reliable source that is certified free of pathogens.		
	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Negligible	**Low**	▪ Fauna fencing (operation) ▪ Fauna passage (operation) ▪ Weeds and pests (operation) Flora and Fauna Sub-plan activities ongoing: ▪ Fauna management and incident register including observed collisions associated with rail operations ▪ Information on collisions used to inform potential for further measures to be applied to minimise/eliminate incidents. Biosecurity Management Plan ongoing: ▪ Continued annual weed monitoring with required control protocols in place where weed invasion is identified ▪ Continued opportunistic monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter. Fauna fencing (operation) including ongoing maintenance of fauna passages and fencing during the operational life of the Project (i.e. 100 years) Project design to incorporate minimum lighting requirements feasible for Project safety	Negligible	**Low**
New Holland mouse							
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality	Moderate	**High**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning)	Low	**Moderate** (refer to Section 5.3.5.3 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
		Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts			▪ Fauna passage (detailed design, construction and commissioning) **Species specific** Within the Project disturbance footprint the Helidon Hills area may provide habitat and the species has been recorded nearby. Pre-construction survey of species-specific habitat (refer species habitat mapping in Appendix F) and habitat features considered suitable for species presence (e.g. well-developed ground/shrub layer). Targeted surveys as per relevant QLD guidelines (Eyre et al 2018) where suitable habitat is identified (noted New Holland mouse is not included in MNES guidelines). Flora and Fauna Sub-plan to include the following construction measures for pre-clearance surveys at a minimum: ▪ Engagement of a qualified fauna spotter/ecologist for pre-clearance surveys ▪ Restricted works measures in place should species be located during site inspections ▪ Measures to allow safe handling of fauna (where required) and repatriation in suitable habitat away from site ▪ Measures to responsibly handle injured fauna ▪ Measures to control vehicle speed limits onsite to no more than 40 km/hr ▪ Fauna management and incident register Measures to minimise habitat loss during vegetation clearing to include at a minimum: ▪ All vegetation outside of construction footprint will be appropriately marked as a No-Go Zone to site workers ▪ Vegetation clearance will be approved and carried out under ecological supervision		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					■ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them Weed species are not considered a to be more than a minor impact on this species. The MNES study area is already subject to significant weed invasion including *Lantana* species. Habitat degradation via *Phytophthora cinnamomi* is thought to be a potential threat. Project CEMP Biosecurity Management Plan developed and in place prior to construction. General measures to include: ■ Pre-construction weed and *Phytophthora cinnamomi* assessment of potential habitat of species ■ Construction vehicle weed certification and wash down procedures in place ■ Contractor education on the requirements for site access regarding identified habitat (including procedures regarding clean clothing/footwear) ■ Weed monitoring within immediate vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified ■ Measures to ensure pest predator fauna are not attracted to works areas or utilising Project disturbance footprint for shelter Project design to incorporate fauna crossing structures to allow fauna movement across alignment. Fauna passage and fauna-proof fencing design will be used to guide fauna to crossing structures. Fauna crossings will be consistent with the intent of DTMR's Fauna Sensitive Road Design Manual (DTMR 2010) and where applicable species-specific requirements. Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Project CEMP to include measures to minimise noise as much as feasible and Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Project design to incorporate minimum lighting requirements feasible for Project safety		
	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Low	Moderate	■ Flora and fauna (detailed design, pre-construction, construction and commissioning) ■ Weeds and pests (pre-construction, construction and commissioning) ■ Fauna passage (detailed design, construction and commissioning) ■ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) Flora and Fauna Sub-plan activities ongoing: ■ Measures to control vehicle speed limits onsite to no more than 40 km/hr ■ Fauna management and incident register Biosecurity Management Plan ongoing: ■ Construction vehicle weed certification and wash down procedures in place ■ Continued weed and *Phytophthora cinnamomi* monitoring and with required control protocols in place where weed invasion is identified ■ Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out in accordance with the post-construction MNES Monitoring Plan. Noise and Air Quality Management Sub-plan measures ongoing Project design to incorporate minimum lighting requirements feasible for Project safety Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas where woodland habitat has been cleared. Revegetation species to be obtained from source certified free of *Phytophthora cinnamomi.*	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Low	**Moderate**	▪ Fauna passage (detailed design, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) Flora and Fauna Sub-plan activities ongoing: ▪ Fauna management and incident register including observed collisions associated with rail operations Biosecurity Management Plan ongoing: ▪ Continued weed and *Phytophthora cinnamomi* monitoring and with required control protocols in place where weed invasion is identified ▪ Continued opportunistic monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out for at least two consecutive years within two years of Project completion Project design to incorporate minimum lighting requirements feasible for Project safety	Negligible	**Low**
Spotted tail quoll, Brush tailed rock wallaby and Collare							
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors	High	**Major**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) **Species-specific:** Within the Project disturbance footprint the Helidon Hills may provide habitat for these species. Little Liverpool Range also provides potential habitat for Collared delma.	Moderate	**High** (refer to Section 5.3.5.3 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
		Habitat fragmentation Barrier effects Noise, dust, and light impacts			Targeted surveys for identified mammal species will follow the *Survey guidelines for Australia's threatened mammals* (DSEWPaC 2011a) and include the identification of species-specific habitat (refer species habitat mapping in Appendix F) and habitat features considered suitable for species presence (e.g. cliff faces/boulder piles for Brush-tailed rock-wallaby and Spotted-tail quoll). Targeted surveys for Collared delma as per *Survey guidelines for Australia's threatened reptiles* (DSEWPaC 2011c) where suitable habitat is identified refer species habitat mapping in Appendix F). Flora and Fauna Sub-plan to include the following construction measures at a minimum: ▪ Engagement of a qualified fauna spotter/ecologist for pre-construction surveys ▪ Measures to ensure retrieval of potential habitat elements (loose surface rock, large fallen timber) during vegetation clearing and placement in adjacent unimpacted habitat ▪ Restricted works measures in place should larger species (Spotted-tail quoll and Brush-tailed rock-wallaby) be observed within or adjacent to Project disturbance footprint to allow safe movement safe away from works area ▪ Measures to allow safe handling of fauna (where required) and repatriation in suitable habitat away from site. Species-appropriate alternative habitat sites will be located as close as feasible to the disturbance area and determined prior to any repatriation activity. ▪ Measures to responsibly handle injured fauna ▪ Measures to control vehicle speed limits onsite to no more than 40 km/hr ▪ Fauna management and incident register Measures to minimise habitat loss during vegetation clearing to include at a minimum: ▪ All vegetation outside of construction footprint will be appropriately marked as a No-Go Zone to site workers		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					■ Vegetation clearance will be approved and carried out under ecological supervision ■ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them Weeds species are not considered to be more than a minor impact on these species excepting Brush-tailed rock-wallaby (particularly *Lantana camara*). The MNES study area is already subject to significant weed invasion including *Lantana* species. Project CEMP Biosecurity Management Plan developed and in place prior to construction. General measures to include: ■ Pre-construction weed assessment of potential habitat of species ■ Construction vehicle weed certification and wash down procedures in place ■ Weed monitoring within immediate vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified ■ Measures to ensure pest predator fauna are not attracted to works areas or utilising Project disturbance footprint for shelter Project design to incorporate fauna crossing structures to allow fauna movement across alignment. Fauna passage and fauna fencing design will be used to guide fauna to crossing structures. Fauna crossings will be consistent with the intent of DTMR's Fauna Sensitive Road Design Manual (DTMR 2010) and where applicable species-specific requirements. Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Project CEMP to include measures to minimise noise as much as feasible and Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Project design to incorporate minimum lighting requirements feasible for Project safety		
	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Low	**Moderate**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) Flora and Fauna Sub-plan activities ongoing: ▪ Measures to control vehicle speed limits onsite to no more than 40 km/hr ▪ Fauna management and incident register Biosecurity Management Plan ongoing: ▪ Construction vehicle weed certification and wash down procedures in place ▪ Continued weed monitoring with required control protocols in place where weed invasion is identified ▪ Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out in accordance with the post-construction MNES Monitoring Plan. Noise and Air Quality Management Sub-plan measures ongoing Project design to incorporate minimum lighting requirements feasible for Project safety Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas where woodland habitat has been cleared	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Low	**Moderate**	▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) Flora and Fauna Sub-plan activities ongoing: ▪ Fauna management and incident register including observed collisions associated with rail operations Biosecurity Management Plan ongoing: ▪ Continued annual weed monitoring with required control protocols in place where weed invasion is identified ▪ Continued opportunistic monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out for at least two consecutive years within two years of Project completion. MNES Monitoring Plan to incorporate passive monitoring above tunnel (prior to, during and post construction) to better understand impacts to fauna inhabiting the area directly above the tunnel and any changes to fauna movement as a result of the Project. Project design to incorporate minimum lighting requirements feasible for Project safety	Negligible	**Low**
Grey headed flying-fox							
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Noise, dust, and light impacts	High	**Major**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning)	Negligible	**High** (refer to Section 5.3.5.3 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
		Aquatic habitat degradation			**Species specific** A Flora and Fauna Sub-plan developed and in place prior to construction. The Plan will detail pre-construction surveys of riparian habitat identified as potential roost sites of species to identify whether camps occur within or near the Project disturbance footprint. The nearest known roost sites are located 600 m and 1.2 km from the Project. Should a roost site be found to occur management actions will incorporate the mitigation standards detailed in the Commonwealth's *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE 2015a). Where possible, reduce the disturbance footprint in winter foraging habitat, including avoiding clearing for ancillary works. Incorporate winter foraging species into the rehabilitation/ revegetation plans for the Project. Work with the design team and property team to incorporate fencing which minimises the risk of entanglement (e.g. barbed wire fencing with a high tensile wire strand as the top wire). Measures to minimise habitat loss during vegetation clearing to include at a minimum: ▪ All vegetation outside of construction footprint will be appropriately marked as a No-Go Zone to site workers ▪ Vegetation clearance will be approved and carried out under ecological supervision ▪ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them Project CEMP to include measures to minimise noise as much as feasible and Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods Project design to incorporate minimum lighting requirements feasible for Project safety		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Surface Water Management Sub-plan developed and in place prior to construction. To include at a minimum: ▪ Wetland and watercourse-specific water quality criteria based on baseline data ▪ A surface water quality sampling monitoring detailing water quality parameters and schedule Response framework where water quality impacts identified from Project activities		
	Commissioning and reinstatement	Noise, dust, and light impacts Aquatic habitat degradation	Negligible	**Low**	▪ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning) Noise and Air Quality Management Sub-plan measures ongoing Project design to incorporate minimum lighting requirements feasible for Project safety	Negligible	**Low**
	Operation	Light impacts	Negligible	**Low**	Project design to incorporate minimum lighting requirements	Negligible	**Low**
Woodland birds: Swift parrot, Painted Honeyeater, Regent honeyeater, Red goshawk and Grey falcon							
High	Construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation	High	**Major**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning) Three of these species are generalist nectivores which are nomadic, following flowering events. None of these species nest in the area. Both the Grey falcon and Painted honeyeater are only occasional visitors to the region (normally occurring to the west of the Great Dividing Range). Red goshawk requires large areas of woodland habitat and is only likely to occur in the Helidon Hills and potentially the Little Liverpool Range.	Moderate	**High** (refer to Section 5.3.5 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by ‘Environmental value impacted’ and ‘Delivery phase’	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					A Flora and Fauna Sub-plan developed and in place prior to construction. The Plan will detail pre-construction surveys of woodlands identified as *potential habitat* for Red goshawk (refer species habitat mapping in Appendix F) to identify whether individuals occur and potentially nest within the Project disturbance footprint. Surveys for nest sites within or adjacent to the disturbance footprint will be as per MNES guidelines where suitable nesting habitat (i.e. large emergent trees near water) is identified. Should an active Red goshawk nest site be identified, the Plan will incorporate restricted works measures during construction to allow nesting to continue undisturbed as determined by pre-clearance surveys (e.g. micrositing of works to avoid nests or maximise separation distance, 100 m buffer and signage around nests, no disturbance to nests until after breeding season (being until fledglings/offspring no longer use the nest/roost for habitat)). Some limited works may occur in the buffer zone during this period (e.g. cultural heritage surveys). Measures to minimise habitat loss during vegetation clearing to include at a minimum: ▪ All vegetation outside of construction footprint will be appropriately marked as a No-Go Zone to site workers ▪ Vegetation clearance will be approved and carried out under ecological supervision ▪ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them Weeds species are not considered as an impact on these species. The MNES study area is already subject to significant weed invasion including *Lantana camara*. Project CEMP Biosecurity Management Plan developed and in place prior to construction. General measures to include: ▪ Pre-construction weed assessment of potential habitat of species		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					▪ Construction vehicle weed certification and wash down procedures in place ▪ Weed monitoring within immediate vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified ▪ Measures to ensure pest predator fauna are not attracted to works areas or utilising Project disturbance footprint for shelter Project CEMP to include measures to minimise noise as much as feasible and Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods Project design to incorporate minimum lighting requirements feasible for Project safety Surface Water Management Sub-plan developed and in place prior to construction. To include at a minimum: ▪ Wetland and watercourse-specific water quality criteria based on baseline data ▪ A surface water quality sampling monitoring detailing water quality parameters and schedule ▪ Response framework where water quality impacts identified from Project activities		
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation	Low	**Moderate**	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning) Biosecurity Management Plan ongoing: ▪ Construction vehicle weed certification and wash down procedures in place ▪ Continued weed monitoring with required control protocols in place where weed invasion is identified	Negligible	**Low**

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by 'Environmental value impacted' and 'Delivery phase'	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					▪ Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter Noise and Air Quality Management Sub-plan measures ongoing Project design to incorporate minimum lighting requirements feasible for Project safety Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas where woodland habitat has been cleared Surface Water Management Sub-plan monitoring and evaluation ongoing		
	Operation	Displacement of fauna species from invasion of weed and pest species Noise and light impacts	Negligible	**Low**	▪ Weeds and pests (pre-construction, construction and commissioning) Biosecurity Management Plan ongoing: ▪ Continued annual weed monitoring with required control protocols in place where weed invasion is identified ▪ Continued opportunistic monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter ▪ Project design to incorporate minimum lighting requirements feasible for Project safety	Negligible	**Low**

Table notes:

1 Refer Table 3.8 for 'sensitivity' and 'magnitude' criteria.
2 Potential impacts to MNES in the above table are based upon those presented in Section 5.1.
3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for information relating to the use of offsets to compensate Project related impacts that are not sufficiently reduced in the above table.

5.3.3 Significant residual impact assessment for threatened ecological communities

Of the five TECs identified from the desktop assessment, two have been confirmed as occurring within the MNES study area (although not within the Project disturbance footprint) based on existing vegetation mapping (neither have been confirmed through ground-truthing surveys). These TECs consist of the following:

- Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ
- Brigalow (*Acacia harpophylla* dominant and codominant) (refer Section 4.4.1.3).

Assessment of the significance of impact in accordance with the criteria contained within the MNES Guidelines has been undertaken for the TECs. In accordance with the guidelines, an action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
- Adversely affect habitat critical to the survival of an ecological community
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - Assisting invasive species, that are harmful to the listed ecological community, to become established, or
  - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community
- Interfere with the recovery of an ecological community.

A range of mitigation measures have been proposed to ameliorate potential impacts to occurrences of TEC wherever possible (refer Section 5.2.2 and specific measures in Table 5.5). These include measures considered as effective in addressing the recognised threats to TECs as recognised in approved conservation advice, and DAWE-adopted threat abatement plans including but not restricted to:

- Identify the extent of any occurrence of TEC within the vicinity of the disturbance footprint in response to changes to the Project disturbance footprint and outcomes from ecological surveys. Provide these outcomes to relevant agencies to inform their mapping and understanding of this community
- MNES Monitoring Plan will incorporate monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent occurrences of TEC can be identified and relevant corrective actions implemented
- Biosecurity Management Plan to protect flora habitats adjacent to the Project from deleterious impacts including weed invasion, pest fauna and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*)
- Erosion and Sediment Control Plan and Surface Water Sub-plan to protect water quality values associated with wetlands and waterways

- Air Quality Sub-plan includes measures to minimise dust impacts on vegetation/habitats including dust monitoring and suppression methods
- Reinstatement and Rehabilitation Plan to detail rehabilitation of temporary construction areas not required for Project operation.

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

- Habitat modelling based on ecological surveys and TEC descriptions (refer Section 4.4.1.3)
- The design and layout of the Project (refer Section 1.7)
- Information on potential impacts of Project during construction and operation (refer Section 5.1)
- Proposed Project mitigation measures (refer Section 5.2 and Table 5.3).

At this stage the Project is not predicted to impact an occurrence of TEC. Assessment against the significant impact criteria for the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC is presented in Table 5.8. Assessment against the significant impact criteria for the Brigalow (*Acacia harpophylla* dominant and codominant) TEC is presented in Table 5.9.

Table 5.8 Assessment of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC against the EPBC Act matters of national environmental significance significant impact criteria for Critically Endangered threatened ecological communities

Significant impact criteria	Potential impact to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC
Reduce the extent of an ecological community	**No** – Clearing is a major threat to this community. However, the Project does not require any clearing of any instances of this TEC. The nearest occurrence is located over 500 m from the Project disturbance footprint in the easternmost extent of the Project alignment.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**No** – Although the Project is linear in nature, no instances of this TEC will be impacted by clearing and no further fragmentation will result.
Adversely affect habitat critical to the survival of an ecological community	**No** – the Project does not require any clearing of any instances of this TEC. The nearest occurrence is located over 500 m from the Project disturbance footprint. The Project will not adversely impact habitat critical to the survival of an ecological community.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	**No** – There is no potential for the Project to alter hydrology and destroy both biotic and abiotic factors essential to the survival of the TEC. For the most part the impacts will be localised to the Project disturbance footprint. The hydrology modelling indicates changes to the local flow paths upgradient and downgradient of the alignment. However, these changes are generally not considered to be substantial with the Project flooding and groundwater modelling indicating little to no change to the hydrology in the areas of mapped TEC in the Calvert area. Refer EIS Chapter 13: Surface water and hydrology, EIS Chapter 14: Groundwater and EIS Appendix M: Hydrology and Flooding Technical Report.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	**No** – Management of weeds will be undertaken as part of the Project mitigation measures. It is expected that these activities will reduce the likelihood of significant alterations to species diversity associated with the TEC.

Significant impact criteria	Potential impact to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: ▪ Assisting invasive species, that are harmful to the listed ecological community, to become established, or ▪ Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	**No** – The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads, will be managed by the following measures: The nearest occurrence of the TEC to the Project is over 500 m away. Management of pests and weeds within the Project disturbance footprint will be undertaken as part of the Project mitigation measures. In addition, management measures will be in place to reduce the risk of herbicides, chemicals, run-off and sediment entering the TEC. These control measures are likely to remove any chance of a substantial reduction in the quality or integrity of an occurrence of an ecological community.
Interfere with the recovery of an ecological community	**No** – Any removal of this TEC will affect the recovery of the ecological community, however the Project will not impact any instance of this TEC. The Project will not interfere with the recovery of this community.
Assessment of potential for significant residual impacts	Under the seven-part test detailed above, there is unlikely to be a 'significant residual impact' on Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC as a result of the Project.

Table 5.9 Assessment of the Brigalow (*Acacia harpophylla* dominant and codominant) TEC against the EPBC Act matters of national environmental significance significant impact criteria for Endangered threatened ecological communities

Significant impact criteria	Potential impact to the Brigalow (*Acacia harpophylla* dominant and codominant) TEC
Reduce the extent of an ecological community	**No** – Clearing is a major threat to this community. However, the Project does not require any clearing of any instances of this TEC. The nearest potential occurrence is located 30 m from the Project disturbance footprint, with the works occurring on the northern side of the existing QR West Moreton System rail corridor. This community is mapped within a heterogeneous polygon (i.e. occurs mixed with other vegetation communities) and it is not known to what extent the community occurs, if at all. Under the Flora and Fauna Sub-plan currently mapped occurrences of this community in the immediate vicinity of the Project (i.e. within 50 m of the Project disturbance footprint) will be surveyed during pre-construction surveys to ascertain whether the community occurs and if so the extent of occurrence of the community (refer Table 5.5).
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**No** – Although the Project is linear in nature, no instances of this TEC will be impacted by clearing and no further fragmentation will result.
Adversely affect habitat critical to the survival of an ecological community	**No** – the Project does not require any clearing of any instances of this TEC. The nearest occurrence is potentially located 30 m from the Project disturbance footprint although this has not been confirmed. The Project will not adversely impact habitat critical to the survival of an ecological community.

Significant impact criteria	Potential impact to the Brigalow (*Acacia harpophylla* dominant and codominant) TEC
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	**No** – The nearest occurrence is potentially located 30 m from the Project disturbance footprint although this has not been confirmed. There is no potential for the Project to alter hydrology and destroy both biotic and abiotic factors essential to the survival of the TEC. Bushfire is a potential threat to the community, with the construction and operation of the Project a potential ignition source. it is noted that the works will occur to the north of the existing rail alignment (potential fire break) and measures will be implemented to mitigate and manage bushfire risk. The hydrology modelling indicates changes to the local flow paths upgradient and downgradient of the alignment. However, these changes are generally not considered to be substantial with the Project flooding and groundwater modelling indicating little to no change to the hydrology in the areas of mapped TEC in the area to the west of Laidley. Refer EIS Chapter 13: Surface water and hydrology, EIS Chapter 14: Groundwater and EIS Appendix M: Hydrology and Flooding Technical Report.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	**No** – Within the MNES study area this TEC is already subject to land use impacts associated with previous clearing and cattle grazing activity. Management of weeds will be undertaken under the Biosecurity Management Plan as part of the Project mitigation measures. It is expected that these activities will reduce the likelihood of significant alterations to species diversity associated with the TEC.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: ▪ Assisting invasive species, that are harmful to the listed ecological community, to become established, or ▪ Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	**No** – The threats outlined in the *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads* (DSEWPaC 2011d) are considered applicable to this TEC. Cane toads are already widespread in the region and there is no conceivable activity associated with the Project likely to increase their occurrence. The nearest potential occurrence of the TEC to the Project is 30 m from the Project disturbance footprint. Under the Flora and Fauna Sub-plan mapped occurrences of this community in the immediate vicinity of the Project (i.e. within 50 m of the Project disturbance footprint) will be surveyed during pre-construction surveys to ascertain whether the community occurs and if so the extent of occurrence of the community. Management of pests and weeds will be undertaken through the Project's Biosecurity Management Plan of the Project mitigation measures. In addition, management measures will be in place to reduce the risk of herbicides, chemicals, run-off and sediment entering occurrences of the TEC. These control measures are likely to remove any chance of a substantial reduction in the quality or integrity of an occurrence of an ecological community.
Interfere with the recovery of an ecological community	**No** – Any removal of this TEC will affect the recovery of the ecological community, however the Project will not impact any instance of this TEC. The Project will not interfere with the recovery of this community.
Assessment of potential for significant residual impacts	Under the seven-part test detailed above, there is unlikely to be a 'significant residual impact' on Brigalow (*Acacia harpophylla* dominant and codominant) TEC as a result of the Project.

5.3.4 Significant residual impact assessment for threatened flora

This section assesses the potential for significant residual impacts from the Project on each MNES using the relevant criteria outlined in the MNES Guidelines. Within the MNES Guidelines there are specific criteria where a species is listed as vulnerable. Key terms relevant to the assessment include:

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable species, occurrences include but are not limited to:

- A geographically distinct regional population, or collection of local populations, or
- A population, or collection of local populations, that occurs within a particular bioregion.

An ‘invasive species’ is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

‘Habitat critical to the survival of a species or ecological community’ refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitats may be, but are not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the register of Critical Habitat maintained by the minister under the EPBC Act.

The following sections assess the potential for significant residual impacts on the seven vulnerable flora species identified as potentially occurring within the MNES study area (refer Section 4.4.3) using the criteria set out in the MNES Guidelines. The ecology, life history and distribution of these species are summarised in the following section and Appendix B. Relevant Commonwealth documents applicable to each species including threat abatement plans, Approved Conservation Advice, and recovery plans are also summarised in Appendix B.

As noted in Section 4.4.1.2, only one species, Lloyd’s olive (*Notalea lloydii*) was confirmed as occurring within the Project disturbance footprint.

Key impacts to terrestrial threatened flora are considered to be restricted to direct clearing of individuals/populations. Given the degraded nature of the majority of the woodlands within the Project 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 Project’s mitigation measures and restricted to the construction period.

A range of mitigation measures have been proposed to ameliorate these impacts wherever possible (refer Section 5.2.2 and species-specific measures in Table 5.6). These include measures considered as effective in addressing the recognised threats for each species as recognised in recovery plans, approved conservation advice, and DAWE-adopted threat abatement plans (as identified in the following sections for each species) including but not restricted to:

- Flora and Fauna Management Sub-plan will incorporate species-specific monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent habitats is not occurring as a result of the Project – applicable to all species
- Biosecurity Management Plan to protect flora habitats adjacent to the Project from deleterious impacts including weed invasion, pest fauna (such as feral pigs and European rabbit) and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*) – applicable to all species
- Erosion and Sediment Control Plan and Surface Water Sub-plan to protect water quality values associated with wetlands and waterways – applicable to aquatic species
- Air Quality Sub-plan includes measures to minimise dust impacts on vegetation/habitats including dust monitoring and suppression methods – applicable to all species
- Reinstatement and Rehabilitation Plan to detail rehabilitation of temporary construction areas not required for Project operation – applicable to all species

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

- Currently knowledge of the species, including local populations and habitat requirements (refer Appendix B)

- Predictive habitat modelling for each species (refer Table 5.4) based on the habitat assumptions associated with each species, along with the findings of ecological surveys (refer Appendix A)
- The design and layout of the Project (refer Section 1.7)
- Information on potential impacts of Project during construction and operation (refer Section 5.1)
- Proposed Project mitigation measures (refer Section 5.2 and Table 5.6).

In addition, it is noted that targeted surveys for MNES flora species have not been carried out throughout the entirety of the alignment as part of Project ecology surveys. Where protected plant surveys have been undertaken including in areas of *potential habitat* for the species listed in Table 5.10, only one species was detected (Lloyd's olive (*Notelaea lloydii*)) indicating that predicted habitat mapping overestimates the extent of habitat present for these species.

ARTC is committed to undertaking additional ecological surveys in accordance with relevant State survey guidelines to verify and further refine the habitat mapping and extent of local populations (where applicable) which will inform relevant approvals and management plans, along with offset requirements and disturbance limits.

A summary of the findings of the significant residual impact assessment for threatened flora is provided in Table 5.10. Section 5.3.4.1 provides the significant impact assessment for vulnerable species.

Table 5.10 Summary of the results of the significant impact assessment for matters of national environmental significance flora species

Flora species	EPBC Act status*	Results of assessment	Table containing assessment against MNES Guidelines
Hairy-joint grass (*Arthraxon hispidus*)	V	No significant residual impact - no important populations or critical habitat have been identified for this species within the Project disturbance footprint	Table 5.11
Four-tailed grevillea (*Grevillea quadricauda*)	V	Project has potential to cause 'significant residual impacts' on an important population of Four-tailed grevillea	Table 5.12
Blunt-leaved leionema (*Leionema obtusifolium*)	V	Project has a minor potential to cause 'significant residual impacts' on an important population of Blunt-leaved leionema	Table 5.13
Lloyd's olive (*Notelaea lloydii*)	V	Project is likely to cause 'significant residual impacts' on an important population of Lloyd's olive	Table 5.14
Paspalidium grandispiculatum (a grass)	V	Project has potential to cause 'significant residual impacts' on an important population of *Paspalidium grandispiculatum*	Table 5.15
Brush sophora (*Sophora fraseri*)	V	No significant residual impact - no important populations or critical habitat have been identified for this species within the Project disturbance footprint	Table 5.11
Austral toadflax (*Thesium australe*)	V	No significant residual impact - no important populations or critical habitat have been identified for this species within the Project disturbance footprint	Table 5.11

Table notes:

* CE = Critically endangered, E = Endangered, V = Vulnerable

5.3.4.1 Vulnerable flora species populations

In accordance with the MNES Guidelines, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species
- Reduce the area of occupancy of an important population
- Fragment an existing important population into two or more populations

- Adversely affect Habitat critical to the survival of a species
- Disrupt the breeding cycle of an important population
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- Introduce disease that may cause the species to decline
- Interfere substantially with the recovery of the species.

As evident the criteria, the impact is only applicable if the population is important. An 'important population' as defined within the MNES Guidelines is:

'*An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

- *Key source populations either for breeding or dispersal;*
- *Populations that are necessary for maintaining genetic diversity; and/or*
- *Populations that are near the limit of the species range'*

An initial assessment was undertaken to determine whether an 'important population' is present in the MNES study area. Where an 'important population' is considered not to be present an assessment against the above criteria was not undertaken.

Given the specificity of the above definition and the scarcity of information and records available for most listed species and populations in the region (and Australia), it is difficult to determine: 1) attributes such as breeding and dispersal behaviour and whether the population is a 'key source' and 2) the genetic diversity of individuals inhabiting a population or sub-population. It is noted the Project is linear and is not expected to impact the potential distribution of local pollinators for most (if not all) plant species and as such is not considered likely to impact dispersal or genetic exchange within a plant population.

Given the paucity of information available, significance of impacts to threatened species has been based on experience of the assessment team and the latest available information.

Impacts and mitigation measures associated with this species are identified within Table 5.6 and Table 5.11 provides an evaluation of the populations of vulnerable flora species considered as potentially associated with the MNES study area.

Table 5.11 Assessment of status of vulnerable flora species population against matters of national environmental significance Guidelines criteria

Species name	Common name	Project disturbance footprint population evaluation
Arthraxon hispidus	Hairy-joint grass	This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). There are no database records of this species within or adjacent to the Project disturbance footprint. Database records indicate the species has been recorded in the wider region surrounding the Project. The nearest database records are recent (post 2000) and located in the Toowoomba Range area approximately 14.5 km west of the Project disturbance footprint. There are a few other records within a 50 km radius located to the south, east and north-east. These include a recent record (2009) from Main Range National Park (30 km south of the MNES study area), an old record (1941) from Mount Chinghee (46 km south-east), and a 1993 record from the Samford area (45 km north-east) (refer Figure 1.26 in Appendix B). DAWE (2020b) mapping indicates the species as may occur in sporadic areas surrounding the Project disturbance footprint. The species occurs from Port Douglas (north Queensland) south to Kempsey in NSW (DEWHA 2008a). The MNES study area is not located near the limit of the species range.

Species name	Common name	Project disturbance footprint population evaluation
		There is no recovery plan adopted by the Commonwealth for this species. A review of the available literature including the approved conservation advice for the species (DEWHA 2008a) has not revealed any important populations or definition of *Habitat critical to the survival of the species.* No populations that are important for the long-term survival and recovery of the species have been identified. The species can be found in a variety of habitats including edges of rainforest, wet eucalypt forest, woodland, creek banks and beds, shaded gullies and mound springs (DEWHA 2008a). Recent studies of the species in New South Wales indicate a preference for native dominated freshwater wetlands, drainage lines, and groundwater seepages with little canopy cover (White et al. 2019). As such, no habitat can be identified as Habitat critical to the survival of the species in the absence of the species presence. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for mapping methodology). The Project is linear and is not expected to impact dispersal or breeding capacity. Predictive habitat mapping indicates there is no *potential habitat* for this species within the Project disturbance footprint, while there is estimated to be only 1.16 ha of potential habitat in the wider MNES study area (refer Table 4.4 and habitat figure in Appendix F). No wetland areas are intersected by the Project disturbance footprint (refer Section 4.4.4.7). No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project, the species occurs across a wide area, and there are no recent records of the species within 14 km of the Project. The predicted impact area is minor and will not conceivably impact the species such that it is likely to decline or impact recovery of the species. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.
Grevillea quadricauda	Four-tailed grevillea	This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment where this species occurs (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). Database records (i.e. AoLA) indicate that this species occurs within the MNES study area to the north of the alignment between Helidon and Gatton the south-eastern corner of the Lockyer Resource Reserves area (refer Figure 4.1). These records are recent (2018) and note up to 28 individual plants at the location. Other records exist within 500 m of the MNES study area to the south of the alignment at Helidon dated 1992. A number of other records exist to the north associated with the Helidon Hills area. Other records occur to the south-west between the disturbance footprint and Toowoomba dated between 1968 to 2000 (refer Figure 1.8 in Appendix B). The species only occurs in north-east NSW and the Helidon-Toowoomba area (DEWHA 2008b). DAWE (2020b) mapping indicates the species as likely to occur in the Helidon Hills area including habitat intersected by the Project disturbance footprint. There is no recovery plan adopted by the Commonwealth for this species. A review of the available literature including the approved conservation advice for the species (DEWHA 2008b) has not revealed any important populations or definition of *Habitat critical to the survival of the species*. However, given there are database records in close proximity to the Project disturbance footprint and the species has a narrow range of occurrence there is potential for an 'important population' to be impacted by the Project. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). Predictive habitat mapping indicates that the project may disturb 26.06 ha of *potential habitat* for this species in the Helidon area (refer Table 4.4 and habitat figure in Appendix F). Under the MNES Guidelines there may be an 'important population' of the species in the area and there is potential for the Project to impact the species. The potential for significant residual impacts on an important population of Four-tailed grevillea is assessed under the MNES Guidelines in Table 5.12.

Species name	Common name	Project disturbance footprint population evaluation
Leionema obtusifolium	Blunt-leaved Leionema	This species was not identified within any Project-associated field surveys including protected plant surveys within the alignment where this species occurs (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). Database records (i.e. AoLA) describe two older records approximately 300 m south of the western section of the MNES study area dated 1964 and 1978 in what is now cleared habitat. The majority of records for this species occur within the Lockyer Resource Reserve to the north of the Project (between 5 km and 13 km from the Project disturbance footprint) and are dated 1970 to 2016. The nearest recent record (2016) is located 5.5 km north of the Project. A single record from 1963 is located 5.5 km south of the western extent of the alignment, although this record has a high spatial uncertainty. Another group of records exist at Crows Nest located approximately 30 km north-west of the Project. A number of other records exist to the north associated with the Helidon Hills area (refer Figure 1.35 in Appendix B). The species is only known from the Helidon-Ravensbourne area (DEWHA 2008c). DAWE (2020b) mapping indicates the species as likely to occur in the Helidon Hills adjacent to the north of the Project disturbance footprint. There is no recovery plan adopted by the Commonwealth for this species. A review of the available literature including the approved conservation advice for the species (DEWHA 2008c) has not revealed any important populations or definition of *Habitat critical to the survival of the species*. However, given there are database records in close proximity to the Project disturbance footprint and the species has a narrow range of occurrence there is potential for an 'important population' to be impacted by the Project. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). Predictive habitat mapping indicates that the project may disturb 29.26 ha of *potential habitat* for this species (refer Table 5.4 and habitat figure in Appendix F). This is a conservative figure which includes suitable vegetation communities that occur in the Little Liverpool Range area (outside of the species range) and is a likely overestimate. Under the MNES Guidelines there may be an 'important population' of the species in the area and there is potential for the Project to impact the species. The potential for significant residual impacts on an important population of Blunt-leaved leionema is assessed under the MNES Guidelines in Table 5.13.
Notelaea lloydii	Lloyd's olive	Lloyd's olive has been identified within the Project disturbance footprint to the east of Laidley (EMM 2018b). Another record from 1990 exists further east near Grandchester within the MNES study area (refer Figure 4.1). The nearest record outside of the MNES study area exists to the north of Grandchester within approximately 5 km of the alignment and dated 2011 (refer Figure 1.10 in Appendix B). A review of the available literature has not revealed any important populations or definition of *Habitat critical to the survival of the species* (DEWHA 2008d). However, given the species has been recorded from the Project disturbance footprint there is potential to impact a source population for the species. This species has a restricted distribution, has undergone historical loss and will encounter future loss resulting from rural and urban development. As such the population relevant to the project can be considered an important population and therefore key to the long-term survival of this species. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habita*t (refer Appendix A for methodology). It is estimated that the Project is likely to impact 112.77 ha of potential habitat and 21.26 ha of Habitat critical to the survival of the species in which this species is predicted to occur (refer Table 5.4). Under the MNES Guidelines there may be an 'important population' of the species in the area and there is potential for the Project to impact the species. The potential for significant residual impacts on an important population of *Lloyd's olive* is assessed under the MNES Guidelines in Table 5.14.

Species name	Common name	Project disturbance footprint population evaluation
Paspalidium grandispiculatum	A grass	This species was not identified within any Project-associated field surveys including protected plant surveys within the alignment where this species occurs (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). Database records (i.e. AoLA) indicate this species occurs to the north of the western end of the Project disturbance footprint in the Helidon Hills area. The nearest record dated 1998 is located within approximately 5 km from the Project. Other records exist within the vicinity of the Project from between 1980 to 2013 throughout the Helidon Hills (refer Figure 1.18 in Appendix B). The species has a limited range extending in a narrow band from Kingaroy to Canungra (DEWHA 2008e). DAWE (2020b) mapping indicates the species as likely to occur in the Helidon Hills area including habitat intersected by the Project disturbance footprint. A review of the available literature has not revealed any important populations or definition of *Habitat critical to the survival of the species* including the approved conservation advice for the species (DEWHA 2008e). However, given there are database records in close proximity to the Project disturbance footprint and the species has a narrow range of occurrence there is potential for an 'important population' to be impacted by the Project. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology). It is estimated that the Project is likely to impact 84.58 ha of potential habitat in which this species is predicted to occur (refer Table 5.4). This is a conservative figure which includes suitable vegetation communities that occur in the Little Liverpool Range area (where the species is not currently known to occur) and is a likely overestimate. Under the MNES Guidelines there may be an 'important population' of the species in the area and there is potential for the Project to impact the species. The potential for significant residual impacts on an important population of *Paspalidium grandispiculatum* is assessed under the MNES Guidelines in Table 5.15.
Sophora fraseri	Brush sophora	This species was not identified within any Project-associated field surveys including protected plant surveys within the alignment (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). Database records (i.e. AoLA) indicate the nearest occurrence exists 5 km north of the Project at the eastern end of the alignment (west of Rosewood) dated 1992. A very old record (1930) occurs 5 km south of Helidon at the western end of the alignment. A few scattered records exist to the north-west, west and south-west within a 50 km buffer of the Project disturbance footprint (refer Figure 1.33 in Appendix B). The nearest recent records are from Toowoomba (2018 and located 14.5 km west of the western extent of the Project) and north of Marburg (2001 and 17 km north of the eastern extent of the Project). A large number of other records exist over 35 km to the north-east of the eastern section of the Project throughout the D'Aguilar National Park. DAWE (2020b) mapping indicates the species as likely to occur in the Little Liverpool Range likely where it is intersected by the Project disturbance footprint. The species occurs from Casino (north-east NSW) north to the Boyne Valley (west of Miriam Vale in SEQ (DEWHA 2008f). The MNES study area is not located near the limit of the species range. There is no recovery plan adopted by the Commonwealth for this species. A review of the available literature has not revealed any important populations or definition for *Habitat critical to the survival of the species* (DEWHA 2008f). No populations that are important for the long-term survival and recovery of the species have been identified. The species occurs in moist habitats on the edges of rainforest and in canopy gaps in closed forest communities (DEWHA 2008f). In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). The Project is linear and is not expected to impact dispersal or breeding capacity. Brush sophora normally grows in wet sclerophyll forest and a range of rainforest types. It has been reported growing in hilly terrain on hillslopes at altitudes from 60 m to 660 m on sandstone or basalt derived soils. It appears to prefer growing along rainforest margins, in eucalypt forests in the vicinity of rainforests or in large canopy gaps in closed forest communities. Predictive habitat mapping indicates that the project may disturb 39.98 ha of *potential habitat* for this species (refer Table 5.4 and habitat figure in Appendix F). However, the modelling has been carried out in a conservative manner including dry sclerophyll vegetation communities on sandstone/basalt derived soils and is a likely substantial overestimate. There is no wet rainforest or sclerophyll habitat actually mapped as occurring within the MNES study area.

Species name	Common name	Project disturbance footprint population evaluation
		No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project, the species occurs across a relatively wide area, and there are no recent records of the species within 14 km of the Project. As noted above the predicted impact area is very conservative and comprises little habitat that is most suitable for the species (i.e. wet forests). The Project will not conceivably impact the species such that it is likely to decline or impact recovery of the species. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.
Thesium australe	Austral toadflax	This species was not identified within any Project-associated field surveys including protected plant surveys within the Project disturbance footprint (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). The species has been recorded (i.e. AoLA) within the MNES study area (dated 1985) from two records located between the Project disturbance footprint and the University of QLD Gatton Campus (approximately 500 m from the Project disturbance footprint) on lands that appear to be currently used for irrigated agriculture. There are 1930 records from the Forest Hill area (4.5 km north of the Project) and Ipswich area (23 km east), and a 1993 record from Harrisville (21 km south-east). The nearest recent records (2009 and 2012) are from the Toowoomba Range (10 km south-west of the western extent of the Project). Other records within a 50 km buffer of the Project include the Toowoomba area, D'Aguilar National Park, Main Range National Park and Crows Nest with records ranging between 1930 to 2009 (refer Figure 1.4 in Appendix B). DAWE (2020b) mapping indicates the species as likely to occur in much of the Project disturbance footprint. The species occurs from Carnarvon National Park (southern QLD) east to the coast and south through NSW and Victoria (DotE 2013b). The MNES study area is not located near the limit of the species range. There is no recovery plan adopted by the Commonwealth for this species. A review of the available literature has not revealed any important populations or definition for *Habitat critical to the survival of the species* when referring to the Approved conservation advice for the species (DotE 2013b). No populations that are important for the long-term survival and recovery of the species have been identified. The species can be found in a number of habitats including grassland, shrubland and woodland in a variety of climates and altitudes (subtropical, temperate and alpine) and on varying soils (DAWE 2020b). As such, no habitat can be identified as critical in the absence of the species presence. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology). The Project is linear and is not expected to impact dispersal or breeding capacity. Predictive habitat mapping indicates that the project may disturb 94.77 ha of *potential habitat* for this species (refer Table 5.4 and habitat figure in Appendix F). It is noted database records older than 30 years (as referred to above) are not included within the habitat modelling of Habitat critical to the survival of the species. However, the modelling has been carried out in a conservative manner which includes non-remnant communities in road reserves and is a likely overestimate. No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project, the species occurs across a wide area, and there are no recent records of the species within 10 km of the Project. The Project will not conceivably impact the species such that it is likely to decline or impact recovery of the species. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.

5.3.4.2 Significant impact assessment – Vulnerable flora

Four-tailed grevillea (*Grevillea quadricauda*)

Ecology and distribution

Four-tailed grevillea is a dense shrub growing up to 2 m high. The species occurs on gravelly loam soils or in sandy soils. It inhabits the understorey of dry sclerophyll forest or eucalypt woodland, usually along creeks or drainage lines. Associated plant communities include creek line forest dominated by Turpentine (*Syncarpia glommulifera*) and Brush-box (*Lophostemon confertus*) (Makinson 2000; NSW NPWS 2005; Olde and Marriott 1995). Flowering in this species occurs between August to September (DAWE 2020b).

Four-tailed grevillea occurs in north-east NSW and near Toowoomba, in southeast QLD, where the species has been recorded from the Helidon Hills and in the Murphys Creek area. The species occurs in the Northern Rivers (NSW) and Condamine (QLD) Natural Resource Management regions (DAWE 2020b).

Distribution in context to the Project

This species was not identified within any Project-associated field surveys including protected plant surveys within the alignment where this species occurs (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). Database records (i.e. AoLA) indicate this species has been recorded 500 m north of the Project disturbance footprint between Helidon and Gatton the south-eastern corner of the Lockyer Resource Reserves area (refer Figure 4.1). These records are recent (2018) and note up to 28 individual plants at the location. Two records exist 1.1 km to the south of the Project disturbance footprint at Helidon (dated 1992). Most records exist to the north of the Project and are associated with the Helidon Hills area. A number of these records are recent (2005 to 2017) and located between 2 km and 5 km north of the Project disturbance footprint. Other records occur to the south-west between including two 1968 records (5.3 km south of the western extent of the Project) and several records in the Toowoomba range (13 km south-west of the western extent of the Project) dated from 1996 and 2000 (refer Figure 1.8 in Appendix B).

Recovery plan/threat abatement plans

No recovery plan or threat abatement plans have been adopted for this species. The Approved conservation advice for the species (DEWHA 2008b) identifies the following threats:

- Clearing and habitat fragmentation for urban and rural development
- Inappropriate fire regimes
- Road maintenance activities
- Timber harvesting
- Within the Lockyer Resource Reserves the population has been impacted by extractive industry (quarries)

Important population and Habitat critical to the survival of the species

There are no important populations or definitions of *Habitat critical to the survival* of Four-tailed grevillea identified in published information. Nevertheless, given the restricted area of occurrence of the species it may be inferred that the population occurring in the Helidon Hills could be considered on the edge of the species range. As such, for the purposes of this assessment the habitat adjacent to this area which is intersected by the Project is considered as potentially comprising individuals within an 'important population'. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 5.6. Predictive habitat mapping indicates the Project may impact 26.06 ha of *potential habitat* for this species as identified under the predictive mapping approach used for this assessment (refer Table 5.4 and habitat figure in Appendix F). This is a conservative figure which includes suitable vegetation communities that occur in the Little Liverpool Range area (outside of the species range) and is a likely overestimate. It is noted there is no potential habitat located within the Project disturbance footprint within 1 km of the nearby database records referred to above and as such no *Habitat critical to the survival of the species* has been identified. Assessment against the significant impact criteria for endangered species is shown in Table 5.12.

Table 5.12 Assessment against the significant impact criteria: *Grevillea quadricauda*

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population	The species has a restricted range encompassing habitat within the western extent of the Project disturbance footprint (adjacent to the Helidon Hills). No individuals have been identified within the Project disturbance footprint during Project-associated surveys. Nevertheless, an 'important population' has been identified as potentially occurring in the area. Recent database records (2018) indicate the species is known to occur close to the Project disturbance footprint in the Helidon area, although most records are located further north. Modelling indicates 26.06 ha of *potential habitat* is predicted to occur within the Project disturbance footprint, although this is a likely overestimate. It is noted that the Project may be a point source for bush fires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. As part of the Project Flora and Fauna Management Sub-plan additional protected plant surveys targeting this species will be undertaken prior to vegetation clearing to confirm whether the species occurs (refer Table 5.6). Should the species occur within the disturbance footprint there is potential for the Project to result in a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	An 'important population' has been identified as potentially occurring in the area, although no individuals have been identified within the Project disturbance footprint during Project surveys. Modelling indicates 26.06 ha of *potential habitat* is predicted to occur within the Project disturbance footprint, although this is a likely overestimate. Should the species be found to occur within the Project disturbance footprint the Project has potential to reduce the area of occupancy of an 'important population' for the species.
Fragment an existing important population into two or more populations	An 'important population' has been identified as potentially occurring in the area, although it is unknown at this stage if any individuals occur within the Project disturbance footprint. The species is known to occur nearby (potentially to the north and south) and suitable habitat is predicted to occur within the Project disturbance footprint. Nevertheless, the local area is already highly fragmented in the Helidon area. There is substantial existing linear disturbance running parallel to the Project to the south including a powerline easement, Connors Road and the Warrego Highway. The Project is considered unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	The species occurs in dry sclerophyll or eucalypt forests usually along drainage lines (DEWHA 2008b) which is widespread to the north of the Project. Predictive mapping indicates no habitat considered as Habitat critical to the survival of the species (for the purposes of this assessment) occurs within the Project disturbance footprint, although 26.06 ha of *potential habitat* occurs. As such, the Project is not considered likely to adversely affect Habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	An 'important population' has been identified as potentially occurring in the area, although it is unknown at this stage if any individuals occur within the Project disturbance footprint. Flowering occurs from August to September. The Project may disturb individuals (should they be present) but it is considered unlikely impacts will be to the extent that the breeding cycle of the population would be disrupted.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	An 'important population' has been identified as potentially occurring in the area, although it is unknown at this stage if any individuals occur within the Project disturbance footprint. Predictive mapping indicates 26.06 ha of Habitat critical to the survival of the species occurs within the Project disturbance area, although this is a likely overestimate. Nevertheless, there is extensive suitable habitat located north of the Project in the Helidon Hills where the bulk of the population occurs. It is noted the Project may be a point source for bushfires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event.

Criterion	Assessment against significance criteria
	Given the relatively small area the Project occupies within this area the Project is not considered to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion is not identified as a particular threat to the species although weed control is identified as a management action for the species, including for *Lantana* (DEWHA 2008b). *Lantana camara* was noted as occurring at all sites in varying densities in the Helidon area during the Project EIS surveys. Eighteen species listed as restricted matters under the Queensland *Biosecurity Act 2014* were recorded within the alignment during the EIS surveys. Other Project-associated surveys have also noted areas of heavy infestations of weed species including 17 species listed under the Act (EMM 2019a, 2019b). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project EMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice for the species (DEWHA 2008b) identifies research priorities and regional priority actions including: ▪ Monitoring known populations and identifying high conservation value populations ▪ Limiting the impact of disturbance from adjacent land use and activities associated with road maintenance and upgrading ▪ Manage any changes to hydrology that may adversely impact the species ▪ Identifying and controlling problem weed species including *Lantana camara* ▪ Developing a fire management strategy for the species The Project is considered unlikely to interfere with the recovery strategies listed above. The Project will control the impact of problem weed species in the vicinity of the Project disturbance footprint. Given the relatively small area of suitable habitat impacted the Project is considered unlikely to substantially interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is potential for the Project to cause 'significant residual impacts' on *an important population* of Four-tailed grevillea if the species is found to occur within the Project disturbance footprint.

Blunt-leaved leionema (*Leionema obtusifolium*)

Ecology and distribution

Blunt-leaved leionema (*Leionema obtusifolium*) is a shrub growing to approximately 1 m high. It is known to inhabit eucalypt forest, often with White mahogany (*Eucalyptus acmenoides*) and Brown bloodwood (*Corymbia trachyphloia*), on sandstone substrates in the Helidon Hills and White Mountain State Forest areas, and on granite at Crows Nest National Park (DAWE 2020b). Little is known about the biology and reproduction of Blunt-leaved leionema, apart from the species is known to flower in spring (Stanley and Ross 1983).

The species is known to occur in a small area of SEQ, in the Helidon and Ravensbourne areas (Stanley and Ross, 1983). It has been collected at sites near Crows Nest in the upper reaches of Alice Creek, from the Helidon Hills, and White Mountain State Forest, north-east of Murphys Creek (DAWE 2020b).

Distribution in context to the Project

This species was not identified within any Project-associated field surveys including protected plant surveys within the Project disturbance footprint where this species occurs (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). Database records (i.e. AoLA) describe two older records approximately 300 m south of the western section of the MNES study area dated 1964 and 1978 in what is now cleared habitat. The majority of records for this species occur within the Lockyer Resource Reserve to the north of the Project (between 5 km and 13 km from the Project disturbance footprint) and are dated 1970 to 2016. The nearest recent record (2016) is located 5.5 km north of the Project. A single record from 1963 is located 5.5 km south of the western extent of the alignment, although this record has a high spatial uncertainty. Another group of records exist at Crows Nest located approximately 30 km north-west of the Project (refer Figure 1.35 in Appendix B). DAWE (2020) mapping indicates the species as likely to occur in the Helidon Hills adjacent to the north of the Project disturbance footprint.

Recovery plan/threat abatement plans

No recovery plan or threat abatement plans have been adopted for this species. The Approved conservation advice for the species (DEWHA 2008c) identifies the following threats:

- Habitat loss and fragmentation
- Too frequent fires resulting inappropriate prescribed burning regimes and grazing management may deplete the soil seed bank
- Habitat degradation resulting from forestry activities and grazing activity (Boyes 2004).

Important population and Habitat critical to the survival of the species

There are no important populations or *Habitat critical to the survival* of Blunt-leaved leionema identified in published information. Nevertheless, given there are database records in relatively close proximity to the Project disturbance footprint and the species has a narrow range of occurrence there is potential for an 'important population' to be impacted by the Project. As such, for the purposes of this assessment the habitat which is intersected by the Project is considered as an 'important population'. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 5.6. Predictive habitat mapping indicates the Project may impact 29.26 ha of *potential habitat* for this species (refer Table 5.4 and habitat figure in Appendix F). This is a conservative figure which includes suitable vegetation communities that occur in the Little Liverpool Range area (outside of the species range) and is a likely overestimate. Assessment against the significant impact criteria for vulnerable species is shown in Table 5.13.

Table 5.13 Assessment against the significant impact criteria: *Leionema obtusifolium*

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population	The species has a restricted range encompassing habitat within the western extent of the Project disturbance footprint (adjacent to the Helidon Hills). No individuals have been identified within the Project disturbance footprint during Project-associated surveys. Nevertheless, an 'important population' has been identified as potentially occurring in the area. Older database records (1964 and 1978) are located close to the Project in what is now cleared habitat. Nevertheless, all other database records including recent records indicate the species occurs at least 5 km north of the Project disturbance footprint in the Helidon Hills and Crows Nest areas. Modelling indicates 29.26 ha of *potential habitat* is predicted to occur within the Project disturbance footprint, although this is a likely overestimate. It is noted the Project may be a point source for bushfires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event.

Criterion	Assessment against significance criteria
	As part of the Project Flora and Fauna Sub-plan additional protected plant surveys targeting this species will be undertaken prior to vegetation clearing to confirm whether the species occurs (refer Table 5.6). Should the species occur within the Project disturbance footprint there is potential for the Project to result in a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	An 'important population' has been identified as potentially occurring in the area, although no individuals have been identified within the Project disturbance footprint during Project-associated surveys Modelling indicates 29.26 ha of *potential habitat* is predicted to occur within the Project disturbance footprint, although this is a likely overestimate. Should the species be found to occur within the disturbance footprint the Project has potential to reduce the area of occupancy of an 'important population' for the species.
Fragment an existing important population into two or more populations	An 'important population' has been identified as potentially occurring in the area, although no individuals have been identified within the Project disturbance footprint during Project-associated surveys. The species is currently known only to occur north of the Project although suitable habitat is predicted to occur within the Project disturbance footprint. Nevertheless, the local area is already highly fragmented in the Helidon area. There is substantial existing linear disturbance running parallel to the Project to the south including the Roma Brisbane Gas Pipeline, a powerline easement, Connors Road and the Warrego Highway. The Project is considered unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	The species occurs in dry sclerophyll or eucalypt forests usually along drainage lines (DEWHA 2008c) which is widespread to the north of the Project. Predictive mapping indicates no habitat considered as Habitat critical to the survival of the species (for the purposes of this assessment) occurs within the Project disturbance footprint, although 29.26 ha of *potential habitat* occurs. As such, the Project is not considered likely to adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	An 'important population' has been identified as potentially occurring in the area, although no individuals have been identified within the Project disturbance footprint during Project-associated surveys. Flowering occurs in spring. The Project may disturb individuals (should they be present) but it is considered unlikely impacts will be to the extent that the breeding cycle of the population would be disrupted.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	An 'important population' has been identified as potentially occurring in the area, although no individuals have been identified within the Project disturbance footprint during Project-associated surveys. Predictive mapping indicates 29.26 ha of *potential habitat* occurs within the Project disturbance footprint, although this is likely an overestimate. Nevertheless, there is extensive suitable habitat located north of the Project in the Helidon Hills where the known population occurs. It is noted the Project may be a point source for bushfires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. Given the relatively small area the Project occupies within this area the Project is not considered to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion is not identified as a particular threat to the species. *Lantana camara* was noted as occurring at all sites in varying densities in the Helidon area during the Project EIS surveys. Eighteen species listed as restricted matters under the Queensland *Biosecurity Act 2014* were recorded within the alignment during the EIS surveys. Other Project-associated surveys have also noted areas of heavy infestations of weed species including 17 species listed under the Act (EMM 2019a, 2019b). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project EMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.

Criterion	Assessment against significance criteria
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice for the species (DEWHA 2008c) identifies research priorities and regional priority actions including: ▪ Monitoring known populations and identifying high conservation value populations ▪ Limiting the impact of disturbance from adjacent land use and activities including road widening and maintenance activities ▪ Manage any changes to hydrology that may adversely impact the species ▪ Identifying and controlling problem weed species including *Lantana camara* ▪ Developing fire management and stock (grazing) management strategies for the species The Project is considered unlikely to interfere with the recovery strategies listed above. The Project will control the impact of problem weed species in the vicinity of the Project disturbance footprint. Given the relatively small area of suitable habitat impacted the Project is considered unlikely to substantially interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Based on current record the species is only known to occur north of the Project disturbance footprint. Nevertheless, *potential habitat* occurs. Under the nine-part test detailed above, there is a minor potential for the Project to cause 'significant residual impacts' on *an important population* of Blunt-leaved leionema.

Lloyd's olive (*Notelaea lloydii*) - vulnerable

Ecology and distribution

Lloyd's olive (*Notelaea lloydii*) is a shrub that grows to an approximate height of 1 m to 4 m. The species is known to occur in open eucalypt forest, often near the margins of vine thickets, vine forests and softwood scrub. It is usually found on stony, shallow and rocky soils derived from sandstone or acid volcanic rocks, often on steep slopes, or near drainage lines (DAWE 2020b).

The species occurs from the Somerset Dam area to south of Beaudesert and west to Mount Berryman near Laidley. The species is estimated to have an area of occupancy of 3,700 km^2 (DAWE 2020b).

Distribution in context to the Project

Two specimens of Lloyd's olive were recorded within the Project disturbance footprint during Project-associated pre-clearance surveys to the east of Laidley on the western slope of the Little Liverpool Range (EMM 2018b) (refer Figure 4.4). Two records from 1990 exist further east near Grandchester within the MNES study area (refer Figure 4.1). The nearest records outside of the MNES study area exists to the north of Grandchester (within the Little Liverpool Range) within approximately 2.5 km of the alignment (dated 2011), and a 2017 record 3.5 km north of the Project at Calvert. All other records occur further east in the areas of Ipswich, Mount Crosby Weir Nature Reserve, Moggill Conservation Park and to the south-east between the Teviot Range and Moogerah Peaks National Park (refer Figure 1.10 in Appendix B).

Recovery plan/threat abatement plans

No recovery plan or threat abatement plans have been adopted for this species. The Approved conservation advice for the species (DEWHA 2008d) identifies the following threats:

- Habitat fragmentation for urban development and associated infrastructure (Halford 1998)
- Inappropriate fire regimes. Mature Lloyd's native olive are known to withstand fire, but frequent fire kills juvenile plants and seedlings, supressing species recruitment (Halford 1998)

- Road maintenance
- Weed invasion, in particular *Lantana camara* is known to invade forest margins, smothering plants, reducing light and increasing fuel loads
- Some remnant populations occur on roadsides and therefore are potentially affected by road widening and maintenance.

Important population and Habitat critical to the survival of the species

There are no important populations or *Habitat critical to the survival* of Lloyd's olive identified in published information. Nevertheless, given the small area of occurrence of the species it may be inferred that a population in the Laidley-Grandchester area could be considered as both isolated and on the edge of the species range. As such, for the purposes of this assessment the habitat which is intersected by the Project is considered as an 'important population'. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 5.6. Predictive habitat mapping indicates the Project may impact 112.77 ha of *potential habitat* for this species and 21.26 ha of *Habitat critical to the survival of the species* as identified under the predictive mapping approach used for this assessment (refer Table 5.4 and habitat figure in Appendix F). The modelling has used a conservative approach and the total includes potential habitat within the Helidon Hills which is outside the known range of the species and includes cleared habitat associated with the 1 km buffer on records (considered as potential habitat). As such, the predictive mapping is likely an overestimate of the suitable habitat available within the Project disturbance footprint. Assessment against the significant impact criteria for vulnerable species is shown in Table 5.14.

Table 5.14 Assessment against the significant impact criteria: Notelaea lloydii

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population	The species has a restricted range encompassing the eastern section of the Project disturbance footprint. An 'important population' has been identified as occurring in the area from Laidley to Grandchester (largely associated with habitat in the Little Liverpool Range) The species was identified within the Project disturbance footprint during Project-associated surveys in the Laidley area (EMM 2018b). Two specimens were recorded in the same area on the western slope of the Little Liverpool Range. The species is known to occur and 21.26 ha of Habitat critical to the survival of the species (under the conservative approach used for this assessment) and 112.77 ha of potential habitat is predicted to occur within the Project disturbance footprint, although this is likely a substantial overestimate. Under the conservative approach used for this assessment, Habitat critical to the survival of the species is based on a 1 km buffer around the known record. No other individuals have been identified within the Project disturbance footprint during targeted protected plant surveys. A portion of the identified habitat is located above the tunnel (in the vicinity of where the species was recorded). Construction and operation of the tunnel will not impact this habitat. It is noted that the Project may be a point source for bushfires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. In addition, the species and known habitat are not considered to be reliant on groundwater, with the local groundwater resources potentially impacted by the construction and operation phases of the tunnel (refer 5.1.2.13). As part of the Project Flora and Fauna Sub-plan additional protected plant surveys targeting this species will be undertaken prior to vegetation clearing to confirm whether the species occurs (refer Table 5.6). The two individuals cannot be avoided and, as outlined, are considered to be part of an important population and as such there is potential for the Project to result in a long-term decrease in the size of an important population. Though it is noted that no other records were identified within 100 m of the disturbance footprint with the records generally to the east.

Criterion	Assessment against significance criteria
Reduce the area of occupancy of an important population	An 'important population' has been identified as potentially occurring in the area, and individuals are known to occur within the disturbance footprint. The species is known to occur and 21.26 ha of *Habitat critical to the survival of the species* (under the conservative approach used for this assessment) and 112.77 ha *of potential habitat* is predicted to occur within the Project disturbance footprint, although this is likely a substantial overestimate. The Project has potential to reduce the area of occupancy of an 'important population' for the species, through the direct loss of individuals, along with habitat.
Fragment an existing important population into two or more populations	An 'important population' has been identified as potentially occurring in the area (refer Section 4.4.1.2). The species is known to occur nearby (potentially to the north and south where the Project intersects the Little Liverpool Range and adjacent areas) and suitable habitat is predicted to occur within the Project disturbance footprint. The Project is linear but impacts areas which are already subject to extensive fragmentation in this area. The alignment crosses through the Little Liverpool Range via an 850 m long tunnel (avoiding habitat for the species) and lies north of the Rosewood-Laidley Road which already intersects the area. As such it is considered unlikely the Project will fragment an existing important population into two populations.
Adversely affect habitat critical to the survival of the species	The species occurs in open eucalypt forest which is a widespread vegetation type. Predictive mapping indicates 21.26 ha of *Habitat critical to the survival of the species* (for the purposes of this assessment) occurs within the Project disturbance area as well as a further 112.77 ha of *potential habitat* (although this is likely a substantial overestimate). As such, there is potential the Project will adversely affect *Habitat critical to the survival of the species.*
Disrupt the breeding cycle of an important population	An 'important population' has been identified as potentially occurring in the area. Little information is available on the flowering/fruiting season for the species. The Project may disturb individuals but it is considered unlikely impacts will be to the extent that the breeding cycle of the population would be disrupted.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	An 'important population' has been identified as potentially occurring in the area. The species is known to occur and 21.26 ha of *Habitat critical to the survival of the species* (under the conservative approach used for this assessment) and 112.77 ha *of potential habitat* is predicted to occur within the Project disturbance footprint, although this is likely a substantial overestimate. It is noted that the Project may be a point source for bush fires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. In addition, the species and known habitat are not considered to be reliant on groundwater, with the local groundwater resources potentially impacted by the construction and operation phases of the tunnel (refer Section 5.1.2.13). However, there is 2,593 ha of suitable habitat within 1 km of the Project disturbance footprint (i.e. the MNES study area). The species is thought to have an area of occupancy of 3,700 km^2 (DAWE 2020b). Given the relatively small area the Project occupies within this area the Project is not considered to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion, particularly by *Lantana camara* is a potential threat to the species (DEWHA 2008d). *Lantana camara* was noted as occurring at several sites in the Little Liverpool Range with densities ranging from not occurring at more remote sites to heavy infestations in disturbed areas or near cleared habitats. Prickly pear (*Opuntia* species) were also present at several sites. Eighteen species listed as restricted matters under the Queensland *Biosecurity Act 2014* were recorded within the alignment during the EIS surveys. Other Project-associated surveys have also noted areas of heavy infestations of weed species including 17 species listed under the Act (EMM 2019a, 2019b). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project EMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criterion	Assessment against significance criteria
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice for the species (DEWHA 2008d) identifies research priorities and regional priority actions including: ▪ Monitoring known populations and identifying high conservation value populations ▪ Limiting the impact of disturbance from adjacent land use and activities associated with road maintenance and upgrading ▪ Identifying and controlling problem weed species including *Lantana camara* ▪ Developing a fire management strategy for the species The Project is considered unlikely to interfere with the recovery strategies listed above. Should the species be found to occur within the Project disturbance footprint it may be argued this is increasing knowledge on the species distribution. The Project will control the impact of problem weed species in the vicinity of the Project disturbance footprint. Given the relatively small area of suitable habitat impacted the Project is considered unlikely to substantially interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is potential for the Project to cause 'significant residual impacts' on *an important population* of Lloyd's olive.

Paspalidium grandispiculatum (a grass) - vulnerable

Ecology and distribution

Paspalidium grandispiculatum is a perennial, tufted grass growing to 1.5 m tall. In QLD the species occurs in mixed forest with *Corymbia citriodora*, on sub-coastal, old loamy and sandy plains (RE 12.5.1) and mixed open forest often with *Corymbia trachyphloia*, *Corymbia citriodora, Eucalyptus crebra*, and *Eucalyptus fibrosa* (RE 12.9-10.5). Records also exist from native pastures and open-forest communities. The soil type where *P. grandispiculatum* is generally found are shallow with a sandy texture, dark in colour, well drained and derived from sandstone rocks (DEWHA 2008e; Halford 1998). The species is a perennial grass which is assumed to be wind-pollinated. The flowering and fruiting period is from January to May for QLD populations (DAWE 2020b).

Paspalidium grandispiculatum occurs in SEQ in a band from Canungra to Kingaroy, over a range of approximately 100 km. It occurs in mixed Eucalypt forest, mixed open forest, and native pasture occurring as a result of land clearing for agriculture. One population has been recorded in the Crows Nest Falls National Park, the remaining known populations occur in either State forest or on private land (Halford 1998; Boyes 2001; DEWHA 2008e).

Distribution in context to the Project

Paspalidium grandispiculatum was not identified within any Project-associated field surveys including limited protected plant surveys within the Project disturbance footprint where this species occurs (Ecological 2019a; EMM 2018a; EMM 2019a, 2019b). Database records (i.e. AoLA) indicate this species occurs to the north of the western end of the Project disturbance footprint in the Helidon Hills area. The nearest records dated 1997 and 1998 are located 3.3 km and 2.8 km (respectively) from the Project disturbance footprint. A 2016 record is located 4.2 km north of the Project. All other records (from 1980 to 2013) in the vicinity of the Project occur further north throughout the Helidon Hills and Crows Nest area (refer Figure 1.18 in Appendix B).

Recovery plan/threat abatement plans

No recovery plan or threat abatement plans have been adopted for this species. The Approved conservation advice for the species (DEWHA 2008e) identifies the following threats:

- Habitat clearing and inappropriate grazing pressure (on private and State lands)

- Habitat disturbance caused by timber harvesting
- Inappropriate fire regimes

Important population and Habitat critical to the survival of the species

There are no important populations or *Habitat critical to the survival* of *Paspalidium grandispiculatum* identified in published information. Nevertheless, given the small area of occurrence of the species it may be inferred that a population in the Helidon Hills could be considered as on the edge of the species range. As such, for the purposes of this assessment the local population within the Helidon Hills, the southern edge of which is intersected by the Project is considered as an 'important population'. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 5.6. Predictive habitat mapping indicates the Project may impact 84.58 ha of *potential habitat* for this species as identified under the predictive mapping approach used for this assessment (refer Table 5.4 and habitat figure in Appendix F). This is a conservative figure which includes suitable vegetation communities that occur in the Little Liverpool Range area (where the species is not currently known to occur) and is likely a substantial overestimate. Assessment against the significant impact criteria for endangered species is shown in Table 5.15.

Table 5.15 Assessment against the significant impact criteria: *Paspalidium grandispiculatum*

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population	The species has a restricted range encompassing habitat within the western extent of the Project disturbance footprint (adjacent to the Helidon Hills. No individuals have been identified within the Project disturbance footprint during Project-associated surveys. Nevertheless, an 'important population' has been identified as potentially occurring in the area. Recent database records indicate the species is only known to occur north of the Project with the nearest record located 2.8 km from the Project disturbance footprint. Predictive mapping indicates 84.58 ha of *potential habitat* is predicted to occur within the Project disturbance footprint, although this is likely a substantial overestimate. Nevertheless, there is abundant suitable habitat in which the species is known to occur to the north of the Project in the Helidon Hills area. Predictive mapping indicates there is 2,359.53 ha of *potential habitat* for the species within the overall MNES study area. It is noted the Project may be a point source for bush fires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. As part of the Project Flora and Fauna Sub-plan additional protected plant surveys targeting this species will be undertaken prior to vegetation clearing to confirm whether the species occurs (refer Table 5.4). Given the Project is located south of the known population and the *potential habitat* within the disturbance footprint is relatively minor given the extent of available habitat in the wider area, it is considered unlikely the Project will result in a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	An 'important population' has been identified as potentially occurring in the area, although it is unknown at this stage if any individuals occur within the disturbance footprint. All local records occur to the north of the Project. Predictive mapping indicates 84.58 ha of *potential habitat* is predicted to occur within the Project disturbance footprint, although this is likely a substantial overestimate. Nevertheless, there is abundant suitable habitat in which the species is known to occur to the north of the Project in the Helidon Hills area. Predictive mapping indicates there is 2,359 ha of *potential habitat* for the species within the overall MNES study area. Should the species occur within the Project disturbance footprint there is potential to reduce the area of occupancy of an 'important population' for the species but only to a very minor extent.
Fragment an existing important population into two or more populations	An 'important population' has been identified as potentially occurring in the area, although it is unknown at this stage if any individuals occur within the disturbance footprint. The species is known to occur nearby and suitable habitat is predicted to occur within the disturbance area. Nevertheless, all local records occur to the north of the Project. The Project is linear but the species pollination is thought to be wind-associated and as such is unlikely to impact the population (should individuals be found to occur south of the Project disturbance footprint). It is considered unlikely the Project will fragment an existing important population into two populations.

Criterion	Assessment against significance criteria
Adversely affect habitat critical to the survival of the species	The species occurs in mixed eucalypt forest communities and modified pasture, both of which is a widespread vegetation type in the local area. Predictive mapping indicates no habitat considered as Habitat critical to the survival of the species (for the purposes of this assessment) occurring within the Project disturbance area, although 84.58 ha of *potential habitat* may occur. It is not known if the species occurs within the Project disturbance footprint. As such, the Project is considered unlikely to adversely affect *Habitat critical to the survival of the species.*
Disrupt the breeding cycle of an important population	An 'important population' has been identified as potentially occurring in the area, although it is unknown at this stage if any individuals occur within or south of the disturbance footprint. The flowering and fruiting period is from January to May. The Project is linear but the species pollination is thought to be wind-associated and as such is unlikely to impact the population (should individuals be found to occur south of the Project disturbance footprint). The Project may disturb individuals but it is considered unlikely impacts will be to the extent that the breeding cycle of the population would be disrupted.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	An 'important population' has been identified as potentially occurring in the area, although it is unknown at this stage if any individuals occur within the disturbance footprint. The species is known to occur nearby. Predictive mapping indicates 84.58 ha of *potential habitat* is predicted to occur within the Project disturbance footprint, although this is likely a substantial overestimate. Nevertheless, all local records occur to the north of the Project. There is abundant suitable habitat to the north of the Project in which the species is known to occur. It is noted the Project may be a point source for bush fires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. Given the relatively small area the Project occupies within this area the Project is not considered to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion is not identified as a threat to this species. *Lantana camara* was noted as occurring at all sites in varying densities in the Helidon area during the Project EIS surveys. Eighteen species listed as restricted matters under the Queensland *Biosecurity Act 2014* were recorded within the alignment during the surveys. Other Project-associated surveys have also noted areas of heavy infestations of weed species including 17 species listed under the Act (EMM 2019a, 2019b). Weed and pest control measures will be incorporated into the Project Biosecurity Management Sub-plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Sub-plan will be a part of the overall Project EMP. The Sub-plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Sub-plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved Conservation Advice for the species (DEWHA 2008e) identifies research priorities and regional priority actions including: ▪ Monitoring and managing known populations and identifying high conservation value populations ▪ Limiting the impact of disturbance from adjacent land use and activities associated with road maintenance and upgrading ▪ Develop a stock management plan for public lands and manage grazing practises at known sites ▪ Developing a fire management strategy for the species The Project is considered unlikely to interfere with the recovery strategies listed above. Given the relatively small area of suitable habitat impacted the Project is considered unlikely to substantially interfere with the recovery of the species.

Criterion	Assessment against significance criteria
Assessment of potential for significant residual impacts	The Project is predicted to impact 84.58 ha of potential habitat for the species although this is likely a substantial overestimate. The Project disturbance footprint is located south of all known records. The nine-part test detailed above has been undertaken in a conservative manner. The Project has a minor potential to cause 'significant residual impacts' on *an important population* of *Paspalidium grandispiculatum* should the species be found to occur within the Project disturbance footprint.

5.3.5 Significant residual impact assessment for threatened fauna

There are 17 threatened fauna species listed as MNES relevant to the MNES study area including 11 species listed as vulnerable and a further six species listed as endangered or critically endangered. The ecology, life history and distribution of these species are summarised in Appendix C. Relevant Commonwealth documents applicable to each species including threat abatement plans, Approved Conservation Advice, and recovery plans are also summarised in Appendix B. This section of the MNES report assesses the potential for significant residual impacts from the Project using the MNES Guidelines.

Key impacts to threatened fauna are considered to include the following:

- Direct clearing of species habitats
- Injury/mortality to individuals during vegetation clearing in the construction period (arboreal fauna and terrestrial fauna)
- Ongoing collisions with trains during operation of the rail line (larger arboreal and terrestrial mammal fauna).

A range of mitigation measures have been proposed to ameliorate these impacts wherever possible (refer Section 5.2.2 and species-specific measures in Table 5.7). These include measures considered as effective in addressing the recognised threats for each species as recognised in recovery plans, approved conservation advice, and DAWE-adopted threat abatement plans (as identified in the following sections for each species) including but not restricted to:

- Flora and Fauna Management Sub-plan will incorporate species-specific monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent habitats is not occurring as a result of the Project – applicable to all species
- Biosecurity Management Plan to protect fauna habitats adjacent to the Project from deleterious impacts including weed invasion, proliferation of pest predators and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*) – applicable to all species
- Erosion and Sediment Control Plan and Surface Water Sub-plan to protect water quality values associated with wetlands and waterways – applicable to aquatic species/wetland birds
- Air Quality Sub-plan includes measures to minimise dust impacts on vegetation/habitats including dust monitoring and suppression methods – applicable to all species
- 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
- Reinstatement and Rehabilitation 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 Project 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.

Impacts to aquatic species (i.e. Australian lungfish) include barrier works in waterways, impacts to riparian and instream habitat, and surface water quality (refer Table 5.7). These impacts are expected to be temporary and largely during Project construction (i.e. sporadic maintenance works may be required at sites during the Project operation). The proposed tunnel will require ongoing release of groundwater seeping into the tunnel during the life of the Project. Groundwater entering the tunnel will be released as surface water flows via the eastern portal. The groundwater will be treated prior to discharge. Discharged waters will be required to meet established water quality objectives for receiving (downstream) waterways. There are no predicted impacts to downstream habitats (refer EIS Chapter 13: Surface water and Hydrology and Chapter 14: Groundwater for further detail).

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

- The design and layout of the Project (refer Section 1.7)
- Currently known information about the MNES affected (refer Appendix B)
- Predictive habitat modelling for MNES species (refer Table 5.4) based on the habitat assumptions associated with each species (refer Appendix A)
- Information on potential impacts of Project construction and operation (refer Section 5.1)
- Proposed Project mitigation measures (refer Section 5.2 and Table 5.7).

In addition, it is noted that targeted surveys for most fauna species have not been carried out thus far as part of Project ecology surveys. ARTC are committed to undertaking additional pre-clearing surveys in accordance with relevant State and Commonwealth guidelines throughout the Project disturbance footprint and where any of these species are encountered (or any additional threatened species) or habitat critical for the survival of the species is identified the habitat mapping and the above assumptions will be reassessed and appropriate mitigation measures developed with regard to the recovery plans and conservation advices, including changes to offset requirements and disturbance limits.

A summary of the findings of the assessment of the significant residual impact assessment for threatened fauna is provided in Table 5.16. Section 5.3.5.1 provides the significant impact assessment for Critically endangered and endangered species, and Section 5.3.5.3 provides the significant impact assessment for vulnerable species with potential to be impacted by the Project.

Table 5.16 Summary of the results of the significant impact assessment for matters of national environmental significance fauna species

Flora species	EPBC Act status*	Results of assessment	Table containing assessment against MNES guidelines
Regent honeyeater (*Anthochaera phrygia*)	E	No significant residual impact – no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint	Table 5.17
Australasian bittern (*Botaurus poiciloptilus*)	E	No significant residual impact – no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint	Table 5.18
Curlew sandpiper (*Calidris ferruginea*)	CE	No significant residual impact – no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint	Table 5.19
Spotted-tail quoll (*Dasyurus maculatus maculatus*)	E	Possible that the Project will have a significant impact	Table 5.20
Swift parrot (*Lathamus discolor*)	CE	Significant residual impact likely	Table 5.21
Australian painted snipe (*Rostratula australis*)	E	Possible that the Project will have a significant impact	Table 5.22

Flora species	EPBC Act status*	Results of assessment	Table containing assessment against MNES guidelines
Collared delma (*Delma torquata*)	V	Significant residual impact likely	Table 5.24
Red goshawk (*Erythrotriorchis radiatus*)	V	Possible that the Project will have a significant impact	Table 5.25
Grey falcon (*Falco hypoleucos*)	V	No significant residual impact – no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint	Table 5.23
Painted honeyeater (*Grantiella picta*)	V	No significant residual impact – no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint	Table 5.23
Australian lungfish (*Neoceratodus forsteri*)	V	No significant residual impact	Table 5.26
Greater glider (*Petauroides volans*)	V	No significant residual impact – no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint	Table 5.27
Brush-tailed rock-wallaby (*Petrogale penicillata*)	V	Possible that the Project will have a significant impact	Table 5.28
Koala (*Phascolarctos cinereus*)	V	Significant residual impact likely	Table 5.29 and Table 5.30
Long-nosed potoroo (*Potorous tridactylus tridactylus*)	V	No significant residual impact – no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint	Table 5.23
New Holland mouse (*Pseudomys novaehollandiae*)	V	Possible that the Project will have a significant impact.	Table 5.31
Grey-headed flying-fox (*Pteropus poliocephalus*)	V	Possible that the Project will have a significant impact.	Table 5.32

Table notes:

* CE = Critically endangered, E = Endangered, V = Vulnerable

5.3.5.1 Critically endangered and endangered fauna species

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable species, occurrences include but are not limited to:

- A geographically distinct regional population, or collection of local populations
- A population, or collection of local populations, that occurs within a particular bioregion.

Under the Guidelines an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population
- Reduce the area of occupancy of the species
- Fragment an existing population into two or more populations
- Adversely affect *Habitat critical to the survival of the species*
- Disrupt the breeding cycle of a population

- Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- Introduce disease that may cause the species to decline
- Interfere with the recovery of the species.

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitats may be, but are not limited to: habitat identifies in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the register of Critical Habitat maintained by the Minister under the EPBC Act.

Impacts and mitigation measures associated with these species are identified within Table 5.7. The following sections assess the potential for significant residual impacts on the 10 endangered or critically endangered fauna species identified as potentially occurring within the Project disturbance footprint using the criteria set out in the Guidelines.

Regent honeyeater (*Anthochaera phrygia*) - endangered

Ecology and distribution

Regent honeyeater is largely known to occur in box-ironbark eucalypt woodlands. The preferred habitat is wet areas containing fertile soils that provide reliable nectar seasonally in areas of creek flats, river valleys and lower slopes. They are also found in dry eucalypt woodland and open forest in both rural and urban environments with mature eucalypts (DES 2017a). The Regent honeyeater's diet consists of nectar from key species such as Yellow Box (*Eucalyptus melliodora*), White Box (*Eucalyptus albens*) and Mugga Ironbark (*Eucalyptus sideroxylon*) as well as sugary exudates. It also forages in Swamp mahogany (*Eucalyptus robusta*) and Spotted gum (*Corymbia maculate*) close to the coast. The species is also known to consume insects particularly when breeding (Birdlife International 2016a). The species prefers mature large trees that produce more flowers, particularly those on fertile soils and in riparian areas (DotE 2016). The species breeds as individual pairs or sometimes in loose colonies with the female honeyeater incubating eggs whilst both parents feed the young.

The Regent honeyeater is endemic to south-east Australia, ranging from SEQ to central Victoria. In SEQ, the Regent Honeyeater's distribution ranges from the Cooloola Plains in the north to inland areas such as Dalby, and further south into areas such as Narrabri (NSW). Regent honeyeater is known to breed in small numbers regularly to the west of Warwick in Durikai State Forest (over 80 km south-west of the Project). The species is considered to comprise one population with some movements of individuals between regularly used areas (Garnett et al 2011).

Distribution in context to the Project

Regent honeyeater is transient in the Lockyer Valley/greater Brisbane region, being sporadically recorded in the winter months. It is noted AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. Database records (i.e. AoLA) indicate this species has been recorded approximately 5 km north-west of the western extent of the Project disturbance footprint in the Helidon Hills however this record is older (pre-1980), does not have a recorded sighting date and is not spatially reliable. A second record exists further north within the Lockyer Reserves, however has the same date and spatial issues. There are a large number of records to the east of the Project from 2019 located over 25 km from the Project disturbance footprint. Many of these records are likely associated with a well known pair of birds that occurred in urban parklands in the Springfield Lakes area over an extended period in winter 2019 (pers. comm. B Taylor) (refer Figure 5.21 in Appendix B). Records to the south of the Project include Main Range National Park (2000) and an older record (<1980) from Mount Alford area. Both of these records are over 30 km south of the Project disturbance footprint (AoLA 2020).

Recovery plans/threat abatement plans

The *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) has been adopted by DAWE and has been in effect since May 2016. The Plan identifies the following threatening processes as applicable to the species:

- Small population size
- Habitat loss, fragmentation and degradation
- Competition with other nectivorous bird species as well as European honeybees (*Apis mellifera*)

Other identified threats include:

- Suppression of natural regeneration of overstorey tree species and shrub species as a result of overgrazing
- Disturbance to nesting sites leading to abandonment (DES 2017a).

The following threat abatement plan has been identified has been adopted as relevant to this species:

- *Threat abatement plan for competition and land degradation by rabbits* (DotE 2016).

Important populations and Habitat critical to the survival of the species

There are no important populations identified for this species. The overall population is difficult to define due to fluctuating numbers between years but is estimated at 350 to 400 mature individuals. The species is considered to occur as single widespread inter-breeding population (Garnett et al 2011). The *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) identifies the following as *Habitat critical to the survival* of the Regent honeyeater:

- Any breeding or foraging area where the species is likely to occur
- Any newly discovered breeding or foraging areas

Three known key breeding regions include:

- North-east Victoria (Chiltern-Albury)
- Capertee Valley NSW
- Bundarra-Barraba region NSW (DotE 2016).

The nearest breeding site to the Project is the Durikai area over 80 km south-west of the Project. The species may sporadically occur as foraging individuals/pairs within the Project disturbance footprint during flowering events but it is not considered 'likely to occur'. There is no evidence the species occurs regularly/seasonally anywhere within the MNES study area or surrounds. The species forages widely and may as easily occur in modified urban environments as well as natural woodlands. This assessment has defined *Habitat critical to the survival of the species* by applying a 1 km buffer on known records that intersect *potential habitat* for the species (refer Appendix A for methodology). As such, the Project disturbance footprint is not considered to comprise *Habitat critical to the survival of the species*.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Impact assessment for this species predicts that 84.58 ha of *potential habitat* used for foraging may be impacted under the current Project disturbance footprint (refer Table 5.4 and habitat figure in Appendix F). Assessment of potential impacts to this species against the MNES significant impact assessment criteria is provided in Table 5.17.

Table 5.17 Assessment against the significant impact criteria – Regent honeyeater

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	As noted above there are no identified important breeding locations or habitat critical to the survival of the species as identified in the *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) which are within or near the MNES assessment area. The nearest known breeding location is Durikai State Forest which is over 80 km south-west of the Project. However, the species now rarely visits the Durikai (Gore-Karara) region (NESPTSRH 2019). Key breeding regions include: ▪ North-east Victoria (Chiltern-Albury) ▪ Capertee Valley NSW ▪ Bundarra-Barraba region NSW (DotE 2016). The species is considered to occur as a single interbreeding population across its range. The species is only likely to occur in the MNES study area transiently (in winter during flowering events) in small numbers, if the species occurs in the area at all. No individuals have been observed during field investigations associated with the Project. The opening up of corridors within tracts of habitat may have potential to lead to an increase in aggressive/competitive honeyeater species accessing previously undisturbed woodlands. Nevertheless, this is not expected to be an impact from the Project. The Project occurs largely in heavily disturbed lands. The proposed tunnel will leave a substantial area of vegetation in the Little Liverpool Range undisturbed. It is uncertain how many individuals occur in the area or if the species occurs in the area at all. The nearest database record (AoLA) is located approximately 5 km from the Project disturbance footprint, however this record is classified as sensitive and has been generalised to 0.1 degrees and may be located further away from the Project. It is considered likely that potential foraging individuals disturbed by construction activities will temporarily move away from the area of disturbance and return post-construction. Predictive mapping for this species predicts that 84.58 ha of *potential habitat* (foraging) may be impacted under the current disturbance footprint. Nevertheless, the species can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The Project is considered unlikely to result in a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	It is estimated the Project will result in the loss of 84.58 ha of *potential habitat* (foraging) for the species, although this represents predicted habitat. The nearest database record (AoLA) is located approximately 5 km from the Project disturbance footprint (generalised to 0.1 degrees) and no individuals were observed during field investigations associated with the Project. The Project is located to the east of the Great Dividing Range, with the species known from vagrant records in the region. The nearest database record (AoLA) is located approximately 5 km from the Project (generalised to 0.1 degrees) and no individuals were observed during field investigations associated with the Project. The species now rarely visits the Durikai (Gore-Karara) region of Queensland (NESPTSRH 2019) where the majority of Queensland records are from. This may be a result of recent dry conditions in the region. Drought conditions reduces the number of locations where high quality food may be found in the landscape by suppressing flowering events in key eucalypt species.

Criterion	Assessment against significance criteria
	The species is only likely to occur in the MNES study area transiently (in winter during flowering events) in small numbers, if the species occurs in the area at all. Therefore, no areas of known occupancy are considered to occur within the Project disturbance footprint and the Project is not likely to reduce the potential area of occupancy for the species.
Fragment an existing population into two or more populations	The species is highly mobile and the Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of the species	The *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) identifies the following as habitat critical to the survival of the Regent honeyeater: ▪ Any breeding or foraging area where the species is likely to occur ▪ Any newly discovered breeding or foraging areas. The Project is located east of the Great Dividing Range in an area mapped as where the species may occur (DAWE 2020b), The Project is located 80 km north-east of a key region known to support this species (breeding and foraging) in Queensland (i.e. Durikai State Forest and surrounds). No individuals have been observed foraging or breeding within or adjacent the Project disturbance footprint, with the nearest database record (AoLA) located approximately 6 km from the Project (generalised to 0.1 degrees). The absence of the species may be the extended dry weather reducing the number of sites where high quality food may be found in the landscape, noting that over 920 ha of *potential habitat* has been predicted to occur with the MNES study area. Recent studies have however noted this species now rarely visits the Durikai (Gore-Karara) region (NESPTSRH 2019), much less the area associated with the Project. It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	It is uncertain how many individuals occur in the area or if the species occurs in the area at all. The nearest breeding records are located in Durikai State Forest and are over 80 km south-west of the Project disturbance footprint. Three known key breeding regions include: ▪ North-east Victoria (Chiltern-Albury) ▪ Capertee Valley NSW ▪ Bundarra-Barraba region NSW (DotE 2016). The nearest breeding records are located in Durikai State Forest and are over 100 km south-west of the Project. This area is considered to be habitat critical for the species given the area is known to support the species. However, the species now rarely visits the Durikai (Gore-Karara) region (NESPTSRH 2019). It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historical records of the species within the MNES study area and the species is currently considered as rare in the region. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The 84.58 ha of *potential habitat* that is estimated to be cleared is not considered critical to the survival of the species. The nearest *Habitat critical to the survival of the species* is in Durikai State Forest over 80 km south-west of the Project disturbance footprint. The species can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. This impact is not considered to be of the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Habitat degradation by European rabbit (*Oryctolagus cuniculs*) has been identified as a threatening process for Regent Honeyeater (DotEE 2016). Rabbits were identified as present during Project-associated surveys. There are no particular weed species identified as relevant to the species. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 17 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2019a, 2019b). Relevant habitats for the species (eucalypt open forest and woodlands) within the MNES assessment area were often noted to have high levels of introduced species (particularly *Lantana camara* and *Opuntia* species) during the Project EIS surveys.

Criterion	Assessment against significance criteria
	Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and potential use of Project infrastructure as shelter by pest fauna such as European rabbit. The Plan will be in place for the life of the Project and will minimise the potential for weed and pest invasion or spread. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	Recovery strategies listed in the *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) include: ▪ Improve the extent and quality of Regent honeyeater habitat ▪ Bolster the wild population with captive-bred birds until the wild population becomes self-sustaining ▪ Increase understanding of the size, structure, trajectory and viability of the wild population ▪ Maintain and increase community awareness, understanding and involvement in the recovery program The Project is considered unlikely to interfere with any of the recovery strategies listed above to the extent it will interfere with the recovery of the species. The species is only sporadically recorded in the wider area. Should Regent honeyeater be identified during Project activities this will contribute to current information on the species in the SEQ region.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is unlikely to be a 'significant residual impact' on Regent honeyeater as a result of the Project.

Australasian bittern (*Botaurus poiciloptilus*) - endangered

Ecology and distribution

The Australasian bittern (Botaurus poiciloptilus) is a large stocky, partially nocturnal heron which can reach up to a total body length of 75 cm with a wingspan just over 1 m. Australian bittern is largely a solitary species although sometimes can be found in pairs or small dispersed groups. Preferred habitat for the Australasian bittern consists of permanent freshwater wetlands with tall dense vegetation including bulrushes (*Typha* spp.), spikerushes (*Eleocharis* spp.) and tall emergent sedges. Rice paddies within the Murray-Darling basin are a known habitat for the species who disperse widely during periods of droughts to coastal wetlands and to ephemeral wetlands. The species breed around summer, between October and February, as solitary pairs and begin building nests in secluded, densely vegetated wetlands on platforms of reeds approximately 30 cm above water level. (Birdlife International 2016b; OEH 2017a).

This species occurs from Bundaberg in SEQ south to Victoria and west into South Australia.

Distribution in context to the Project

The species was not identified during Project surveys, although dry conditions at the time likely precluded the species from being present. The nearest database record is located 4.5 km to the north-west of the western extent of the Project disturbance footprint in the Lockyer Reserves area, however this record is older (pre-1980), does not have a recorded sighting date and is not spatially reliable. Location information refers only to the Lockyer Valley. This record has been generalised to protect the species and so may not reflect the actual occurrence location. There are a few similar records in the region to the north of the Project. The nearest dated records are from Lake Clarendon (north of Gatton) (2009 and 1990) located 6.5 km north of the Project disturbance footprint (refer Figure 5.2 in Appendix A). Lake Clarendon is identified as a 'key area' for sightings of the species.

Wetland habitats within the MNES study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (palustrine). Dams and reservoirs are generally unlikely to provide suitable dense aquatic vegetation for the species. Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants and Queensland bluegum (*Eucalyptus tereticornis*). Riverine wetlands through much of the Project disturbance footprint are highly degraded with little aquatic vegetation present suitable for Australian bittern (refer Section 4.4.4.6 and EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for further detail). Wetlands considered to be of 'high ecological significance' under State mapping are intersected by the eastern extent of the Project disturbance footprint (north-west of Helidon) and are associated with the local hydrological catchment of Lockyer Creek.

Palustrine wetlands within the MNES study area typically occur on alluvial floodplains and may be dominated by grasses (Poaceae), rushes (Restionaceae) and/or sedges (Cyperaceae). Areas of remnant Palustrine wetland within the MNES study area are represented by RE 12.3.8 and are considered the most likely wetland habitat present with potentially suitable values for Australasian bittern although these areas are highly ephemeral in nature (refer Section 4.4.4.7). There are two wetlands corresponding to this RE at the western extent of the Project (east of Calvert) although both lie outside of the Project disturbance footprint (90 m and 300 m north respectively) (refer EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for further detail regarding wetland values).

Recovery plans/threat abatement plans

There is currently a draft *National recovery plan for the Australasian bittern (Botaurus poiciloptilus*) (DotEE 2019b) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Reduced wetland availability due to changed hydrology
- Habitat loss and degradation such as reduced water quality
- Low genetic diversity
- Invasive species including herbivores impacting habitat (horses, pigs, goats and deer) and predators (red fox, cats, rats and pigs)
- Climate variability and change

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008g)

Important populations and Habitat critical to the survival of the species

Population estimates of the number of adult birds in Queensland from 2009 to 2010 are 3 to 16 individuals in Queensland (Garnett et al 2011). The draft *National recovery plan for the Australasian bittern (Botaurus poiciloptilus*) (DotEE 2019b) identifies all populations of Australasian bittern should be considered as important. Habitat 'critical to the survival of the species' is described as:

- Any wetland habitat where the species is known or likely to occur (breeding or foraging habitat) within the indicative distribution map
- Any location with suitable habitat outside the above area that may be periodically occupied by Australasian Bittern.

The Project disturbance footprint is located outside of the known or likely to occur habitat mapped within the distribution map.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat modelling for the species estimates that 15.43 ha of *potential habitat* may be impacted under the current disturbance footprint (refer Table 5.4 and habitat figure in Appendix F). *Habitat critical to the survival of the species* is not considered to occur. The predictive habitat mapping has been approached in a conservative manner and is based on the inclusion of all wetland habitat within the disturbance footprint (refer Appendix A for methodology). This is largely modelled on available vegetation and corresponding wetland community mapping as provided by DES. This includes creek line vegetation and waterbodies and farm dams which are much less likely to present suitable habitat values (tall aquatic vegetation) for the species. Given the ephemeral nature of most natural wetlands in the area the predictive habitat figure is likely to be an overestimation of the available habitat suitable for this species in the disturbance footprint.

Nevertheless, given suitable habitat is predicted to be present and under the definition identified above there is potential the Project will impact potential habitat for Australasian bittern. Assessment of potential impacts to this species against the MNES significant impact assessment criteria is provided in Table 5.18.

Table 5.18 Assessment against the significant impact criteria – Australasian bittern

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	The species occurs as a widely dispersed population (estimated at 3,500 individuals) across south-eastern Australia. As such, no resident population can be attributed to the MNES study area or immediate surrounds. There are no records of this species within or adjacent to the MNES study area, though habitat is known to exist in the Lockyer Valley which is likely to be large permanent wetlands (DotEE 2019b). This is supported by database records, with several records of the species in the wider area surrounding the Project including Lake Clarendon. Should the species occur within the disturbance footprint it is unlikely to occur as more than one or two individuals at a site (i.e. the Project is unlikely to impact a population). As outlined in Section 4.4.4 and above there are wetlands present surrounding the Project. Predictive mapping estimates that 15.43 ha of *potential habitat* will be impacted by the Project although this is likely to be an overestimation given that the wetland systems present are ephemeral and have limited vegetation cover (dense aquatic vegetation is a key feature of preferred habitat). The condition characteristics of these systems across the Project disturbance footprint is variable and it is unknown at this stage to what extent the predicted wetland habitat comprises values suitable for the presence of Australasian bittern (i.e. the majority of the wetlands were dry during the field surveys and the values could not be confirmed). As noted in Section 5.1.2 the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. Construction activity at watercourse crossings will disturb the riparian zone and instream habitats, including *potential habitat* for the species. Activities will include clearing of vegetation, reprofiling of banks and instream substrate, deposition of material (e.g. rip rap for erosion and sediment control), erection of temporary barriers (e.g. coffer dam), water extraction, disturbance of sediment causing elevated nutrients and turbidity, and result in the loss of wetlands and direct disturbance of local individuals (should they occur within the Project disturbance footprint). However, the species is less likely to occur in riverine environments and this disturbance is expected to be restricted to the construction period with occasional works during the operation of the Project (design life of 100 years). The Project will not create any permanent barriers to flow as watercourse crossings will consist of bridges or culverts. Following construction localised habitat suitable for the species is expected to return to its prior natural conditions. The use of bridge structures across some of the major watercourses and associated floodplains (e.g. Lockyer Creek) will also avoid and/or minimise the impact to riparian zones, wetlands and instream habitat (e.g. footings are outside the channel or the highwater banks). Flood modelling (refer Appendix M of the EIS: Hydrology and Flooding Technical Report) indicates local changes to the catchment hydrology is minimal, including on the mapped wetlands identified in the Calvert area (refer Section 4.4.4.7).

Criterion	Assessment against significance criteria
	Under the Project Flora and Fauna Sub-plan pre-construction surveys will be carried out following optimal (wet) conditions to assess whether wetland habitat values are suitable for the species, and if so, if the species occurs. Surveys will follow Commonwealth survey guidelines for the species (e.g. DEWHA 2010a). If the species or habitat is identified during pre-construction surveys, further pre-clearance surveys will be carried out to assess whether the species is present with mitigation measures in place should this be the case (refer Table 5.7). Should the species be found individuals would be expected to disperse from the construction area. The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of the population.
Reduce the area of occupancy of the species	There are no reliable records of this species within or close to the Project disturbance footprint. Predictive mapping estimates that 15.43 ha of *potential habitat* may be impacted by the Project, although this is likely to be an overestimation. It is unknown at this stage to what extent the predicted wetland habitat within the Project disturbance footprint comprises values suitable for the presence of Australasian bittern. No database records of the species occur within the MNES study area, although there are several records in the wider surrounds. It is unknown to what extent the species may utilise wetland habitats associated with the Project disturbance footprint, or if it occurs at all. The species is nomadic and unlikely to use these areas in more than a transient manner dependent on local conditions. The impacts of the Project are considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	The species is highly mobile. Individuals have been shown to disperse over 100 km in response to changing wetland conditions (Bitterns in Rice Project 2016). The Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	There are no reliable records of this species within or close to the Project disturbance footprint. Predictive mapping estimates that 15.43 ha of *potential habitat* will be impacted by the Project, although this is likely to be an overestimation. *Habitat critical to the survival of the species* is not considered to occur. There Project is considered unlikely to adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	There are no reliable records of this species within or close to the Project disturbance footprint. Predictive mapping estimates that 15.43 ha of *potential habitat* will be impacted by the Project, although this is likely to be an overestimation. If the species is present this habitat may be used by the species for breeding. The species is known to breed from October to February, nesting in densely vegetated freshwater wetlands, building nests within dense cover over shallow water placed about 30 cm above the water level. This type of habitat is absent/limited from the Project disturbance footprint. It is noted that if population densities are high, the species may resort to more open wetlands for nesting (DotEE 2019b). However, the population in Queensland is considered low, with Garnet (2011) estimating it to be between 3 and 16 mature individuals. Pre-construction surveys will be carried out to assess whether wetland habitat values are suitable for the species, and where suitable habitat is identified whether the species occurs. Should the species be observed as nesting measures will be in place within the Project Flora and Fauna Sub-plan to allow nesting to occur undisturbed (refer Table 5.7). It is possible that Australasian bittern individuals could be disrupted during breeding, but it is considered very unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no reliable records of this species within or close to the Project disturbance footprint. Predictive mapping estimates that 15.43 ha of *potential habitat* will be impacted by the Project, although this is likely to be an overestimation. It is unlikely much of this area is of a suitable quality to support the species. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). Nevertheless, given the species wide range of occurrence it is unlikely the Project would impact suitable habitat to the extent the species would decline.

Criterion	Assessment against significance criteria
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	There are no particular weed species identified as relevant to Australasian bittern, although invasion of wetland habitat by weeds is considered a potential threat (TSSC 2019). Project-associated surveys have noted Canadian pondweed (*Elodea* spp.) as currently present in some waterways within the MNES study area. Surveys also recorded feral cat which is thought to be a threat to the species. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Project is not expected to lead to increased abundances of introduced predator species. Nevertheless, measures will be incorporated to monitor pest species observations associated with Project activities, and pest control actions where considered necessary. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and pest proliferation and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	Conservation objectives listed in the draft Commonwealth recovery plan for the species (DotEE 2019a) include: ▪ Identify the key sites where Australasian Bitterns occur throughout their range and establish a baseline measure of abundance. This baseline will then be used to track change over time. ▪ Manage key sites to ensure habitat is suitable for Australasian Bitterns. This will require measures that primarily target adequate water flow and quality, and measures to ensure weed species and grazing animals do not compromise wetland structure and function. ▪ Improve understanding of foraging and breeding behaviour, in order to better design recovery actions. ▪ Engage community and stakeholders in Australasian Bittern conservation. The Project is considered unlikely to interfere with any of the recovery strategies listed above. Key sites are unlikely to occur and should Australasian bittern be identified during Project activities this will contribute to current information on the species in the SEQ region.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is unlikely to be a 'significant residual impact' on Australasian bittern as a result of the Project.

Curlew sandpiper (*Calidris ferruginea*) – critically endangered

Ecology and distribution

In Australia, the Curlew sandpiper forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Curlew sandpipers usually forage by pecking and probing in water, near the shore or on bare wet mud at the edge of wetlands. They glean from mud, from the surface of water, or in drier areas above the edge of the water. Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand (DAWE 2020b).

The species breeds in Siberia in the northern hemisphere summer. The species has been recorded in all Australian states and territories. In Queensland, widespread records occur along the coast south of Cairns with sparsely scattered records inland. The species migrates to Australia in the non-breeding season arriving in early September and leaving in March-April. Younger birds may over-winter in Australia (DotE 2015d).

Distribution in context to the Project

The nearest record (i.e. AoLA) of this species is from Lake Apex in Gatton located 2 km south of the Project disturbance footprint (the recorded date is uncertain based on the data associated with the record). The closest recent record (2001) of the species to the Project is from Lake Dyer (Bill Gunn Dam) in the Laidley area approximately 2 km south of the Project disturbance footprint (AoLA 2020). An older record (<1985) is located in the Plainlands area approximately 4 km north of the Project disturbance footprint. However, this record has a high spatial uncertainty attached and no location information and has been disregarded. There are also recent records from the wider Gatton area including 2017 and 2018 records from Lake Clarendon (6.5 km north of the Project), a 2009 record from Janke's Swamp (4 km north of the Project) and 2003 records from Atkinson's Lagoon in Gatton (20 km north of the Project). The majority of records from the region are coastal or from inshore islands in Moreton Bay (refer Figure 5.27 in Appendix B).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved Conservation Advice (DotE 2015d) notes the following potentially threatening processes identified for Australian habitat as relevant to Curlew sandpiper:

- In non-breeding grounds in Australia, this species mostly occurs in highly populated areas and is therefore vulnerable to possible habitat alteration
- Threats to the Curlew sandpiper include the loss and fragmentation of feeding and roosting habitat from human development, human disturbance at roost and feeding sites, disturbance by wild dogs, water pollution and invasive plants

Important populations and Habitat critical to the survival of the species

The breeding population of Curlew sandpiper migrating to Australia occurs across much of the Australian coastline as well as some inland sites. As such there is no important population relevant to individual locations. There is no description of Habitat critical to the survival of the species for this species. 'Nationally important habitat' for migratory shorebirds in Australia is described as comprising 0.1 per cent of the flyway population of a single species of migratory shorebird (DotE 2017). For Curlew sandpiper this equates to 90 individuals based on current population estimates (Hansen et al 2016). There is no evidence the Project disturbance footprint or surrounding MNES study area comprises any areas of suitable open wetland habitat capable of supporting this many individuals. The species is very unlikely to utilise riverine wetland habitat in the area the dominant wetland type within the MNES study area, though these areas have been conservatively mapped as potential habitat. All known inland records of the species occurrence in the local region are located on large permanent or semi-permanent waterbodies in the Lockyer Valley and located well away from the Project disturbance footprint. The nearest 'nationally important habitat' for migratory waders to the Project is the Moreton Bay Ramsar wetland area which is located over 65 km downstream of the Project.

Impacts and mitigation measures associated with this species are identified within Table 5.7. The Project is predicted to impact 15.43 ha of potential habitat for Curlew sandpiper under the predictive mapping approach used for this assessment (refer Table 5.4 and habitat figure in Appendix F). However, the predictive habitat mapping has been approached in a conservative manner and is largely modelled on available vegetation and corresponding wetland communities mapping provided by DES. This includes riverine habitats and farm dams which are much less likely to provide suitable habitat values for the species. Given the species coastal habits and the ephemeral nature of most natural wetlands in the area the predictive habitat figure is likely to be a substantial overestimation of the available habitat suitable for this species in the disturbance footprint. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology). As such, there is no Habitat critical to the survival of the species identified within the Project disturbance footprint.

Assessment against the significant impact criteria for endangered species is shown in Table 5.19.

Table 5.19 Assessment against the significant impact criteria: Curlew sandpiper

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	Based on habitat modelling the Project predominantly avoids wetland habitats (Refer Section 4.4.4.7) though the Project is predicted to impact 15.43 ha of potential habitat for Curlew sandpiper although this is likely an overestimation (i.e. habitat mapping includes watercourses mapped as riverine wetlands/waterbodies, although the species is not associated with this type of habitat). In addition, bridge structures will be provided to avoid/minimise impacts on instream habitats and wetlands. It is unlikely the Project disturbance footprint or immediate surrounds comprises habitat likely to support large numbers of individuals of the species. There are no historic records of this species within the MNES study area, although there are relatively recent records (2001) from Lake Dyer near Laidley. Lake Dyer is located 2 km south of the Project and will not be impacted by Project activities. The species occurs as a dispersed population around coastal Australia. As outlined in Section 4.4.4 and above there are wetlands present surrounding the Project. Predictive mapping estimates that 15.43 ha of *potential habitat* will be impacted by the Project although this is likely to be an overestimation given that the wetlands systems present are ephemeral and have limited vegetation cover with dense vegetation a key feature of preferred habitat. The condition characteristics of these systems across the Project disturbance footprint is variable, with it unknown at this stage to what extent the predicted wetland habitat comprises values suitable for the presence of Australasian bittern (i.e. the majority of the wetlands were dry during the field surveys and the values could not be confirmed). As noted in Section 5.1.2 the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. Construction activity at watercourse crossings will disturb the riparian zone and instream habitats, including *potential habitat* for the species. Activities will include clearing of vegetation, reprofiling of banks and instream substrate, deposition of material (e.g. rip rap for erosion and sediment control), erection of temporary barriers (e.g. coffer dam), water extraction, disturbance of sediment causing elevated nutrients and turbidity, and result in the loss of wetlands and direct disturbance of local individuals (should they occur within the Project disturbance footprint). However, the species is less likely to occur in riverine environments and this disturbance is expected to be restricted to the construction period with occasional works during the operation of the Project (design life of 100 years). The Project will not create any permanent barriers to flow as watercourse crossings will consist of bridges or culverts. Following construction localised habitat suitable for the species is expected to return to its prior natural conditions. The use of bridge structures across some of the major watercourses and associated floodplains (e.g. Lockyer Creek) will also avoid and/or minimise the impact to riparian zones, wetlands and instream habitat (e.g. footings are outside the channel or the highwater banks). Flood modelling (refer Appendix M of the EIS: Hydrology and Flooding Technical Report) indicates local changes to the catchment hydrology is minimal. The Project is unlikely to result in a long-term decrease in the size of a population of Curlew sandpiper.

Criterion	Assessment against significance criteria
Reduce the area of occupancy of the species	Based on habitat modelling the Project is predicted to impact 15.43 ha of *potential habitat* for Curlew sandpiper although this is likely an overestimation. It is unknown if the species actually occurs within or near the Project disturbance footprint, and it is unlikely the Project disturbance footprint or surrounds comprises habitat likely to support large numbers of individuals of the species. There are no historic records of this species within the MNES study area, although there are relatively recent records (2001) from Lake Dyer near Laidley. Lake Dyer is located 2 km south of the Project and will not be impacted by Project activities. The species occurrence is largely coastal and occurs as a dispersed population around coastal Australia. The Project is considered unlikely to reduce the potential area of occupancy for the species.
Fragment an existing population into two or more populations	The population of Curlew sandpiper is distributed across much of coastal Australia. It is considered inconceivable the Project will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of a species	The Project disturbance footprint does not comprise *Habitat critical to the survival of the species* as described for this assessment (refer Table 5.4 and Appendix A), or nationally important habitat as described by DotEE (2017). It is considered unlikely that the Project will adversely affect *Habitat critical to the survival of the species.*
Disrupt the breeding cycle of a population	The species breeds in the northern hemisphere. It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Based on habitat modelling the Project is predicted to impact 15.43 ha of potential habitat for Curlew sandpiper although this is likely an overestimation. There are no historic records of this species within the MNES study area, although there are relatively recent records (2001) from Lake Dyer near Laidley. Lake Dyer is located 2 km south and up-gradient of the Project and will not be impacted by Project activities. While Lake Clarendon, an off-stream storage located east of Gatton, is unlikely to be hydrologically linked to the Project. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). Nevertheless, the species occurrence is largely coastal. The Project is not considered to impact the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	There are no particular weed species identified as relevant to Curlew sandpiper, although invasion of wetland habitat by weeds is considered a potential threat (DotE 2015d). Project-associated surveys have noted aquatic weeds Canadian pondweed (*Elodea* spp.) as currently present within the MNES study area. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be a part of the overall Project EMP. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criterion	Assessment against significance criteria
Interfere with the recovery of the species	There is no recovery plan for Curlew sandpiper or migratory shorebirds in general. The approved conservation advice for this species (DotE 2015d) notes the following management actions: ▪ Improve protection, management, and monitoring of roosting and feeding sites ▪ Control of invasive species at important sites ▪ Manage disturbance at important sites (e.g. horse riding, pet dog controls, and vehicle access) ▪ Incorporate coastal planning and management requirements addressing Curlew sandpiper. The Project is considered unlikely to interfere with the management actions listed above and is very unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there will be no 'significant residual impact' on Curlew sandpiper as a result of the Project.

Spotted-tail quoll (*Dasyurus maculatus maculatus*) - endangered

Ecology and distribution

Spotted-tail quolls have been recorded from a wide range of habitats, including temperate and subtropical rainforests in mountain areas, wet sclerophyll forest, lowland forests, open and closed eucalypt woodlands, inland riparian and River red gum (*Eucalyptus camaldulensis*) forests, dry 'rainshadow' woodland, sub-alpine woodlands, coastal heathlands and occasionally in open country/other treeless areas. Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves (DAWE 2020b). The species requires large home ranges of several hundred hectares (Victorian Department of Environment, Land, Water and Planning (DELWP) 2016).

In Queensland, the Spotted-tail quoll occurs in the southeast, coastally from Bundaberg to the NSW border, and inland to Monto and Stanthorpe. Spotted-tail quolls are known from five broad geographic regions: four from coastal ranges and the Great Dividing Range from the NSW border to Gladstone. The fifth is centred on the eastern Darling Downs-Inglewood Sandstone provinces of the Brigalow Belt South Bioregion. Unconfirmed reports suggest the subspecies may also occur in the Clarke and Conway Range areas, along the central Queensland coast.

Distribution in context to the Project

There are a number of older database records in the region surrounding the MNES study area. The nearest record is from 1975 in the Rosewood area (located 7 km east of the Project disturbance footprint). There is a 1989 record from the Atkinson's Dam area located 16 km north of the MNES study area. There are other scattered records within 50 km of the MNES study area, although no post 1995 records are within 35 km of the Project disturbance footprint (refer Figure 4.18 in Appendix B). The nearest recent records (post 2000) are located in the Greenbank area (40 km east) and the Wivenhoe/D'Aguilar Range area (over 40 km north of the eastern extent of the Project).

Habitat assessments carried out for the EIS studies identified very little suitable rocky denning habitat within the MNES study area and none within the Project disturbance footprint itself (refer habitat assessment sheets in Appendix H). The most likely habitat for the species may be where the Project intersects the lower slopes of Helidon Hills which may support the species given the extensive habitat remaining in this area. The Little Liverpool Range may also support this species, although the area relevant to the Project is subject to a large amount of disturbance including rural housing, and existing road and rail infrastructure. Suitable denning habitat (extensive rocky areas) for the species was not observed in this area during Project surveys.

Recovery plan/threat abatement plans

The *National recovery plan for the Spotted-tail quoll (Dasyurus maculatus*) (DEWLP 2016) identifies the following threatening processes as applicable to the species:

- Habitat loss and fragmentation
- Targeted killing and poison baiting (directed at introduced predators)
- Ingestion of Cane toads (*Rhinella marina*)
- Invasive predators (red fox, cats and wild dogs)
- Road mortality
- Climate change and increased fire frequency/intensity

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008g)

Important populations and Habitat critical to the survival of the species

The overall Australian population (including all subspecies) is not reliably known but is estimated to be 20,000 mature individuals (Woinarski et al 2014). Important populations in southern Queensland include the Granite belt region around Stanthorpe, the Cherrabah area, the ranges extending from Main Range to Lamington National Parks, the Burnett Range and the Dalby region (DEWLP 2016). Main Range and Lamington National Parks are located over 30 km south from the MNES study area.

The recovery plan describes *Habitat critical to the survival* of Spotted-tail quoll as 'large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey' (DEWLP 2016). The recovery plan also notes given the difficulty defining the threshold habitat requirements of these resources it currently impossible to map *Habitat critical to the survival of the species*. This assessment has taken a conservative approach and included all areas of *potential habitat* that intersect with remnant vegetation that are greater than 200 ha in size (given the species extensive home range) as *Habitat critical to the survival of the species* (refer Table 5.2 in Appendix A for further information).

Impacts and mitigation measures associated with this species are identified within Table 5.7. Habitat within Little Liverpool Range extending north and south of the eastern portion of the Project disturbance footprint comprises an extensive tract of relatively contiguous habitat which may support the species. Habitat within the Helidon Hills area may also support the species. The Project is predicted to impact 75.48 ha of *potential habitat* and 1.59 ha of *Habitat critical to the survival of the species* under the approach used for this assessment (refer Table 5.4 and habitat figure in Appendix F). This assessment has taken a conservative approach and the identified habitat is likely to comprise foraging habitat rather than denning/breeding sites. The following significant impact assessment (refer Table 5.20) has been informed by the information detailed above.

Table 5.20 Assessment against the significant impact criteria: Spotted-tail quoll

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population of a species	It is uncertain if the species occurs. There are no records of this species within or close to the MNES study area. The nearest recent (post 2000) records are located over 40 km east of the Project. Nevertheless, predictive habitat modelling indicated that the project may impact 77.07 ha of suitable habitat (75.48 ha of *potential habitat* and 1.59 ha of *Habitat critical to the survival of the species*) for the species. This habitat is largely associated with the Little Liverpool Range and the southern edge of the Helidon Hills. Preferred rocky shelter sites for the species have generally been avoided and were not observed during Project surveys. It is noted both of these areas are subject to substantial existing disturbance where the Project disturbance footprint occurs. There is mining/quarry activity in the Helidon Hills north of the Project and substantial disturbance to the south including cleared areas associated rural housing, a powerline easement and roads. Where the alignment intersects the Little Liverpool Range there is rural housing along the ridgeline and an existing rail line (West Moreton System) and the Laidley-Rosewood Road is located to the south.

Criterion	Assessment against significance criteria
	Where the alignment intersects higher altitude habitat within the Little Liverpool Range the Project is largely comprised within a tunnel (850 m long) avoiding the large area of habitat modelled as *Habitat critical to the survival of the species*. This will maintain connectivity along the vegetated habitat within this potential wildlife corridor (it is noted urban housing already occurs in this area). Fauna crossing structures will be applied as part of the Project design to enhance fauna movement across the Project alignment and the wider landscape. These measures will also help to avoid or at the very least significantly reduce the risk of vehicle strikes during operations. This species is susceptible to road mortality due to scavenging for carrion with juvenile males most likely at risk due to extensive ranging behaviour. The Project will result in increased traffic through adjacent potential habitat for this species (e.g. Helidon Hills) during construction increasing the risk of vehicle strikes. Similarly, the operating rail line may also pose a threat once operational. However, it is unlikely to lead to the long-term decline of the species. The Project may also result in changes to prey interactions, including competition from feral animals such as the Red fox, Wild dogs and feral cats. Under the Project Flora and Fauna Sub-plan targeted pre-construction surveys will be carried out if suitable denning habitat for this species is identified within or adjacent to the final construction footprint to identify whether the species actually occurs or not (refer Table 5.7). Should the species be found individuals are expected to be moved away from the area of disturbance prior to construction activities. The species requires large home ranges. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The Project is considered unlikely to lead to a long-term decrease in an important population.
Reduce the area of occupancy for a population	The estimated extent of occurrence is estimated at 575,991 km^2 and the area of occupancy at 10,388 km^2 (although this is considered to be a significant underestimate) (Woinarski et al 2014). There are no records of this species within or close to the MNES study area. The nearest recent (post 2000) records are located over 40 km east of the Project. Predictive habitat modelling indicated that the project may impact 77.07 ha of habitat considered suitable for the species. Where the alignment intersects the Little Liverpool Range it avoids substantial (~850 m wide) Habitat critical to the survival of the species via the proposed tunnel. Preferred rocky shelter sites for the species have been avoided. Nevertheless, should the species occur in the area the Project has potential to reduce the occupancy of a population across the local region although to no more than a minor extent.
Fragment an existing population into two or more populations	This species has large home ranges with the female home ranges (88–1515 ha) generally non-overlapping, while male home ranges are much larger, from 359–5512 ha in size, and overlap and encompass multiple female home ranges (DEWLP 2016). There are no records of this species within or close to the MNES study area. Predictive habitat modelling indicated that the project may impact 77.07 ha of habitat considered suitable for the species. The Project is linear but impacts areas which are already subject to extensive fragmentation. The alignment crosses through the Little Liverpool Range via a tunnel (allowing movement through the range at this point) and lies north of the existing Rosewood-Laidley Road. The section of the alignment north of Helidon lies adjacent to a powerline easement and local roads and the Warrego Highway to the south. The remainder of the Project largely lies adjacent to the existing rail line (West Moreton System) and passes through heavily disturbed agricultural and urban lands. The final Project design will incorporate fauna crossing structures to allow fauna movement north and south of the alignment within the Helidon area. There is also an extensive portion of the alignment above the proposed rail tunnel within the Little Liverpool Range (~850 m) which will remain unimpacted and function as a movement corridor. The Project is considered unlikely to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	There are no records of this species within or close to the MNES study area. Predictive mapping indicates 1.59 ha of habitat considered as Habitat critical to the survival of the species (for the purposes of this assessment) occurs within the Project disturbance footprint with the majority of this habitat avoided, including area above the tunnel. A further 75.48 ha of ‘potential’ habitat mainly associated with the Little Liverpool Range and Helidon Hills occurs within the Project disturbance footprint. The disturbance footprint largely intersects already disturbed (cleared) habitat through much of the alignment. Nevertheless, the Project has a minor potential to adversely affect *Habitat critical to the survival of the species*, should the species be found to occur.

Criterion	Assessment against significance criteria
Disrupt the breeding cycle of a population	There are no records of this species within or close to the MNES study area. Predictive habitat modelling indicated the project may impact 77.07 ha of suitable habitat including 1.59 ha of *Habitat considered critical for the species* within the Little Liverpool Range. Where the alignment intersects the Little Liverpool Range the proposed tunnel avoids substantial habitat. Preferred rocky shelter sites potentially used for denning/breeding for the species have been avoided and were not observed during Project surveys. The Project will result in the removal and potential relocation of hollow logs and hollow bearing trees into adjacent landscapes. While the disturbance of these features during breeding season (i.e. the winter months (June to August)) may result in the death of individuals. In addition, connectivity will be maintained via fauna crossing structures and the tunnel area through the Little Liverpool Range (construction and operations) allowing roaming males the potential to mate with multiple females during the breeding season. Pre-clearance surveys will be carried out if suitable den habitat for this species is identified within or adjacent to the temporary construction disturbance footprint. The species breeds in the winter months (June to August). Where possible the Project will avoid clearing/construction activities in sensitive habitat (should such habitat be identified) during the breeding season. Given the lack of observed suitable den habitat in the area the Project is not considered likely to disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subspecies occurs from central coastal Queensland, south to south-west Victoria. It's uncertain whether the species occurs within or close to the Project disturbance footprint. The disturbance footprint intersects *Habitat considered critical for the species* within the Liverpool Range via tunnel minimising aboveground habitat disturbance in this area. It is also anticipated that the tunnel construction and operational activities will not impact the quolls use of this area (e.g. foraging and movement corridor). As noted above the Project will directly impact on 77.07 ha of suitable habitat including 1.59 ha of *Habitat critical to the survival of the species*. The predictive mapping also identified an additional area of approximately 319.04 ha of habitat critical for the survival of the species, along with approximately 1,807.43 ha of *potential habitat* within the MNES study area. As outlined in Section 5.1.2, the Project may impact the quality of habitat available as a result of edge effects; displacement and mortality of fauna, habitat fragmentation and barrier effects. These changes may influence predator-prey interactions with many of the prey species hollow-dependent and the loss of these resources as a result of the Project impacting their abundance and distribution. However, where possible microhabitat features such as hollow logs, hollow bearing trees and rocky outcrops will be relocated into adjacent habitats. Given the extent of occurrence of Spotted-tail quoll the Project is considered unlikely to decrease the availability of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a endangered species becoming established in the endangered species' habitat	Relevant threat abatement/recovery plans for Spotted-tail quoll include management measures to address the impact of feral cats and European red fox. Feral cat was identified as present during Project-associated surveys. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo and cat) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	Recovery strategies listed in the *National Recovery Plan for the Spotted-tailed quoll Dasyurus maculata* (DEWLP 2016) include: ▪ Determine population trends for the species including distribution and abundance ▪ Investigate key aspects of the species biology/ecology to improve management ▪ Reduce the rate of habitat loss and fragmentation ▪ Determine and manage threats from introduced predators and uncontrolled fires ▪ Assess and minimise sources of mortality including road deaths, deliberate killings and the threat of cane toads.

Criterion	Assessment against significance criteria
	If the species does occur on and around the Project disturbance footprint there is some potential for the Project to interfere with the recovery objectives outlined in the Plan through potential habitat loss. The MNES study area is already subject to high levels of fragmentation. The Project Biosecurity Management Plan will control introduced predators associated with Project infrastructure. Nevertheless, any impact on the species will be minor, and is considered unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	The Project will result in the clearance of 75.48 ha of *potential habitat* and 1.59 ha of *Habitat critical to the survival of the species* that potentially supports a population. Although it remains highly uncertain if the species occurs the assessment has been carried out in a conservative manner and the Project has a minor potential to have significant residual impacts on the Spotted-tail quoll.

Swift parrot (*Lathamus discolor*) – critically endangered

Ecology and distribution

The Swift parrot feeds mostly on nectar, mainly from Eucalypts, but also eats psyllid insects and lerps (waxy secretion on Eucalypt leaves produced as a protection by young psyllid insects), seeds and fruit. Foraging habitat on the mainland includes inland box-ironbark and grassy woodlands, and coastal Swamp mahogany (*Eucalyptus robusta*) and Spotted gum (*Corymbia maculata*) woodland when in flower. In northern NSW and south-east Queensland, Forest red gum (*E. tereticornis*) forests and Yellow box (*E. melliodora*) forest are commonly utilised by Swift parrots (Saunders and Tzaros 2011, OEH 2017b). In northern New South Wales the species is known to use Northern grey box (*E. mollucana*) and Blackbutt (*E. pilularis*) (Saunders and Heinsohn 2008), both of which also occur in south-east Queensland.

The Swift parrot typically inhabits dry eucalypt forests and woodlands, occasionally wet sclerophyll forests, suburban parks and sometimes gardens with flowering fruit trees (Saunders and Tzaros 2011). Coastal forests from eastern Victorian to the central coast of New South Wales are utilised during periods of drought as refuge habitats. The species is found to prefer large mature trees for foraging as these provide more reliable resources than smaller immature trees (Saunders and Tzaros 2011).

The Swift parrot breeds in Tasmania during summer (mid-September to late-January) and migrates north to mainland Australia during the winter. Small numbers of Swift parrots occur in SEQ on a regular basis (TSSC 2016a).

Distribution in context to the Project

This species was identified foraging in Northern grey box (*E. moluccana*) in a patch of woodland in the Rosewood area (5 km east of the Project disturbance footprint) during protected plant surveys in June 2018 for a related project (EMM 2018a). There are a number of database records (i.e. AoLA) within 10 km of the disturbance footprint in the western portion of the alignment. This includes a 2000 record 5 km north of Gatton, a 2010 record in the Murphys Creek area (6 km north-west of the western extent of the Project), a 1998 record (6 km west of the of the western extent of the Project) and a record of uncertain provenance (i.e. no date and location generalised to 0.1 degree) located 7 km south of the same area. In south-east Queensland it is a significant species to birdwatchers and sightings of the species become well known and recorded rapidly. Nevertheless, other records for this species occur to the west of the alignment from the Toowoomba Range, and to the north at Atkinson's Dam (refer Figure 5.25 in Appendix B).

Recovery plans/threat abatement plans

The *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Saunders and Tzaros 2011) identifies the following threatening processes as applicable to the species:

- Habitat loss and alteration from forestry activities (including firewood harvesting), and land developments
- Suppression of tree regeneration and loss/dieback of eucalypts on agricultural land
- Climate change and frequent fires

- Mortality resulting from collision with wire netting or mesh fences
- Competition with Noisy miner (*Manorina melanocephala*) and other aggressive honeyeaters

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c)

Important populations and Habitat critical to the survival of the species

The overall population is poorly known but estimated at 2000 mature individuals and is declining (Garnett et al 2011). The wintering population of Swift parrot is spread across much of mainland south-east Australia. As such there is no important population relevant to individual locations. The species' recovery Plan does not define habitat critical to the survival of the species but does identify priority habitats which are used by large proportions of the population (repeatedly between seasons or for prolonged periods of time).

Priority habitat areas identified in SEQ include the following localities:

- Bowman Park, Bardon
- Rafting Ground Reserve, Kenmore
- Glen Lomond Park, Toowoomba (Saunders and Tzaros 2011)

The nearest of these to the MNES study area (Glen Lomond Park) is located on the south-eastern outskirts of Toowoomba and is 15 km south-west of the Project. Other habitats considered important for the species are nesting and habitats used by a large proportion of the population (Saunders and Tzaros 2011). The species nests in Tasmania and although the species was recorded close to the disturbance footprint during Project surveys there is no evidence provided by available records indicating the disturbance footprint, MNES study area or surrounds provides habitat considered as a 'priority habitat' i.e. regularly used by the species either repeatedly or for extended periods. For the purposes of this assessment habitat considered 'critical to the survival' of Swift parrot has been considered as foraging habitat in mature (remnant) vegetation communities comprising the tree species discussed above as relevant to south-east Queensland (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping estimates that 13.34 ha of foraging habitat considered to constitute *Habitat critical to the survival of the species* for the Swift parrot will be impacted by the Project (refer Table 4.4 and habitat figure in Appendix F). There is no habitat identified as important (priority habitat areas) within or near the Project footprint, although a further 85.33 ha of *potential habitat* for the species has been modelled as being present within the Project disturbance footprint (refer Table 4.4). The predictive habitat modelling has taken a conservative approach and includes regrowth woodlands (that dominate the mapped vegetation in the MNES study area) and which may not be likely to provide favoured foraging habitat given the species prefers large mature trees (Saunders and Tzaros 2011). There is approximately 362.66 ha of *Habitat critical to the survival of the species* within the immediate surrounds of the MNES study area (refer Table 4.4 and Table 5.4) and over 94,800 ha within a 50 km radius of the disturbance footprint (refer Table 7.1). Assessment of potential disturbance of this species against the MNES Significant impact guidelines is provided in Table 5.21.

Table 5.21 Assessment against the significant impact criteria – Swift parrot

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	The population of Swift parrot is dispersed across mainland south-eastern Australia in the winter months. Small numbers of individuals occur sporadically in SEQ in a variety of habitats including urban areas. The nearest database records of Swift parrot are located 5 km to 6 km from the disturbance footprint. The species was recorded 5 km east of the Project during a survey for a related project in 2018 (EMM 2018a). There is no evidence the species uses the MNES study area or surrounds on a regular basis or provides habitat considered to be of importance or regularly used by the species.

Criterion	Assessment against significance criteria
	It is considered very unlikely the Project will result in direct mortality of individuals of the species. The Project will not impact any of the identified priority habitat areas (where the species is thought to regularly occur) in Queensland. Predictive habitat modelling indicates the project may impact 13.34 ha of *Habitat critical to the survival of the species* (refer Table 4.4) and 85.33 ha of *potential habitat* although this may be an overestimate of the potential for the species to occur. The opening up of corridors within tracts of habitat may have potential to lead to an increase in aggressive/competitive honeyeater species accessing previously undisturbed woodlands. Nevertheless, this is not expected to be an impact from the Project. The Project occurs largely in heavily disturbed lands. The proposed tunnel will leave a substantial area of vegetation in the Little Liverpool Range undisturbed. Nevertheless, the species ranges widely and can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is over 362.66 ha of identical *Habitat critical to the survival of the species* adjacent to the Project (within the MNES study area, refer Table 4.4) and over 94,800 ha estimated within a 50 km radius that will remain undisturbed. The Project is considered unlikely to result in a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	Small numbers of individuals sporadically occur in SEQ in winter. The species was recorded 5 km east of the Project disturbance during survey for a related project in 2018 (EMM 2018a). The Project will not impact any identified priority habitat areas in Queensland. However, the Project has been predicted to impact 13.34 ha of *Habitat critical to the survival of the species* and 85.33 ha of *potential habitat*, although this may be an overestimate of the potential for the species to occur. Nevertheless, the species ranges widely and can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is 362.66 ha of *Habitat critical to the survival of the species* adjacent to the Project (within the MNES study area, refer Table 4.4) and over 94,800 ha estimated within a 50 km radius that will remain undisturbed. The Project is considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	The Project is not considered to represent a barrier to movement for the species. It is considered very unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	The Project will not impact any identified priority habitat areas in Queensland. Small numbers of individuals occur in Queensland in winter. The species breeds in Tasmania. Predictive habitat modelling indicates that the Project has been predicted to impact 13.34 ha of *Habitat critical to the survival of the species* and 85.33 ha of *potential habitat*, although this may be an overestimate of the potential for the species to occur. Nevertheless, the species ranges widely and can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is over 362.66 ha of *Habitat critical to the survival of the species* adjacent to the Project (within the MNES study area, refer Table 4.4) and over 94,800 ha estimated within a 50 km radius that will remain undisturbed. Nevertheless, given *Habitat critical to the survival of the species* may occur there is potential the Project may adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	The species breeds in Tasmania in summer. Small numbers of birds occur in Queensland each year. It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project will not impact any identified priority habitat areas in Queensland. The Project has been predicted to impact 13.34 ha of *Habitat critical to the survival of the species.* Nevertheless, the species may utilise a wide variety of habitats including urban parklands. The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. That is, the predictive modelling indicates that there is 362.66 ha of *Habitat critical to the survival of the species* adjacent to the Project (within the MNES study area, refer Table 4.4) and over 94,800 ha estimated within a 50 km radius that will remain undisturbed. As outlined in Section 5.1.2, the Project may impact the quality of habitat available as a result of edge effects; habitat fragmentation and barrier effects. These impacts however are unlikely to result in changes to flowering events or result in the suppression of tree regeneration and loss/dieback of eucalypts. The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. The Project will not impact habitat suitable for Swift parrot to the extent that the species is likely to decline.

Criterion	Assessment against significance criteria
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	The relevant threat abatement plan for Swift parrot include management measures to address the impact of feral cats. Feral cat was observed during Project-associated surveys. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The National Recovery Plan for the Swift Parrot (*Lathamus discolor*) (Saunders and Tzaros 2011) lists the following recovery actions: ▪ Identify the extent and quality of habitat ▪ Manage and protect Swift Parrot habitat at the landscape scale ▪ Monitor and manage the impact of collisions, competition and disease ▪ Monitor population and habitat. The Project is considered unlikely to interfere with any of the recovery actions listed above to the extent it is likely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	The Project is considered to have potential to have a significant impact on Swift parrot through clearing of 13.34 ha of habitat identified as *Habitat critical to the survival of the species*.

Australian painted snipe (*Rostratula australis*) – endangered

Ecology and distribution

The Australian painted snipe generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. The species has also been observed to use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. The Australian painted snipe has been recorded nesting in and near swamps, canegrass swamps, flooded areas, including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch, saltbush (*Halosarcia* sp.) and grass, in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush (DAWE 2020b).

Australian painted snipe is a very cryptic species that generally occurs in low numbers and has been recorded at wetlands in all states and territories of Australia but is more common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia. It is a highly nomadic species dependent on wetland conditions throughout its range. There is evidence that part of the population may migrate from south-eastern Australia to central and northern Queensland during autumn and winter. It's known distribution has likely declined by approximately 50 per cent in Australia since European settlement (Garnett et al 2011).

Breeding has been recorded at all times of the year and is likely a response to wetland conditions. Nesting habitat appears quite specific requiring shallow wetlands, exposed mud and nearby vegetative cover. Nests are often located on or near islands within the wetland (DAWE 2020b).

Distribution in context to the Project

The species was not identified during Project surveys, although dry conditions in 2017 likely precluded the species potential presence. There are numerous database records within 50 km of the MNES study area. This includes several records within 5 km of the MNES study area. Australian painted snipe has been recorded 500 m south of the Project disturbance footprint at a site west of Gatton (1991 record) and 500 m north at a site near Helidon (1982 record). Recent records from nearby include 2013 records in the Helidon area (2 km and 4 km south of the Disturbance footprint), a 2012 record from the Gatton campus of the University of Queensland (2 km north), and records from the 2000s from Lake Dyer in the Laidley area (2.5 km south) (refer Figure 5.4 in Appendix B).

Wetland habitats within the MNES study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (palustrine). Dams and reservoirs are generally unlikely to provide suitable dense aquatic vegetation for the species. Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants and Queensland bluegum (*Eucalyptus tereticornis*). Riverine wetlands through much of the Project disturbance footprint are highly degraded with little aquatic vegetation present suitable for Australian painted snipe (refer Section 4.4.4.6 and EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for further detail). Riverine wetlands considered to be of 'high ecological value' under State mapping are intersected by the western extent of the Project disturbance footprint (north-west of Helidon) and are associated with a localised hydrological catchment (Sheepstation Creek) off the main channel of Lockyer Creek.

Palustrine wetlands within the MNES study area typically occur on alluvial floodplains and may be dominated by grasses (Poaceae), rushes (Restionaceae) and/or sedges (Cyperaceae). Floodplain areas were all observed to be dry during the site surveys for the Project. Areas of remnant Palustrine wetland within the MNES study area are represented by RE 12.3.8 and are considered the most likely wetland habitat present with potentially suitable values for Australian painted snipe although these areas are highly ephemeral in nature (refer Section 4.4.4.7). There are two wetlands corresponding to this RE at the eastern extent of the Project (east of Calvert) although both lie outside of the Project disturbance footprint (90 m and 300 m north respectively) (refer EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for further detail regarding wetland values).

Recovery plans/threat abatement plans

There is currently a draft *National recovery plan for the Australian painted snipe (Rostratula australis*) (DotEE 2019c) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Reduced wetland availability due to draining, fragmentation and changed hydrology
- Habitat degradation such as reduced water quality
- Low genetic diversity
- Invasive species including herbivores impacting habitat (horses, pigs, goats and deer) and predators (red fox and cats)
- Wetland vegetation structure change caused by native plants (e.g. *Typha* spp.) and non-native plants (e.g. Lippia (*Phyla canescens*)
- Climate variability and change.

The are no Commonwealth adopted threat abatement plan considered relevant to this species.

Important populations and Habitat critical to the survival of the species

The Australian population is thought to range between 1,000 to 1,500 mature individuals (Garnett et al 2011). The draft *National recovery plan for the Australian painted snipe (Rostratula australis*) (DotEE 2019b) identifies the population as a single homogenous breeding population spread thinly across much of Australia. The species is widespread with an extent of occurrence estimated at 7,100,000 km^2 (Garnett et al 2011). As such there is no population relevant to individual locations. Habitat 'critical to the survival of the species' is described as:

- Any wetland habitat where the species is known or likely to occur (especially with suitable breeding habitat) within the indicative distribution map
- Any location with suitable habitat outside the above area that may be periodically occupied by Australian Painted snipe when conditions are favourable.

The Project disturbance footprint is located within the 'known or likely to occur' habitat mapped within the distribution map from the draft recovery plan.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping indicates that the Project is predicted to impact 17.95 ha of *potential habitat* and 15.43 ha of habitat considered *Habitat critical to the survival of the species* for Australian painted snipe (refer Table 5.4 and habitat figure in Appendix F). However, the predictive habitat mapping has been approached in a conservative manner and is largely modelled on available vegetation and corresponding wetland communities mapping provided by DES (refer Appendix A for methodology). This includes creek lines, associated riparian habitat and farm dams which are less likely to provide habitat for Australian painted snipe (large shallow wetlands with dense vegetative cover). The predictive habitat modelling also includes all habitat within 1 km of a database record which may comprise habitat that is not suitable for the species. The predictive habitat figure is likely to be an overestimation of the available habitat suitable for this species within the disturbance footprint.

Assessment of potential impacts to this species against the MNES significant impact assessment criteria is provided in Table 5.22.

Table 5.22 Assessment against the significant impact criteria – Australian painted snipe

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	Australian painted snipe occurs as a single homogenous breeding population dispersed thinly across much of Australia. As such, no resident population can be attributed to the MNES study area or immediate surrounds. There are a number of records in MNES study area and wider surrounds and the species is known to occur sporadically in the region. It is unknown to what extent the species may utilise wetland habitats associated with the Project disturbance footprint, or if it occurs at all. The species is highly nomadic and unlikely to use these areas in more than a transient manner as a response to local conditions. Based on habitat modelling, the Project predominantly avoids wetland habitats (refer Section 4.4.4.7) through the Project has the potential to impact 33.38 ha of suitable habitat for this species (comprising 17.95 ha of *potential habitat* and 15.43 ha of *Habitat critical to the survival of the species*), although this is likely to be a substantial overestimate given that the wetlands systems present are ephemeral and have limited vegetation cover with dense vegetation a key feature of preferred habitat. The condition characteristics of these systems across the Project disturbance footprint is variable, with it unknown at this stage to what extent the predicted wetland habitat comprises values suitable for the presence of Australian painted snipe (i.e. the majority of the wetlands were dry during the field surveys and the values could not be confirmed). It is unknown at this stage to what extent the predicted wetland habitat within the Project disturbance footprint comprises values suitable for the presence of Australian painted snipe.

Criterion	Assessment against significance criteria
	As noted in Section 5.1.2.11, the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. Construction activity at watercourse crossings will disturb the riparian zone and instream habitats, including *potential habitat* for the species. Activities will include clearing of vegetation, reprofiling of banks and instream substrate, deposition of material (e.g. rip rap for erosion and sediment control), erection of temporary barriers (e.g. coffer dam), water extraction, disturbance of sediment causing elevated nutrients and turbidity, and result in the loss of wetlands and direct disturbance of local individuals (should they occur within the Project disturbance footprint). However, the species is less likely to occur in riverine environments and this disturbance is expected to be restricted to the construction period with occasional works during the operation of the Project (design life of 100 years). The Project will not create any permanent barriers to flow as watercourse crossings will consist of bridges or culverts. Following construction localised habitat suitable for the species is expected to return to its prior natural conditions. The use of bridge structures across some of the major watercourses and associated floodplains (e.g. Lockyer Creek) will also avoid and/or minimise the impact to riparian zones, wetlands and instream habitat (e.g. footings are outside the channel or the highwater banks). Flood modelling (refer Appendix M of the EIS: Hydrology and Flooding Technical Report) indicates local changes to the catchment hydrology is minimal, including on the mapped wetlands identified in the Calvert area (refer Section 4.4.4.7). Under the Project Flora and Fauna Sub-plan pre-construction surveys will be carried out following optimal (wet) conditions (where possible) to assess whether wetland habitat values are suitable for the species, and if so, if the species actually occurs. Surveys will follow Commonwealth survey guidelines for the species (e.g. DEWHA 2010a). If the species or habitat is identified during pre-construction surveys, further pre-clearance surveys will be carried out to assess whether the species is present with mitigation measures in place should this be the case (refer Table 5.7). Should the species be found individuals would be expected to disperse from the construction area. The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of the population.
Reduce the area of occupancy of the species	Predictive habitat mapping indicates the Project has the potential to impact 33.38 ha of suitable habitat for this species (comprising 17.95 ha of *potential habitat* and 15.43 ha of *Habitat critical to the survival of the species*), although this is likely to be a substantial overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the Project disturbance footprint comprises values suitable for the presence of Australian painted snipe. No database records of the species occur within the MNES study area, although there are many records in the wider surrounds. It is unknown to what extent the species may utilise wetland habitats associated with the Project disturbance footprint, or if it occurs at all. The species is highly nomadic and unlikely to use these areas in more than a transient manner dependent on local conditions. The impacts of the Project are considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	Australian painted snipe occurs as a single homogenous breeding population dispersed thinly across much of Australia. As such, no resident population can be attributed to the Project disturbance footprint. The species is highly mobile and dispersive. The Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of the species	Predictive habitat mapping indicates the Project has the potential to impact 15.43 ha of *Habitat critical to the survival of the species for this species*, although this is likely to be a substantial overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the Project disturbance footprint comprises values suitable for the presence of Australian painted snipe. Pre-construction surveys will be carried out to assess whether wetland habitat values are suitable for the species, and where suitable habitat is identified whether the species actually occurs. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). Until specific site assessments for the species are carried out it is uncertain whether the Project will adversely affect *Habitat critical to the survival of the species*.

Criterion	Assessment against significance criteria
Disrupt the breeding cycle of a population	Australian painted snipe occurs as a single homogenous breeding population dispersed thinly across much of Australia. As such, no resident population can be attributed to the Project disturbance footprint. The species is known to breed in SEQ, with breeding habitat considered to be quite specific (i.e. shallow wetlands with areas of bare wet mud and mixed heights of low vegetation) (DotEE 2019c). The species may breed at any time of year dependent on local wetland conditions. Predictive habitat mapping indicates the Project has the potential to impact 33.38 ha of suitable habitat for this species (comprising 17.95 ha of *potential habitat* and 15.43 ha of *Habitat critical to the survival of the species*), although this is likely to be a substantial overestimate (i.e. mapping includes riverine wetlands and regional ecosystem wetlands, likely to be of limited value). Pre-construction surveys will be carried out to assess whether wetland habitat values are suitable for the species, and where suitable habitat is identified whether the species occurs. Should the species be observed as nesting measures will be in place within the Project Flora and Fauna Sub-plan to allow nesting to occur undisturbed (refer Table 5.7). It is possible that Australian painted snipe individuals will be disrupted during breeding, but it is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No database records of the species occur within the MNES study area. The species is widespread with an extent of occurrence estimated at 7,100,000 km^2 (Garnett et al 2011). Predictive habitat mapping indicates the Project has the potential to impact 33.38 ha of suitable habitat for this species (comprising 17.95 ha of *potential habitat* and 15.43 ha of *Habitat critical to the survival of the species*), although this is likely to be a substantial overestimate. Predictive habitat mapping also identifies approximately 446 ha of additional *Habitat critical to the survival of the species* within the MNES study area. It is unknown at this stage to what extent the predicted wetland habitat within the Project disturbance footprint comprises values suitable for the presence of Australian painted snipe. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). Given the very minor extent of habitat within the Project disturbance footprint the potential impacts of the Project are considered unlikely to be of the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Aquatic weed species have been identified as a potential threat to Australian painted snipe habitat (DotEE 2019c). Project-associated surveys have noted Canadian pondweed (*Elodea* spp.) is currently present within some wetlands in the MNES study area. Project surveys have recorded pest fauna thought to be a threat to the species: feral cat. Feral dogs were also observed. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Project is not expected to lead to increased abundances of introduced predator species. Nevertheless, measures will be incorporated to monitor pest species observations associated with Project activities, and pest control actions where considered necessary. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and pest proliferation and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral species (i.e. wild dogs/dingo, Red fox and pigs) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criterion	Assessment against significance criteria
Interfere with the recovery of the species	The draft recovery Plan for the species identifies the following recovery objectives for Australian painted snipe: ▪ Manage and protect known Australian Painted Snipe breeding habitats at the landscape scale ▪ Develop and apply techniques to measure changes in population trajectory in order to measure the success of recovery actions ▪ Reduce, or eliminate threats at breeding and non-breeding habitats ▪ Improve knowledge of the habitat requirements, biology and behaviour of Australian Painted Snipe ▪ Engage community stakeholders to improve awareness of the conservation of Australian Painted Snipe ▪ Coordinate, review and report on recovery process (DotEE 2019b). At this stage it is uncertain the Project disturbance footprint comprises habitat likely to support breeding. The Project is considered unlikely to interfere with any of the recovery actions listed above to the extent it will interfere with the recovery of the species. Should Australian painted snipe be identified during Project activities this will contribute to current information on the species in the SEQ region. Weed and pest mitigation measures applied within the Project Biosecurity Management Plan will contribute to eliminating threats to the species across the wider area.
Assessment of potential for significant residual impacts	Although it remains uncertain there is some potential for the Project to have a significant impact on Australian painted snipe through impacts to wetland habitat considered Habitat critical to the survival of the species. Extended dry conditions in the Project disturbance footprint during construction may minimise any direct impacts on the species, while risks of impacts may be increased where optimal conditions are present, including potential impacts to breeding habitat.

5.3.5.2 Vulnerable fauna species populations

The assessments commence with an evaluation of the likely importance of the population of vulnerable fauna species associated with the MNES study area. Under the Guidelines vulnerable species are considered as subject to significant impacts when an 'important population' is impacted. Therefore, those species that are not considered to have an important population present are not considered further in the assessment.

An 'important population' as defined within the Guideline significant impact criteria for vulnerable species is as follows:

'*An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

- *Key source populations either for breeding or dispersal;*
- *Populations that are necessary for maintaining genetic diversity; and/or*
- *Populations that are near the limit of the species range.'*

Given the specificity of the above definition and the scarcity of information and records available for most listed species and populations in the region (and Australia), it is difficult to determine:

- Attributes such as breeding and dispersal behaviour and whether the population is a 'key source'
- The genetic diversity of individuals inhabiting a population or sub-population.

Given the paucity of information available, significance of impacts to threatened species has been based on professional experience of the assessment team and the latest available information relating to habitat and ecological requirements and distribution. This information is compiled in Appendix B for all of the species assessed including mapping of database records associated with the wider Project disturbance footprint.

Table 5.23 provides an evaluation of the populations of vulnerable fauna species associated with the MNES study area.

Table 5.23 Assessment of status of vulnerable fauna species population against Guideline criteria

Species name	Common name	Project disturbance footprint population evaluation
Delma torquata	Collared delma	There are no known records of this species within or adjacent to the Project disturbance footprint. Predictive habitat mapping indicates that the Project has the potential to impact 85.33 ha of *important habitat* for this species (refer Table 5.4). There are 1995 records from the Helidon Hills (5 km north of the Project) and the Toowoomba Range (13 km west). The Project disturbance footprint is located near the southern limit of the species range. There is no recovery plan for this species. Given the difficulty in detecting this species the *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) considers the presence of known important habitat for this species a surrogate for an important population of the species. Known *important habitat* is considered as suitable habitat within the mapped 'known/likely to occur' distribution within the guidelines. The Project occurs partially within this mapped distribution in the Helidon area and there is suitable habitat present. Therefore, important habitat for this species will be impacted and may result in a significant impact to the species. Given that *important habitat* under the referral guidelines has been identified for this species (in relation to the Project) there is potential to significantly impact Collared delma and it is considered further in the following section (refer Table 5.24).
Erythrotriorchis radiatus	Red goshawk	The species has not been recorded within the MNES study area although there are a number of records in the wider area, particularly around the western portion of the Project. There are several records within 10 km of the Project in the Gatton and Helidon areas. It is noted available records have all been generalised in order to protect the species. The Project disturbance footprint is located near the southern limit of the species current range (the species may be extinct in northern NSW). The *National recovery plan for the red goshawk Erythrotriorchis radiatus* (DERM 2012) does not identify important populations. Delineating an important population for this species is complicated by the ecology of the species (large home ranges and very sparse distribution). Habitat 'critical to the species survival' is considered those areas which supports nesting and associated habitat factors to support nesting. This habitat may occur in the Helidon Hills and Little Liverpool Range areas. Predictive habitat mapping indicates that the Project has the potential to impact 46.24 ha of *potential habitat* and 4.15 ha of *Habitat critical to the survival of the species* in which this species is predicted to occur (refer Table 5.4). Given the species occurs at the southern limit of its distribution in relation to nearby records the Project could impact an important population. The Project may also impact critical habitat. Therefore there is potential to significantly impact Red goshawk and it is considered further in the following section (refer Table 5.25).
Falco hypoleucos	Grey falcon	This species was identified during Project surveys in the Gatton area (refer Figure 4.5) however few database records exist for this species in proximity to the Project disturbance footprint. There are two records of this species within the Toowoomba region (i.e. Toowoomba Range) dated 2013 and 2008 approximately 20 km and 25 km west of the Project disturbance footprint. A third record dated 1983 occurs approximately 20 km north of the Project disturbance footprint to the east of Lockyer Reserves near Lockyer Creek (AoLA 2020). Grey falcon is considered to occupy the arid and semi-arid zone of Australia where annual rainfall is <500 mm. Younger individuals may disperse outside of this habitat in drought years that follow wet years in inland Australia. The total population size is now generally accepted to be <1,000 mature individuals (Schoenjahn 2018, TSSC 2020). The breeding range has contracted to the arid parts of its range since the 1950s (OEH 2017e). Known breeding sites in Queensland are all in the arid zone well west of the Project (refer Schoenjahn 2018). The species appears to be partially nomadic, responding to local drought conditions. The species likely occupies large home ranges with preferred habitat including sparsely timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter (TSSC 2020).

Species name	Common name	Project disturbance footprint population evaluation
		It is noted average annual rainfall in the region in which the Project footprint occurs is 765.6 mm (BoM 2020) which is outside the generally accepted range of the species as identified above. Given the sparse distribution of the overall population, specific important populations have not been identified. *Habitat critical to the species survival* is considered those areas which supports nesting and associated habitat factors to support nesting. Delineating an important population for this species is complicated by the ecology of the species. The Project is predicted to impact 351.94 ha of *potential habitat* and with none of this constituting *Habitat critical to the survival of the species* (as defined for this assessment – refer Appendix A for methodology) in which this species is predicted to occur (refer Table 4.4 and habitat figure in Appendix F). It is acknowledged the species was identified within the MNES study area during Project surveys. Nevertheless, the species core range is in the arid zone well to the west of the Project and it is not known to occur more than sporadically in the wider region surrounding the alignment. It is highly likely the individual observed was a dispersing young individual and can be considered a vagrant in the area. The Project is considered unlikely to significantly impact habitat for the species. It is inconceivable that any potential impact will be to the extent it will adversely impact the species or affect the species recovery. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.
Grantiella picta	Painted honeyeater	Database records indicate this species does not occur within the MNES study area however has occurred within 50 km of the Project. There is a single nearby database record of uncertain provenance (no date) located 2 km south of the Project at Lake Apex, Gatton. Other database records occur largely to the west of the Project with the closest approximately 14 km west (refer Figure 5.17 in Appendix B). The species population is sparsely dispersed across south-east Australia to north-west Queensland and eastern Northern Territory. There are a few scattered coastal records to the east of the Project but the vast majority of records lie on the western slopes of the Great Dividing Range. Coastal records may be considered as vagrant individuals. Rowland (2012) notes non-breeding individuals are recorded occasionally from coastal areas along the eastern seaboard. There is no Commonwealth adopted recovery plan for this species. A review of the available literature including the approved conservation advice for the species has not revealed any important populations (DotE 2015e). The species is considered to occur as a single wide-ranging population (Garnett et al 2011). As such no important populations have been identified that are key to the long-term survival and recovery of this species. The approved conservation advice for the species (DotE 2015e) notes the greatest concentrations of individuals and almost all breeding records are located on the inland slopes of the Great Dividing Range. The Project is located to the east of the Great Dividing Range. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology). As such, there is no Habitat critical to the survival of the species identified within or close to the Project disturbance footprint. Predictive habitat mapping indicates that the Project has the potential to impact 13.34 ha of *potential habitat* in which this species may occur (refer Table 5.4 and habitat figure in Appendix F). There is widespread identical habitat surrounding the Project disturbance footprint that will remain unimpacted. The Project disturbance footprint is located to the east of the species normal distribution. There are no identified important populations and there is no Habitat critical to the survival of the species associated with the Project. While the Project may remove 13.34 ha of potential foraging habitat for the species it is inconceivable this will be to the extent it will adversely impact the species or affect the species recovery. Therefore, under the Project is unlikely to significantly impact this species and it is not considered further.

Species name	Common name	Project disturbance footprint population evaluation
Turnix melanogaster	Black-breasted button-quail	The species was not recorded during Project surveys which included targeted searches for the distinctive platelets the species leaves when foraging. Database records (i.e. AoLA) indicate this species has occurred within 50 km of the Project. The nearest database record is from 2018 and located 8 km south of the western extent of the Project, although the location has been generalised to 0.1 of a degree. There are a number of records to the west in the Toowoomba Range (approximately 15 km west) and to the north in the Ravensbourne area (approximately 18 km north). There is a recent record from the Rosewood area (2015) located 9 km north-west of the Project (refer Figure 5.6 in Appendix B). There are 1993 records from Berlin Scrub Nature Refuge (12 km south-west of Laidley) (AoLA 2020). The *National Recovery Plan for the Black-breasted button quail Turnix melanogaster* (Mathieson and Smith 2009) identifies important populations in the following areas: Yarraman-Nanango, the Jimna-Conondale Range, the Great Sandy region, populations in Barakula State Forest and Palmgrove National Park, and all populations in New South Wales. None of these are relevant to the MNES study area. Habitat identified as Habitat critical to the survival of the species includes dry vine thickets and rainforest types, low thickets or woodlands with a dense understorey, and littoral areas with dry vine scrubs, acacia thickets and shrubby areas. The Project disturbance footprint is not located at the limit of the species range and will not impact the dispersal of individuals should a population occur in the area. There is no *potential habitat* within the Project disturbance footprint and little within the MNES study area (refer Table 5.4 and habitat figure in Appendix F). There are no identified important populations and there is no habitat critical to the species survival within the Project disturbance footprint. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.
Neoceratodus forsteri	Australian lungfish	The nearest database records are from Lake Apex in Gatton from 1994 (2 km south of the Project) and a 2003 record from Lockyer Creek, also in the Gatton area (1.2 km north of the Project) (refer Figure 2.2 in Appendix B). The species is native to the Mary and Burnett Rivers and was potentially in the Brisbane River catchment. A number of individuals were translocated from the Mary River in the 1890s. Creeks crossed by the Project alignment are within the upper catchment of the Brisbane River. The Project disturbance footprint is therefore located at the southern limit of the species range (AoLA 2020). The *Draft national recovery plan for the Australian lungfish (Neoceratodus forsteri*) (DotEE 2019a) defines Habitat critical to the survival of the species as 'breeding or foraging habitat in areas where the species occurs' as defined by the Plan's distribution map for the Brisbane River catchment. The Project intersects the Lockyer Creek within the mapped distribution. Project-associated aquatic habitat assessment surveys along Lockyer Creek indicate aquatic habitat potentially able to support the species may occur in some stretches where pooled water is retained for long periods although the creek is ephemeral. Predictive habitat mapping indicates that the Project has the potential to impact 0.28 ha of *potential habitat* and 1.96 ha of *Habitat critical to the survival of the species* in which this species may occur (refer Table 4.4). Therefore, the Project has potential to impact *Habitat critical to the survival of the species* and is considered further in the following section (refer Table 5.26).
Petauroides volans volans	Greater glider	The species has not been recorded during Project-associated surveys (including feeder trees) and there are no database records (AoLA) within the MNES study area. The nearest database records are several (all from the 1990s) and located in the Helidon Hills (all between 5 km and 8 km north of the Project). Another 1989 record is from the Rosewood area located 8 km north-east of the eastern extent of the Project (AoLA 2020). The nearest recent records are from 2010 and 2016 and located north of Toowoomba (16 km west and 22 km north-west of the Project) (refer Figure 4.4 in Appendix B). The species occurs from south-east Australia to central and north-east Queensland. The northern subspecies (*Petauroides volans minor*) occurs on the Atherton Tablelands. The Project disturbance footprint is not located near the limit of the species range.

Species name	Common name	Project disturbance footprint population evaluation
		No recovery plan exists for this species. A review of the available literature including the approved conservation advice for the species (TSSC 2016b) has not identified any important populations. No populations have been identified that are key to the long-term survival and recovery of this species. There is no habitat critical to the survival of the species defined for the species in approved conservation advice for the species (TSSC 2016b). In the absence of a definition for *Habitat critical to the survival of the species* for the species this assessment has applied a 1 km buffer on known records that intersect *potential habitat* (refer Appendix A for methodology). The predictive habitat mapping indicates there is 30.64 ha of *potential habitat* within the Project disturbance footprint for the species (refer Table 5.4 and habitat figure in Appendix F). No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project. The Project may impact 30.64 ha of *potential habitat* for the species. The assessment has taken a conservative approach for this species and it is considered further in the following section (refer Table 5.27).
Petrogale penicillata	Brush-tailed rock-wallaby	There is a database record from 1996 located adjacent to the Project disturbance footprint in the Helidon area. There are records from the Helidon Hills area and the species is also known from the Little Liverpool Range although much further south of the Project disturbance footprint (ICC 2018) (refer Figure 4.2 in Appendix B). Other database records occur to the north and west of the Project in the Crows Nest area and the Toowoomba Range (AoLA 2020). The *National Recovery Plan for the Brush-tailed Rock-wallaby Petrogale penicillata* (Menkhorst and Hynes 2010) identifies important populations in Victoria and NSW and outlines important populations as being at the limit of the species' range, outlying populations, stronghold populations, research populations and others where recovery actions are being implemented. The population in the Little Liverpool Range is the subject of recovery actions implemented by Ipswich City Council under the *Brush-tailed rock wallaby recovery plan* (ICC 2018). The predictive habitat mapping indicates there is 36.37 ha of *potential habitat* and 4.88 ha of *Habitat critical to the survival of the species* within the Project disturbance footprint for the species (refer Table 5.4). Therefore, the Project has potential to impact an 'important population and is considered further in the following section (refer Table 5.28).
Phascolarctos cinereus	Koala combined populations of QLD, NSW and the ACT)	This species has been detected during Project-associated surveys including one record near Helidon, three records between Laidley and Grandchester and one near Calvert. There are numerous records (including recent) of Koala from the region surrounding the Project including many within the MNES study area (refer Figure 4.2). The majority of records are clustered to the north of Helidon and Gatton, with several further records north of Calvert Habitat critical to the survival of the species for Koala is used as a 'surrogate' for important populations as per the *EPBC Act referral guideline for the vulnerable Koala* (DoE 2014). The Project disturbance footprint is considered as habitat critical to the survival of the species under the guidelines. Noting that this includes areas that have been extensively cleared where the species is unlikely to occur (clearing greater than 2 km). An assessment has been carried out based on the available habitat within the MNES study area (refer Table 5.29). Based on this assessment there is 98.66 ha of *Habitat critical to the survival of the species* (i.e. remnant and regrowth koala habitat) for Koala within the disturbance footprint (refer Table 5.4). The potential for significant impacts are assessed further in Table 5.30.
Potorous tridactylus tridactylus	Long-nosed potoroo (SE mainland)	Database records indicate this species does not occur within the MNES study area, however has occurred within 50 km of the Project. Species mapping on the SPRAT database shows the species or species habitat as 'may occur' only (DAWE 2020b). The nearest database record is from Lockyer National Park (1990) located 7.5 km north of the Project. More recent records (post 2000) occur further north in Crows Nest National Park and Deongwar State Forest (over 20 km north). There is also a 2015 record from the Toowoomba Range 17 km south-west of the Project (refer Figure 4.12 in Appendix B).

Species name	Common name	Project disturbance footprint population evaluation
		DAWE mapping (2020) indicates the species as may occur in the western portion of the alignment. The subspecies occurs in patchy populations from south-east of Gladstone through to Victoria. The Project disturbance footprint is not located near the limit of the species range. No recovery plan exists for this species. A review of the available literature has not revealed any important populations when referring to DAWE's SPRAT database (2020) which notes, with reference to the Project, the species occurring in Lamington National Park (to the south) and the Belthorpe area (80km north of the Project). It is noted the Queensland populations are considered as being reasonably secure (DAWE 2020b). No populations have been identified that are key to the long-term survival and recovery of this species and *Habitat critical to the survival of the species for the species* has not been identified or defined. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). As such, there is no *Habitat critical to the survival of the species* identified within or close to the Project disturbance footprint (refer Table 5.4 and habitat figure in Appendix F). The Project is predicted to impact 84.58 ha of *potential habitat* for the species under the approach used for this assessment. Nevertheless, this is a conservative assessment encompassing most woodland habitat within the Project disturbance footprint. The necessary habitat values to support the species presence (grassy and shrubby understorey) were generally not observed to be present and the species is usually found in found in wet eucalypt forests, warm temperate rainforest and coastal heaths (DAWE 2020b) none of which occur within the MNES study area. No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project. There is no evidence the species occurs in the MNES study area. It is not considered there are any direct or indirect impacts associated with Project activities likely to impact the species or potential habitat, such that the Project will cause the species to decline or impede the recovery of the species. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.
Pseudomys novaehollandiae	New Holland mouse	The nearest database record is from 1982 taken from 1 km south of the Project in Gatton. The location data associated with this record is likely to be erroneous. More recent database records occur further north-west of this record in the Helidon Hills (recorded in 2000) and Crow's Nest areas (2000 and 2012) (6 km and 17 km north of the Project respectively) (AoLA 2020) (refer Figure 5.14 in Appendix B). The Project disturbance footprint intersects habitat associated with the northernmost population of the species and therefore may be considered to potentially impact an 'important population'. No recovery plan exists for this species. A review of the available literature has not revealed any important populations when referring to DAWE's SPRAT database (2020). No populations have been identified that are key to the long-term survival and recovery of this species and *Habitat critical to the survival of the species* has not been identified or defined. In the absence of a definition for Habitat critical to the survival of the species this assessment has applied a 1 km buffer on known records that intersect 'potential habitat' (refer Appendix A for methodology). As such, there is no *Habitat critical to the survival of the species* identified within or close to the Project disturbance footprint (refer Table 5.4 and habitat figure in Appendix F). Predictive habitat mapping indicates that the Project has the potential to impact 88.12 ha of *potential habitat* in which this species may occur (refer Table 5.4). The Project has potential to impact an 'important population and is considered further in the following section (refer Table 5.31).

Species name	Common name	Project disturbance footprint population evaluation
Pteropus poliocephalus	Grey-headed flying-fox	This species was detected during Project-associated surveys in the vicinity of a known roost site for the species in Gatton (outside of the MNES study area). The nearest database records are from Laidley (2009 and 2011) and are located within the MNES study area. There is a 2009 Gatton record form the approximate location of the Project survey observation (AoLA 2020) (refer Figure 4.6 in Appendix B). The species distribution extends from Rockhampton south to Victoria and South Australia. The Project disturbance footprint is not at the limit of the species range. Based on quarterly flying-fox data collected by DES in the SEQ region there are three Flying-fox camps located within 15 km of the Project which regularly comprise Grey-headed flying-fox: one each in Laidley, Gatton and the Murphy's Creek areas. The draft *National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus*) (DotEE 2017) does not identify important populations for the species. The Plan does not specifically identify H*abitat critical to the survival of the species* but does recommend management of habitat associated with a number of tree species located within the MNES study area. This is a highly mobile species and the linear nature of the Project is not expected to impact dispersal or breeding capacity. Predictive impact assessment has taken a conservative approach for this species and included all habitat within a 15 km radius of the known regular roost sites for the species that are local to the MNES study area (refer Appendix A for methodology). As such, the predictive assessment estimates that 99.46 ha of *Habitat critical to the survival of the species* may be impacted under the current disturbance footprint (refer Table 5.4). The Project has potential to impact *Habitat critical to the survival of the species* under the approach used for this assessment. The potential for significant impacts are assessed further in Table 5.32.

5.3.5.3 Significant impact assessment - Vulnerable fauna species

Collared delma (*Delma torquata*) - vulnerable

Ecology and distribution

The Collared delma typically inhabits eucalypt-dominated woodlands and open-forests in Queensland on RE land zones 3, 9 and 10 (Brigalow Belt Reptiles Workshop 2010). Recent studies in the Toowoomba Range associated with the species indicated the species was frequently associated with open *Eucalyptus crebra* woodland located on northwest facing slopes on land zone 9 (Schell and Stark pers. obs. 2017).

The Collared delma has been recorded from rocky areas associated with dry open forests. This species occurs in open eucalypt and *Acacia* woodland with an understorey of native grasses and loose rocks. The Collared delma has also been recorded from Eucalypt woodland adjacent to semi-evergreen vine thicket. This species shelters under rocks, fallen timber, leaf litter and in soil cracks (Richardson 2006). The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of the Collared delma microhabitat and is always present where the species occurs (Brigalow Belt Reptiles Workshop 2010; Davidson 1993; Schell and Stark pers. obs. 2017).

The Collared delma is endemic to the SEQ and Southern Brigalow Belt Bioregions. The known distribution of the species includes Western Creek near Millmerran, the Toowoomba Range, and the Helidon Hills north of Helidon, eastward to Moggill on the western outskirts of Brisbane. The largest known occurrence of this species occurs on the Toowoomba Range where large numbers of this species were subject to translocation activities associated with the Toowoomba Second Range Crossing project (DAWE 2020b; Schell and Stark pers. obs. 2017).

Distribution in context to the Project

The Collared delma has not been recorded within or adjacent to the Project disturbance footprint. The nearest database records are two from 1995 taken from the Helidon Hills 4.5 km and 6 km north of the Project in the Helidon area. There is a 2019 record with a high spatial uncertainty located further north-west (16 km north of Gatton). Records associated with the population associated with the Toowoomba second range crossing project are approximately 11 km west of the western extent of the Project (Schell and Stark pers. obs. 2017) (refer Figure 5.2 of Appendix B). Further north and west the species occurs in Bunya Mountains National park and Yarraman State Forest and surrounds (AoLA 2020). The Project disturbance footprint is located near the southern limit of the species range.

Project associated surveys noted potential habitat for the species (woodlands with loose surface rocks) as occurring where the Project disturbance footprint intersects the Little Liverpool Range and habitat connected to the south of the Helidon Hills in the Helidon area (refer assessment proformas in Appendix H).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species. The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) is applicable to this species and outlines primary threats, impacts and mitigations to this species and other Brigalow Belt reptiles.

The DAWE Approved Conservation Advice (DEWHA 2008h) notes the following potentially threatening processes identified for Australian habitat as relevant to Collared delma:

- Loss and modification of habitat due to urban and agricultural development
- Landscaping activities removing surface rocks
- Fire and invasive weed species, particularly Dwarf lantana (*Lantana montevidensis*).

Important populations and Habitat critical to the survival of the species

There are no identified important populations or definitions of habitat critical to the survival of the species. The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) considers the presence of suitable and important habitat for this species a surrogate for an important population of the species. This includes known/likely habitat for the species as mapped within the guidelines. The Project lies within known/likely habitat from Gatton to Helidon. The remainder of the alignment is mapped as may occur only. Other important habitat factors include: habitat near the limit of the species known range; and large patches of contiguous, suitable habitat and viable landscape corridors. Habitat within the Helidon Hills and the Little Liverpool Range is extensive, acts as a wildlife corridor, and includes the following habitat types which the species is known to occur in:

- Open forest eucalypt woodland dominated by ironbarks
- Woodland adjacent to exposed rocky areas
- Regional ecosystems on land zones 3, 9 and 10 (DAWE 2020b).

As such, the Project disturbance footprint includes habitat that may be considered as *'important habitat'* for Collared delma.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping for this species estimates that 88.53 ha of *important habitat* may be impacted under the current disturbance footprint (refer Table 5.4 and habitat figure in Appendix F). This habitat is associated with the Little Liverpool Range (east of Laidley) and the southern edge of the Helidon Hills (north of Helidon in the western portion of the Project alignment). Assessment against the significant impact criteria for vulnerable species is shown in Table 5.24.

Table 5.24 Assessment against the significant impact criteria: Collared delma

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population of a species	Predictive habitat mapping indicates the Project has the potential to impact 88.53 ha of *important habitat* for the species. There are no known records of this species within or adjacent to the Project disturbance footprint. The closest known records are located 4.5 km to 6 km north of the Project in the Lockyer Forest Reserves area. The species is also known to occur in the Toowoomba Range to the direct west of the Project. Suitable (or important) habitat impacted by the Project is restricted to the southern edge of this area and within the Little Liverpool Range. The vast majority of the Project disturbance footprint impacts already cleared lands and avoids suitable rocky habitat where possible. In accordance with the *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) the presence of *important habitat* is a surrogate for an important population. As such, should the species be found to occur, the Project has the potential to result in the long-term decrease in the size of an important population through: ■ Loss of habitat ■ Fragmentation of an important population ■ Mortality of individuals during construction Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final Project disturbance footprint to identify whether the species occurs or not as part of the Project Flora and Fauna Sub-plan. Survey methods will follow the relevant MNES survey guidelines. Should the species be found individuals will be relocated from the area of disturbance prior to construction/disturbance activities (refer Table 5.7). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The Project is considered unlikely to lead to a long-term decrease in an important population (or analogous important habitat).
Reduce the area of occupancy for an important population	Predictive habitat mapping indicates the Project has the potential to impact 88.53 ha of *important habitat* for the species. There are no known records of this species within or adjacent to the Project disturbance footprint although the species is known from the Toowoomba Range to the west. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint to identify whether the species actually occurs or not. Should the species be found to occur in the area the Project has potential to reduce the occupancy of an important population (or analogous *important habitat*) across the local region.
Fragment an existing important population into two or more populations	It is uncertain if the species occurs although *important habitat* is considered present. The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) notes that fragmentation of *important habitat* or landscape corridors through the introduction of a barrier to dispersal presents a 'high risk' of significant residual impacts to the species. The Project is linear but impacts areas which are already subject to extensive fragmentation. The alignment crosses the Little Liverpool Range via a tunnel and lies north of the existing Rosewood-Laidley Road. The section of the alignment north of Helidon lies adjacent to a powerline easement and local roads and the Warrego Highway to the south. Given the existing infrastructure already in place in the immediate surrounds the Project is considered unlikely to further fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) notes that the loss of 2 ha of *important habitat* for this species poses a high risk of causing a significant residual impact to the species. It is uncertain if the species occurs although *important habitat* is present. There are no database records within 4.5 km of the Project disturbance footprint and only in the western extent of the alignment. Predictive habitat mapping indicates the Project has the potential to impact 88.53 ha of *important habitat* for the species. As such the Project has the potential to impact habitat (i.e. important population is not confirmed but is based on the presence of *important habitat*) considered critical to survival of the species.
Disrupt the breeding cycle of an important population	This species is known to produced eggs in December, which hatch in February–March. As noted above the Project disturbance footprint incorporates 9.56 ha of *important habitat* and clearing activities within this habitat between December and March has the potential to impact the species breeding cycle.

Criterion	Assessment against significance criteria
	No historical records for the species exist within the MNES study area, although the species has been recorded in the surrounding area 4.5 km north of the Project although only in the western extent of the alignment. Potential habitat will be inspected prior to clearing activity. Provisions to relocate individuals of Collared delma will be in place within the Project Flora and Fauna Sub-plan should any be recorded. Although the Project may impact individuals it is considered unlikely that the Project will disrupt the breeding cycle of an important population as a whole.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historical records of the species within the MNES study area although the species has been recorded in the wider area 4.5 km north of the western extent of the Project. Predictive habitat mapping indicates the Project has the potential to impact 88.53 ha of *important habitat* for the species. As noted in Section 5.1.2, Project impacts are not restricted to the footprint and there is the potential to impact on potential habitat as a result of edge effects, dust deposition, noise and light, changes to soil and changes to hydrology. These indirect impacts on habitat are not likely to be of the extent that the species is likely to decline. The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011e) notes that the introduction of invasive weeds, including the deliberate or accidental sowing of pasture grasses, within 30 m of important reptile habitat without appropriate and ongoing control measures also poses a high risk to the species. The rail corridor will be cleared and stabilised, including revegetation using grass species (i.e. woody vegetation will be permanently cleared from the operational rail corridor). Lands within the construction footprint not required for operations will also be rehabilitated, with rehabilitation works likely to reflect pre-existing conditions and as such there is a risk that pastoral grass may be re-introduced to areas within 30 m of *important habitat*. Fire is also a key threat to the species and species habitat with both construction and operation activities potential points sources. The risk of bushfires as a result of the Project are low, while the Project may also provide access to manage bushfires in the vicinity of the alignment. As noted above the Project will remove, destroy or modify *important habitat* for this species (i.e. important population is not confirmed but is based on the presence of *important habitat*), however the Project is not likely to modify or degrade the quality of habitat outside of the Project disturbance footprint to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 17 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2019a, 2019b). Dwarf lantana has been identified as a particular threat to Collared delma habitat (DEWHA 2008h) and noted as present in some areas within the alignment during Project EIS surveys. Relevant habitats for the species (eucalypt woodlands) within the MNES study area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species. Feral predators including cat and dog were observed as present during Project site surveys. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The Approved conservation advice (DEWHA 2008h) notes the following priority actions applicable to the species: ▪ Protect and monitor known populations and identify threats ▪ Develop a fire management strategy for known populations and habitat ▪ Minimise adverse impacts from land use including road widening and maintenance ▪ Identify and control threatening weeds in Collared delma habitat.

Criterion	Assessment against significance criteria
	It is not known if the species occurs in the area. The Project is considered unlikely to interfere with any of the priority actions listed above such that it will substantially interfere with the recovery of the species. The Project Biosecurity Management Plan will help to control weeds in the vicinity of the Project. Should Collared delma be identified during Project activities this will contribute to current information on the species in the SEQ region.
Assessment of potential for significant residual impacts	The Project is considered to have potential for a significant residual impact on Collared delma through a reduction in the occupancy of *important habitat* and fragmentation of a population, although this is dependent on the species actually being found within the Project disturbance footprint.

Red goshawk (*Erythrotriorchis radiatus*)

The solitary Red goshawk is known to mostly prey on larger birds such as Australian brush-turkeys (*Alectura lathami*), Kookaburras (*Dacelo novaeguineae* and *leachii*), Rainbow lorikeet (*Trichoglossus moluccanus*), and other parrots, as well as small mammals, reptiles and insects. The species is known to attack its prey from the air, gliding straight down or chasing it down. The species occupies large home ranges estimated to be up to 120 km^2 (females) and 200 km^2 (males). Preferred habitat requirements are extensive tracts or remnant woodlands/forests on fertile soils with a mosaic of vegetation types, access to permanent water, and large populations of birds (DERM 2012).

The male of the species will build nests using dead sticks lined with twigs and green leaves within an exposed fork in the upper quarter of a tree between 10 to 20 m above ground and used each year. Nest sites are usually located on an emergent tree within 1 km of permanent water. The breeding season for Red goshawk occurs from September to December with one to two eggs being laid by the females between August and October in the southeast regions (DES 2017b; OEH 2017c).

The species is sparsely distributed across coastal and near-coastal areas of northern Australia, with occasional records along major inland rivers. The distribution range of Red goshawk previously included north-eastern NSW but has contracted since European settlement (DERM 2012). The southern limit of the species in NSW has undergone a 500 km northward contraction (Debus and Czechura 1988).

Distribution in context to the Project

No individuals were observed during Project associated survey works, including targeted surveys for breeding places (nests) along the Project alignment (Ecological 2019). Database records indicate this species has been recorded within 50 km of the Project. It is noted available records (AoLA) have all been generalised in order to protect the species and so accurate locations have not been published. The nearest recent records include: a 2008 record located 3.7 km north-west of the western extent of the Project in the Lockyer Resources Reserve; 2002 and 2003 records located 5 km south in the Grantham area; a record from 2009 located 8 km north-east of the Project in the Rosewood area (although attached location data indicates Ipswich as the locality); and a 2012 record near Toowoomba (13 km south-west of the western extent of the Project) (AoLA 2020) (refer Figure 5.19 in Appendix B).

No individuals were observed during Project associated survey works, including targeted surveys for breeding places along the Project alignment (e.g. Ecological (2019b) and EMM (2018c, 2018d)). The population in the south-east Queensland bioregion is thought to consist of 10 to 30 breeding pairs (Garnett et al 2011). An intensive study on the species was carried out in favoured sites (largely well-vegetated montane and foothill areas) in south-east Queensland over 60 survey days from December 2013 to May 2014. No individuals and a single potential nest site were observed across the survey period (Seaton 2014).

Recovery plans/threat abatement plans

The *National recovery plan for the Red goshawk (Erythrotriorchis radiatus)* (DERM 2012) came into effect under the EPBC Act in July 2012. The Plan identifies the following threatening processes as applicable to the species:

- Loss of habitat
- Fragmentation of existing habitat
- Reduction in nest sites through the loss of mature trees
- Reduction to the prey base
- Threats to prey availability
- Knowledge and communication gaps for this species
- Poor management practices.

The are no Commonwealth adopted threat abatement plans considered relevant to this species.

Important populations and Habitat critical to the survival of the species

Specific important populations have not been identified for this species due to the sparse distribution of the species. The population in the SEQ bioregion is thought to consist of 10 to 30 breeding pairs (Garnett et al 2011). It is considered likely that the SEQ population of Red goshawk represents the southernmost limit of the species at the time of this assessment. Under the definition provided in the MNES guidelines (DotE 2013a), any individuals occurring in or near the Project may be are considered an important population as they are part of a population near the limit if the species range.

Under the recovery plan habitat critical for the species survival comprises all required habitat elements including 'sites for nesting, food resources, water, shelter, essential travel routes, dispersal, buffer areas, and sites needed for the future recovery' (DERM 2012) (refer Appendix A for methodology). This requires riverine areas with permanent water located within or near extant tracts of woodland which is very limited across the Project disturbance footprint.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping for this species estimates that 71.08 ha of *potential habitat* and 17.74 ha of *Habitat critical to the survival of the species* may be impacted under the current disturbance footprint (refer Table 5.4 and habitat figure in Appendix F). This habitat is associated with the Helidon and Little Liverpool Range areas. Assessment against the significant impact criteria for vulnerable species is shown in Table 5.25.

Table 5.25 Assessment against the significant impact criteria: Red goshawk

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population of a species	No historical records exist within the MNES study area and no individuals or raptor nests were observed during field investigations. The nearest recent record is located 3.7 km from the disturbance footprint and there are several other recent records (post 2000) surrounding the Project. Should individuals occur in the area they may be considered as part of an 'important population'. Predictive habitat mapping indicates the Project has the potential to impact 88.82 ha of suitable habitat for the species (including 71.08 ha of *potential habitat* and 17.74 ha of *Habitat critical to the survival of the species*). This habitat is largely associated with the Helidon Hills and Little Liverpool Range areas. The species requires large home ranges of between 120 km^2 and 200 km^2. The species does not generally occur in cleared habitat or in dense vegetation and there are no breeding records from areas where vegetation is extensively fragmented. Through this area the Project will remove mature trees reducing the availability of potential nest trees, though no nests have been identified from the Project disturbance footprint. The Project also has the potential to impact this species through the following: ▪ Fragmentation of existing habitat ▪ Reduction to the prey base ▪ Threats to prey availability

Criterion	Assessment against significance criteria
	The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint in the Little Liverpool Range. The potential area of impact would be a very minor percentage of an individuals overall range. Potential nesting habitat (emergent trees within 1 km of permanent waterbodies in larger tracts of woodland) will be inspected during targeted pre-construction surveys of the Project disturbance footprint (refer Table 5.7). Provisions to protect Red Goshawk nest sites will be in place within the Project Flora and Fauna Plan should any nest sites be recorded. It is considered likely that foraging individuals disturbed by construction activities will temporarily move away from the area of disturbance and return post-construction. The Project is considered unlikely to result in a long-term decrease in the size of an important population should the species be found to occur in the area.
Reduce the area of occupancy for an important population	Predictive habitat mapping indicates the Project has the potential to impact 88.82 ha of suitable habitat for the species (including 71.08 ha of *potential habitat* and 17.74 ha of *Habitat critical to the survival of the species*). It is uncertain if the species occurs in the area. The nearest recent record is located 3.7 km from the disturbance footprint and there are several other recent records (post 2000) in the surrounding area, although the actual locality of these sighting is uncertain. The species requires large home ranges of between 120 km^2 and 200 km^2. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint in areas of extensive habitat (such as the Little Liverpool Range and Helidon area). It is considered likely that foraging individuals disturbed by construction activities will temporarily move away from the area of disturbance and return post-construction. The Project is considered unlikely to reduce the potential area of occupancy for the species should the species be found to occur in the area.
Fragment an existing important population into two or more populations	The species is highly mobile and the Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	Predictive habitat mapping indicates the Project has the potential to impact 88.82 ha of suitable habitat for the species, of which 17.74 ha may be considered as *Habitat critical to the survival of the species*. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint in areas of extensive habitat (such as the Little Liverpool Range). The species requires large home ranges (between 120 km^2 and 200 km^2) and the Project will impact a very minor proportion of the available Habitat critical to the survival of the species in the wider area. Nevertheless, although minor in extent, the Project has potential to adversely affect *habitat critical to the survival of the species*.
Disrupt the breeding cycle of an important population	No historical records or recent field observations for the species exist within or close to the MNES study area itself. No breeding sites are known to the MNES study area. Potential nesting habitat (emergent trees within 1 km of permanent waterbodies in the Little Liverpool Range) will be inspected prior to clearing activity. Provisions to protect Red Goshawk nest sites will be in place within the Project EMP should any nest sites be recorded. The recovery plan notes Red goshawks are very tolerant of moderate numbers of people visiting their nest sites. However, the Project will result in the clearing of mature trees up to a kilometre from watercourses, with these trees as potential suitable nest sites. No raptor nests were identified from the Project disturbance footprint during the EIS studies, including within large mature trees within 1 km of a major watercourse. Tree clearing during the breeding season (generally occurs in spring), egg-laying (August to October) or fledging (65-80 days) may present a direct impact on the species breeding cycle. Provisions to protect Red goshawk nest sites will be in place within the Project EMP should any nest sites be recorded. This will likely include buffer zones and the erection of barriers and/or signage around the trees during construction and micrositing of the clearing works to avoid nests. It is considered unlikely that the Project will disrupt the breeding cycle of an important population.

Criterion	Assessment against significance criteria
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historical records of the species within the MNES study area and the species is currently considered as rare in the region. Predictive habitat mapping indicates the Project has the potential to impact 88.82 ha of suitable habitat for the species (including 71.08 ha of *potential habitat* and 17.74 ha of *Habitat critical to the survival of the species*). However, the species has large home ranges and the Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint in areas of extensive habitat (such as the Little Liverpool Range and Helidon area). Impacts will be temporary and restricted to the construction period. This impact is not considered to be of the extent that the species is likely to decline, should the species be found to occur in the area.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	There are no weeds or pests identified as relevant to Red goshawk. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 17 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2019a, 2019b). Project surveys within the MNES assessment area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	Recovery strategies listed in the Commonwealth recovery plan for the species include: ▪ Identify and map important Red goshawk habitat ▪ Protect and appropriately manage important habitat area to ensure long-term survival of the Red goshawk ▪ Increase knowledge about the Red goshawk's productive success and its survival ▪ Identify important populations of Red goshawks ▪ Increase community awareness about the Red goshawk and the conservation of the species (DERM 2012). The Project is considered unlikely to interfere with any of the recovery strategies listed above. Should Red goshawk be identified during Project activities this would contribute to current information on the species in the SEQ region.
Assessment of potential for significant residual impacts	The Project has potential to have a significant impact on the Red goshawk through impact to habitat considered as Habitat critical to the survival of the species.

Australian lungfish (*Neoceratodus forsteri*)

Ecology and distribution

Australian lungfish prefers still or slow-flowing, shallow waters with clear, vegetated pools to allow feeding, shelter and spawning. Riparian vegetation such as Red bottle-brush (*Melaleuca viminalis*), She-oak (*Casuarina* spp.) and aquatic macrophytes are the dominant species used by the lungfish. Despite the capability of the species to breathe aerially using its single lung, it requires permanent water and cannot live in saline environments (Brooks and Kind 2002). The primary source of food for the Australian lungfish is molluscs and other small animals. The species is known to be a low level benthic carnivore with hatchlings and juveniles feeding on small invertebrates as active predators during the developmental stage (Kemp 1996).

The breeding cycle of the lungfish occurs at around 15 years of age for the male and 20 years for the female with spawning at night between August and December in preferably clear waters. The species is known to abandon any spawning sites upon disturbance (DAWE 2020b).

The lungfish is an endemic species to Australia and limited in distribution to southeast Queensland. River systems such as the Mary, Burnett and Brisbane Rivers are currently inhabited. The species has also been translocated successfully to the Condamine, Albert and Logan Rivers (DAWE 2020b). The species is native to the Mary and Burnett Rivers and was potentially present in the Brisbane River catchment, although this remains uncertain. A number of individuals were translocated from the Mary River in the 1890s to several locations including a farm dam in the upper Brisbane River, the North Pine River, a lagoon near the Albert River, Enoggera Reservoir and the Condamine River (DotEE 2019a).

Distribution in context to the Project

Database records (i.e. AoLA, Wildlife Online) indicate this species has been recorded within the MNES study area. There is a 2003 record from Lockyer Creek in the Gatton area (1.2 km north of the Project disturbance footprint). A second record from 1994 is from Lake Apex in Gatton (2 km south of the Project) and is very likely to be the result of human introduction to the lake. There are no records upstream of the Project. There are several further records on Lockyer Creek downstream of the Project although these are all older (pre-2000) until the confluence of the creek with the Wivenhoe Dam spillway (28 km north-east of the Project). The nearest recent record to the eastern extent of the Project (2017) is from the Bremer River located 10 km east of the Project in the Rosewood area (refer figure 2.2 in Appendix B). The densest population in the catchment is thought to be over 30 km downstream of the Project in the Brisbane River between Wivenhoe Dam and Mount Crosby Pumping Station (DotEE 2019a).

Waterways crossed by the Project alignment are within the upper catchment of the Brisbane River and include Lockyer Creek. Habitat values across the catchment appeared poor with little canopy cover over creeks, heavily impacted riparian zones, and cattle access in some areas. Aquatic habitat assessment at the location of the Project crossing on the Lockyer Creek in September 2017 noted water as present (refer Photograph 4.9) with shallow pools being dominant with few deeper pooled areas likely to be suitable for Australian lungfish. Emergent macrophytes were present along approximately 5 per cent of the 100 m of reach assessed. Similar instream habitat elements were noted at a second site 300 m further upstream although macrophyte cover was generally higher (approximately 30 per cent cover). Lockyer Creek occurs in a heavily modified landscape and riparian cover at these sites was very poor. Downstream sites included the section of Lockyer Creek where the 2003 record noted above was approximately located. Habitat values were similar to the upstream sites and no water was present during the aquatic habitat assessment.

Surface water quality sampling for the EIS studies was carried out on three sampling occasions (October 2017, March 2018 and March 2019) at the 12 aquatic habitat assessment sites. Six of the sites could only be sampled on one occasion due to dry conditions (i.e. no water was present). The other six sites were sampled on only two of the three water sampling surveys due to dry conditions indicating waterways in the assessment catchment are ephemeral and less likely to be suitable for Australian lungfish (refer EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for further detail).

Recovery plan/threat abatement plans

There is currently a draft *National recovery plan for the Australian lungfish (Neoceratodus forsteri*) (DotEE 2019a) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Instream barriers preventing movements and impacting habitat conditions
- Regulated stream flows impacting habitat conditions (considered a specific threat to Brisbane River populations)
- Stream habitat and water quality degradation from land clearing, livestock access and increased salinity

- Potential competition with invasive species and native species. Small species such as the introduced Mosquitoe-fish (*gambusia holbrooki*) may compete with the larval stage of cod. Native species such as Australian bass (*Macquaria novaemaculeata*) and Golden perch (*Macquaria ambigua*) have been stocked outside of their natural range and may predate on juvenile lungfish and eggs. Introduced species such as Tilapia (*Oreochromis mossambicus*) and European carp (*Cyprinus carpio*) may impact lungfish habitat.
- Fishing and boating activities.

The are no Commonwealth adopted threat abatement plan considered relevant to this species.

Important populations and Habitat critical to the survival of the species

The *Draft national recovery plan for the Australian lungfish (Neoceratodus forsteri*) (DotEE 2019a) does not identify important populations but suggests all populations are under threat. The MNES study area is located at the southern edge of the species range and as such any populations present may be considered part of an 'important population' under the MNES Guidelines.

The Plan defines *habitat critical to the survival of the species* as 'breeding or foraging habitat in areas where the species occurs' as defined by the Plan's distribution map for the Brisbane River catchment. The Project intersects Lockyer Creek within the mapped distribution. As noted above, Lockyer Creek at the point of intersection with the alignment may provide some temporal value to support the species, particularly following flow events, although over longer periods the ephemeral nature of the creek (and the catchment in general) may preclude this area as permanently supporting the species.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping estimates that 0.28 ha of *potential habitat* and 1.96 ha of *Habitat critical to the survival of the species* will be impacted by the Project (refer Table 5.4 and habitat figure in Appendix F). Assessment of potential disturbance of this species against the MNES Significant impact guidelines is provided in Table 5.26.

Table 5.26 Assessment against the significant impact criteria – Australian lungfish

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	There is a single relatively recent record downstream of the Project disturbance footprint and no records upstream. Should the species be found to occur there is potential the population may be considered as an 'important population'. Predictive habitat mapping indicates that the Project may impact 2.24 ha of suitable habitat (including 0.28 ha of *potential habitat* and 1.96 ha of *Habitat critical to the survival of the species*) within the upper reaches of the Brisbane catchment. Nevertheless, general habitat values for Australian lungfish appear poor at the waterway crossing points associated with the Project and most, if not all sites within the assessment area were found to be ephemeral (refer Section 4.4.4.6). As noted in Section 5.1.2 the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. As noted above, some of these impacts are recognised threats to the species. Physical barriers that prevent individuals from accessing breeding sites and the flooding of spawning sites are two key threats (DotEE 2019a). It should be noted that breeding and spawning sites within and upstream of the Project are likely limited (i.e. habitats are ephemeral systems with limited macrophyte richness and abundance). The Project design incorporates culverts and bridges to allow fish passage, including bridge crossings of Lockyer Creek, Laidley Creek, Sandy Creek and Western Creek (refer Section 5.2.1). Flood modelling indicates that stream flows (e.g. flood heights and flow velocities) will not be adversely impacted as a result of the Project (refer EIS Appendix M: Hydrology and flooding technical report). The culvert design will also incorporate (where applicable) measures to maintain fish passage, minimise changes to environmental flows and water quality, with ongoing maintenance of these structures also required. Construction activity at watercourse crossings will also disturb the riparian zone and instream habitats, including potential habitat for the species. These impacts are likely to be localised and occur in areas which are unlikely to be breeding or foraging habitat for the species.

Criterion	Assessment against significance criteria
	The Project's construction phase may require temporary stream impoundments at waterway crossing points, along with the removal of instream habitat. These works will be temporary and localised. Dewatering activities of impounded areas will be carried out with consideration of the DAF Guidelines for fish salvage in impounded areas under the Project Flora and Fauna Plan (refer Table 5.7). The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of the population.
Reduce the area of occupancy of the species	There is a single relatively recent record downstream of the Project disturbance footprint and no records upstream. Should the species be found to occur there is potential the population may be considered as an 'important population'. Predictive habitat mapping indicates that the Project may impact 2.24 ha of suitable habitat (including 0.28 ha of *potential habitat* and 1.96 ha of *Habitat critical to the survival of the species*), within the upper reaches of the Brisbane catchment. The Project design incorporates culverts and bridges to allow fish passage, including bridges over Lockyer Creek, Laidley Creek, Sandy Creek and Western Creek. Construction works within these watercourses will also result in changes to instream habitats which may temporarily influence the species behaviour and distribution (should it be present). Stream impoundments may be required temporarily during the construction phase and as part of maintenance activities during operations. The Project will also result in some infilling and diversions of drainage lines. The impacts of the Project are temporary and considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	The Project is not considered to represent a barrier to movement for the species. The Project design incorporates culverts and bridges to allow fish passage, including bridges over Lockyer Creek, Laidley Creek, Sandy Creek and Western Creek. Stream impoundments may be required temporarily only during the construction phase. These structures and construction measures will avoid fragmentation of an existing population. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	The Project will intersect *Habitat critical to the survival of the species* as mapped under the species recovery Plan where it crosses Lockyer Creek. Onsite assessments indicate this section of the river provides potential temporal habitat value for Australian lungfish although the ephemeral nature of the creek may preclude area as permanently supporting the species. There is a single relatively recent record downstream of the Project disturbance footprint and no records upstream. Project disturbance to this area will be temporary being restricted the construction period (there will be maintenance activities during the operation phase). The Project will also have a temporary impact on environmental flows noting the downstream receiving environment is *Habitat critical to the survival of the species* (i.e. during construction coffer dams will be erected within watercourses preventing and/or regulating stream flows). Changes to water quality may also occur if not appropriately managed during construction (e.g. overland flow from cleared lands, loss of riparian zones and instead habitats, erosion and sediment controls) or operations (accidental spills and maintenance of waterway barriers). However, the risk of impact is likely to be low and localised. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). It is considered unlikely that the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	The Australian lungfish is restricted to areas of permanent water and is known to complete their lifecycle entirely within freshwater habitats (i.e. potamodromous). Breeding occurs from August through to December in shallow runs and along river margins in close proximity to aquatic vegetation. Submerged aquatic plants are an important habitat feature for breeding grounds, nursery areas and adult foraging zones. In general habitat values for Australian lungfish appear poor at the waterways crossing points associated with the Project (e.g. limited submerged plants are present if at all) and most sites are ephemeral. As such it is unlikely that the species breeds within the reach intersected by the Project. The temporary impoundment of these watercourses may pose a risk to these species given they are potamodromous. However, the Project design incorporates culverts and bridges to allow fish passage, including bridges over Lockyer Creek, Laidley Creek, Sandy Creek and Western Creek. Stream impoundments may be required temporarily only during the construction phase. Project disturbance to waterways will be temporary being restricted the construction period. It is considered unlikely that the Project will disrupt the breeding cycle of a population.

Criterion	Assessment against significance criteria
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Aquatic habitat degradation is contributing a factor to the decline in Australian lungfish populations. The degradation generally occurs at a catchment scale such as land clearing, pesticide use and irrigation abstraction which influence water quality. Under the draft recovery plan potential threats relevant to habitat degradation is relevant to populations within Lockyer Creek and Bremer River catchments. Despite this the Project will require works within instream habitats, which will result in the remove of woody debris and changes to the local geomorphology. There features are believed to be important to the species but are not utilised as extensively as macrophytes habitats. The majority, if not all of the water crossing points are ephemeral and instream habitat complexity is limited, in particular the presence of aquatic plants. Project disturbance to waterways will be localised and temporary being restricted the construction period. Changes to water quality may also occur if not appropriately managed during construction (e.g. erosion and sediment controls) or operations (accidental spills and maintenance of waterway barriers). However, the risk of impact is likely to be low and localised. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). The impacts of the Project are considered unlikely to be of the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Under the draft recovery plan potential threats relevant to the populations within the Brisbane River and Logan River catchments include the introduction of pest specie, including competition/predation by introduced species (especially Tilapia (*Oreochromis mossambicus*) and Banded grunter (*Amniataba percoides*)). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction of novel weeds and spread of existing weed species across the Project disturbance footprint. This will include measures to ensure aquatic weeds and pest species are not introduced as a result of the Project. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The draft recovery Plan for the species includes the following recovery actions: ▪ Reduce the impacts of, and remove any redundant, artificial barriers ▪ Manage waterways to optimise breeding and recruitment opportunities ▪ Limit habitat degradation and maintain or enhance water quality ▪ Reduce the impacts of introduced pest and weed species ▪ Manage the impacts of water-based recreational activities ▪ Address key knowledge gaps to improve Australian lungfish management ▪ Facilitate high levels of community participation and support in the implementation of Australian lungfish management strategies (DotEE 2019a) With mitigation measures in place, particularly for the construction phase, the Project is considered unlikely to interfere with any of the recovery actions listed above and will not interfere with the recovery of the species. Should Australian lungfish be identified during Project activities this will contribute to current information on the species in the SEQ region.
Assessment of potential for significant residual impacts	Although it is acknowledged the Project will have impacts on Habitat critical to the survival of the species this impact will be temporary only during construction. Under the nine-part test detailed above the Project is considered unlikely to have a significant impact on Australian lungfish.

Greater glider (*Petauroides volans*)

Ecology and distribution

The Greater glider (*Petauroides volans*) is the largest species of gliding possum. It has large ears fringed with thick fur and a gliding membrane which attaches to the elbows and ankles. Greater gliders are typically found in mature eucalypt forests and woodlands with a variety of eucalypt species and a high density of large tree hollows (van der Ree et al. 2004). The diet is largely composed of eucalypt leaves and sometimes flowers. Large hollows in old trees are favoured as shelter sites during the daytime (Goldingay 2012). Sites with a high abundance of suitable hollows appear to support higher populations. The species uses relatively small home ranges of 1 ha – 4 ha in more productive forests (Gibbons and Lindenmayer 2002), but up to 16 ha in more open and dry habitats (Smith et al. 2007).

Females breed in their second year giving birth to a single young each year (March to June). Their low birth rate may cause isolated populations in small forest fragments to be vulnerable to extinction (van der Ree et al. 2004).

The Greater glider occurs in eucalypt forests along the ranges and coastal plains of eastern Australia from central Victoria near Daylesford to the Windsor Tablelands in far northern Queensland. It has an elevational range from sea level to 1,200 m above sea level (TSSC 2016b; OEH 2018a).

Distribution in context to the Project

The species has not been recorded during Project-associated surveys and there are no database records (AoLA) within the MNES study area. The nearest database records are several (all from the 1990s) located in the Helidon Hills. These are all between 5 km and 8 km north of the Project between Helidon and Gatton. The only record in the vicinity of the east of the Project is from the Rosewood area (1989) located 8 km north-east of the eastern extent of the Project (AoLA 2020). The next closest record is from the Purga area (1999) located 18 km east of the eastern extent of the Project. The nearest recent records are from 2010 and 2016 and located north of Towoomba (16 km west and 22 km north-west of the Project) (refer Figure 4.4 in Appendix B).

In general, the Project surveys observed that habitat containing large tree hollows suitable for Greater glider was rare, being restricted to large trees on creek lines (such as on Western Creek) or on road reserves in the vicinity of the Warrego Highway. Large hollows were not recorded at sites located in the Little Liverpool Range and the Helidon areas (refer Appendix H). It is noted that much of the MNES study area is dominated by regrowth communities that are unlikely to comprise mature trees with larger hollows.

Recovery plan/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved Conservation Advice (TSSC 2016b) notes the following potentially threatening processes identified for Australian habitat as relevant to Collared delma:

- Habitat loss and fragmentation through tree clearing and logging (including for timber production) and loss of dead stag trees (with hollows) due to prescribed burning
- Changed fire regimes (including from climate change) leading too intense and/or frequent fires
- Entanglement in barbed wire is a minor threat
- Impacts from native bird species including hyper-predation by owls and competition with cockatoos for tree hollows
- Impact to habitat from *Phytophthora cinnamomi*.

Important populations and Habitat critical to the survival of the species

There are no important populations or definition of *Habitat critical to the survival of the species* in any available literature for the species. The species occurs across eastern Australia and the Project footprint is not located on the edge of the species range and there is no evidence to suggest the area supports a key source population. In the absence of any other habitat definition for the species this assessment has defined *Habitat critical to the survival of the species* by applying a 1 km buffer on known records that intersect 'potential habitat' for the species (refer Appendix A for methodology). As such, the Project disturbance footprint is not considered to comprise *Habitat critical to the survival of the species*. Predictive habitat mapping indicate the Project may impact 30.64 ha of *potential habitat* in which this species may occur (refer Table 5.4 and habitat figure in Appendix F). Assessment against the significant impact criteria for vulnerable species is shown in Table 5.27.

Table 5.27 Assessment against the significant impact criteria: Greater glider

Criteria	Assessment against significance criteria (vulnerable species)
Lead to a long-term decrease in the size of an important population of the species	The species has not been recorded within or near the Project footprint during Project surveys and no 'important population' is predicted to occur in the area. There are no database records within 5 km of the Project footprint with the nearest records all located in the Helidon Hills area. There are no records in the Little Liverpool Range in the vicinity of the Project disturbance footprint. The nearest recent records (>2,000s) are located over 16 km west of the western extent of the Project disturbance footprint in the Toowoomba Range. It is uncertain to what extent the habitat within the Project footprint retains suitable large tree hollows within contiguous woodlands that may support the species. The majority of the area impacted by the Project supports regrowth vegetation which is much less likely to support the species. The species is known to glide over a distance of up to 100 m, but usually tends not to glide further than 30 m. The species also has a steeper trajectory than other species of glider. As the rail corridor is over 60 m wide there is the potential for the Project to impact movement, noting that individuals appear to use the same routes repeatedly as they move from hollows to feeding areas and occupy relatively small home ranges (average 1 ha to 4 ha in productive habitat). Where the Project intersects the Little Liverpool Range suitable remnant eucalypt habitat located above the tunnel area is not expected to be impacted. Pre-construction surveys (it is noted there are no DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint. Provisions to protect the species will be in place within the Project Flora and Fauna Management Sub-plan should individuals be located within the disturbance footprint (refer Table 5.7). Should the species be found individuals will be relocated from the area of disturbance by qualified fauna spotter-catchers. The Project is predicted to impact 30.64 ha of *potential habitat* for the species. Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint including 1,527 ha within the MNES study area. It is considered unlikely the Project will lead to a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population	The species has not been recorded within or near the Project footprint and no 'important population' is predicted to occur in the area. It is uncertain to what extent the habitat within the Project footprint retains suitable large tree hollows within contiguous woodlands that may support the species. Pre-construction surveys will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint. The Project is predicted to impact 30.64 ha of *potential habitat* for the species. Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint including 1,527 ha within the MNES study area. The Project is considered unlikely to reduce the area of occupancy of an important population of the species.
Fragment an existing important population into two or more populations	The species has not been recorded within or near the Project footprint and no 'important population' is predicted to occur in the area. The Project is linear but impacts areas which are already subject to extensive fragmentation. The section of the alignment north of Helidon lies adjacent to a powerline easement and local roads and the Warrego Highway to the south. The species is known to glide over a distance of up to 100 m, but usually tend not to glide further than 30 m. The species also has a steeper trajectory than other species of glider. As the rail corridor is over 60 m wide there is the potential for the Project to impact movement, noting that individuals appear to use the same routes repeatedly as they move from hollows to feeding areas. If any of these routes are impacted by the Project there is the potential to fragment a population unless appropriate fauna passage is provided.

Criteria	Assessment against significance criteria (vulnerable species)
	The tunnel proposed through the Little Liverpool Range avoids fragmentation of the *potential habitat* for the species in this area. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	It is uncertain if the species occurs in the Project disturbance footprint. The Project is predicted to impact 30.64 ha of potential habitat for the species. This includes habitat within the Little Liverpool Range where the species has not been recorded previously. There is no Habitat critical to the survival of the species (as defined for this assessment). The Project is located within an area already subject to substantial disturbance. As such The Project is considered unlikely to adversely affect habitat critical to the survival of Greater glider.
Disrupt the breeding cycle of an important population	The species has not been recorded within or near the Project footprint and no 'important population' is predicted to occur in the area. It is uncertain to what extent the habitat within the Project footprint retains suitable large tree hollows within contiguous woodlands that may support the species. The species is known to breed from March to June. It is uncertain if the species occurs in the Project disturbance footprint. Pre-clearance surveys will be carried out where suitable habitat for this species is identified within the final construction footprint. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	It is uncertain if the species occurs in the Project disturbance footprint. The Project is predicted to impact 30.64 ha of *potential habitat* for the species. There is no *Habitat critical to the survival of the species* (as defined for this assessment) with the Project located within an area already subject to substantial disturbance. Intense fires are a recognised threat to the species and species habitat with both construction and operation activities providing potential points sources of ignition. Nevertheless, the risk of bushfires as a result of the Project are low, while the Project may also provide access to manage bushfires in bushland areas along the alignment. Predictive mapping identified approximately 1,527 ha of additional habitat within the MNES study area. As noted in Section 5.1.2, Project impacts are not restricted to the footprint and there is the potential to impact on potential habitat as a result of edge effects, dust deposition, noise and light, changes to soil and changes to hydrology. These indirect impacts on habitat are not likely to be to the extent that the species is likely to decline. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed or pest species identified as relevant to Greater glider. *Phytophthora cinnamomi* is considered a potential threat to the species habitat. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction, *Phytophthora cinnamomi* outbreaks and associated diseases resulting from Project activities (refer Table 5.7). The Plan will consider relevant guidelines to control *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities. This will include at a minimum vehicle washdown procedures and contractor education (including procedures regarding cleaning clothing). This will be particularly important during any revegetation activities in the vicinity of potential Greater glider habitat. Revegetation plant species will be obtained from a reliable source that is certified free of the pathogen. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for Greater glider. The Approved conservation advice (TSSC 2016b) notes the following priority management actions applicable to the species: ▪ Active threat mitigation in Greater glider habitat including managing fire regimes, constraining timber harvesting activity and clearing in forests with significant subpopulations ▪ Avoid fragmentation and habitat loss from developments and upgrades of transport corridors

Criteria	Assessment against significance criteria (vulnerable species)
	▪ High priority monitoring actions include designing an integrated monitoring program across major subpopulations and monitor the abundance/size structure of critical tree species and their responses to management actions ▪ Assess the impacts of fire management strategies on habitat values and Greater glider populations ▪ Assess the abundance, density and types of hollow-bearing trees required to support viable populations It is not known if the species occurs within the Project disturbance footprint. The Project Biosecurity Management Plan will control introduced predators and weeds associated with Project infrastructure, and ensure *Phytophthora cinnamomi* is not introduced to the area as a result of Project activities. Should the species occur any impact will be minor, and is considered unlikely to interfere substantially with the management actions identified above or the recovery of the species.
Assessment of potential for significant residual impacts	It is uncertain if the species actually occurs in the area. Under the current Project disturbance footprint there will be clearance of up to 30.64 ha of potential habitat for the species. There is extensive identical habitat remaining in the immediate surrounds. Based on the nine-part test above the Project is considered unlikely to have a significant residual impact on Greater glider.

Brush-tailed rock-wallaby (*Petrogale penicillata*)

Ecology and distribution

Brush-tailed rock-wallaby requires rocky habitat including rock faces, boulder piles and isolated rock stacks for refuge sites. The species forages in adjacent grassy woodlands and includes cleared pasture. Rocky outcrops appear crucial to current habitat selection by rock-wallabies, however, vegetation structure and composition is also considered to be an important factor determining habitat suitability. In many parts of their range, including at the Warrumbungles, Brush-tailed rock-wallabies are closely associated with dense arboreal cover, especially fig trees. The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases may provide some protection from predation. A range of vegetation types are associated with Brush-tailed rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest (DAWE 2020b).

Brush-tailed rock-wallabies are known to shelter during the day in rock crevices, caves and overhangs, but have been observed to bask in exposed sunny spots. Within their home range, rock-wallabies habitually use the same refuges, sunning spots, feeding areas and pathways and these are often defended vigorously (DAWE 2020b).

In SEQ the species historically occurred throughout the Great Diving Range but has since declined significantly undergoing localised extinction and is now patchily distributed along the range from Yarraman (north of Toowoomba) to the upper Snowy River in eastern Victoria (DAWE 2020b). The distribution is broken up into three distinct Ecologically Significant Units with the Northern Ecologically Significant Units ranging from northern NSW to south-eastern Queensland. Several populations in SEQ occur in protected areas including the following locations:

- Queen Mary Falls
- Mt Barney
- Sundown and Main Range National Parks.

Distribution in context to the Project

Database records indicate Brush-tailed rock-wallaby has been recorded adjacent to the Project disturbance footprint in the Helidon area, although this is an older record (1996). There are records (1997 and 2004) from the Helidon Hills area further north (6 km and 10 km respectively from the Project) and a 2001 record 20 km north of Gatton. Other database records occur to the north of the Project in the Crows Nest area. To the west there are two older records (1973) from the Toowoomba Range.

The species is also known from the Little Liverpool Range (ICC 2018) although the nearest record (2019) is 16 km south of the Project (refer Figure 4.2 in Appendix B). The population in the Little Liverpool Range has been subject to limited onsite assessment since 2013 under activities implemented by Ipswich City Council as part of the *Brush-tailed rock wallaby recovery plan* (ICC 2018). Observations on the local population have been focused on the Mount Beau Brummell Conservation park and adjacent lands (16 km south of the Project). It is unknown to what extent the species may occur further north where the Project occurs, if at all. It is noted this area is already highly modified with existing road and rail infrastructure and rural housing occurring in the area.

Habitat assessments carried out for the Project EIS studies identified no rocky shelter habitat suitable for Brush-tailed rock-wallaby within the sites visited within the MNES study area or Project disturbance footprint (refer habitat assessment sheets in Appendix H). Analysis of aerial imagery shows the database records located north of the Project are mostly associated with rocky areas located in the Helidon Hills, Toowoomba Range and Crow's Nest areas. This habitat was not observed within the Project disturbance footprint.

Recovery plan/threat abatement plans

The *National Recovery Plan for the Brush-tailed Rock-wallaby (Petrogale penicillata)* (Menkhorst and Hynes 2010) came into effect under the EPBC Act in February 2012. The Plan identifies the following threatening processes as applicable to the species:

- Historical hunting and persecution for fur and meat
- Habitat degradation and loss
- Predation from native and feral species
- Competition with native and introduced herbivores
- Decline in genetic diversity.

Other threats identified for the species includes the following:

- The invasion of grassy feeding areas by weed species such as *Lantana camara* is thought to reduce habitat quality for the species (DAWE 2020b)
- Bioclimatic changes resulting in lower rainfall and a decline in rainforest vegetation, may have contributed to the recently contracting distribution of *P. penicillata* throughout its range (DEC 2005).
- Small, fragmented populations which exhibit low migration rates are highly vulnerable to local catastrophes (DEC 2005).

The following threat abatement plans have been identified as being relevant for this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c)
- *Threat abatement plan for competition and land degradation by rabbits* (DotEE 2016)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008g)
- *Threat abatement plan for competition and land degradation by unmanaged goats* (DEWHA 2008i).

Important populations and Habitat critical to the survival of the species

The National recovery plan identifies several populations important to the survival of the species however these are located in New South Wales and Victoria only. Other important populations may be identified 'based on populations at the limits of its range, outlying populations, stronghold populations, research populations and others where recovery actions (e.g. predator control, reintroductions) are being implemented' (Menkhorst and Hynes 2010). The population in the Little Liverpool Range is the subject of recovery actions implemented by Ipswich City Council under the *Brush-tailed rock wallaby recovery plan* (ICC 2018) which uses the National recovery plan as a framework. Given the Little Liverpool Range population is subject to recovery actions then any individuals, should they occur in the Project disturbance footprint, may be considered as part of an important population. This assessment has been approached in a conservative manner and all individuals potentially occurring in the Project area are assessed as such.

The National recovery plan also notes *Habitat critical to the survival of the species* includes 'includes rocky refuge habitat, foraging habitat and commuting routes between the two', but also notes this has not been mapped/defined precisely and requires further work (Menkhorst and Hynes 2010). In the absence of a concise definition for Habitat critical to the survival of the species this assessment has included potential habitat within a 1 km buffer of an accurate database record to be critical habitat.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Under the habitat assessment approach used for this assessment (refer Appendix A for method) the Project is not expected to directly impact on any Habitat critical to the survival of the species suitable for this species, however, it is predicted that 41.25 ha of *potential habitat* and 4.88 ha of *Habitat critical to the survival of the species* occurs within the MNES study area (refer Table 5.4 and habitat figure in F). The critical habitat is based on the presence of the 1996 record in the Helidon area. No potential shelter habitat (rocky cliffs or boulder piles) was observed within the Project disturbance footprint during site surveys (refer habitat assessment result in Appendix H), although the entirety of the alignment has not been surveyed. The following significant impact assessment (refer Table 5.28) under the MNES guidelines (DotE 2013a) has been informed by the information detailed above.

Table 5.28 Assessment against the significant impact criteria: Brush-tailed rock-wallaby

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population of a species	This species has been recorded previously (1996) adjacent to the Project disturbance footprint in the Helidon area. There is potential for an important population to exist in the Little Liverpool Range and Helidon area (largely to the north of the Project in this area). Predictive habitat mapping indicated 46.13 ha of suitable habitat (including 41.25 ha of *potential habitat* and 4.88 ha of *Habitat critical to the survival of the species*) may be impacted within the Project disturbance footprint. The recovery plan (Menkhorst and Hynes 2010) notes that in most parts of its range the species has probably always occurred as a metapopulation comprised of colonies centred on areas of high-quality rock habitat that provided adequate refuges within reach of reliable food resources. Although adults show high fidelity to refuge sites, sub-adults (mostly males) moved between colonies, which probably overcame genetic problems associated with isolation of small populations. Where the alignment intersects the Little Liverpool Range it only impacts lower-lying lands as the proposed tunnel through the range avoids impacting more elevated habitat in the range modelled as *Habitat critical to the survival of the species*. Preferred rocky shelter sites (used for breeding) for the species were not observed within the Project disturbance footprint. Similarly, the alignment intersects the lower slopes/foothills of the Helidon Hills in the Helidon area. Both areas are already subject to a range of disturbance including road and powerline easements, rural housing and quarrying activities. Under the Project Flora and Fauna Sub-plan pre-construction surveys for the species will be carried out in accordance with relevant Commonwealth survey guidelines where suitable habitat is identified within or adjacent to the final temporary construction disturbance footprint to identify whether the species actually occurs or not. Should the species be found individuals are expected to be moved away from the area of disturbance during pre-clearance activities (e.g. using temporary exclusion fencing) and prior to any construction activities. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The Project is considered unlikely to lead to a long-term decrease in an important population.
Reduce the area of occupancy for an important population	There may be an important population existing within the MNES study area, although it is uncertain whether the species will occur in the disturbance footprint itself. Predictive habitat mapping indicated 46.13 ha of suitable habitat (41.25 ha of *potential habitat* and 4.88 ha of *Habitat critical to the survival of the species*) may be impacted by the Project. The disturbance footprint is largely located within habitat already subject to existing disturbance. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. Nevertheless, should the species occur in the area the Project has potential to reduce the occupancy of an important population across the local region although to no more than a minor extent.

Criterion	Assessment against significance criteria
Fragment an existing important population into two or more populations	It is uncertain if the species currently occurs within the Project disturbance footprint although suitable habitat is considered present (41.25 ha of *potential habitat* and 4.88 ha of *Habitat critical to the survival of the species*). The Project is linear but impacts areas which are already subject to extensive fragmentation. The alignment crosses through the Little Liverpool Range via a tunnel (allowing movement through the range at this point) and lies north of the existing Rosewood-Laidley Road which bisects the range. The section of the alignment north of Helidon lies adjacent to a powerline easement and local roads and the Warrego Highway to the south. Given the existing infrastructure already in place in the immediate surrounds the Project is considered unlikely to further fragment an existing important population into two or more populations, should the species occur at all.
Adversely affect habitat critical to the survival of the species	The Project is predicted to impact 4.88 ha of habitat considered as *Habitat critical to the survival of the species* (as well as 41.25 ha of *potential habitat*). It is uncertain if the species currently occurs within or directly adjacent to the Project disturbance footprint. Suitable lands within the MNES study area are already subject to a range of existing disturbance including road and powerline easements, rural housing and quarrying activities. Nevertheless, *Habitat critical to the survival of the species* occurs (as defined for this assessment) and as such the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	It is uncertain if the species currently occurs within the Project disturbance footprint although suitable habitat is considered present in the Helidon and Little Liverpool Range areas (41.25 ha of *potential habitat* and 4.88 ha of *Habitat critical to the survival of the species*). Breeding habitat for this species is recognised as rocky habitat with an abundant supply of ledges, caves and potential pathways. Sites with a northerly aspect are found to be important. The species may breed at any time of year. The Project disturbance footprint intersects the Little Liverpool Range in low-lying lands and is located within a proposed tunnel in the steeper area. The Helidon area is already subject to extensive existing disturbance. Preferred rocky shelter sites (used for breeding) for the species were not observed within the Project disturbance footprint. The Project is considered unlikely to disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species occurs across numerous areas of SEQ, New South Wales and Victoria. It is uncertain if the species currently occurs within the Project disturbance footprint although suitable habitat is considered present. The Project disturbance footprint intersects the Little Liverpool Range in low-lying lands and is located within a proposed tunnel in the steeper area. The Helidon area is already subject to extensive existing disturbance. Given the extent of occurrence of Brush-tailed rock wallaby the Project is considered unlikely to decrease the availability of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Relevant threat abatement/recovery plans for Brush-tailed rock-wallaby include management measures to address the impact of feral cats, rabbits, red fox and goats. Feral predators including feral cat and dog were recorded during Project-associated surveys. Rabbits were also noted as present. Invasive weed species have also been noted as impacting rock-wallaby habitat in the area, particularly foraging habitat (ICC 2018). Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 17 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2019a, 2019b). Habitats within the MNES assessment area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criterion	Assessment against significance criteria
Interfere substantially with the recovery of the species	Recovery strategies listed in the Commonwealth recovery plan for the species (Menkhorst and Hynes 2010) include: ▪ Determine and manage threats to the species habitat ▪ Determine population trends for the species including distribution and abundance ▪ Investigate key aspects of the species biology/ecology to improve management ▪ Undertake translocations to improve genetic viability of populations. There is no reason for the Project to substantially interfere with the recovery objectives outlined in the *National Recovery Plan for the Brush-tailed rock-wallaby Petrogale penicillata* (Menkhorst and Hynes 2010). Any impact on the species will be very minor at worst and is considered unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	The Project will result in the clearance of Habitat critical to the survival of the species (as defined for this assessment) that may support an important population. The Little Liverpool Range and Helidon areas are mapped as where species is likely to occur, however it remains uncertain as to whether the species occurs within the Project disturbance footprint. The assessment has been carried out in a conservative manner and the Project has potential to have significant residual impacts on Brush-tailed rock-wallaby.

Koala (*Phascolarctos cinereus*) (Qld, NSW and ACT populations)

Ecology and distribution

The Koala is a leaf-eating specialist feeding primarily during dawn, dusk or during the night. Its diet is restricted mainly to foliage of Eucalyptus spp.; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. Koala habitat can be broadly defined as any environment containing Koala food tree species or shelter trees. Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands dominated by *Eucalyptus* species. Koalas are also known to occur in highly modified (e.g. urbanised) or regenerating native vegetation communities. Home range size is dependent on the quality of habitat. In central QLD home ranges may be as large as 135 ha (Ellis et al. 2002) and a s little as 37 ha in northern New South Wales (Goldingay and Dobner 2014). Koalas are generally sedentary with longer movements largely restricted to dispersing males which may extend several kilometres through lands cleared of vegetation (DAWE 2020b).

Female Koalas generally produce one offspring each year with births occurring between October and May (DAWE 2020b). Males are not involved with parental care. Mothers engage in increased feeding and related movements while lactating (Logan and Sanson 2003). The young vacate the pouch permanently at 7 months and then travels with the mother (generally carried on her back) becoming fully weaned at 12 months (van Dyck and Strahan 2008).

The Koala is distributed along the east coast of Australia extending from QLD to NSW (refer Figure 5.7). In QLD, the Koala's distribution extends across several bioregions, encompassing a great diversity of habitats with the greatest concentration in SEQ. In NSW, the species occurs mostly in central and north coasts with populations known to inhabit the area west of the Great Dividing Range (DES 2017c; OEH 2018b).

Distribution in context to the Project

There are numerous database records (i.e. AoLA and Wildlife Online) indicating Koala occurring within the MNES study area and surrounds. A single 2014 record occurs on the edge of the Project disturbance footprint 1.5 km west of Gatton. There are several records within the MNES study area from Helidon to Gatton (refer Figure 4.2). There are records throughout the surrounding area with clusters to the north of the Project in the Helidon Hills area, to the immediate south of Helidon, and north of Calvert (refer Figure 4.8 in Appendix B). Project associated surveys have recorded Koala scats through much of the alignment including within the Project disturbance footprint (refer Figure 4.5).

The South East Queensland Koala Conservation Strategy 2020–2025 (DES 2020d) was recently introduced by the Queensland Government. The Strategy aims to arrest the decline of Koalas in the region through the following targeted outcomes:

- Stabilise Koala population numbers in SEQ.
- A net increase in the total core koala habitat area in the region.
- Commence rehabilitation to restore 10,000 hectares of koala habitat.
- Commence 10 programs in threat priority areas to support at least a 25 per cent reduction in disease, injury and mortality rates in those locations.

The Strategy is supported by new Koala habitat mapping which maps the following key areas within the Project disturbance footprint:

- Koala priority areas: 193.49 ha - defined as large, connected areas to focus habitat conservation strategies with the highest likelihood of conserving SEQ Koala populations.
- Koala core habitat areas: 95.62 ha – defined as the best quality Koala habitat based on habitat modelling

Refer EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for further detail regarding State based mapping of Koala habitat values.

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plan applicable to Koala. The National Koala Conservation and Management Strategy 2009-2014 (NRMMC 2009) expired in 2014. The DAWE Approved Conservation Advice (DSEWPaC 2012b) notes the following potentially threatening processes identified for Koala:

- Habitat loss, modification or fragmentation as a result of urbanisation
- Secondary threats such as predation by domestic dogs, vehicle strikes and stress
- Extreme heat events and drought
- Chlamydia and other diseases (such as Koala retrovirus) which reduces the life expectancy of the species (DAWE 2020b)
- Myrtle rust (*Austropuccinia psidii*) is an introduced fungus impacting trees in the Myrtaceae family which includes eucalypts. A small number of trees used by Koalas for foraging have been infected although it is uncertain if this is currently a threat to the species (DAWE 2020b).

Important populations and Habitat critical to the survival of the species

There are no ‘important populations’ identified for Koala in the Approved Conservation Advice (DSEWPaC 2012b) or the (lapsed) National Koala Conservation and Management Strategy 2009 – 2014 (NRMMC 2009). The species occurs from north QLD south to Victoria and west to central QLD. The area is not on the edge of the species distribution and there is no evidence to suggest Koalas in the area are a source for breeding or dispersal or for maintaining genetic diversity. Population modelling based on field survey data carried out in SEQ shows the species occurs in low-medium densities in areas encompassed by the Project (Rhodes et al 2015).

The ‘EPBC Act referral guidelines for the vulnerable Koala’ (DotE 2014) does not refer to any ‘important populations’ but provides a ‘koala habitat assessment tool’ to assist in the determining the sensitivity, value and quality of lands potentially impacted under development proposals. The assessment tool is used to determine whether lands may be considered as ‘critical to the survival of the Koala’ and therefore critical to the long-term survival and recovery of the species. The results of the assessment are to aid the decision-making process and determine whether a Project may need to be referred to DAWE based on potential significant impacts to Koalas and/or habitat critical to the survival of the species. The identification of habitat ‘critical to the survival of the Koala’ may be used as a surrogate for ‘important populations’ when assessing a Project’s impacts under the Guidelines. The assessment summarised in Table 5.29 is based on information obtained from desktop information and opportunistic surveys within the MNES study area.

Table 5.29 Koala habitat assessment tool (DotE 2014) - Project disturbance footprint

Attribute	Score	Details
Koala occurrence	2	Fauna surveys found evidence of koala (scats) within the MNES study area.
Vegetation composition	2	The vegetation communities contain woodlands/open forest with two or more koala food trees.
Habitat connectivity	2	Based on koala habitat extent, the areas in the Little Liverpool Range and Helidon Hills are a part of a contiguous landscape that is greater than 1000 ha.
Key existing threats	1	There are populations of feral dogs that roam the area, that would result in koala mortality. Sections of the Project lies close to an existing rail line (West Moreton System) and the Warrego highway where car mortality may be an issue. Records of sick and injured koalas have been reported from a broad distribution throughout the region (Ipswich Koala Protection Society cited in Bussey and Ellis 2016).
Recovery value	1	It is uncertain whether the habitat is important for achieving interim recovery, as: ▪ Much of the vegetation is identified as non-remnant under the State vegetation framework and is at risk of being thinned for timber and livestock purposes ▪ Continued mortality due to vehicle strikes and dog attacks.
Koala habitat score	**8**	Habitat is ‘critical to the survival of Koala’ where Koala habitat score is ≥ 5.

Habitat within the Project disturbance footprint is considered ‘critical to the survival of Koala’ based on the Koala habitat score (8) for the disturbance footprint. Under the referral guidelines for Koala (DotE 2014) it is recommended that a project be referred where it is proposed to ‘clear ≥ 20 ha of habitat containing known Koala food trees in an area with a habitat score ≥ 8.’ For the significant impact assessment this habitat is considered a surrogate for an ‘important population’.

The main impacts predicted from the Project include habitat removal, injury/mortality to individuals during clearing and vehicle/train collision, and habitat fragmentation. The predictive habitat modelling indicates 98.66 ha of *Habitat critical to the survival of the species* and 205.29 ha of *potential habitat* occurs within the disturbance footprint (refer Table 4.4 and habitat figure in Appendix F) under the habitat modelling approach used for this assessment (refer Appendix A). Critical habitat includes all mapped remnant and regrowth vegetation communities containing eucalypt species and includes drainage lines which may provide suitable riparian habitat trees located outside of known vegetation mapping. Habitat critical to the survival of the species occurs between Laidley and Grandchester (Little Liverpool Range) and from west of Gatton to Helidon and is similar to the extent of ‘core Koala habitat area’ mapped under the State’s Koala habitat mapping.

The *EPBC Act referral guidelines for the vulnerable Koala* (DotE 2014) broadly defines koala habitat as:

> *“any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. This can include remnant and non-remnant vegetation in natural, agricultural, urban and peri-urban environments. Koala habitat is defined by the vegetation community present and the vegetation structure; the koala does not necessarily have to be present.”*

The Project is located within the coastal environments and within this area koala habitat has been further defined as:

> *"large, connected areas of native vegetation including in forests and woodlands where logging has altered tree species composition, these areas may be*
>
> - *Remnant, regrowth or plantation vegetation*
> - *Small, isolated patches of native vegetation in rural, urban or peri-urban areas*
> - *Windbreaks and narrow areas of native vegetation along riparian areas of linear infrastructure*
> - *Isolated food and/or shelter trees (i.e. on farmlands, in suburban streetscapes, parks and yards)"* (Dote 2014)

The Project disturbance footprint comprises habitat considered as *Habitat critical to the survival of the species* as defined above and assessed in Table 5.29. However, it is noted areas between Laidley and Gatton (where the Project is co-located with the existing QR West Moreton System rail corridor) remain heavily cleared (i.e. even isolated trees often do not occur) and where there are existing artificial barriers to movement and, as such, would not constitute *Habitat critical to the survival of the species* under the guidelines. In addition, existing paddock trees associated with the Project disturbance footprint are unlikely to provide the only movement opportunity/refuge to, or between, areas of *Habitat critical to the survival of the species.* This includes a number of creek lines (e.g. Sandy Creek and Laidley Creek) where the riparian zone has been cleared to accommodate the existing rail corridor and currently acts as a potential barrier to movement.

In addition to Habitat Critical to the survival of the species, Potential habitat has been identified within the project footprint. Potential habitat is based on a 1 km buffer place on recent species records (refer Figure 4.2) located outside of mapped vegetation communities (remnant or regrowth) (refer Appendix F). This encompasses habitat comprising scattered trees in grazing paddocks (in which the species may occur but do not necessarily link larger patches of vegetation), habitat within urban areas (such as Gatton), and grazing and cropped areas which do not feature trees at all. As such, potential habitat significantly over-estimates areas of available habitat for the species. Habitat determination will be subject to further refinement during the final design stage of the Project.

Impacts and mitigation measures associated with this species are identified within Table 5.7. The main impacts predicted from the Project include habitat removal, injury/mortality to individuals during clearing and vehicle/train collision, and habitat fragmentation. The following significant impact assessment (refer Table 5.30) under the MNES guidelines (DotE 2013a) has been informed by the information detailed above.

Table 5.30 Matters of national environmental significance significant residual impact criteria - Koala

Criteria	Assessment against significance criteria (vulnerable species)
Lead to a long-term decrease in the size of an important population of the species	There is no evidence the MNES study area comprises habitat supporting an 'important population' of Koala. The species was identified as present in eucalypt habitat within the MNES study area. Evidence suggests the species occurs in low-medium densities in the wider area. Pre-clearance surveys will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint. Provisions to protect Koalas will be in place within the Project Flora and Fauna Sub-plan should individuals be located within the disturbance footprint (refer Table 5.3 and Table 5.7). Should the species be found individuals will remain undisturbed and allowed to leave the construction area of their own volition or be relocated from the area of disturbance by qualified fauna spotter-catchers. In addition to loss of habitat, the Project (construction and operations) will act as a potential barrier to movement (generally north south, with east west connectivity maintained). Fauna passage will be provided at a number of locations along the alignment to facilitate fauna movement (refer Section 5.2.1), with these measures to consider the DTMR fauna sensitive design manual (DTMR 2010) which are known to be used by koalas (such as Koala refuge poles) especially in association with fauna friendly fencing. Koala-proof fencing will be used to guide Koalas through crossing structures with extent of Koala proof fencing dependent on surrounding Koala habitat availability and known movement corridors.

Criteria	Assessment against significance criteria (vulnerable species)
	There is some potential for ongoing Koala mortality during the Project's operational phase through collisions with trains. This will be mitigated with the incorporation of fauna crossing structures as part of the final Project design (refer Section 5.2.1). Fauna crossing structures will enhance Koala movement across the Project alignment and the wider landscape. These structures will target key movement areas such along major watercourses and the Helidon Hills area. The Project is predicted to require clearing up to 98.66 ha of *Habitat critical to the survival of the species* and 205.29 ha of *potential habitat* for the species. Habitat critical to the survival of the species is associated with habitat north of Helidon and in the Little Liverpool Range. Potential habitat is likely a substantial over-estimate of actual habitat available for Koala. The Project is linear and there is abundant similar habitat in the region surrounding the Project alignment. It is considered unlikely the Project will lead to a long-term decrease in the size of an important population of Koala.
Reduce the area of occupancy of an important population	There is no evidence the MNES study area supports an important population of Koala. Evidence suggests the species occurs in low-medium densities in the area. The Project is predicted to require clearing up to 98.66 ha of *Habitat critical to the survival of the species* and 205.29 ha of *potential habitat* for the species. As such the Project will likely reduce the potential area of occupancy of the local population, although as noted, an 'important population' is not known to occur in the area.
Fragment an existing important population into two or more populations	Evidence suggests the species occurs in low-medium densities in the area. Lands surrounding much of the Project disturbance footprint (excluding the Little Liverpool Range and Helidon areas) have been substantially cleared. Nevertheless, the species is known to traverse cleared lands when foraging. The Project is linear but impacts areas which are already subject to extensive fragmentation. The alignment crosses through the Little Liverpool Range via a 850 m long tunnel (allowing movement through the range at this point) and lies north of the existing Rosewood-Laidley Road. The section of the alignment north of Helidon lies adjacent to a powerline easement and local roads and the Warrego Highway to the south. The remainder of the Project largely lies adjacent to the existing rail line (West Moreton System) and passes through heavily disturbed agricultural and urban lands. The Project is predicted to require clearing up to 98.66 ha of *Habitat critical to the survival of the species* and a further 205.29 ha of *potential habitat*. The Project will also apply design mitigations with the incorporation of fauna crossing structures (including Koala-proof fencing) at targeted areas as part of the final Project design (refer Section 5.2.1). Given the existing linear infrastructure already in place in the immediate surrounds and the incorporation of crossing structures the Project is considered unlikely to further fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	*Habitat critical to the survival of the species* for Koala has been assessed as occurring on the site as defined under the Koala referral guidelines. The Project is predicted to require clearing of up to 98.66 ha of *Habitat critical to the survival of the species* (refer Table 5.29). As such the Project will adversely affect Habitat critical to the survival of the Koala.
Disrupt the breeding cycle of an important population	Where possible, clearing activities will take place outside the breeding season for Koala (October-May). Provisions to protect Koalas will be in place within the Project Flora and Fauna Sub-plan should individuals be located within the disturbance footprint (refer Table 5.3 and Table 5.7). For example, should the species be found individuals will remain undisturbed and allowed to leave the construction area of their own volition or be relocated from the area of disturbance by qualified fauna spotter-catchers. There are no particular breeding requirements associated with the species. (young travel with the mothers within the individual's territory). Barriers to movement and dispersal have been incorporated into the design of the Project (fauna crossing structures, fencing and avoidance of habitat above the tunnel). Should the species be found individuals will remain undisturbed and allowed to leave the construction area of their own volition or be relocated from the area of disturbance by qualified fauna spotter-catchers. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is suitable woodland habitat for the species within the Project disturbance footprint. However; there is abundant suitable habitat for the species in the area surrounding the Project and the wider SEQ region. The species occurs across a wide area from northern central QLD south to Victoria. As noted in Section 5.1.2, Project impacts are not restricted to the footprint and there is the potential to impact on potential habitat as a result of edge effects, dust deposition, noise and light, changes to soil and changes to hydrology. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.

Criteria	Assessment against significance criteria (vulnerable species)
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed species identified as relevant to Koala. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 17 species listed as restricted matters under the QLD *Biosecurity Act 2014* (EMM 2019a, 2019b). Relevant habitats for the species (eucalypt open forest and woodlands) within the MNES assessment area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species during Project surveys. Feral predators are identified as a threat to the species (DSEWPaC 2012b). Feral dog was recorded as present in the area during Project-associated surveys. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be a part of the overall Project EMP. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The local landscape is already subject to extensive weed infestation with *Lantana camara* in forest habitats and exotic grasses in agricultural habitats. The EMP will be in place for the life of the Project and will minimise the potential for weed invasion or spread. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction, *Phytophthora cinnamomi*, Myrtle rust outbreaks and associated diseases (such as Chlamydia) resulting from Project activities (refer Table 5.7). The Plan will consider relevant guidelines to control *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities. This will include at a minimum vehicle washdown procedures and contractor education (including procedures regarding cleaning clothing). This will be particularly important during any revegetation activities in the vicinity of Koala habitat. Revegetation plant species will be obtained from a reliable source that is certified free of these pathogens. Vegetation clearing within the Project disturbance footprint in Koala habitat will be carried out in a manner to minimise stress on potential individuals as much as is practicably possible (e.g. sequential clearing and minimising time of disturbance to animals) as stressed animals are more susceptible to Chlamydia infection. Where individuals are required to be handled during vegetation clearing they will be examined by experienced personnel. If the individual is suspected of Chlamydia infection it will be taken to a veterinarian/wildlife care facility for treatment prior to release. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for Koala. The *EPBC Act referral guidelines for the vulnerable Koala* (DotE 2014) notes the following actions that may substantially interfere with the recovery of the Koala in areas associated with Habitat critical to the survival of the species: ▪ Increasing koala fatalities due to dog attacks to a level that is likely to result in multiple, ongoing mortalities ▪ Increasing koala fatalities due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities. ▪ Facilitating the introduction or spread of disease or pathogens for example Chlamydia or *Phytophthora cinnamomi*, to habitat critical to the survival of the koala ▪ Creating a barrier to movement that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala ▪ Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term The Project will employ a range of mitigation measures (refer Table 5.7) to minimise these impacts including measures identified in Section 8 of the referral guidelines (DotE 2014). Of the identified actions the Project may increase mortality due to ongoing vehicle (rail line) strikes in the long-term. Evidence suggests the species occurs in low-medium densities in the area. With mitigation of potential Project impacts through measures incorporated within the Project EMP, any potential impact on Koala will be minor and is considered unlikely to interfere substantially with the recovery of the species.

Criteria	Assessment against significance criteria (vulnerable species)
Assessment of potential for significant residual impacts	The Project will result in the clearance of up to 98.66 ha of Habitat critical to the survival of the species. Based on the nine-part test for significance the Project is likely to have a significant residual impact on Koala.

New Holland mouse (*Pseudomys novaehollandiae*)

Ecology and distribution

The New Holland mouse is a native small, burrowing rodent. The species is a nocturnal and omnivorous species feeding on seeds, insects, leaves, flowers as well as fungi. This is a social species living in shared burrows. Considerable time is spent foraging above ground for food (DAWE 2020b). The known breeding period for the species in NSW occurs between August and January but can extend to autumn with slight variation between years producing litters ranging from 2 to 6 young. Female New Holland mouse are capable of producing two litters in a breeding season (Woinarski et al 2014).

In the south of its range New Holland mouse is known to inhabit open heathlands, woodlands and forests with heathland understorey as well as vegetated sand dunes. However, populations in SEQ have also been trapped in dry sclerophyll forest with little shrub or ground cover (Van dyck and Lawrie 1997; Menkhorst and Knight 2001). Peak population abundance is thought to be in early to mid-stage vegetation succession typically induced by fire. Populations have also been noted as influenced by rainfall with higher numbers occurring during years of above average rainfall (Woinarski et al 2014). The species has a large home range of between 0.44 to 1.4 ha (DAWE 2020b; OEH 2017d).

The known distribution of the New Holland mouse is fragmented along the east coast of Australian from QLD through to Tasmania. The extent of occurrence of New Holland mouse in QLD, NSW, Victoria and Tasmania is still unknown, although further research is currently being undertaken (DAWE 2020b). There appears to be little information on the species potential extent of occurrence in SEQ.

Distribution in context to the Project

The nearest database record (AoLA) is from 1982 taken from 1 km south of the Project in Gatton. This is based on remains found in an excavated owl pellet from a rocky overhang. The location data associated with this record is likely to be wrong. Van dyck and Lawrie (1997) note the location of the find as likely to be from an area south of Flagstone Creek (approximately 10 km south of the western extent of the MNES study area). More recent database records occur north of the western extent of the alignment in the Helidon Hills (two records from 2000) and the Crows Nest areas (records from 2000, 2001 and 2012) (6 km and 17 km north of the Project respectively) (AoLA 2020) (refer Figure 5.14 in Appendix B). The only other QLD records are from 1997 and are located in Main Range National Park over 35 km south of the Project.

Recovery plan/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved Conservation Advice (DEWHA 2010b) notes the following potentially threatening processes identified for Australian habitat as relevant to New Holland Mouse:

- Loss and modification of habitat due to urban and agricultural development
- *Phytophthora* is thought to be a threat to the species habitat
- Introduced predators including Red fox (*Vulpes Vulpes*) cat (*Felis catus*) and dog (*Canis familiaris*)
- Inappropriate fire management and invasive weed species
- Climate change impacts to habitat alteration and fragmentation

The following threat abatement plans have been identified as being relevant for this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c)
- *Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi.* (DotEE 2018)

Important populations/Habitat critical to the survival of the species

There are no important populations or definition of *Habitat critical to the survival of the species* in any available literature for the species. The Project disturbance footprint intersects habitat associated with the northernmost population of the species (in the Helidon Hills) and therefore may be considered to potentially impact an 'important population'.

In the absence of any other habitat definition for the species this assessment has defined *Habitat critical to the survival of the species* by applying a 1 km buffer on known records that intersect 'potential habitat' for the species (refer Appendix A for methodology). As such, the Project disturbance footprint is not considered to comprise Habitat critical to the survival of the species. Predictive habitat mapping indicates that the Project may impact 88.12 ha of *potential habitat* in which this species may occur (refer Table 5.4 and habitat figure in Appendix F). This includes habitat within the Little Liverpool Range where the species has not been recorded previously. Assessment against the significant impact criteria for vulnerable species is shown in Table 5.31.

Table 5.31 Matters of national environmental significance significant residual impact criteria – New Holland mouse

Criteria	Assessment against significance criteria (vulnerable species)
Lead to a long-term decrease in the size of an important population of the species	There is potential for habitat supporting an 'important population' to occur within the Project disturbance footprint. Although there are no records within the MNES study area the species has been recorded in the wider area surrounding the Project to the north of Helidon. The nearest records (2000) are located 6 km north of the Project disturbance footprint. It is uncertain to what extent habitat within the footprint may be suitable for the species. It is noted the area is subject to substantial existing disturbance where the Project disturbance footprint occurs. There is mining/quarry activity in the Helidon Hills north of the Project and substantial disturbance to the south including cleared areas associated rural housing, a powerline easement and roads. Pre-construction surveys (as per State survey guidelines – it is noted there are no DAWE guidelines relevant to the species) will be carried out where suitable habitat for this species is identified within the final Project disturbance footprint. Provisions to protect the species will be in place within the Project Flora and Fauna Sub-plan should individuals be located within the disturbance footprint (refer Table 5.7). Should the species be found individuals will be relocated from the area of disturbance by qualified fauna spotter-catchers as close as possible to where the species was collected and in suitable habitat. It is noted that the Project may be a point source for bush fires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. The Project is predicted to impact 88.12 ha of *potential habitat* for the species. This includes habitat within the Little Liverpool Range where the species has not been recorded previously. Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint to the north where the species is known to occur. It is considered unlikely the Project will lead to a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population	There is potential for habitat supporting an 'important population' to occur within the Project disturbance footprint although it is unknown if the species occurs. Pre-construction surveys (as per State guidelines) will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint. The Project is predicted to impact 88.12 ha of *potential habitat* for the species. This includes habitat within the Little Liverpool Range where the species has not been recorded previously. Should the species be found to occur there is potential the Project will reduce the area of occupancy of an important population of the species.

Criteria	Assessment against significance criteria (vulnerable species)
Fragment an existing important population into two or more populations	There is potential for habitat supporting an 'important population' to occur within the Project disturbance footprint. The Project is linear but impacts areas which are already subject to extensive fragmentation. The section of the alignment north of Helidon lies adjacent to a powerline easement and local roads and the Warrego Highway to the south. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	It is uncertain if the species occurs in the Project disturbance footprint. The Project is predicted to impact 88.12 ha of *potential habitat* for the species. This includes habitat within the Little Liverpool Range where the species has not been recorded previously. There is no *Habitat critical to the survival of the species* (as defined for this assessment). The Project is located within an area already subject to substantial disturbance. As such The Project is considered unlikely to adversely affect Habitat critical to the survival of New Holland mouse.
Disrupt the breeding cycle of an important population	There is potential for habitat supporting an 'important population' to occur within the Project disturbance footprint. The species breeding pattern in QLD remains unknown. In NSW the species may breed from August through to Autumn although breeding may be irruptive dependent on local weather conditions. It is uncertain if the species occurs in the Project disturbance footprint. Pre-clearance surveys (as per DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the final construction footprint. Should the species be found to occur there is some potential for the Project to disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	It is uncertain if the species occurs in the Project disturbance footprint. The Project is predicted to impact 88.12 ha of *potential habitat* for the species. Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint to the north where the species is known to occur. It is noted that the Project may be a point source for bush fires (construction and operation) though the risk is considered to be low. The Project may also benefit the species (should it be found to occur) by providing access to otherwise inaccessible areas during a bushfire event. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed or pest species identified as relevant to New Holland mouse. *Phytophthora cinnamomi* is considered a potential threat to the species habitat. Project-associated surveys observed feral predators including cats (a significant predator of small mammals) as present in the area. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction, *Phytophthora cinnamomi* and Myrtle rust outbreaks resulting from Project activities (refer Table 5.7). The Plan will consider relevant guidelines to control *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities. This will include at a minimum vehicle washdown procedures and contractor education (including procedures regarding cleaning clothing). This will be particularly important during any revegetation activities in the vicinity of New Holland Mouse habitat. Revegetation plant species will be obtained from a reliable source that is certified free of these pathogens. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for New Holland mouse. The Approved conservation advice (DEWHA 2010b) notes the following priority actions applicable to the species: ▪ Protect and monitor known populations and identify threats ▪ Develop a fire management strategy for known populations and habitat ▪ Minimise adverse impacts from land use including grazing pressure ▪ Identify and control threatening weeds in New Holland mouse habitat ▪ Develop management protocols to prevent outbreaks of dieback associated with *Phytophthora cinnamomi*

Criteria	Assessment against significance criteria (vulnerable species)
	It is not known if the species occurs within the Project disturbance footprint. The Project Biosecurity Management Plan will control introduced predators and weeds associated with Project infrastructure, and ensure *Phytophthora cinnamomi* is not introduced to the area as a result of Project activities. Should the species occur any impact will be minor, and is considered unlikely to interfere substantially with the recovery of the species.
Assessment of potential for significant residual impacts	It is uncertain if the species occurs in the area. Under the current Project disturbance footprint there will be clearance of up to 88.12 ha of potential habitat for an important population of the species. This includes habitat within the Little Liverpool Range where the species has not been recorded previously. A conservative approach has been applied to the assessment and based on the nine-part test for significance the Project has the potential to have a significant residual impact on New Holland mouse.

Grey-headed flying-fox (*Pteropus poliocephalus*)

Ecology and distribution

The Grey-headed flying-fox is a canopy-feeding species that eats fruit and nectar. This species utilises a range of vegetated habitats, including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. In an urban setting, this species is known to feed on commercial fruit crops, and on introduced tree species. Roost sites are generally located near water bodies. This species is known to roost in vegetation ranging from rainforest, Melaleuca stands, mangroves and riparian vegetation. The species has a high level of roost site fidelity, although new sites have been known to be colonised (DAWE 2020b). The species travels to foraging areas usually located within 15 km of the roost site (Tidemann 1998), although they are capable of travelling up to 50 km when local foraging resources change (Eby 1991).

Nectar and pollen from *Eucalyptus*, *Corymbia, Angophora, Melaleuca*, and *Banksia* species are considered the primary food source for Grey-headed flying foxes. This species is known to supplement its diet with a wide range of rainforest fruits and introduced species (Duncan et al. 1999). Mating is known to occur in the early autumn months, after which time the larger camps begin to separate, reforming in late spring/early summer when food resources become more abundant. Males and females typically separate in October, when the young are born.

The Grey-headed flying-fox occurs in the coastal belt of Eastern Australia, typically ranging from Rockhampton in central QLD to Melbourne in Victoria. It is noted that only a small portion of this range is used at any one time, as the species selectively forages where resources are available. The availability of food resources have a direct influence on the occurrence and relative abundance within the Grey-headed flying foxes distribution in various seasons and years (DAWE 2020b). As such, the species is known to make seasonal movements between camps. Dispersal from large breeding camps in the Brisbane area to regional areas occurs in winter (Nelson 1965).

Distribution in context to the Project

This species was detected during Project-associated surveys in the vicinity of a known roost site for the species in Gatton (1.5 km south of the Project disturbance footprint) (refer Figure 4.5). The nearest database records are from Laidley (2009 and 2011) and are located within the MNES study area (refer Figure 4.2). There is a 2009 Gatton record form the approximate location of the Project survey observation. In the wider area there are a large number of records occurring in all directions around the Project, although these are largely concentrated to the east of the Project (from Ipswich to Brisbane) and to the west around Toowoomba (AoLA 2020) (refer Figure 4.6 in Appendix B). Based on quarterly flying-fox data collected by DES in the SEQ region (extending from 2007 to November 2019) there are three Flying-fox camps located within 15 km of the Project which regularly comprise Grey-headed flying-fox: one each in Laidley, Gatton and the Murphys Creek areas (DES2020a). The camps at Laidley and Gatton are located 600 m and 1.2 km south of the Project disturbance footprint respectively.

The *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE 2015a) identifies 'nationally important' camps for Grey-headed flying-fox as:

- Camps that have contained ≥ 10,000 grey-headed flying-foxes in more than one year in the last 10 years, or
- Have been occupied by more than 2,500 grey-headed flying-foxes permanently or seasonally every year for the last 10 years

None of the identified camps have sustained numbers of Grey-headed flying-fox analogous to the definition of a 'nationally important' camp based on the available data. The camp at Gatton regularly comprised large numbers of individuals until 2017. No individuals have been present during surveys since February 2017 (DES 2020e).

Recovery plan/threat abatement plans

There is currently a draft *National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus*) (DotEE 2017) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Loss of roosting and foraging sites (particularly winter foraging habitat)
- Human animal conflict, particularly in rural areas where flying-foxes can impact fruit orchards and in urban areas where roosts are perceived to impact local residents. This is a particular issue applicable to flying-fox camps in urban areas.
- Heat stress during extreme heat waves
- Entanglement in backyard netting and electrocution on power lines
- Potential threats include the impacts of climate change (particularly with reference to extended heat waves) and zoonotic diseases.

Important populations/Habitat critical to the survival of the species

Important populations are not identified in the draft *National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus*) (DotEE 2017). The species distribution extends from Rockhampton south to Victoria and South Australia. The Project disturbance footprint is not at the limit of the species range. This is a highly mobile species and the linear nature of the Project is not expected to impact dispersal or breeding capacity.

The Plan does not specifically identify habitat critical to the survival of the species but does recommend management of habitat associated with a number of tree species located within the MNES study area including *Eucalyptus tereticornis, E. crebra, E. siderophloia, Corymbia citriodora citriodora,* and *Grevillea robusta*. Vegetation communities associated with the Project disturbance footprint generally comprise at least one of these species. All vegetation within the alignment is considered 'potential habitat' for the species. Predictive impact assessment has taken a conservative approach for this species and included all remnant and regrowth vegetation communities within a 15 km radius of the known regular roost sites for the species that are local to the MNES study area as *Habitat critical to the survival of the species*.

Impacts and mitigation measures associated with this species are identified within Table 5.7. The predictive assessment estimates 99.46 ha of *Habitat critical to the survival of the species* (<15 km from known roost sites) may be impacted under the current disturbance footprint (refer Table 5.4 and habitat figure in Appendix F). Assessment against the significant impact criteria for vulnerable species is shown in Table 5.32.

Table 5.32 Matters of national environmental significance significant residual impact criteria – Grey-headed flying-fox

Criteria	Assessment against significance criteria (vulnerable species)
Lead to a long-term decrease in the size of an important population of the species	There are no 'important populations' defined for this species. The species was not observed within the MNES study area during Project surveys and no roost sites were observed in the vicinity. There are records within the MNES study area from Laidley. The species has been commonly recorded in the wider area surrounding the Project, largely to the east and west. There are at least three camp locations regularly used by the species located within 15 km of the MNES study area. The camps at Laidley and Gatton are located 600 m and 1.2 km from the Project disturbance footprint respectively. The Project will not conceivably impact these sites. A study by Law and Eby 2008 (ranking the feeding habitats of Grey-headed flying foxes for conservation management) noted that the during winter productive areas are concentrated in coastal floodplains, coastal dunes and inland slopes of SEQ. In addition, the study noted that the majority of winter habitats are heavily cleared, poorly conserved and recognised as endangered vegetation communities. The Project is located in the coastal floodplains and inland slopes of SEQ and as such poses a risk to the species (i.e. loss of foraging habitat in particular winter and spring is a key threat to the species). Important winter and spring habitats include vegetation communities that contain *Eucalyptus tereticornis, E. crebra, E. melliodora, E. pilularis, Corymbia citriodora, Grevillea robusta or Melaleuca quinquenervia*) with these species known from the MNES study area. The species will sporadically utilise these resources based on local flowering patterns, with the species known to have a high degree of annual variation in the occurrence at a local scale. Foraging habitat for Grey-headed flying-fox occurs across the Project disturbance footprint encompassing 99.46 ha of *Habitat critical to the survival of the species* (as defined for this assessment). Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint (including 2,812 ha within the MNES study area) and the species will forage in heavily modified habitats such as urban gardens. As outlined in Section 5.1.2 the Project will result in edge effects, changes to biological viability of soil or from the deposition of dust, which may result in the degradation of foraging habitat. However, the extent of these impacts will vary spatially and temporally across the Project disturbance footprint. Given there are no 'important populations' identified for Grey-headed flying-fox it is considered unlikely the Project will lead to a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population	There are no 'important populations' defined for this species. The Project will not impact local roost sites the species is known to regularly use. Foraging habitat for Grey-headed flying-fox occurs across the Project disturbance footprint encompassing 99.46 ha of *Habitat critical to the survival of the species* (as defined for this assessment). Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint (including 2,812 ha within the MNES study area) and the species will forage in heavily modified habitats such as urban gardens. The species is only likely to utilise the area seasonally based on local flowering patterns. Given there are no 'important populations' identified for Grey-headed flying-fox it is considered unlikely the Project will reduce the area of occupancy of an important population of the species.
Fragment an existing important population into two or more populations	The species is highly mobile and the Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	Foraging habitat for Grey-headed flying-fox occurs across the Project disturbance footprint encompassing 99.46 ha of *Habitat critical to the survival of the species* (as defined for this assessment). It is noted this is a conservative approach given there is abundant suitable habitat for the species in the area surrounding the Project and the wider SEQ region. As such the Project will adversely affect habitat critical to the survival of the Grey-headed flying-fox.
Disrupt the breeding cycle of an important population	There are no 'important populations' defined for this species. The Project will not impact local roost sites (potentially used as breeding locations) the species is known to regularly use. The recovery plan for the species notes that roosting requirements are not well understood, nor are the impacts on the species of loss of long-term sites which may be selected to meet specific requirements.

Criteria	Assessment against significance criteria (vulnerable species)
	There are three Flying-fox camps located within 15 km of the Project which regularly comprise Grey-headed flying-fox: one each in Laidley, Gatton and the Murphy's Creek areas. The camps at Laidley and Gatton are located 600 m and 1.2 km south of the Project disturbance footprint respectively. The recovery plan notes that flying-foxes are prone to abort foetuses and mass abortions and premature births are known to occur in the wild in response to environmental stress. The nearest camp is 600 m south of the Project and there is negligible risk of this scenario occurring as a result of the Project. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Foraging habitat for Grey-headed flying-fox occurs across the Project disturbance footprint encompassing 99.46 ha of *Habitat critical to the survival of the species* (as defined for this assessment) and will be subject to removal during construction. The operational rail corridor will not be rehabilitated/landscaped with woody vegetation, however there will be an opportunity to rehabilitate temporary construction areas and riparian zones. However; there is abundant suitable habitat for the species in the area surrounding the Project and the wider SEQ region (including 2,812.21 ha within the MNES study area). As outlined in Section 5.1.2 the Project will result in edge effects, changes to biological viability of soil or from the deposition of dust, which may result in the degradation of foraging habitat but is unlikely to lead to a decline in the species. However, the extent of these impacts will vary spatially and temporarily across the Project disturbance footprint. Given the mobility of the species it is unlikely that any habitat will be isolated, with the species known to utilise heavily modified environments including urban gardens and commercial orchards. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed or pest species identified as relevant to Grey-headed flying-fox. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 17 species listed as restricted matters under the QLD *Biosecurity Act 2014* (EMM 2019a, 2019b). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	The draft recovery Plan for the species includes the following recovery objectives: ▪ Identify, protect and enhance roosting habitat and native foraging habitat critical to the survival of the species ▪ Determine population trends in Grey-headed flying-foxes so as to monitor the species' national distribution and conservation status ▪ Increase public awareness and understanding of Grey-headed flying-foxes and build community capacity to coexist with flying-foxes and minimise the impacts on urban settlements from existing camps without resorting to dispersal ▪ Improve the management of Grey-headed flying-fox camps in sensitive areas and support research activities that will improve the conservation status and management of the species. ▪ Significantly reduce levels of deliberate Grey-headed flying-fox destruction associated with commercial horticulture ▪ Assess and reduce the impact on Grey-headed flying-foxes of electrocution on power lines, and potential entanglement (DotEE 2017) The Project will impact foraging habitat which is a relatively minor portion of the habitat available within the surrounding landscape. No roost sites are located within or adjacent to the Project. None of the other recovery objectives are applicable to the Project. The Project is considered unlikely to interfere substantially with any of the recovery objectives listed above and will not interfere with the recovery of the species.

Criteria	Assessment against significance criteria (vulnerable species)
Assessment of potential for significant residual impacts	Under the current Project disturbance footprint up to 99.46 ha of *Habitat critical to the survival of the species* (as defined for this assessment) will be cleared. A conservative approach has been applied to the assessment of habitat within the Project disturbance footprint which may not reflect actual impacts on the species. Nevertheless, based on the nine-part test for significance the Project is likely to have a significant residual impact on Grey-headed flying-fox.

5.4 Biodiversity offsets for significant adverse residual impacts

Residual impacts are those impacts that remain after the successful implementation of the avoidance hierarchy and mitigation measures identified in Section 5.2. The significance of residual impacts reflects the effectiveness of the proposed mitigation but allows for the identification of areas where further management measures may be required.

The significance ratings of most potential impacts identified in Section 5.1 will be reduced after the implementation of mitigation measures, including the avoidance, minimisation and mitigation strategies. In addition, the implementation of the mitigation measures identified in Section 5.2 and Section 5.3.2 will considerably reduce the significance of these impacts potentially resulting from the Project's activities.

Although terrestrial and aquatic MNES will be avoided where practicable and potential impacts will be minimised and mitigated to the greatest extent practical (refer Table 5.5), in some instances the magnitude and significance ratings will remain unchanged following the implementation of the mitigation measures.

There is 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 to *Habitat critical to the survival of the species* or *Important habitat* 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) (refer Sections 5.3.3, 5.3.3 and 5.3.5).

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'. Offsets will be required to compensate for the significant residual impacts on MNES *to Habitat critical to the survival of the species* or *Important habitat* as a result of the Project. An Environmental Offset Strategy for the Project has been prepared and included as Appendix I.

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).

An offset is likely to be required for MNES that experience a significant residual impact which may include areas containing Habitat *critical to the survival of a species* or *Important habitat* for EPBC Act listed species and any area occupied by an EPBC Act listed TEC.

An assessment of the relevant MNES to the Project has been undertaken in accordance with the MNES significant impact criteria within the MNES Guidelines (refer Section 5.3.3, Section 5.3.4 and Section 5.3.5). Analysis indicates that Residual impacts to *Habitat critical to the survival of the species* or *Important habitat* for the following sensitive environmental values have potential to occur:

- Lloyd's olive (*Notelaea llooydii*) (refer Table 5.14)
- *Paspalidium grandispiculatum* (refer Table 5.15)
- Spotted-tail quoll (*Dasyurus maculatus maculatus*) (refer Table 5.20)
- Collared delma (*Delma torquata*) (refer Table 5.24)

- Red goshawk (*Erythrotriorchis radiatus*) (refer Table 5.25)
- Brush-tailed rock-wallaby (*Petrogale penicillata*) (refer Table 5.28)
- Koala (*Phascolarctos cinereus*) (refer Table 5.30)
- Grey-headed flying-fox (*Pteropus poliocephalus*) (refer Table 5.32)
- Australian painted snipe (*Rostratula australis*) (refer Table 5.22).

The current identified extent of significant residual impact to each specific MNES is quantified in Table 5.33. These extents will be subject to further refinement through ongoing targeted field surveys as the Project progresses. It is noted the extent of significant residual impacts identified overlap substantially. The Project disturbance footprint encompasses only 98.65 ha of mapped vegetation communities (refer Section 5.1.2.1).

Table 5.33 Quantification of anticipated significant residual impacts to matters of national environmental significance

Sensitive environmental receptor (MNES)	Identified Significant residual impact
Lloyd's olive (*Notelaea lloydii*)	21.26 ha *Habitat critical to the survival of the species*, potential for significant residual impacts on an important population
Spotted-tail quoll (*Dasyurus maculatus maculatus*)	1.59 ha *Habitat critical to the survival of the species*, minor potential to have significant residual impacts
Collared delma (*Delma torquata*)	85.33 ha *important habitat*, potential reduction in the occupancy of 'important habitat and fragmentation of a population
Red goshawk (*Erythrotriorchis radiatus*)	17.74 ha *Habitat critical to the survival of the species*, potential significant impact on habitat
Swift parrot (*Lathamus discolor*)	13.34 ha of *Habitat critical to the survival of the species*, potential significant impact on habitat
Brush-tailed rock-wallaby (*Petrogale penicillata*)	4.88 ha *Habitat critical to the survival of the species*
Koala (*Phascolarctos cinereus*)	98.66 ha *Habitat critical to the survival of the species*
Grey-headed flying-fox (*Pteropus poliocephalus*)	99.46 ha *Habitat critical to the survival of the species*
Australian painted snipe (*Rostratula australis*)	15.43 ha *Habitat critical to the survival of the species*

ARTC's Environmental Offset Delivery Strategy – Qld (Strategy) is contained in Appendix I of this report. This Strategy informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans. A detailed Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction commencement subject to the approval under the EPBC Act.

The Environmental Offset Delivery Plan will:

- Quantify the significant residual impact of the Project on MNES
- Detail offsets to address significant residual impacts for MNES
- Include:
  - Details of milestones to establish the offset
  - Evidence that significant residual impacts can be offset
  - The offset delivery mechanisms, comprising one or more of: land-based offsets, direct benefit management plans, offset transfers or offset payments
  - Identification of land required to provide the offset
  - A legally binding mechanism that ensures protection and management of land-based offset areas.

6 Commitments

The approach outlined in this report is adequate to address the controlling provisions relevant to the Project. The report describes the aspects of the environment relevant to these matters and addresses the relevant sections of the EIS ToR.

As the Project moves into the detailed design and construction phases, more focused and comprehensive ecological surveys in accordance with the Commonwealth's survey guidelines will be undertaken under the Project's Flora and Fauna Sub-plan. Ecological survey plans (e.g. targeted fauna and flora surveys, vegetation mapping verification) have been developed, with on-ground surveys to commence Q2/Q3 2021. The surveys will aim to confirm and map out terrestrial and aquatic habitat, vegetation communities and extant threatened populations, along with known threats within and adjacent to the Project disturbance footprint.

The surveys will aim to address any changes to the Project design and disturbance footprint, along with informing the design and construction, including specific measures to avoid, mitigate, minimise impacts on a 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.

During detailed design ARTC will also finalise the location and design of fauna movement structures across the Project alignment, targeting key locations (for example, in the Helidon area, and in the Woolooman and Little Liverpool Range). ARTC will work with the relevant stakeholders including DTMR, local councils, DES and where applicable local environmental groups to finalise the location and design of any crossing structures. This will be especially important in areas of future development or complementary to any ecological corridor strategies within the MNES study area, including those associated with the Draft SEQ Koala Conservation Strategy.

Environmental offsets will be provided where Project works are found to have a significant residual impact on flora and fauna that are matters of national or State environmental significance following the results of the targeted surveys for MNES species outlined above.

An Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction subject to approval under the EPBC Act. The Environmental Offset Delivery Plan will quantify the significant residual impacts of the Project and detail offsets to address these significant residual impacts.

The Environmental Offset Delivery Plan will detail the following (at a minimum):

- Quantifies the significant residual impact of the Project on matters of State environmental significance
- Quantifies the significant residual impact of the Project on MNES
- Quantifies habitat values of lands associated with MNES requiring offsets as per the relevant assessment guidelines and details the required quantum of offsets as per the DAWE offset calculator
- Details proposed offsets to address significant residual impacts for matters of State environmental significance (except where those matters are also significant residual impacts on matters of national environmental significance)
- Details proposed offsets to address significant residual impacts for matters of national environmental significance.

- The Environmental Offset Delivery Plan will also include:
  - Details of milestones to establish the offset
  - Evidence that significant residual impacts can be offset
  - The offset delivery mechanism(s) comprising one or more of: land-based offsets; direct benefit management plans; offset transfers and/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.

7 Cumulative impact assessment

Cumulative impacts were assessed using the methodology identified in Section 3.5, incorporating the projects identified in Table 3.12 and depicted in Figure 3.4. The assessment has been based on MNES occurring within the Project disturbance footprint (refer Figure 1.1). The assessment has been based on MNES occurring within the Project disturbance footprint (refer Table 7.1) and used uses a conservative approach to assessment of habitat lost (i.e. combines the habitat categories as identified in Table 4.5 to identify the maximum potential habitat loss).

The cumulative impacts of multiple projects occurring in the vicinity of the Project disturbance footprint will likely include the continued loss of biodiversity in the SEQ bioregion. The major potential impacts identified as a result of the Project are common to all projects throughout the region and are therefore cumulative in nature. Six projects have been identified within the cumulative impact assessment impact study area, which are either currently underway or are going through the EIS process, all of which will likely result in some extent of:

- 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.

Cumulative impacts range from short-term to long-term. The total impact area for all habitat categories (i.e. Potential, Important and Habitat Critical to the survival of the species) of significant MNES contained within the disturbance footprints of the selected projects within the cumulative impact study area, based on bioregional and State extents, is provided in Table 7.1. The results of the significance assessment of these cumulative impacts are presented in Table 7.2. Total habitat areas have been used to represent a highly conservative estimation of impacts, however the total residual impacts as a result of the current project are expected to be significantly less than those reported within this section.

The greatest potential predicted cumulative impacts (including all habitat categories) as a result of the Project and other similar projects that occur within the Project cumulative impact area may be upon the following MNES:

- Flora and fauna species habitat
  - *Notelaea lloydii* (Lloyd's olive) - cumulative removal of up to 509.23 ha of which the project contributes 26.32 per cent
  - *Paspalidium grandispiculatum* (a grass) - cumulative removal of up to 596.55 ha of which the project contributes 14.18 per cent
  - Grey falcon (*Falco hypoleucos*) - cumulative removal of up to 9,185.74 ha of which the project contributes 3.83 per cent
  - White-throated needletail (*Hirundapus caudacutus*) - cumulative removal of up to 11,620.85 ha of which the project contributes 5.77 per cent
  - Swift parrot (*Lathamus discolor*) - cumulative removal of up to 1,371.32 ha of which the project contributes 7.20 per cent

- Spotted-tail quoll (*Dasurus maculatus maculatus*) - cumulative removal of up to 1,213.77 ha of which the project contributes 6.35 per cent
- Koala (*Phascolarctos cinereus*) - cumulative removal of up to 3,821.32 ha of which the project contributes 7.95 per cent
- Grey-headed flying-fox (*Pteropus poliocephalus*) - cumulative removal of up to 1,425.16 ha of which the project contributes 6.98 per cent.

Table 7.1 Cumulative impact assessment of magnitude for matters of national environmental significance

MNES	EPBC Act status	A. Extent within cumulative impact study area (50km extent) (ha) (i.e. 1,254,287 ha)	B. Extent within cumulative impact disturbance footprint (defined projects Figure 3.4) (i.e. 10,986 ha)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 3.4) including the disturbance footprint	D. Percentage (%) total disturbance to receptors within Cumulative impact study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance considering D and E
Commonwealth significant ecological receptors							
Threatened ecological communities							
Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC	CE	326.04	10.86	0.00	3.33	0.00	Negligible
Brigalow (*Acacia harpophylla* dominant and codominant)	E	377.19	0.00	0.00	0.00	0.00	Negligible
Threatened flora habitat							
Hairy-joint grass (*Arthraxon hispidus*)	V	17,961.04	367.85	367.85	2.05	0.00	Negligible
Four-tailed grevillea (*Grevillea quadricauda*)	V	20,806.43	1.02	27.08	0.13	96.22	Low
Blunt-leaved Leionema (*Leionema obtusifolium*)	V	34,928.48	0.63	29.89	0.09	97.99	Low
Lloyd's olive (*Notelaea lloydii*)	V	83,970.92	375.19	509.23	0.61	26.32	Low
Paspalidium grandispiculatum (a grass)	V	126,600.68	511.97	596.55	0.47	14.18	Low
Brush sophora (*Sophora fraseri*)	V	83,759.19	127.60	167.58	0.20	23.86	Low
Austral toadflax (*Thesium australe*)	V	17,961.04	367.85	462.61	2.58	20.48	Low
Threatened fauna habitat							
Birds							
Regent honeyeater (*Anthocharea phrygia*)	CE	218,434.97	611.13	695.71	0.32	12.16	Low
Australasian bittern (*Botaurus poiciloptilus*)	E	43,323.05	289.26	304.70	0.70	5.06	Low
Curlew sandpiper (*Calidris ferruginea*)	CE, M	43,512.94	289.26	304.70	0.70	5.06	Low
Red goshawk (*Erythrotriorchis radiatus*)	V	52,578.33	256.89	345.71	0.67	25.69	Low
Grey falcon (*Falco hypoleucos*)	V	461,283.59	8,833.77	9,185.74	1.99	3.83	Low
Painted honeyeater (*Grantiella picta*)	V	30,573.73	402.15	415.49	1.36	3.21	Low

MNES	EPBC Act status	A. Extent within cumulative impact study area (50km extent) (ha) (i.e. 1,254,287 ha)	B. Extent within cumulative impact disturbance footprint (defined projects Figure 3.4) (i.e. 10,986 ha)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 3.4) including the disturbance footprint	D. Percentage (%) total disturbance to receptors within Cumulative impact study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance considering D and E
White-throated needletail (*Hirundapus caudacutus*)	V	1,254,287.63	10,986.29	11,620.85	0.93	5.77	Low
Swift parrot (*Lathamus discolor*)	CE	245,758.79	1,272.65	1,371.32	0.56	7.20	Low
Australian painted snipe (*Rostratula australis*)	E	45,887.01	320.01	353.39	0.77	9.44	Low
Black-breasted button-quail (*Turnix melanogaster*)	V	103,702.86	9.18	9.18	0.01	0.00	Negligible
Mammals							
Spotted-tail quoll (*Dasyurus maculatus maculatus*)	E	294,795.21	1,136.71	1,213.77	0.41	6.35	Low
Greater glider (*Petauroides volans volans*)	V	122,616.32	350.18	380.82	0.31	8.75	Low
Brush-tailed rock-wallaby (*Petrogale penicillata*)	V	47,808.99	0.00	41.25	0.09	100	Low
Koala (*Phascolarctos cinereus*)	V	434,266.23	3,517.35	3,821.32	0.88	7.95	Low
Long-nosed potoroo (*Potorous tridactylus tridactylus*)	V	218,207.42	580.56	665.14	0.30	12.72	Low
New Holland mouse (*Pseudomys novaehollandiae*)	V	175,517.05	582.54	670.66	0.38	13.14	Low
Grey-headed flying-fox (*Pteropus poliocephalus*)	V	440,130.79	1,325.70	1,425.16	0.32	6.98	Low
Reptiles							
Collared delma (*Delma torquata*)	V	212,161.94	808.25	893.57	0.42	9.55	Low
Fish							
Australian lungfish (*Neoceratodus forsteri*)	V	10,691.44	103.92	106.16	0.99	2.12	Low

Table 7.2 **Significance assessment of cumulative impacts to matters of national environmental significance**

Receptor(s)	Potential impacts#	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth significant ecological receptor (community listed under the EPBC Act): ▪ Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC ▪ Brigalow (*Acacia harpophylla* dominant and codominant)	▪ Habitat loss from vegetation clearing/removal	1	1	1	1	4	Low
	▪ Edge effects	1	2	1	1	5	Low
	▪ Habitat fragmentation	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	2	5	Low
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	1	1	3	6	Low
	▪ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
Commonwealth significant ecological receptor (species listed under the EPBC Act): **Flora:** ▪ Hairy-joint grass (*Arthraxon hispidus*) ▪ Four-tailed grevillea (*Grevillea quadricauda*) ▪ Blunt-leaved Leionema (*Leionema obtusifolium*) ▪ Lloyd's olive (*Notelaea lloydii*) ▪ *Paspalidium grandispiculatum* (a grass) ▪ Brush sophora (*Sophora fraseri*) ▪ Austral toadflax (*Thesium australe*) **Fauna:** ▪ Regent honeyeater (*Anthochaera phrygia*) ▪ Australasian bittern (*Botaurus poiciloptilus*)	▪ 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	2	2	1	3	8	Medium
	▪ 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	3	7	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
	▪ Edge effects	2	2	1	3	8	Medium
	▪ Habitat fragmentation	2	2	2	3	9	Medium
	▪ Barrier effects	2	2	1	3	7	Medium

Receptor(s)	Potential impacts#	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
▪ Curlew sandpiper (*Calidris ferruginea*) ▪ Red goshawk (*Erythrotriorchis radiatus*) ▪ Grey falcon (*Falco hypoleucos*) ▪ White-throated needletail (*Hirundapus caudacutus*) ▪ Painted honeyeater (*Grantiella picta*) ▪ Swift parrot (*Lathamus discolor*) ▪ Australian painted snipe (*Rostratula australis*) ▪ Black-breasted button-quail (*Turnix melanogaster*) ▪ Spotted-tail quoll (*Dasyurus maculatus maculatus*) ▪ Greater glider (*Petauroides volans volans*) ▪ Brush-tailed rock-wallaby (*Petrogale penicillata*) ▪ Koala (*Phascolarctos cinereus*) ▪ Long-nosed potoroo (*Potorous tridactylus tridactylus*) ▪ New Holland mouse (*Pseudomys novaehollandiae*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*) ▪ Collared delma (*Delma torquata*) ▪ Australian lungfish (*Neoceratodus forsteri*)	▪ Reduction in connectivity of biodiversity corridors	1	1	1	3	6	Low
	▪ Dust and light and contaminant disturbance	1	1	1	2	5	Low

Table notes:

1 Table 3.12 defines the consequences of the impact significance ratings, as follows:

- **Low** (sum of relevance factors = 1 to 5): Negative impacts need to be managed by standard environmental management practices. Special approval conditions unlikely to be necessary. Monitoring to be part of general project monitoring program
- **Medium** (sum of relevance factors = 6 to 9): Mitigation measure likely to be necessary and specific management practices to be applied. Specific approval conditions are likely. Targeted monitoring program required
- **High** (sum of relevance factors = 10 to 12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Specific approval conditions required. Targeted monitoring program necessary

8 Conclusion

In February 2017, the Project was submitted as an EPBC Act referral to the DotEE (EPBC 2017/7883). On 17 March 2017, the Minister for the Environment determined that the Project is a ‘controlled action’ to be assessed under the bilateral agreement between the State of Queensland and the Commonwealth. The controlling provision for the Project is listed threatened species and communities.

This technical report has been prepared in accordance with Sections 11.1 to 11.35 of the *Terms of Reference for an environmental impact statement: Inland Rail – Helidon to Calvert Project* issued on 5 October 2017 by the Coordinator-General. It has been prepared as a ‘stand-alone’ document that assesses potential impacts on listed threatened species and communities under the EPBC Act during construction, operation and decommissioning of the Project. This technical report has been prepared for the purpose of supporting the Primary approvals for the Project.

The MNES study area contains two unconfirmed TECs and suitable habitat for threatened species as listed under the provisions of the EPBC Act.

Twenty-six MNES were identified as potentially present within the MNES study area for the purposes of this assessment. These consisted of a single TEC and threatened flora and fauna species. These MNES were grouped into high, moderate and low sensitivity categories based on factors including conservation status, exposure to threatening processes, resilience and representation in the broader landscape.

The construction and operation of the Project has the potential to impact on ecological receptors through:

- 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.

In order to determine the significance of potential impacts of the Project upon the identified MNES, sensitivity categories were applied to each of the MNES. The sensitivity of the MNES was grouped into three distinct categories: high, moderate and low. These groupings were based on factors including, but not limited to, legislative status, resilience and representation in the broader landscape. In addition to sensitivity, the magnitude of each potential impact was assigned based on the extent, duration and resultant change to the MNES. The magnitude of impact was grouped into five categories: major, high, moderate, low and negligible. Both the sensitivity of a MNES and the magnitude of the potential impact were used to determine the significance of a potential impact.

The proposed mitigation measures for the Project were considered in order to reduce the initial magnitude and ultimately the significance of the potential impacts upon the listed threatened species and communities. Project mitigation measures included (but were not limited to):

- Development and implementation of a Flora and Fauna Sub-plan as a component of the CEMP

- Development and implementation of a Soil Management 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 Reinstatement and Rehabilitation Management Plan and a Landscape and Rehabilitation Management Plan
- Development and implementation of the whole-of-Project draft Outline EMP.

Following the implementation of a range of mitigation measures and management plans including, but not limited to, avoidance, minimisation and mitigation, the magnitude of residual impacts to the listed threatened species and communities were predicted to be generally reduced, followed by a subsequent reduction in the significance of the impact. However, one potential impact (i.e. habitat loss from vegetation clearing/removal upon most of the terrestrial MNES) was not predicted to significantly reduce in magnitude of impact following the implementation of Project mitigation measures, resulting in a residual impact to each of the MNES.

As a result of the modelling approach, it is predicted that the significant residual impacts are likely to occur to the following listed threatened species and communities:

- Flora
  - Lloyd's olive (*Notelaea lloydii*) – 134.03 ha to *potential habitat* and *Habitat critical to the survival of the species*
- Fauna
  - Collared delma (*Delma torquata*) - 85.33 ha to *important habitat*
  - Koala (*Phascolarctos cinereus*) - 98.66 ha to *Habitat critical to the survival of the species* and 205.29 ha of *potential habitat*

There are also a number of threatened fauna species of which there is uncertainty as to whether they occur in the area, or if impacts of the Project may be considered as residual impacts. The assessment has followed a conservative approach and there is also potential to have significant residual impacts to the following flora and fauna species:

- Flora
  - Four-tailed grevillea (*Grevillea quadricauda*) – total potential impact of 26.06 ha to *potential habitat*
  - Blunt-leaved leionema (*Leionema obtusifolium*) – total potential impact of 29.26 ha to *potential habitat*
  - *Paspalidium grandispiculatum* (a grass) - total potential impact of 84.58 ha to *potential habitat*
- Fauna
  - Spotted-tail quoll (*Dasyurus maculatus maculatus*) - total potential impact of 77.07 ha to *potential habitat* and *Habitat critical to the survival of the species*
  - Red goshawk (*Erythrotriorchis radiatus*) - total potential impact of 88.82 ha to *potential habitat* and *Habitat critical to the survival of the species*
  - Swift parrot (*Lathamus discolor*) - potential impact of 98.67 ha to *potential habitat* and *Habitat critical to the survival of the species*
  - Brush-tailed rock-wallaby (*Petrogale penicillata*) – total potential impact of 41.25 ha to *potential habitat* and *Habitat critical to the survival of the species*
  - New Holland mouse (*Pseudomys novaehollandiae*) - total potential impact of 88.12 ha to *potential habitat*
  - Grey-headed flying-fox (*Pteropus poliocephalus*) – total potential impact of 99.46 ha to *Habitat critical to the survival of the species*

- Australian painted snipe (*Rostratula australis*) – total potential impact of 33.38 ha to *potential habitat* and *Habitat critical to the survival of the species.*

The primary reason for these significant residual impacts is the potential loss of habitat as a result of the Project, along with barrier effects and habitat fragmentation. During the detailed design phase, the expected extent of the clearing will be minimised, along with the implementation of design solutions to mitigate barrier effects (e.g. fauna fencing and fauna passageways which will facilitate the movement of wildlife across the alignment).

Predicted cumulative impacts within 50 km of the Project may potentially include habitat loss from vegetation clearing/removal, fauna species injury or mortality, reduction in biological viability of soil to support growth due to soil compaction, displacement of flora and fauna species due to invasion of weeds and pest species, reduction in connectivity of biodiversity corridors, edge effects, habitat fragmentation, barrier effects, noise, dust, and light impacts and increase in litter (waste) and aquatic habitat degradation. However, the significance of the predicted cumulative impact as a result of the Project and other similar projects that occur within 50 km of the Project boundary are likely to be higher on the following ecological MNES flora and fauna species:

- Lloyd's olive (*Notelaea lloydii*)
- *Paspalidium grandispiculatum* (a grass)
- Grey falcon (*Falco hypoleucos*)
- White-throated needletail (*Hirundapus caudacutus*)
- Swift parrot (*Lathamus discolor*)
- Spotted-tail quoll (*Dasyurus maculatus maculatus*)
- Koala (*Phascolarctos cinereus*)
- Grey-headed flying-fox (*Pteropus poliocephalus*).

The MNES identified through the EIS will be subject to further investigations and surveys during the detailed design phase to more accurately determine the magnitude of the significant residual impacts upon the listed threatened species and communities. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as is reasonably practicable. Significant residual impacts will be offset through the development and implementation of an Environmental Offset Delivery Plan and associated Offset Area Management Plans.

There is the potential for some Project activities (e.g. vegetation clearing) to have a cumulative, irreversible and/or permanent impact upon some ecological MNES, even after the implementation of all Project mitigation measures. In these cases, the compensation for the residual impact will need to occur. An Environmental Offset Delivery Plan and Offset Area Management Plans for the Project will be prepared in consultation with the relevant State and Commonwealth agencies and will comply with the relevant offsets policies. Strategic offsets will be provided in accordance with Commonwealth and State based policies.

8.1 Post primary approval

Should primary approval be issued, all relevant approval conditions will be fully addressed and adhered to at all Project stages.

ARTC will continue to work with relevant stakeholders and agencies to implement the measures and recommendations of this assessment.

Potential impacts on MNES will be managed and where possible, minimised.

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APPENDIX

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Matters of National Environmental Significance Technical Report

Appendix A Predictive Habitat Modelling Methodology

HELIDON TO CALVERT ENVIRONMENTAL IMPACT STATEMENT

IR_1381

Inland Rail Helidon to Calvert EIS

Appendix A – Predictive habitat modelling methodology

Australian Rail Track Corporation

Reference: 3300

Contents

Tables

1 Introduction

1.1 Background

For the purposes of the Inland Rail Project (Helidon to Calvert) (the Project) predictive habitat models for flora and fauna have been prepared. These models have been designed to map the potential areas that are likely to be analogous to habitat associated with *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth (Cth)) (EPBC Act) threatened species. This mapping has the following objective:

- To provide predictive habitat modelling for EPBC Act listed flora and/or fauna species to:
  - Identify areas of potential habitat for EPBC Act and *Nature Conservation Act 1992* (Qld) (NC Act) listed species
  - Facilitate the calculation of potential disturbance areas associated with the Project and to subsequently inform the assessment of significant residual impacts for matters of national environmental significance (MNES).

This document outlines the methodology used for the development of the predictive habitat models and provides the species/community specific assumptions and mapping requirements required to reproduce the predictive habitat models for each individual species. The models have been used to prepare maps indicating the potential extent of each threatened species associated with the Project as identified in the Project Environmental Impact Statement (EIS) Terms of Reference (ToR), in addition to those species identified from the desktop review phase of the Project EIS. The methodologies presented here represent a conservative approach to mapping and apply the precautionary principle to the identification of habitat for each specific matter.

The approach adopted 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. DES 2019) 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.

1.2 Context

For context with respect to the methodology's compliance with EPBC Act Survey Guidelines for threatened species, the more conservative approach of this methodology surpasses the guidelines expectations. The *"How to use these guidelines"* statement includes:

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

This methodology includes analysis of historic and current data gained from a range of sources (as listed in Table 1.1) with direct and current survey efforts including dedicated ground truthing surveys of the database mapping and follow-up ecological assessments within the project area as part of the projects geotechnical drilling survey program.

1.3 Review of existing databases and literature

Each predictive fauna habitat model has been developed to deliver a process that is robust, transparent and repeatable. The first stage in developing each of the models involved determining the extent of species occurrence and the availability of information pertaining to available species habitat.

Eleven government databases were accessed to identify MNES and NC Act listed species and communities that have potential to occur within the Project ecology study area (refer Table 1.1).

In addition to these reports, A total of five ecological assessment assessment were identified which describe the MNES values, including species protected under the EPBC Act within the MNES study area (refer Table 1.2).

Table 1.1 Database and document review summary

Database/data source name	Database search date	Database search areas	Data type
Atlas of Living Australia (2020a)	29/03/2020	MNES study area	Ongoing inspection of records of flora and fauna, including threatened species listed under the EPBC Act.
Atlas of Living Australia (2020b)	29/03/2020	Ecology study area	Records of flora and vertebrate fauna, including conservation significant species listed under the EPBC Act and/or NC Act
Flying Fox Monitoring Program (DES 2020a)	24/03/2020	MNES study area	Show the location of flying-fox roosts in Queensland recorded by the department and include monitoring data of continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Flying-fox roost monitoring and locations (DES 2020b)	04/03/2020	MNES study area	Show the general location of flying-fox roosts in Queensland recorded by the department and include continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Birds Australia (2019)	29/03/2019	MNES study area	Records of avian fauna, including threatened and migratory species listed under the EPBC Act.
EPBC Act Protected Matters Search Tool (Australian Government) (Australian Government 2020)	17/03/2020	MNES study area	Provides a "predictive" account of MNES identified within a specific area. Includes MNES such as world heritage properties, national heritage places or wetlands of international importance and threatened/migratory species.
Regulated Vegetation Management Map (Queensland Government 2020a)	04/03/2020	MNES study area	Mapping of regional ecosystems (REs) and High Value Regrowth that provide habitat for TECs and threatened species under the EPBC Act.
Wetland Info database (Department of Environment and Science (DES) 2020c)	04/03/2020	Impact assessment area	Provides interactive maps, species records, case studies and legislation associated with Queensland wetlands.
MSES Wildlife Habitat Map (Queensland Government 2020c)	17/03/2020	MNES study area	Modelled habitat for threatened species listed under the EPBC Act.
Wildlife Online database (Queensland Government) incorporating Wildlife Online and Herbrecs datasets	17/03/2020	MNES study area	Records of flora and vertebrate fauna including threatened species listed under the EPBC Act.
Queensland Springs Database (Queensland Government 2020b)	04/03/2020	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).

Database/data source name	Database search date	Database search areas	Data type
MNES (Department of Environment and Energy 2020)	17/03/2020	MNES study area	Location of MNES, including: ▪ Threatened species as listed under the EPBC Act ▪ Migratory species listed under the EPBC Act ▪ TECs listed under the EPBC Act ▪ Critical habitats ▪ World Heritage Properties ▪ National Heritage Places ▪ Wetlands of International Importance (i.e. Ramsar) ▪ Great Barrier Reef Marine Park ▪ Commonwealth Marine Area ▪ Nuclear Areas.

Table 1.2 Assessments and reports providing ecological information for areas associated with the Project

Document title	Reference	Summary of significant findings related to MNES
Southern Freight Rail Corridor Study (March 2010) (C2K Project study area adjacent to east of Project)	AECOM (2010)	Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ threatened ecological community (TEC) located immediately east of MNES study area Observations of Koala (*Phascolarctos cinereus*) located immediately east of MNES study area – anecdotally known to occur throughout the study area from community consultation feedback.
Australian Rail Track Corporation/Transport - Land/southwest of Ipswich/Queensland/Inland Rail Helidon to Calvert Project (EPBC referral 2017/7883)	ARTC (2017a)	Observations of Koala (*Phascolarctos cinereus*) presence (scats) – eight distinct locations along the alignment
Initial Advice Statement: Inland Rail, Helidon to Calvert – 15 February 2017.	ARTC (2017b)	Provides initial details on how the project is likely to impact upon MNES. This includes identification of the potential presence of 15 threatened species.
Inland Rail – Gowrie to Kagaru Geotechnical investigations. MNES assessment report – 23 July 2018 Gowrie to Kagaru Geotechnical Investigations Environmental Management Plan – 31 October 2018	EMM (2018a, 2018b, 2018c, 2018d)	Confirmation of the presence of Lloyd's olive (*Notelaea lloydii*) near Laidley Observations of Koala (*Phascolarctos cinereus*) presence throughout alignment (scats and scratches)
Inland Rail – Helidon to Calvert Geotechnical investigations. MNES assessment report – 29 May 2019	Eco logical (2019a, 2019b)	No threatened species observed

In addition to the data sources identified above, findings associated with EIS field investigations/analysis assisted in the validation and iteration of the predictive habitat mapping. However, it must be noted that field investigations were subject to voluntary land access agreements which place heavy restrictions upon areas that were accessible.

In addition to previous surveys and site-based investigations, recovery plans were assessed in order to identify areas of high conservation significance or of recognised conservation value for each of the MNES subject to predictive habitat modelling. In addition, the *Draft Guide to nationally protected species significantly impacted by paddock tree removal* (DoEE 2020) was also assessed to determine species that may be impact by the removal of paddock trees.

Of the species identified as potentially impacted by the project activities, 10 have a Commonwealth approved recovery program. These species consist of the following:

- Regent honeyeater (*Anthochaera phrygia)*
- Large-eared pied bat (*Chalinolobus dwyeri*)
- Eastern bristlebird (*Dasyornis brachypterus*)
- Spotted-tail quoll (*Dasyurus maculatus maculatus*)
- Red goshawk (*Erythrotriorchis radiatus*)
- Swift parrot (*Lathamus discolor*)
- Brush-tailed rock-wallaby (*Petrogale penicillata*)
- Black-breasted button-quail (*Turnix melanogaster*).

Three species relevant to this assessment are subject to a Draft recovery program. These species consist of the following:

- Australian lungfish (*Neoceratodus forsteri*)
- Australasian bittern (*Botaurus poiciloptilus*)
- Australian painted snipe (*Rostratula australis*).

In addition, the Recovery and Draft Recovery Programs identified above, Draft referral guidelines are applicable to the following species:

- Collared delma (*Delma torquata*)
- Dunmall's snake (*Furina dunmalli*)
- Five-clawed worm-skink (*Anomalopus mackayi*)
- Koala (*Phascolarctos cinereus*)
- White-throated needletail (*Hirundapus caudacutus*).

Information derived from the Recovery Plans, Draft Recovery Plans and Draft Referral Guidelines were used to derived specific habitat characterisation criteria to inform the predictive habitat modelling process.

2 Species included within the predictive habitat mapping model

A total of 18 conservation significant flora species and 30 conservation significant fauna species listed under the provisions of the EPBC Act and/or NC Act were identified as occurring or potentially occurring within the MNES study area (refer Table 2.1 and Table 2.2). Of these, 10 flora and 21 fauna species are considered to potentially, likely or known to occur within the Project MNES study area.

All species identified as potentially occurring within the MNES study area were subject to habitat modelling as outlined within this document.

Table 2.1 Threatened flora species identified from database searches

Family	Species name	Common name	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Poaceae	*Arthraxon hispidus*	Hairy-joint grass	V				✓	Possible
Orchidaceae	*Bulbophyllum globuliforme*	Miniature moss-orchid	V				✓	Unlikely. No suitable habitat likely present and no records within 50 km of Project
Surianaceae	*Cadellia pentastylis*	Ooline	V		✓			Unlikely, this species is out of its known distribution
Poaceae	*Dichanthium setosum*	Bluegrass	V		✓		✓	Possible
Euphorbiaceae	*Fontainea venosa*	Bahrs Scrub Fontainea	V		✓			Unlikely. Species only known from small populations in Beenleigh, Gympie and Kilcoy
Proteacaea	*Grevillea quadricauda*	Four-tailed grevillea	V	✓	✓	✓	✓	Possible
Haloragaceae	*Haloragis exalata velutina*	Tall velvet sea-berry	V		✓		✓	Unlikely. No suitable habitat present for this species.
Rutaceae	*Leionema obtusifolium*	Blunt-leaved leionema	V				✓	Possible
Brassicaceae	*Lepidium peregrinum*	Wandering pepper-cress	E				✓	Possible
Characeae	*Lychnothamnus barbatus*	A green algae	E		✓			Unlikely. Known only from Warrill Creek and Wallace Creek in the Boonah area. Project does not intersect these waterways.
Proteceae	*Macadamia integrifolia*	Macadamia nut	V		✓		✓	Unlikely. No suitable habitat likely present and no nearby records. Planted specimens (i.e. not in the wild) may be present but these are considered beyond the intent of the EPBC Act listing
Oleaceae	*Notelaea lloydii*	Lloyd's native olive	V	✓	✓	✓	✓	Likely
Poaceae	*Paspalidium grandispiculatum*	A grass	V		✓		✓	Possible
Rutaceae	*Phebalium distans*	Mt Berryman phebalium	CE		✓		✓	Possible
Asteraceae	*Rhaponticum australe*	Austral cornflower	V	✓	✓	✓	✓	Unlikely, potential habitat for this species is marginal and no recent historic records close to the Project (all nearby records are pre-1950)
Simaroubaceae	*Samadera bidwillii*	Quassia	V		✓		✓	Unlikely. No records in wider area and species occurs between Mackay and Gympie (DAWE 2020)

Family	Species name	Common name	EPBC Act status	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Fabaceae	*Sophora fraseri*	Brush sophora	V				✓	Possible
Santalaceae	*Thesium australe*	Austral toadflax	V	✓	✓	✓	✓	Likely

Table notes:

Status: CE = Critically Endangered E = Endangered V = Vulnerable
Data source: PMST = Protected Matters Search Tool AoLA = Atlas of Living Australia ToR = Terms of reference
✓ = species present within database record within the MNES study area

Table 2.2 Threatened fauna species identified from database searches

Family	Species name	Common name	EPBC Act	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Birds								
Accipitridae	*Erythrotriorchis radiatus*	Red goshawk	V	✓	✓		✓	Possible
Apodidae	*Hirundapus caudacutus*	White-throated needletail	V, M		✓		✓	Likely
Ardeidae	*Botaurus poiciloptilus*	Australasian bittern	E		✓		✓	Possible
Columbidae	*Geophaps scripta scripta*	Squatter pigeon (southern subspecies)	V	✓	✓	✓	✓	Unlikely. The species is typically associated with the westerns slopes of the Great Dividing Range. While there are several records of this species within the broader project context, the majority of these are older and there are no recent records (>1980s) within 5 km of the project disturbance footprint
Dasyornithidae	*Dasyornis brachypterus*	Eastern bristlebird	E				✓	Unlikely, species occurs within very specific altitudinal and habitat limits that are absent from the MNES Study area
Falconidae	*Falco hypoleucos*	Grey falcon	V			✓		Known (observed)
Meliphagidae	*Anthochaera phrygia*	Regent honeyeater	CE		✓		✓	Possible
Meliphagidae	*Grantiella picta*	Painted honeyeater	V		✓		✓	Possible
Passeridae	*Poephila cincta cincta*	Southern black-throated finch	E		✓		✓	Unlikely. Expert advice indicated that this species is locally extinct within SEQ (DAWE 2020)
Psittacidae	*Cyclopsitta diophthalma coxeni*	Coxen's fig-parrot	E				✓	Unlikely. No records close to MNES study area and no wet forest habitat within or near Project
Psittacidae	*Lathamus discolor*	Swift parrot	CE		✓	✓	✓	Possible
Rostratulidae	*Rostratula australis*	Australian painted snipe	E	✓	✓	✓	✓	Possible
Scolopacidae	*Calidris ferruginea*	Curlew sandpiper	CE, M	✓	✓		✓	Possible
Scolopacidae	*Numenius madagascariensis*	Eastern curlew	CE, M		✓		✓	Unlikely. Species is essentially a coastal specialist
Turnicidae	*Turnix melanogaster*	Black-breasted button-quail	V		✓		✓	Possible

Family	Species name	Common name	EPBC Act	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Mammals								
Dasyuridae	*Dasyurus hallucatus*	Northern quoll	E		✓			Unlikely, the MNES study area is beyond the known range of this species
Dasyuridae	*Dasyurus maculatus maculatus*	Spotted-tail quoll	E		✓		✓	Possible
Macropodidae	*Petrogale penicillata*	Brush-tailed rock-wallaby	V	✓	✓	✓	✓	Possible
Muridae	*Pseudomys novaehollandiae*	New Holland mouse	V		✓		✓	Possible
Petauridae	*Petauroides volans volans*	Greater glider	V	✓	✓		✓	Possible
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	✓	✓	✓	✓	Likely
Potoroidae	*Potorous tridactylus tridactylus*	Long-nosed potoroo	V		✓		✓	Possible
Pteropodidae	*Pteropus poliocephalus*	Grey-headed flying-fox	V	✓	✓		✓	Likely
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared pied bat	V				✓	Unlikely. No nearby records and habitat unlikely present
Reptiles								
Pygopodidae	*Delma torquata*	Collared delma	V		✓		✓	Likely
Elapidae	*Furina dunmalli*	Dunmall's snake	V		✓		✓	Possible
Scincidae	*Anomalopus mackayi*	Five-clawed worm-skink	V		✓		✓	Possible
Scincidae	*Coeranoscincus reticulatus*	Three-toed snake-tooth skink	V				✓	Unlikely. No habitat present.
Fish								
Pericichthyidae	*Maccullochella mariensis**	Mary River cod	E		✓		✓	Unlikely. Whilst it is acknowledged the Mary River cod may have potential to ocur within the broader region, these individuals are likely to have resulted from fish stocking activities and are considered to be outside of areas considered to be within their natural distribution. There are no database records of the species in the Brisbane/Logan River catchments. Habitat critical to the survival of this species is restricted to the Mary River drainage system and therefore this species has been excluded from the impact assessment

Family	Species name	Common name	EPBC Act	Data source				Likelihood of occurrence
				Wildlife Online	PMST	AoLA	ToR	
Protopteridae	*Neoceratodus forsteri*	Australian lungfish	V	✓	✓		✓	Possible

Table notes:

Status: CE = Critically Endangered E = Endangered V = Vulnerable
Data source: PMST = Protected Matters Search Tool AoLA = Atlas of Living Australia ToR = Terms of reference
✓ = species present within database record within the MNES study area
PMST = Protected Matters Search Tool
* = Fish species have been actively stocked/translocated in a number of the project catchments

3 Predictive habitat modelling input datasets

Predictive habitat modelling was undertaken to identify and map areas that are considered to have the potential to provide habitat for the conservation significant species listed in Table 2.1 and Table 2.2 which have potential to occur within the Project ecology study area. This modelling provides an additional tool to assess the likely occurrence of species of interest and facilitates impact assessment by allowing for the quantification of areas of habitat using GIS analysis.

In addition to specimen and community specific RE associations that are identified within Table 5.1 and Table 5.2, additional GIS layers and field derived information have been utilised to identify areas of habitat within the Project ecology study area where applicable to a species. These layers include:

- Regional ecosystem datasets (Version 11) (remnant and high value regrowth) and pre-clearing regional ecosystem layers (refer Appendix A for the description of Regional Ecosystems that occur within the MNES study area)
- High resolution aerial photography with site derived datasets (i.e. utilisation of condition data, species records and general observational data pertaining to species habitat where applicable)
- Where available[1], threatened species records from Atlas of Living Australia, the Queensland Department of Environment and Science species profile and previous ecological investigations
- Field derived datasets related to habitat suitability and the presence of micro-habitat features
- Topographic and geological information
- Government derived cadastral datasets
- Where applicable distribution and habitat modelling from the State and Commonwealth
- Essential habitat and wildlife habitat mapping
- Watercourses and wetlands datasets Defined watercourses
  - Queensland waterways for waterway barrier works
  - State government based wetland mapping, including springs and groundwater dependent ecosystems (GDEs).

[1] Some species records are confidential

4 Predictive habitat modelling categories

4.1 Flora and fauna species

4.1.1 General context

Each predictive habitat model allowed partitioning of habitat for flora and fauna species using current scientific knowledge (including relevant Commonwealth threatened species listing advice and recovery plans) and pre-existing data derived from historic surveys and State based mapping identified above. The specific habitat assumptions for each species that were subject to predictive mapping are provided in Table 5.1 and Table 5.2.

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

- Unlikely habitat
- Potential habitat
- Important habitat
- Habitat critical to the survival of the species.

The use of these habitat categories aligns with the Commonwealth Department of Agriculture, Water and Environment's (DAWE's) habitat definitions for species protected under the EPBC Act and terminology used in the DAWE's significant impact assessment guidelines.

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

4.1.2 Unlikely habitat

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

4.1.3 Potential habitat

Potential habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as Important habitat or Habitat critical to the survival of the species (i.e. records of the species are considered anomalies as general microhabitat features are not considered to be present from a desktop perspective). Potential habitat also includes habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records, where these areas are not considered to fulfil the criteria if "*Habitat Critical to the survival of the species*". Potential habitat may include areas of suboptimal habitat for species. Species specific assumptions that define the Potential habitat category are identified in Table 5.1 and Table 5.2. Impacts to *Potential habitat* are not considered to contribute to significant impact to an MNES as the loss of these areas is not deemed to be significant in accordance with the Commonwealth significant impact criteria. However, impact to Potential habitat have been considered in relation to movement of species and the potential to contribute towards fragmentation and barrier effects, rather than the loss of habitat *per se*.

4.1.4 Important habitat

In line with DAWE's guidelines, areas of Important habitat are regarded as a surrogate for important populations of Brigalow belt reptiles. Relevant to the current investigations, the following species are classified as Brigalow Belt reptiles and important habitat for these species has been mapped where relevant:

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

Important habitat for Brigalow Belt reptiles is defined in Section 5 of the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles (Commonwealth of Australia 2011):

"Suitable habitat for any one of the listed Brigalow Belt reptiles is considered important if it is:

- *habitat where the species has been identified during a survey*
- *near the limit of the species' known range*
- *large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations), or*
- *a habitat type where the species is identified during a survey, but which was previously thought not to support the species.*

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

Species specific assumptions that define the Important habitat category for the above-mentioned species is provided in Table 5.2. Impacts to *Important habitat* are considered to contribute to significant impact to an MNES.

4.1.5 Habitat critical to the survival of the species

Habitat critical to the survival of the species represents habitat with the greatest value for the particular MNES. This habitat category identifies areas that align with "*habitat critical to the survival*" of a listed threatened species is identified in an approved Recovery Plan for the relevant MNES. However, in instances where there are no Recovery Plans for a specific species, the presence of a specimen backed record (i.e. derived from either desktop assessments or field investigations) is considered to align with this category where breeding and foraging habitat is potentially present. For these species, elevation of habitat to this level adequately accounts for the significance of such areas regardless of the absence of a Recovery Plan and applies the precautionary principle to mapping areas of potentially high value habitat. Species specific assumptions associated with the mapping of Habitat critical to the survival of the species are detailed in Table 5.1 and Table 5.2. Impacts to *Habitat critical to the survival of the species* are considered to contribute to significant impact to an MNES.

5 Predictive habitat models and general assumptions associated with their development

5.1 Flora and fauna habitat models

The predictive habitat models for each of the relevant flora and fauna species, was designed to provide a dynamic, robust and predictive GIS layer that could incorporate data from scientific literature and DAWE conservation listing advice/recovery plans, verified government datasets, specimen backed datasets (i.e. data derived from a known/confirmed location of an observed specimen) and field identified records into a single layer that could be used to identify areas that are known, or considered to have the potential to support specific threatened EPBC Act listed flora and fauna species. Development of these layers had the ultimate objective to:

- Predict areas that have the potential to support EPBC Act listed flora and fauna species
- Facilitate the quantification of impacts to inform later stages of the EIS process (e.g. offset liabilities)
- Inform the design with respect to identifying areas of high ecological value which should be avoided or measures implemented to minimise the impacts
- Facilitate the assessment of assessment of significant residual impacts in accordance with the *Matters of National Environmental Significance: Significant impact guidelines 1.1* (DotE 2013).

The habitat modelling was created using ESRI ArcGIS, specifically the ESRI ArcGIS Model Builder which facilitated the development of scripts that allowed for the species-specific development of queries that utilised a range of GIS input datasets (e.g. vegetation communities containing site derived and filed verified information).

The models also incorporated the use of selecting relevant components and performing functions such as buffers and intersects that reflected the preferred habitat of a particular species. As a result of this process output habitat layers were generated for each species according to their individual requirements. The species-specific requirements that were used to generate the species-specific queries used to map potential habitat are identified in Table 5.1 and Table 5.2 . Once produced model outputs were reviewed internally by suitably qualified and experience ecologists to assess that they accurately reflected/identified habitat suitable for supporting the relevant species. If anomalies were identified, GIS iterations were undertaken to produce outputs of greater accuracy. However, it is noted that whilst species that were identified to have potential to occur within the broader region underwent habitat modelling, the results of the modelling did not necessarily identify habitat within the MNES study area for all of the species modelled. Where this occurred, these species (i.e. without identified habitat within the MNES study area) did not undergo impact assessment as part of the Project EIS.

As the predictive flora and fauna habitat model mapping has been designed to identify areas of potential habitat for EPBC Act listed species as stipulated by relevant guidelines, policy statements, conservation listing advice and recovery plans, several assumptions to the model have been made. These assumptions are outlined below.

- Heterogeneous vegetation community polygons – Mapping has been designed to identify maximum areas of disturbance based on a conservative approach. In the case of heterogeneous polygons, if the vegetation community code is contained within the heterogeneous polygon, then the entire polygon was selected and included as part of the habitat mapping. This represents a highly conservative approach to habitat modelling as it has potential to significantly over-estimate habitat in the absence of ground-truthing. This is of importance to species such as those that rely on limited areas of habitat such as Brigalow reptiles[2], which would otherwise be overlooked by the model. Areas of predicted habitat may be removed from mapping if field survey indicates that habitat is not available.
- Buffers – Buffers have been used when integrating a specimen backed record into the predicted mapping. Generally, a 1 km buffer from the species data point is used (in line with the methodology adopted by the Queensland Vegetation Management 1999 when identifying essential habitat derived from a specimen backed record under state based legislation) which results in some areas being identified as potential habitat despite being developed for other purposes (i.e. irrelevant on the level of development or clearing) and thus unlikely to support the species. This is particularly apt for the Koala, where the buffer results in areas of grazing land being defined as koala habitat despite the absence of koala trees etc. In these areas it is noted that the loss of habitat is not the risk but the potential for barrier impacts for koalas and potentially the Spotted-tail quoll. Deviations from this methodology (where they occur), are identified in Table 5.1 and Table 5.2.
- Habitat critical to the survival of the species – The predictive flora and fauna habitat mapping outlined in this document primarily proposes potential habitat as the preferred habitat requirements for many of the species mapped. This is as a result of their habitat not being fully understood or cannot be easily extrapolated from available datasets or species information (such as applicable species recovery plans or approved conservation advice). In those cases, site derived species records were used to extrapolate preferred habitat by correlating with the underlying GIS layer. For these species, where a species point record and associated 1 km buffer intersect with areas of predicted potential habitat, the area of overlap has been elevated to the Habitat critical to the survival of the species category. The relationship between potential habitat, important habitat, species records and habitat critical to the survival of the species outlined inTable 5.1 (flora) and Table 5.2 (fauna).
- Use of existing specimen backed records to identify habitat associations – In instances where there was insufficient literature to confidently identify areas of potential habitat, specimen backed records were used to identify the associated vegetation association (e.g. preferred vegetation communities and geological components). These point-selected datasets were then assessed to determine that they were consistent with the species habitat requirements. When identified as valid, the point selected data points were incorporated into the predictive mapping "recipe" for the particular species (refer Table 5.1 and Table 5.2). Point selected datasets that were not identified as being able to support the species were rejected from use in further analysis.
- Minimum areas of habitat – Mapping has been designed to identify maximum areas of disturbance and therefore no minimum area of habitat has been identified. The methodology was developed to predict areas of potential habitat. However, the resolution of the mapping is constrained by the data inputs (e.g. vegetation community mapping) and therefore areas that may potentially be identified as habitat will always be contiguous to areas of similar habitat that reflect the minimum resolution for the input dataset (e.g. minimum vegetation community polygon size, etc.).

[2] The Draft Referral guidelines for the nationally listed Brigalow Belt reptiles noted that the RE's suitability for reptile habitation is only broadly indicative as RE polygons are mapped at a 2-5 ha scale depending on how, where and when the mapping was carried out. This means that RE polygons mapped as unsuitable habitat may actually contain 2-5 ha of suitable habitat and vice versa for polygons mapped as suitable.

- Levels of habitat mapping – Potential habitat has primarily been indicated on the predictive mapping. However, where areas identified in relevant recovery plans or referral guidelines have been identified and these areas overlap with areas of predicted Potential habitat category, these areas have been elevated to Habitat critical to the survival of the species or Important habitat (e.g. for Brigalow belt reptiles) in line with the information contained within the relevant species advice/guideline or policy.

Table 5.1 **Listed conservation significant flora species habitat assumptions used to map areas of occurrence within Project matters of national environmental significance study area**

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Characeae	*Lychnothamnus barbatus*	A green alga	E	*Lychnothamnus barbatus* has not been identified within or near the MNES study area. Database records are located 27 km south-east of the Project disturbance footprint as is likely associated with Warrill Creek. *Lychnothamnus barbatus* occurs in clear flowing water (Queensland Herbarium 2009).	The following is considered to be potential habitat: All areas identified as stream order 3 and above with a 10 m buffer applied. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside areas specified above are considered to constitute potential habitat.*	Not applicable	All areas occupied by the species. Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).
Oleaceae	*Notelaea lloydii*	Lloyd's olive	V	*Notelaea lloydii* has been identified within the Project disturbance footprint to the east of Laidley (EMM 2018). Another record from 1990 exists further east near Grandchester within the MNES study area. The nearest record outside of the MNES study area exists to the north of Grandchester within approximately 5 km of the alignment and dated 2011. A review of the available literature has not revealed any important populations (DEWHA 2008). However, given that the database records are in such close proximity to and have potential to be impacted by the Project there is potential to impact a source population for the species. This species has a restricted distribution, has undergone historical loss and will encounter future loss resulting from rural and urban	Given that this species has been identified within the project footprint, any identified habitat has been categorised as habitat critical to the survival of the species. Potential habitat has not been mapped for this species *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	Not applicable	Given that this species has been identified within the project footprint, the following REs are considered to constitute habitat critical to the survival of the species when it is located at an elevation between 80 to 480 m as it has been identified by the Qld Government as providing habitat for *Notelaea lloydii*: 12.9-10.2. In addition, the following REs (identified as remnant "*open eucalypt forest*"): 12.8.1, 12.8.2, 12.8.8, 12.8.9, 12.8.10, 12.8.1112.8.12, 12.8.24, 12.8.25, 12.9-10.1, 12.9.10.3, 12.9-10.14,

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				development. As such the population relevant to the project can be considered an important population and therefore key to the long-term survival of this species. *Notelaea lloydii* occurs in open eucalypt forest, often near the margins of vine thickets, vine forests and softwood scrub at altitudes between 80 and 480 m. It is usually found on stony, shallow and rocky soils derived from sandstone or acid volcanic rocks, often on steep slopes, or near drainage lines. *Notelaea lloydii* is known from eight sites at five locations within south-east Queensland.			12.9-10.17, 12.9-10.17a, 12.9-10.17b, 12.9-10.17c, 12.9-10.17d, 12.9-10.17e, 12.9-10.23, 12.9-10.27, 12.9-10.29, 12.12.2, 12.12.3, 12.12.15 and 12.12.20 are considered to constitute habitat critical to the survival of the species, when they occur at an elevation between 80 to 480 m and are **located directly adjacent** to the following REs (remnant vegetation), which are identified as either *rainforest*, or *vine thickets*: 12.2.1, 12.2.2, 12.2.3, 12.3.1, 12.3.1a, 12.3.2, 12.3.16, 12.3.21, 12.5.13, 12.5.13a, 12.5.13b, 12.5.13c, 12.8.3, 12.8.4, 12.8.5, 12.8.8, 12.8.9, 12.8.13, 12.8.18, 12.8.21, 12.8.22, 129-10.15, 12.9-10.16, 12.11.1, 12.11.2, 12.11.3, 12.11.4, 12.11.10, 12.11.11, 12.11.12, 12.11.13, 12.12.1, 12.12.13, 12.12.15, 12.12.15a, 12.12.16, 12.12.17 and 12.12.18. A buffer of 200 m is to be used from the above remnant REs to create a new polygon from the larger “parent” REs.

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
							Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are also considered to constitute habitat critical to the survival of the species. *It is also noted that (in the absence of a specimen backed record) non-remnant and regrowth vegetation communities have not been included as part of the habitat mapping as these areas do not conform to habitat as identified within the conservation listing advice for this species.*
Poaceae	*Dichanthium setosum*	A bluegrass	V	*Dichanthium setosum* has not been identified as occurring within or near the MNES study area. Desktop assessments also indicate that there is an absence of specimen backed records within the region. *Dichanthium setosum* is associated with heavy basaltic black soils and stony red-brown hard-setting loam with clay subsoil and is found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The extent to which this species tolerates disturbance is unknown.	The following REs (remnant and regrowth) are considered to constitute potential habitat as they represent grassy woodlands on basalt derived soils. 12.8.14, 12.8.19, 12.8.27. In order to capture information related to cleared woodland, regrowth mapping has been used as these areas have historically been subject to clearing activities. In addition, road reserves that are mapped as RE (pre-clear) 12.8.14, 12.8.19, 12.8.27 are also potential habitat for this species in recognition of the	Not applicable	All areas occupied by the species. Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
					species ability to persist in disturbed environments. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*		
Poaceae	*Paspalidium grandispiculatum*	A grass	V	*Paspalidium grandispiculatum* has not been identified as occurring within the MNES study area. However, database records indicate the species occurs within approximately 5 km from the Project. The species has a limited range extending in a narrow band from Kingaroy to Canungra (DEWHA 2008). A review of the available literature has not revealed any important populations or definition of habitat critical to the survival of the species including the approved conservation advice for the species (DEWHA 2008). However, given there are database records are in close proximity to the Project disturbance footprint and the species has a narrow range of occurrence there is potential for an 'important population' to be impacted by the Project. In Queensland, *Paspalidium grandispiculatum* occurs in mixed forest with *Corymbia citriodora* on sub-coastal, old loamy and sandy plains and mixed open forest often with *Corymbia trachyphloia*, *Corymbia citriodora*, *Eucalyptus crebra*, *Eucalyptus fibrosa* on quartzose sandstone. The species	The following REs (remnant and regrowth) are considered to constitute general habitat as they represent mixed open eucalypt forest on sub-coastal, old loamy and sandy plains: 12.3.18, 12.5.1, 12.5.3, 12.5.7, 12.5.7a, 12.9-10.2, 12.9-10.3, 12.9-10.5, 12.9-10.5a, 12.9-10.5b, 12.9-10.11a, 12.9-10.12, 12.9-10.12a, 12.9-10.17, 12.9-10.17b, 12.9-10.18, 12.9-10.19, 12.9-10.23, 12.9-10.25, 12.9-10.27, 11.5.2, 11.5.9, 11.10.1, 11.10.2, 11.10.13. Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the REs identified above are considered to constitute general habitat.	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				has also been recorded in and in native pasture occurring as a result of land clearing.			
Proteaceae	*Grevillea quadricauda*	A Grevillea	V	*Grevillea quadricauda* was not identified within any Project-associated field surveys however, database records indicate this species has been recorded 500 m north of the Project disturbance footprint between Helidon and Gatton the south-eastern corner of the Lockyer Resource Reserves area. A review of the available literature has not revealed any populations or definitions of habitat critical to the survival of the species. Nevertheless, given the restricted area of occurrence of the species it may be inferred that the population occurring in the Lockyer Forest Reserves could be considered on the edge of the species range. As such, for the purposes of this assessment the habitat adjacent to this area which is intersected by the Project is considered as potentially comprising individuals within an 'important population'. *Grevillea quadricauda* occurs on gravelly loam soils or in sandy soils. It inhabits the understorey of dry sclerophyll forest or eucalypt woodland, usually along creeks or drainage lines. Associated plant communities include creek line forest dominated by *Syncarpia glomulifera* and *Lophostemon confertus*.	The following REs (remnant and regrowth) are considered to constitute general habitat as they represent dry sclerophyll or eucalypt on gravel loam and sandy soils: 12.3.2, 12.3.2a, 12.3.15, 12.5.1, 12.5.11, 12.9-10.5. In addition, the following REs (remnant and regrowth) are considered to constitute general habitat when they are located within 200 m (i.e. create a buffer, which will be used to "cleave" larger REs to create new polygons) of a watercourse (stream order 3 and above): 12.8.1, 12.9-10.1, 12.9-10.1x1, 12.9-10.14, 12.11.3, 12.11.9x1, 12.12.14, 12.12.6, 11.10.2, 11.12.13. Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the REs identified above are considered to constitute general habitat.	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Proteaceae	*Macadamia integrifolia*	Queensland nut tree	V	*Macadamia integrifolia* has not been identified as occurring within or near the MNES study area. Desktop assessments also indicate that there is an absence of specimen backed records within the region. *Macadamia integrifolia* grows in remnant rainforest, preferring partially open areas such as rainforest edges.	The following REs (remnant and regrowth) are considered to constitute potential habitat when they are within an altitude of 5-400 m ASL as they represent complex mixed notophyll forest and rainforest: 12.3.1, 12.3.1a, 12.3.16, 12.3.21, 12.8.3, 12.8.4, 12.8.5, 12.8.13, 12.8.18, 12.8.21, 12.8.22, 12.11.1, 12.11.4, 12.11.10, 12.11.11, 12.11.12, 12.11.13, 12.12.1, 12.12.13, 12.12.16, 12.12.17, 12.12.18. *Note: Any specimen backed records of* ***naturally occurring*** *individuals (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).
Rutaceae	*Phebalium distans*	Mt Berryman phebalium	CE	*Phebalium distans* has not been identified as occurring within or near the MNES study area. Desktop assessments also indicate that there is an absence of specimen backed records within the region. *Phebalium distans* is found in semi-evergreen vine thicket on red volcanic soils, or in communities adjacent to this vegetation type. Vegetation associations in which *Phebalium distans* occur include microphyll to notophyll vine forest with or without *Araucaria cunninghamii* and low microphyll vine forest and semi-evergreen vine	Given that this species requires a well-developed (complex) vegetation community (ie semi-evergreen vine thickets), the following REs (remnant) are considered to constitute potential habitat: 12.12.13, 12.12.16, 12.12.17, 12.12.18. In addition, any RE that is contained within 200 m (create a buffer, which will be used to "cleave" larger REs to create new polygons) of the following	Not applicable	All areas occupied by the species. Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	**Important habitat**	**Habitat critical to the survival of the species**
				thicket with or without *Araucaria cunninghamii.*	REs are considered to constitute potential habitat: 12.12.13, 12.12.16, 12.12.17, 12.12.18. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.* Note that non-remnant and regrowth communities have not been identified as habitat for this species as they lack the required structural complexity required to support the species.		
Santalaceae	*Thesium australe*	Austral toadflax	V	*Thesium australe* was not identified within any Project-associated field surveys. The species has been recorded within the MNES study area (dated 1985) from two records located between the Project disturbance footprint and the University of QLD Gatton Campus (approximately 500 m from the Project disturbance footprint) on lands that appear to be currently used for irrigated agriculture. There are 1930 records from the Forest Hill area (4.5 km north of the Project). A review of the available literature has not revealed any important populations or critical habitat for this species in relation to the Project. The species occurs across a wide area, and there are no recent records of the species within 10 km of the Project. The Project will not	The following REs (remnant) are considered to constitute potential habitat as they comprise *open forest / woodland with a grassy understory,* or *grasslands* on basalt derived sediments: 12.3.3, 12.8.18, 12.8.27, 11.3.4, 11.3.12, 11.3.24, 11.3.30, 11.3.31, 11.3.38, 11.4.13, 11.8.5, 11.8.8, 11.8.10, 11.8.11 and 11.9.3. In addition, the following pre-clearance REs (cleared, non-remnant areas) are considered to constitute habitat when they are contained within a road reserve **on basalt derived soils** as these areas coincide with areas that may historically have contained the species:	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				conceivably impact the species such that it is likely to decline or impact recovery of the species. *Thesium australe* is semi-parasitic on roots of a range of grass species, notably *Themeda triandra* and *Dichanthium* spp. It occurs in shrubland, grassland or woodland, often on damp sites. Vegetation types include open grassy heath dominated by *Leptospermum myrtifolium*, *Hakea microcarpa*, *Callistemon sieberi, Grevillea lanigera*, *Epacris microphylla* and Poa spp.; *Themeda triandra* grassland surrounded by *Eucalyptus* woodland; and grassland dominated by *Cymbopogon refractus.* The species is also known to occur within highly disturbed road reserves within the Toowoomba region which are maintained to control woody weed species.	12.3.3, 12.8.18, 12.8.27, 11.3.4, 11.3.12, 11.3.24, 11.3.30, 11.3.31, 11.3.38, 11.4.13, 11.8.5, 11.8.8, 11.8.10, 11.8.11 and 11.9.3. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*		
Simaroubaceae	*Samadera bidwillii*	Quassia	V	There are no recent records for *Samadera bidwillii* within the Project area or within the broader context of the site. Quassia commonly occurs in lowland rainforest or on rainforest margins, but it can also be found in other forest types, such as open forest and woodland. Quassia is commonly found in areas adjacent to both temporary and permanent watercourses in locations up to 510 m altitude. The species occurs on lithosols, skeletal soils, loam soils,	The following REs (remnant only) are considered to constitute potential habitat at elevations below 510 m as they are identified as rainforest or vine forest vegetation communities: 12.3.1, 12.5.13, 12.8.3, 12.8.4, 12.11.1, 12.11.10, 12.12.1 and 12.12.16. In addition to the above REs, the portions of the following REs (i.e. sections that are located 200 m from the REs identified above) are considered potential	Not applicable	All areas occupied by the species. Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				sands, silts and sands with clay subsoils. Commonly associated tree species include *Corymbia citriodora, Eucalyptus propinqua, Eucalyptus acmenoides, Eucalyptus tereticornis, Eucalyptus intermedia, Eucalyptus siderophloia, Eucalyptus moluccana, Eucalyptus cloeziana* and *Eucalyptus fibrosa*.	habitat as they represent transitional zones between oven forest and rainforest/vine forest vegetation communities: 12.3.3, 12.3.11, 12.3.18, 12.5.1, 12.5.7, 12.8.24, 12.9-10.2, 12.9-10.3, 12.9-10.5, 12.9-10.12, 12.9-10.17, 12.9-10.18, 12.9-10.19, 12.9-10.23, 12.9-10.27, 12.9-10.28, 12.12.3, 12.12.5, 12.12.23, 12.12.24 and 12.12.25. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.* Note that areas identified as non-remnant or regrowth communities have not been included as mapped habitat as these areas do not meet the habitat requirements as identified within the conservation listing advice for *Samadera bidwillii*.		

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Rutaceae	*Leionema obtusifolium*	A Leionema	V	This species was not identified within any Project-associated field surveys including protected plant surveys. Database records describe two older records approximately 300 m south of the western section of the MNES study area dated 1964 and 1978 in what is now cleared habitat. The nearest recent record (2016) is located 5.5 km north of the Project. A review of the available literature has not revealed any important populations or critical habitat for this species in relation to the Project, However, given there are database records are in close proximity to the Project disturbance footprint and the species has a narrow range of occurrence there is potential for an 'important population' to be impacted by the Project. *Leionema obtusifolium* is known from a small area of south-east Queensland, in the Helidon and Ravensbourne areas. L*eionema obtusifolium* occurs in eucalypt forest, often with *Eucalyptus acmenoides* and *Corymbia trachyphloia*, on sandstone substrates	The following REs (remnant) are considered to constitute general habitat for the species as they are comprised of eucalypt forest on sandstone: 12.9-10.5, 12.9-10.5a, 12.9-10.17, 12.9-10.17d, 12.9-10.21. *Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the REs identified above are considered to constitute General habitat.* Note that areas identified as non-remnant or regrowth communities have not been included as mapped habitat as these areas do not meet the habitat requirements as identified within the conservation listing advice for *Leionema obtusifolium*.	Not applicable	All areas occupied by the species – Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Fabaceae	*Sophora fraseri*	Brush sophora	V	This species was not identified within any Project-associated field surveys including protected plant surveys within the alignment (Ecological 2019; EMM 2018; EMM 2019). Database records (i.e. AoLA) indicate the nearest occurrence exists 5 km north of the Project at the eastern end of the alignment (west of Rosewood) dated 1992. A very old record (1930) occurs 5 km south of Helidon at the western end of the alignment. A few scattered records exist to the north-west, west and south-west within a 50 km buffer of the Project disturbance footprint. *Sophora fraseri* grows in moist habitats, often in hilly terrain at altitudes from 60 to 660 m on shallow soils along rainforest margins in eucalypt forests or in large canopy gaps in closed forest communities.	The following REs (remnant vegetation), which are identified as either *rainforest*, or *vine thickets* are considered to constitute potential habitat when they are located within an altitude of 60 to 660 m ASL: 12.8.14, 12.8.14a, 12.8.14 x 1, 12.9-10.5d, 12.9-10.19, 12.11.3, 12.11.3a, 12.11.3b, 12.11.5, 12.11.15a. 12.11.5e, 12.11.5h, 12.11.5j, 12.11.5k, 12.11.25, 12.11.26, 12.11.27. In addition to the above REs, where the following remnant REs (identified as vine forest) occur within an altitude of 60 to 660 m, a 200 m buffer is to be placed around their perimeter where it intersects with any other RE type in order to include vine forest margins and transitional zones into the Potential habitat category: 12.3.1, 12.3.17, 12.11.1. Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat as these areas do not meet the habitat requirements as identified within the conservation listing advice for *Sophora fraseri*.	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Poaceae	*Arthraxon hispidus*	Hairy-joint grass	V	The species is mapped as may occur only in isolated portions of the disturbance footprint. The species was not identified within any Project-associated field surveys. There are no database records of this species within or adjacent to the MNES study area. Database records indicate the species has been recorded in the wider region surrounding the Project. The nearest database records are recent (post 2000) and located in the Toowoomba Range area approximately 14.5 km west of the Project disturbance footprint. Hairy-joint grass is found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps, as well as woodland. In southeast Queensland, Hairy-joint grass has also been recorded growing around freshwater springs on coastal foreshore dunes, in shaded small gullies, on creek banks, and on sandy alluvium in creek beds in open forests, and also with bog mosses in mound springs	The following REs (remnant and regrowth and springs) are considered to constitute potential habitat as they are ether wet eucalypt forest, swamps, woodland freshwater springs on coastal foreshore dunes, shaded small gullies or sandy alluvium or open forests: 12.2.1, 12.2.2, 12.2.3, 12.2.4, 12.3.1, 12.3.1a, 12.3.2, 12.3.16, 12.3.21, 12.5.13, 12.5.13a, 12.5.13b, 12.5.13c, 12.8.3, 12.8.4, 12.8.5, 12.8.8, 12.8.9, 12.8.13, 12.8.18, 12.8.21, 12.8.22, 129-10.15, 12.9-10.16, 12.11.1, 12.11.2, 12.11.3, 12.11.4, 12.11.10, 12.11.11, 12.11.12, 12.11.13, 12.12.1, 12.12.13, 12.12.15, 12.12.15a, 12.12.16, 12.12.17, 12.12.18. In addition, to capture areas of habitat located in proximity to watercourses as identified within the conservation listing advice, the following REs (remnant and regrowth) are considered to constitute potential habitat when they are located **within 100 m** (i.e. create a buffer, which will be used to "cleave" larger REs to create new polygons) of a watercourse (stream order 3 and above): 12.2.6, 12.2.11, 12.3.3, 12.3.7, 12.3.10, 12.3.12.	Not applicable	All areas occupied by the species. Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Family	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	Habitat modelling assumptions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
					Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.		
Brassicaceae	*Lepidium peregrinum*	Wandering pepper-cress	E	*Lepidium peregrinum* has not been identified as occurring within or near the MNES study area. Desktop assessments also indicate that there is an absence of specimen backed records within the region. *Lepidium peregrinum* grows in riparian open forest dominated by *Eucalyptus camaldulensis* and *Casuarina cunninghamiana* with a variably dense shrubby understorey of *Hymenanthera dentata, Bursaria spinosa, Acacia fimbriata, Acacia floribunda, Callistemon viminalis* and *Leptospermum brachyandrum*. This species is often most abundant in tussock grassland fringing riparian open forest (*Poa* sp. - *Lomandra longifolia* - *Paspalum dilatatum*), with some plants scrambling to a height of 2 m in thickets of *Hymenanthera*. It also occurred in shade under shrubs close to the creek bank, where most plants were small, about 30 cm in height.	The following REs (remnant) are considered to constitute potential habitat as they are identified as open forest communities that contain one or more of the following species *Eucalyptus camaldulensis, Casuarina cunninghamiana, Hymenanthera dentata, Bursaria spinosa, Acacia fimbriata, Acacia floribunda, Callistemon viminalis* and/or *Leptospermum brachyandrum*: 11.3.2b, 11.3.25, 113.25c, 11.3.25e and 11.3.27. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.* *Note: this species has been derived from the predictive PMST and has been included for completeness*	Not applicable	All areas occupied by the species - Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Table notes:

CE = Critically endangered E = Endangered V = Vulnerable C = Least concern

Table 5.2 Listed conservation significant fauna species habitat assumptions used to map areas of occurrence within the Project ecology study area

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	**Important habitat**	**Habitat critical to the survival of the species**
Birds	*Anthochaera phrygia*	Regent honeyeater	CE	The Regent honeyeater primarily inhabits inland slopes of the Great Dividing Range, in areas of low to moderate relief with moist, fertile soils. It is most commonly associated with box-ironbark eucalypt woodland and dry sclerophyll forest, but also inhabits riparian vegetation such as She oak (*Casuarina* spp.) where it feeds on needle-leaved mistletoe and occasionally breeds. It may occasionally utilise lowland coastal forest, which may act as a refuge when its usual habitat is affected by drought. Tree species with which the Regent honeyeater is most often associated include *Eucalyptus melliodora, Eucalyptus albens, Eucalyptus sideroxylon* away from the coast, and *Eucalyptus robusta* and *Corymbia citriodora* close to the coast. The species prefers mature large trees that produce more flowers, particularly those on fertile soils and in riparian areas (DES 2017). Not identified as occurring during the Project surveys. In SEQ, the Regent honeyeater irregularly and sparsely occurs as individuals or in pairs from the Cooloola Plains in the north to inland areas such as Dalby. It is known to breed in small numbers regularly to the west of Warwick in	The following REs (remnant) comprise vegetation communities containing the preferred tree species: *Eucalyptus melliodora, Eucalyptus albens, Eucalyptus sideroxylon, Eucalyptus robusta* and *Corymbia maculata,* and are considered as potential habitat: 12.2.7c, 12.3.3c, 12.3.3.d, 12.3.11, 12.3.4, 12.5.1, 12.5.7, 12.5.7a, 12.5.7c, 12.8.14, 12.8.16, 12.8.17, 12.8.24, 12.9-10.2, 12.9-10.5, 12.9-10.17, 12.9-10.27, 12.11.5, 12.11.6, 12.11.9, 12.11.25, 12.12.3, 12.12.5. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	Not applicable	Under the *National recovery plan for the Regent honeyeater (Anthochaera phrygia)* habitat critical to the survival of this species includes: ▪ Any breeding or foraging areas where the species is considered 'known or likely to occur' as indicated in Figure 1 of the plan The Project is located within the 'may occur' area only. Therefore, for this assessment any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*)

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	**Important habitat**	**Habitat critical to the survival of the species**
				Durikai State Forest (Garnett et al. 2011).			
Birds	*Botaurus poiciloptilus*	Australasian bittern	E	The species was not identified during Project surveys, although dry conditions at the time likely precluded the species from being present. The nearest database record is located 4.5 km to the north-west of the western extent of the Project disturbance footprint in the Lockyer Reserves area, however this record is older (pre-1980), does not have a recorded sighting date and is not spatially reliable. Location information refers only to the Lockyer Valley. This record has been generalised to protect the species and so may not reflect the actual occurrence location. There are a few similar records in the region to the north of the Project. The nearest dated records are from Lake Clarendon (north of Gatton) (2009 and 1990) located 6.5 km north of the Project disturbance footprint. The Australasian bittern occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats. It favours wetlands with tall, dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. The species favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. *Phragmites,*	The following mapped vegetation community /wetland areas are considered to constitute potential habitat: Lacustrine REs, lacustrine water bodies, palustrine REs, palustrine water bodies, riverine REs, riverine water bodies, estuarine REs, estuarine water bodies, marine REs and marine water bodies and wetland areas (outside of mapped REs). It is noted that due to the dry conditions during the survey period, some wetland areas may exist that were not detected during the surveys. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	Not applicable	Under the draft *National recovery plan for the Australasian bittern (Botaurus poiciloptilus)* (DoEE 2019) habitat critical to the survival of this species includes: ▪ Any wetland habitat where the species is ‘known or likely to occur’ (breeding or foraging habitat) within the indicative distribution map within the Draft recovery plan; and ▪ Any location with suitable habitat outside the above area that may be periodically occupied by Australasian Bittern. The MNES study area is currently outside of areas mapped within the recovery plan for this species. However, any wetland containing a specimen backed record is considered to constitute Critical habitat for this species.

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus) or cutting grass (Gahnia) growing over muddy or peaty substrate. This species occurs from Bundaberg in south-east Queensland south to Victoria and west into South Australia. There are few and sparse records from SEQ where the population is estimated to be 3 to 16 individuals (Garnett et al. 2011). In SEQ there are records from the Lockyer Valley associated with large permanent water bodies.			
Birds	*Calidris ferruginea*	Curlew sandpiper	CE	The nearest record (i.e. AoLA) of this species is from Lake Apex in Gatton located 2 km south of the Project disturbance footprint (the recorded date is uncertain based on the data associated with the record). The closest recent record (2001) of the species to the Project is from Lake Dyer (Bill Gunn Dam) in the Laidley area approximately 2 km south of the Project disturbance footprint (AoLA 2020). An older record (<1985) is located in the Plainlands area approximately 4 km north of the Project disturbance footprint. The Curlew sandpiper primarily occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded inland, though less often, including	The following mapped vegetation community /wetland areas are considered to constitute potential habitat: Lacustrine REs, lacustrine water bodies, palustrine REs, palustrine water bodies, riverine REs, riverine water bodies, estuarine REs, estuarine water bodies, marine REs and marine water bodies and wetland areas (outside of mapped REs). It is noted that due to the dry conditions during the survey period, some wetland areas may exist that were not detected during the surveys.	Not applicable	Species does not breed in the southern hemisphere. There is no definition of critical habitat available for the species. Therefore, for the purposes of this assessment, wetlands containing a specimen backed record are considered to constitute Critical habitat for this species.

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. Occasionally they are recorded around floodwaters. Species occurs around entire Australian coastline. There are scattered records from large permanent waterbodies in the Lockyer Valley but the majority of records from the region are coastal or from inshore islands in Moreton Bay.	*Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*		
Birds	*Hirundapus caudacutus*	White-throated needletail	M, V	DAWE habitat mapping for the species (2020) indicates the species is 'likely to occur' within the impact assessment area. Database records (i.e. AoLA) occur within the impact assessment area between Helidon and Laidley. This is an aerial species that uses all airspace for general hunting. The species breeds within the northern hemisphere summer. The species is thought to rarely land when in Australia (during the southern hemisphere summer). Night-time roosting sites are rarely recorded although the species has been observed roosting on trees in sclerophyll forest on a low ridgeline (Tarburton 1993). The species may occur across eastern Australia during the summer months.	All areas located outside of mapped remnant vegetation communities are potential habitat.	Under the *Referral guideline for 14 birds listed as migratory species under the EPBC Act (*DoE 2015) important habitat is described as non-breeding habitat – more often over wooded areas. As such all areas mapped as remnant vegetation are considered as 'important habitat'.	Not applicable

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Birds	*Erythrotriorchis radiatus*	Red goshawk	V	No individuals were observed during Project associated survey works, including targeted surveys for breeding places (nests) along the Project alignment (Ecological 2019). Database records indicate this species has been recorded within 50 km of the Project. It is noted available records (AoLA) have all been generalised in order to protect the species and so accurate locations have not been published. The nearest recent records include: a 2008 record located 3.7 km north-west of the western extent of the Project in the Lockyer Resources Reserve; 2002 and 2003 records located 5 km south in the Grantham area; a record from 2009 located 8 km north-east of the Project in the Rosewood area (although attached location data indicates Ipswich as the locality); and a 2012 record near Toowoomba (13 km south-west of the western extent of the Project) (AoLA 2020). The Red goshawk prefers extensive tracts of forest and woodland with a mosaic of vegetation types, large prey populations (birds), and permanent water. Habitat must be open enough for fast attack and manoeuvring in flight but provide cover for ambushing of prey. They avoid very dense and very open habitats. The species occupies large home ranges estimated to be up to 120 km^2 (females) and 200 km^2 (males).	The following REs (remnant) are considered to be potential habitat in the Little Liverpool Range and Helidon Hills area (i.e. small isolated fragments are unlikely to represent habitat): 12.2.4, 12.3.1, 12.3.1a, 12.3.2, 12.3.3, 12.3.3a, 12.3.3c, 12.3.4, 12.3.5, 12.3.7, 12.3.16, 12.3.17, 12.3.18, 12.3.19, 12.3.21, 12.5.1, 12.5.2x1, 12.5.5, 12.7.2, 12.8.1, 12.8.2, 12.8.8, 12.8.10, 12.8.11, 12.8.12, 12.8.23, 12.9-10.1, 12.9-10.1x1, 12.9-10.2, 12.9-10.4a, 12.9-10.5, 12.9-10.11, 12.9-10.14, 12.9-10.14a, 12.9-10.14b, 12.9-10.18, 12.9-10.18b, 12.9-10.29, 12.11.2, 12.11.3b, 12.11.6, 12.11.16, 12.11.16x1, 12.12.2, 12.12.2a, 12.12.15, 12.12.15a, 12.12.15b, 12.12.20 For the purposes of mapping habitat, grasslands/cleared areas were excluded as they are non-conducive to an ambush predator and not compatible with the foraging habitat of this species	Not applicable	The *National recovery plan for the Red goshawk (Erythrotriorchis radiatus)* (DERM 2012) describes habitat critical to the survival of this species comprises all required habitat elements including 'sites for nesting, food resources, water, shelter, essential travel routes, dispersal, buffer areas, and sites needed for the future recovery'. As such, for this assessment any potential habitat when it is contained within 1 km of a stream order 3 watercourse (or above) or a lacustrine or palustrine RE or Water body.

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				The vegetation types utilised by this species include eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins. Nests are in tall trees within 1 km of and often beside permanent water (e.g. river, swamp, pool), usually in fairly open, biologically rich forest or woodland. These habitats provide appropriate foraging conditions for the large Red goshawk, and a diversity and abundance of the medium to large birds taken as food. SEQ is likely the southern extent of the species distribution. There are scattered records from the Lockyer Valley and Toowoomba areas although recent intensive surveys targeting the species did not observe any individuals (Seaton 2014).	*Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*		
Birds	*Falco hypoleucos*	Grey falcon	V	The Grey falcon prefers timbered habitat in the arid to semi-arid zone. However, during drought younger individuals are believed to disperse towards the east coast (Marchant and Higgins 1993). Preferred habitats include open woodland, shrubland, grassland, and pastoral land on alluvial floodplains and flats, clay plains, sandy plains, dunefields and wetlands.	The following REs (remnant and regrowth) are considered to be potential habitat: 11.3.2, 11.3.3, 11.3.4, 11.3.5, 11.3.6, 11.3.7, 11.3.9, 11.3.10, 11.3.12, 11.3.13, 11.3.15, 11.3.16, 11.3.20, 11.3.21, 11.3.23, 11.3.24, 11.3.25, 11.3.27, 11.3.28, 11.3.30, 11.3.31, 11.3.32, 11.3.33, 11.3.34, 11.3.36, 11.3.38, 11.3.39, 11.4.2, 11.4.4, 11.4.5, 11.4.6, 11.4.10, 11.4.11,	No applicable	Any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				Grey falcons hunt from large standing trees in the landscape, with prey species primarily consisting of flocking, ground-feeding granivores (NSW Scientific Committee 2009). Nests of other falcons and corvids are renovated. Suitable nest trees are live and usually adjacent to watercourses or waterholes.	11.4.12, 11.4.13, 11.5.2, 11.5.6, 11.5.8, 11.5.9, 11.5.10, 11.5.11, 11.5.12, 11.5.13, 11.5.14, 11.5.17, 11.5.18, 12.3.3, 12.3.4, 12.3.5, 12.3.6, 12.3.7, 12.3.10, 12.3.11, 12.3.19, 12.5.2, 12.5.4, 12.5.8 and 12.5.10. In addition to the communities identified above, all non-remnant areas that are located within 1km of a Stream Order 3 or greater Watercourse are potential habitat for this species. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute general habitat*		
Birds	*Grantiella picta*	Painted honeyeater	V	Database records indicate this species does not occur within the MNES study area however has occurred within 50 km of the Project. There is a single nearby database record of uncertain provenance (no date) located 2 km south of the Project at Lake Apex, Gatton. Other database records occur largely to the west of the Project with the closest approximately 14 km west.	The following mapped remnant vegetation communities (REs) are considered potential habitat where they comprise the trees identified under the species habitat requirements: 12.3.3, 12.3.3a, 12.3.3b, 12.3.3d, 12.3.6, 12.3.7, 12.3.7a, 12.3.10, 12.3.11, 12.3.19, 12.5.1, 12.5.2, 12.5.6.	Not applicable	There is no definition of habitat critical to the survival of this species available. For the purposes of this assessment this habitat includes: ▪ Any breeding or foraging areas where the species is likely to occur.

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				The Painted honeyeater inhabits mistletoes in eucalypt forests/woodlands, **riparian** woodlands of black box and River red gum, box-ironbark-Yellow gum woodlands, *Acacia*-dominated woodlands, paperbarks, *Casuarinas*, *Callitris*, and trees on farmland or gardens. The species is often associated with following tree species: *Acacia harpophylla, Acacia homalophylla, Acacia pendula, Allocasuarina luehmannii, Eucalyptus largiflorens* and *Eucalyptus camaldulensis.* The Painted honeyeater prefers woodlands which contain a **higher number of mature trees**, as these host more mistletoes. It is more common in wider blocks of remnant woodland than in narrower strips, although it has been observed to breed in relatively narrow roadside strips when ample mistletoe fruit is available. The species population is sparsely dispersed across south-east Australia to north-west Queensland and eastern Northern Territory. There are a few scattered coastal records to the north and south of the Project, but the vast majority of records lie on the western slopes of the Great Dividing Range. Coastal records may be considered as vagrant individuals. Rowland (2012) notes non-breeding individuals are recorded occasionally from coastal areas along the eastern seaboard.	It is noted that Project is located well to the east of the species normal distribution and there are no identified important populations of the species *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*		Therefore, any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (excluding areas that fall outside of identified vegetation communities).

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Birds	*Lathamus discolor*	Swift parrot	E	This species was identified in woodland in the Rosewood area (5 km east of the Project disturbance footprint) during protected plant surveys in June 2018 for a related project (EMM 2018). There are a number of database records (i.e. AoLA) within 10 km of the disturbance footprint in the western portion of the alignment. This includes a 2000 record 5 km north of Gatton, a 2010 record in the murphy's Creek area (6 km north-west of the western extent of the Project), a 1998 record (6 km west of the of the western extent of the Project) and a record of uncertain provenance (i.e. no date and location generalised to 0.1 degree) located 7 km south of the same area. The Swift parrot inhabits dry sclerophyll eucalypt forests and woodlands. It occasionally occurs in wet sclerophyll forests. The Swift parrot predominantly forages within habitats that have been so significantly cleared that they are classified as **endangered** ecological communities. Nevertheless, they are recorded in a wide range of habitats including parklands in urban areas. These sites may be used opportunistically when resources elsewhere are scarce.	The following REs (remnant and HVR) are considered to be potential habitat as they may provide cover for the species but do not provide tree species that are identified as providing feeding resources: 12.3.5, 12.3.14, 12.5.1, 12.5.7, 12.5.7a, 12.5.7c, 12.8.24, 12.9-10.1x1, 12.9-10.2, 12.9-10.5, 12.9-10.5a, 12.9-10.7, 12.9-10.17, 12.9-10.17b, 12.9-10.27, 12.11.5, 12.11.25, 12.12.3, 12.12.5, 12.12.7. It is acknowledged that mature food trees are preferred foraging habitat, however, to capture non-mature foraging habitat, the following regrowth RE containing the food trees (i.e. *Eucalyptus tereticornis, Eucalyptus melliodora, Eucalyptus microcarpa, Eucalyptus robusta and Eucalyptus moluccana*) are considered to provide potential habitat: 12.2.7, 12.3.3, 12.3.4, 12.3.7, 12.3.11, 12.3.11a, 12.3.18, 12.3.19, 12.5.2, 12.5.2a, 12.5.2b, 12.5.2x1, 12.5.7b, 12.8.14, 12.8.16, 12.9-10.1, 12.9-10.3, 12.9-10.8, 12.9-10.11, 12.9-10.14, 12.9-10.18a, 12.11.6, 12.11.9, 12.11.14, 12.11.15,	The *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Saunders and Tzaros 2011) defines important habitat areas (sites used repeatedly between seasons or for prolonged periods) as "priority habitat" for this species. This includes the following: ▪ South-east Queensland: Brisbane - Bowman Park, Bardon; Rafting Creek Reserve Kenmore/Fig Tree Pocket. ▪ Toowoomba - Glen Lomond Park	The recovery plan does not define 'critical habitat' for this species. Therefore, for this assessment the following REs which contain food trees (i.e. *Eucalyptus tereticornis, Eucalyptus melliodora, Eucalyptus microcarpa, Eucalyptus robusta and Eucalyptus moluccana*) have been considered as 'foraging habitat critical to the survival of the species' where they occur in remnant (mature) patches: 12.2.7, 12.3.3, 12.3.4, 12.3.7, 12.3.11, 12.3.11a, 12.3.18, 12.3.19, 12.5.2, 12.5.2a, 12.5.2b, 12.5.2x1, 12.5.7b, 12.8.14, 12.8.16, 12.9-10.1, 12.9-10.3, 12.9-10.8, 12.9-10.11, 12.9-10.14, 12.9-10.18a, 12.11.6, 12.11.9, 12.11.14, 12.11.15, 12.11.18a, 12.12.2, 12.12.12, 12.12.23

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				This species primarily feeds on nectar and lerp in the canopy. The species is observed to prefer foraging in large mature trees (Saunders and Tzaros 2011). In south-east Queensland/northern NSW (coastal) the Swift parrot is known to preferentially forage on the following tree species: Forest red gum (*Eucalyptus tereticornis*), Yellow box (*E. melliodora*), Grey box (*E. microcarpa*) and Swamp mahogany (*E. robusta*) (Saunders and Tzaros 2011). Species also known to forage in Coastal grey box (*E. mollucana*) and Blackbutt (*E. pilularis*) in northern NSW (coastal) (Saunders and Heinsohn 2008) in which the species has been recorded during project surveys. Species identified foraging in *E. moluccana* during surveys for the Project. Swift parrot breeds only in Tasmania. The species is an uncommon but regular visitor to south-east Queensland in the winter months.	12.11.18a, 12.12.2, 12.12.12, 12.12.23 *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat*		

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Birds	*Rostratula australis*	Australian painted snipe	E	The species was not identified during Project surveys, although dry conditions in 2017 likely precluded the species potential presence. There are numerous database records within 50 km of the MNES study area. This includes several records within 5 km of the MNES study area. Australian painted snipe has been recorded 500 m south of the Project disturbance footprint at a site west of Gatton (1991 record) and 500 m north at a site near Helidon (1982 record). Recent records from nearby include 2013 records in the Helidon area (2 km and 4 km south of the Disturbance footprint), a 2012 record from the Gatton campus of the University of Queensland (2 km north), and records from the 2000s from Lake Dyer in the Laidley area (2.5 km south. The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and clay pans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* spp. or cane grass or sometimes *Melaleuca* spp. The Australian painted snipe sometimes utilises	The following mapped vegetation community /wetland areas are considered to constitute potential habitat: Lacustrine REs, lacustrine water bodies, palustrine REs, palustrine water bodies, riverine REs, riverine water bodies, estuarine REs, estuarine water bodies, marine REs and marine water bodies and wetland areas (outside of mapped REs). It is noted that due to the dry conditions during the survey period, some wetland areas and more transient habitats such as drainage channels, waterlogged communities may exist that were not detected during the survey. These areas have not been included within the predictive mapping layer where they fall outside of government datasets. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	Not applicable	Under the draft *National recovery plan for the Australian painted snipe (Rostratula australis*) (DotEE 2019) habitat critical to the survival of the species includes: ▪ Any habitat where the species is known or likely to occur (from map within the Plan). ▪ Any location outside the above area that may be periodically occupied by Australian Painted Snipe when conditions are favourable. The MNES study area occurs within areas mapped as known or likely to support the species as indicated by the Draft Recovery Plan Therefore all wetland areas identified as Potential habitat within the MNES study area constitute critical habitat for this species

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				areas that are lined with trees, or that have some scattered fallen or washed-up timber. Not identified during Project surveys. Scattered but regular records in SEQ including in the Lockyer Valley.			
Birds	*Turnix melanogaster*	Black-breasted button-quail	V	The Black-breasted button-quail primarily occurs in drier low closed forests, particularly semi-evergreen vine thicket (SEVT), low microphyll vine forest, araucarian microphyll vine forest and *Brachychiton* scrubs that may incorporate bottle trees (*Brachychiton* sp.), brigalow (*Acacia harpophylla)* and belah (*Casuarina cristata*). They may also be found in low thickets or woodlands with a dense understorey but little ground cover, typically dominated by *Acacia* spp. The *National Recovery Plan for the Black-breasted button quail Turnix melanogaster* (Mathieson and Smith 2009) identifies important populations in the following areas: Yarraman-Nanango, the Jimna-Conondale Range, the Great Sandy region, populations in Barakula State Forest and Palmgrove National Park, and all populations in New South Wales. These areas are not within the MNES study area.The species was not recorded during Project surveys. The species is known from the surrounding area and is very habitat specific.	The following is considered to be potential habitat: Any specimen backed records (buffered to a 1 km radius) that fall outside of areas identified as Critical habitat.	Not applicable	The recovery plan identifies habitat considered critical to the survival of the species as those communities described under the species habitat requirements (SEVT, dry rainforest communities and Brigalow scrubs). As such the following vegetation communities (REs) are Critical habitat: 11.2.3, 11.3.11, 11.3.11x1, 11.4.1, 11.5.15, 11.7.1x1, 11.8.3, 11.8.6, 11.8.13, 11.9.4, 11.9.4a, 11.9.4c, 11.9.8, 11.9.11, 11.10.2a, 11.10.8, 11.11.5, 11.11.14, 11.11.18, 11.11.21, 11.12.4, 11.12.21, 12.2.1, 12.2.2, 12.2.3, 12.2.4, 12.3.1, 12.3.2, 12.3.15, 12.5.6a, 12.5.13, 12.5.13a, 12.5.13b, 12.5.13c, 12.8.1, 12.8.3, 12.8.4, 12.8.5, 12.8.6, 12.8.7, 12.8.8, 12.8.9, 12.8.13, 12.8.18, 12.8.21, 12.8.22, 12.8.23, 12.9-10.15, 12.11.1, 12.11.2, 12.11.4, 12.11.6, 12.11.10, 12.11.11, 12.11.12, 12.11.13, 12.11.16, 12.12.1, 12.12.2, 12.12.6, 12.12.13, 12.12.16, 12.12.17, 12.12.18, 12.12.26.

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	**Important habitat**	**Habitat critical to the survival of the species**
Lobe-finned fishes	*Neoceratodus forsteri*	Australian lungfish	V	Database records (i.e. AoLA, Wildlife Online) indicate this species has been recorded within the MNES study area. There is a 2003 record from Lockyer Creek in the Gatton area (1.2 km north of the Project disturbance footprint). A second record from 1994 is from Lake Apex in Gatton (2 km south of the Project) and is very likely to be the result of human introduction to the lake. There are no records upstream of the Project. There are several further records on Lockyer Creek downstream of the Project although these are all older (pre-2000) until the confluence of the creek with the Wivenhoe Dam spillway (28 km north-east of the Project). The nearest recent record to the eastern extent of the Project (2017) is from the Bremer River located 10 km east of the Project in the Rosewood area. The Australian lungfish is endemic to Australia and restricted to south-eastern Queensland (Wager 1993). The species' natural distribution is the Mary, Burnett and Brisbane River systems and (possibly) the Pine River system (Kemp 2014). The species has been translocated to many other locations and translocated populations persist in the Coomera, Condamine, Albert and Logan Rivers (Kemp 2014).	The following is considered to constitute Potential habitat: Areas identified within the QLD waterway barrier works mapping as a risk impact of 3 or greater to select wet/inundated vegetation community (RE) areas (with a tolerance of within 20m of the waterway centreline). It is noted that the majority of the watercourses are ephemeral and do not contain permanent pools (at least in the vicinity of the Project). Waterways with a risk impact of less than 3 are unlikely to retain water for extended periods and are therefore unsuitable. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	Not applicable	Under the draft *National recovery plan for the Australian lungfish (Neoceratodus forsteri)* (DotEE 2017) habitat critical to the survival of the species includes: ▪ Any breeding or foraging habitat in areas where the species occurs (from the known distribution in Figure 4 within the Plan) ▪ Any newly discovered breeding or foraging locations. As such, the Bremer River and Lockyer Creek have been identified as Critical habitat for this species.

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				The Australian lungfish requires still or slow-flowing, shallow, vegetated pools with clear or turbid water in which to spawn and feed. The species is restricted to areas of permanent water and **cannot live in saline waters or migrate through sea water**. Emergent or submerged vegetation are essential for successful deposition of eggs and for providing refuges for juveniles.			
Mammals	*Dasyurus maculatus maculatus*	Spotted-tail quoll (southern subspecies)	E	There are a number of older database records in the region surrounding the MNES study area. The nearest record is from 1975 in the Rosewood area (located 7 km east of the Project disturbance footprint). There is a 1989 record from the Atkinson's Dam area located 16 km north of the MNES study area. There are other scattered records within 50 km of the MNES study area, although no post 1995 records are within 35 km of the Project disturbance footprint. In southeast Queensland, the Spotted-tailed quoll occurs coastally from Bundaberg to the border and inland to Monto and Stanthorpe. The Spotted-tailed quoll prefers mature wet forest habitat, especially in areas with rainfall in excess of 600 mm/year. Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable. This subspecies has been recorded from a wide range of habitats, including large tracts of vine forest, wet and dry sclerophyll forest and	Species has broad habitat requirements. The following vegetation communities (REs) are considered to constitute potential habitat (wet and dry sclerophyll forest and woodland) where they occur in areas that **receive at least 600 mm of rainfall annually**: 12.2.1, 12.2.2, 12.2.3, 12.2.4, 12.3.1, 12.3.1a, 12.3.2, 12.3.3, 12.3.11, 12.3.16, 12.3.19, 12.3.21, 12.5.1, 12.5.2, 12.5.13, 12.5.13a, 12.5.13b, 12.5.13c, 12.8.3, 12.8.4, 12.8.5, 12.8.8, 12.8.9, 12.8.13, 12.8.14, 12.8.18, 12.8.16, 12.8.19, 12.8.20, 12.8.21, 12.8.22, 12.8.26, 12.9-10.5, 12.9-10.7, 12.9-10.15, 12.9-10.16, 12.9-10.17, 12.9-10.25, 12.9-10.26, 12.11.1, 12.11.2, 12.11.4, 12.11.5, 12.11.9, 12.11.9x1, 12.11.10, 12.11.11, 12.11.12,	Not applicable	The *National recovery plan for the Spotted-tail quoll (Dasyurus maculatus)* (DEWLP 2016) identifies habitat critical to the survival of the species as including: ▪ large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey. As such, for the purposes of this assessment potential habitat that intersects with remnant vegetation patches that are equal to or greater than 200 ha in size are considered critical habitat for this species (taking into account the species extensive home range requirements).

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				woodland, and is often associated with *Eucalyptus camaldulensis* within the west of its range. Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves (DAWE 2020). The species requires large home ranges of several hundred hectares (DELWP 2016).	12.11.13, 12.11.15, 12.11.26, 12.12.1, 12.12.4, 12.12.9, 12.12.11, 12.12.12, 12.12.13, 12.12.14, 12.12.16, 12.12.17, 12.12.18, 12.12.22, 12.12.23. As part of the modelling process, open areas through which the species may move (transient) have not been captured as habitat as these areas do not contain the microhabitat features required for the survival of this species. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*		
Mammals	*Petauroides volans*	Greater glider	V	The species has not been recorded during Project-associated surveys and there are no database records (AoLA) within the MNES study area. The nearest database records are several (all from the 1990s) located in the Lockyer Forest Reserves. These are all between 5 km and 8 km north of the Project between Helidon and Gatton. The only record in the vicinity of the east of the Project is from the Rosewood area (1989) located 8 km north-east of the eastern extent of the Project (AoLA 2020). The next closest record is from the Purga area (1999) located 18 km east of the eastern	The species main habitat requirement is tall eucalypt woodland/open forests with large tree hollows for shelter. The following tall eucalypt woodland/open forest vegetation communities (REs) are considered to constitute potential habitat for the species in remnant habitat only (i.e. where large hollows are much more likely to occur):	Not applicable	There is no recognised definition of habitat critical to the survival of the species. For the purpose of this assessment critical habitat is considered to include: ▪ Any breeding or foraging habitat in areas where the species occurs Therefore, any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				extent of the Project. The nearest recent records are from 2010 and 2016 and located north of Toowoomba (16 km west and 22 km north-west of the Project). The Greater glider is an arboreal nocturnal marsupial restricted to **eucalypt forests and woodlands**. It is primarily folivorous, with a diet mostly comprising eucalypt leaves, and occasionally flowers. It is typically found in highest abundance in **taller, montane, moist eucalypt forests with relatively old trees and abundant hollows**. The distribution may be patchy even in suitable habitat. The Greater glider favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species. During the day Greater gliders shelter in tree hollows, with a selection for large hollows in large, old trees. Home ranges can be relatively small (1 to 4 ha). Within southeast Queensland, the Greater glider has been reported to feed upon the following species: *Eucalyptus latisinensis, Corymbia intermedia, Eucalyptus drepanophylla, Corymbia trachyphloia* with lesser amounts of *Melaleuca quinquenervia*.	12.2.7, 12.2.5, 12.2.6, 12.2.9, 12.3.5, 12.3.6, 12.3.7,12.3.11, 12.3.12, 12.3.14, 12.3.15, 12.5.1, 12.5.2, 12.5.3, 12.5.3a, 12.5.4, 12.5.5, 12.7.2, 12.8.1, 12.8.8a, 12.8.26, 12.9-10.1, 12.9-10.2, 12.9-10.3, 12.9-10.4, 12.9-10.5, 12.9-10.7a, 12.9-10.12, 12.9-10.20, 12.9-10.21, 12.11.14, 12.11.17, 12.11.20, 12.11.23, 12.11.24, 12.12.3, 12.12.6, 12.12.11, 12.12.12, 12.12.15, 12.12.21, 12.12.27. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*		(excluding areas that fall outside of identified vegetation communities).

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				The Greater glider occurs in eucalypt forests along the ranges and coastal plains of eastern Australia from central Victoria near Daylesford to the Windsor Tablelands in far northern Queensland.			
Mammals	*Petrogale penicillata*	Brush-tailed rock-wallaby	V	Database records indicate Brush-tailed rock-wallaby has been recorded adjacent to the Project disturbance footprint in the Helidon area, although this is an older record (1996). There are records (1997 and 2004) from the Lockyer Forest Reserves area further north (6 km and 10 km respectively from the Project) and a 2001 record 20 km north of Gatton. Other database records occur to the north of the Project in the Crows Nest area. To the west there are two older records (1973) from the Toowoomba Range. The species is also known from the Little Liverpool Range (ICC 2018) although the nearest record (2019) is 16 km south of the Project. This Brush-tailed rock-wallaby prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks. Rocky outcrops appear crucial to current habitat selection by rock-wallabies, however, vegetation structure and composition is also considered to be an important factor. In many parts of their range, rock-wallabies are closely associated with dense arboreal cover, especially fig trees.	The following remnant vegetation communities (REs) are considered potential habitat for the species where they comprise rocky landscapes (land zones 7, 8, 9-10, 11 and 12) and contain **very steep terrain** (i.e. terrain with **a 50% grade**) likely to provide suitable rocky refuge habitat as they have been identified as rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest: 12.7.2, 12.8.1, 12.8.3, 12.8.4, 12.8.5, 12.8.6, 12.8.7, 12.8.8, 12.8.9, 12.8.10, 12.8.13, 12.8.18, 12.8.19, 12.8.21, 12.8.22, 12.8.23, 12.9-10.3, 12.9-10.5, 12.9-10.6, 12.9-10.16, 12.9-10.19, 12.11.1, 12.11.2, 12.11.4, 12.11.6, 12.11.10, 12.11.11, 12.11.12, 12.11.13, 12.11.16, 12.12.1, 12.12.3, 12.12.4, 12.12.5, 12.12.6, 12.12.7, 12.12.8, 12.12.9, 12.12.11, 12.12.12, 12.12.13, 12.12.14,	Not applicable	The *National Recovery Plan for the Brush-tailed Rock-wallaby (Petrogale penicillata)* (Menkhorst and Hynes 2010) describes habitat critical to survival of the species as: ▪ rocky refuge habitat, foraging habitat and commuting routes between the two. Therefore, all areas mapped as potential habitat that intersect with remnant vegetation are considered to constitute critical habitat for the species.

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	**Important habitat**	**Habitat critical to the survival of the species**
				The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases, may provide some protection from predation. A range of vegetation types are associated with Brush-tailed rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest.	12.12.15, 12.12.16, 12.12.17, 12.12.18, 12.12.20, 12.12.21, 12.12.22, 12.12.23, 12.12.24, 12.12.25, 12.12.26, 12.12.27, 12.12.28. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*		
Mammals	*Phascolarctos cinereus*	Koala	V	There are numerous database records (i.e. AoLA and Wildlife Online) indicating Koala occurring within the MNES study area and surrounds. A single 2014 record occurs on the edge of the Project disturbance footprint 1.5 km west of Gatton. There are several records within the MNES study area from Helidon to Gatton. There are records throughout the surrounding area with clusters to the north of the Project in the Lockyer Forest Reserves area, to the immediate south of Helidon, and north of Calvert. Project associated surveys have recorded Koala scats through much of the alignment including within the Project disturbance footprint. Koalas naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by *Eucalyptus* species which can be broadly defined as any forest or	The following is considered to be potential habitat: Any specimen backed records (buffered to a 1 km radius) that fall outside of areas identified as Critical habitat (regardless of the level of clearing or development within the area).	Not applicable	Under the *EPBC Act referral guidelines for the vulnerable Koala* (DotE 2014) critical habitat for Koala can be characterised by areas containing mature and regrowth eucalypt communities. The species has broad habitat preferences that may encompass remnant and non-remnant habitat where suitable eucalypts occur. The following mapped vegetation communities (REs - both remnant and HVR) and unmapped riparian conduits (often featuring large eucalypts), and non-remnant paddock trees (where they facilitate koala movement across the landscape) are considered to constitute critical habitat: 12.3.2, 12.3.3, 12.3.3a, 12.3.3b, 12.3.3c, 12.3.3d, 12.3.4, 12.3.4a, 12.3.6, 12.3.7, 12.3.10, 12.3.11, 12.3.11a, 12.5.1,

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				woodland containing species that are known koala food trees, or shrubland with emergent food trees. Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands mostly dominated by *Eucalyptus* species. Its diet is restricted mainly to foliage of *Eucalyptus* spp.; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. The Koala is distributed along the east coast of Australia extending from Queensland to NSW. Home range size is dependent on the quality of habitat. In northern New South Wales home ranges of 37 ha are recorded (Goldingay and Dobner 2014). Koalas are generally sedentary with longer movements largely restricted to dispersing males which may extend several kilometres through lands cleared of vegetation (DAWE 2020).			12.5.2, 12.5.2x1, 12.5.3, 12.5.3a, 12.5.6, 12.8.14, 12.8.14a, 12.8.14x1, 12.8.16, 12.8.17, 12.9-10.2, 12.9-10.4, 12.9-10.7, 12.9-10.7a, 12.9-10.17, 12.9-10.17a, 12.9-10.17b, 12.9-10.17c, 12.9-10.17d, 12.11.5, 12.11.5a, 12.11.5e, 12.11.5h, 12.11.5j, 12.11.5k, 12.11.18, 12.11.18a, 12.12.12.
Mammals	*Potorous tridactylus tridactylus*	Long-nosed potoroo	V	Database records indicate this species does not occur within the MNES study area, however has occurred within 50 km of the Project. Species mapping on the SPRAT database shows the species or species habitat as 'may occur' only (DAWE 2020). The nearest database record is from Lockyer National Park (1990) located 7.5 km north of the Project. More recent records (post 2000) occur further	The following remnant vegetation communities (REs) are considered to constitute general habitat as they may comprise a suitable shrubby understorey: 12.2.4, 12.5.1, 12.5.6, 12.5.7, 12.8.1, 12.8.9, 12.8.14, 12.8.16, 12.8.17, 12.9-10.2, 12.9-10.14, 12.9-10.18, 12.9-10.18b, 12.11.6,	Not applicable	There is no recognised definition of habitat critical to the survival of the species. For the purpose of this assessment critical habitat is considered to include: ▪ Any breeding or foraging habitat in areas where the species occurs. Therefore, any specimen backed records (buffered to a 1 km radius) that fall within

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	**Important habitat**	**Habitat critical to the survival of the species**
				north in Crows Nest National Park and Deongwar State Forest (over 20 km north). There is also a 2015 record from the Toowoomba Range 17 km south-west of the Project. The Long-nosed potoroo (SE Mainland) is sparsely distributed along the coast and Great Dividing Range of southeast Queensland through NSW. There is limited information about the species habitat in Queensland and NSW. There is no consistent pattern to the habitat of the Long-nosed potoroo (SE Mainland); it can be found in wet eucalypt forests to coastal heaths and scrubs (Woinarski et al 2014). The species requires dense low vegetation and ground cover used for shelter and avoiding predators, although it may forage in more open areas. The species is known to utilise Lantana (*Lantana camara*) thickets for shelter (Lindemayer and Viggers 1994). The main factors would appear to be **access to some form of dense vegetation** for shelter and the presence of an abundant supply of fungi for food. In NSW and Queensland, the Long-nosed potoroo (SE Mainland) has scattered populations east of the Great Dividing Range extending from south-eastern Queensland through to NSW. Its range is largely coastal extending up to 800 m ASL and preferring areas with rainfall exceeding 760 mm.	12.11.9, 12.12.2, 12.12.20, 11.8.5, 11.8.15, 11.10.3, 11.10.6, 11.11.15 and 11.12.20. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute general habitat.*		areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
Mammals	*Pseudomys novaehollandiae*	New Holland mouse	V	The nearest database record is from 1982 taken from 1 km south of the Project in Gatton. The location data associated with this record is likely to be erroneous. More recent database records occur further north-west of this record in the Lockyer Forest Reserves (recorded in 2000) and Crow's Nest areas (2000 and 2012) (6 km and 17 km north of the Project respectively). The New Holland mouse has been found from coastal areas and up to 100 km inland on sandstone country. The species has been recorded from sea level up to around 900 m above sea level. Soil type may be an important indicator of suitability of habitat for the New Holland mouse, with deeper top soils and softer substrates being preferred for digging burrows. The habitat preference in southeast Queensland appears to be limited to tall dry open forest communities with an understorey of heath dominated by ***Xanthorrhoea*** species. In the Gatton and Laidley Shire area, the New Holland mouse has been recorded in the Blackfellow Creek and Helidon Hills areas and its habitat is associated with REs 12.5.1, 12.5.6, 12.8.14, 12.8.17, 12.8.19, 12.9-10.5 and 12.9-10.19 Upon its discovery in Queensland in 1997 at Crow's Nest (near Toowoomba), the species associated habitat appeared to differ substantially from that previously	The following remnant vegetation communities (REs) are considered to constitute potential habitat as they may comprise habitats in or near where the species has been recorded previously in SEQ including tall dry open forest communities with an understorey of heath dominated by *Xanthorrhoea* spp.: 12.5.1, 12.5.4, 12.5.6, 12.8.1, 12.8.14, 12.8.14a, 12.8.17, 12.8.19, 12.9-10.2, 12.9-10.3, 12.9-10.5, 12.9-10.19 and 12.11.5. It is noted that given the conservative mapping approach, an overestimation of habitat for this species is likely. For example, this species does not require a dense understory, however vegetation communities such as RE 12.5.1 have been included as part of the habitat for this species. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	Not applicable	There is no recognised definition of habitat critical to the survival of the species. For the purpose of this assessment critical habitat is considered to include: ▪ Any breeding or foraging habitat in areas where the species occurs. Therefore, any specimen backed records (buffered to a 1 km radius) that fall within areas mapped as potential habitat (refer previous column) constitute Habitat critical to the survival of the species (*excluding areas that fall outside of identified vegetation communities*).

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				known to support the species. Habitat was characterised by **dry open Eucalypt forest** at relatively high elevation (560 m). In addition, there was a **total lack of dense shrubs**, previously thought to be an essential habitat requirement of the species.			
Mammals	*Pteropus poliocephalus*	Grey-headed flying-fox	V	This species was detected during Project-associated surveys in the vicinity of a known roost site for the species in Gatton (1.5 km south of the Project disturbance footprint). The nearest database records are from Laidley (2009 and 2011) and are located within the MNES study area. There is a 2009 Gatton record from the approximate location of the Project survey observation. In the wider area there are a large number of records occurring in all directions around the Project, although these are largely concentrated to the east of the Project (from Ipswich to Brisbane) and to the west around Toowoomba (AoLA 2020).	The following is considered to constitute potential habitat: Any vegetation community (RE) located within a **50 km radius of a flying fox camp known to regularly support Grey headed flying-foxes**. Three camps (based on QLD monitoring data) that fit these criteria are known to occur at the following locations: ▪ Gatton, Amaroo Retirement Village (-27.56479; 152.27258) ▪ Murphy's Creek (-27.46163; 152.05932) ▪ Laidley, Laidley Plainlands Road (-27.620558; 152.394769).	Not applicable	The *draft National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus)* (DoEE 2017) does not define habitat critical to the survival of the species but recommends management of habitat associated with a number of tree species that occur in the area including *Eucalyptus tereticornis, E. crebra, E. siderophloia, Corymbia citriodora,* and *Grevillea robusta*. For the purpose of this assessment critical habitat is considered to include: 100 m buffer surrounding the camps listed below and all mature vegetation within 15 km from a flying fox camp known to regularly support the species: ▪ Gatton, Amaroo Retirement Village (-27.56479; 152.27258) ▪ Murphy's Creek (-27.46163; 152.05932) ▪ Laidley, Laidley Plainlands Road (-27.620558; 152.394769).

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				The Grey-headed flying-fox requires foraging resources and roosting sites. It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. It also feeds on commercial fruit crops and on introduced tree species in urban areas. The primary food source is blossom from *Eucalyptus* and related genera but in some areas it also utilises a wide range of rainforest fruits. None of the vegetation communities used by the Grey-headed flying-fox produce continuous foraging resources throughout the year. As a result, the species has adopted complex migration traits in response to ephemeral and patchy food resources. The Grey-headed flying-fox roosts in aggregations of various sizes on exposed branches. Roost sites are typically located near water, such as lakes, rivers or the coast. Roost vegetation includes rainforest patches, stands of *Melaleuca*, mangroves and riparian vegetation. Grey-headed flying-foxes commute daily to foraging areas, usually within 15 km of the day roost site. Grey-headed flying-foxes are capable of nightly flights of up to 50 km from their roost to different feeding areas as food resources change. At most times of			

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				the year there is a complete exodus from the colony site at dusk.			
Reptiles	*Anomalopus mackayi*	Five-clawed worm-skink	V	The species was not detected during Project-associated surveys. No database records of the species exist east of Toowoomba (AoLA 2020). DAWE habitat mapping for the species (2020) indicates MNES study area is outside of the present distribution of the species. The species shelters at the soil surface where moisture is sufficiently retained under decaying leaf litter, coarse woody debris or artificial debris. The species also lives in cavities in rotting tree bases, logs and in tussock bases. It is known to dig permanent tunnel-like burrows in loose, friable, humic soils in woodlands on slight basalt rises. On the Darling Downs, the species occurs in Bluegrass (Dichanthium sericeum) and/or Mitchell Grass dominated grasslands or mixed grasslands dominated by other grass species. In south-east Queensland, the species may occur in Eucalyptus tereticornis/ Eucalyptus camaldulensis/ Eucalyptus populnea grassy woodland/ open forests. In addition, the species has been recorded in areas characterised by Callitris sp. woodland. The species is not likely to be found in soils in which deep cracks do not	The following remnant vegetation communities (REs) from SEQ are considered to constitute potential habitat based on the presence of cracking clay soils: with grassland or grassy woodland featuring *Eucalyptus tereticornis or Eucalyptus populnea*: 12.3.10, 11.3.2, 11.3.4, 11.3.15, 11.3.21, 11.3.25, 11.4.4, 11.4.7, 11.4.11, 11.5.17, 11.9.12 Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the REs identified above are considered to constitute Potential habitat	The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011) describe 'important habitat' under Section 5 of the guidelines. All habitat within floodplains and riparian zones, uncultivated grassy headlands and strips between cropped areas, road reserves, travelling stock routes and remnant vegetation on vacant lands Habitat within the Known/Likely-to occur distribution of the species The MNES study area does not occur in any area where the species 'may' or is 'known/ likely' to occur' (Map 2 of the Guidelines). Therefore, no important habitat occurs in the Project area.	Not applicable

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	**Important habitat**	**Habitat critical to the survival of the species**
				form, such as hard-setting brown clays or sandy soils types). The species occurs in the Brigalow Belt and is not known to occur east of Toowoomba.			
Reptiles	*Delma torquata*	Collared delma	V	The **presence of rocks, logs, bark and other coarse woody debris**, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of the Collared delma microhabitat and is always present where the species occurs. Whilst Collared delmas are often found associated with small rocks, the presence of small rocks is not an essential habitat characteristic. On the Toowoomba range, the species is most often found in association with ***Eucalyptus crebra* open forest or woodland** with a grassy understorey containing *Lantana montevidensis*. An essential habitat component is the **penetration of sunlight to the ground**. Dense thickets of *Lantana camara* (i.e. reduces light penetration to the ground) has been identified as a threatening process to this species. The nearest database records are two from 1995 taken from the Lockyer Forest Reserves 4.5 km and 6 km north of the Project in the Helidon area. There is a 2019 record with a high spatial uncertainty located further north-west (16 km north of Gatton). Records	The following remnant vegetation communities (REs) from SEQ are considered as potential habitat for the species as they are identified as potentially rocky habitat on hillslopes that is open forest or woodland that contains *Eucalyptus crebra*: 12.3.3a, 12.5.1, 12.5.1e, 12.8.16, 12.8.17, 12.8.24, 12.9-10.2, 12.9-10.5, 12.9-10.7, 12.9-10.8, 12.9-10.18, 12.11.8, 12.11.14. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	The Draft Referral guidelines for the nationally listed Brigalow Belt reptiles (DSEWPaC 2011) describe 'important habitat' under Section 5 of the guidelines. The entire MNES study area has been identified as habitat in which Collared delma 'may occur' (Map 7 of the Guidelines). The Project is located adjacent to (south of) habitat in which the species is considered as 'known/likely' to occur. Given suitable habitat may occur 'important habitat' has been deemed as occurring in the Project area.	Not applicable

Class	Scientific name	Common name	EPBC Act	Habitat requirements that are the basis for the GIS assumptions (derived from references provided within the bibliography)	GIS habitat modelling instructions		
					Potential habitat	Important habitat	Habitat critical to the survival of the species
				associated with the population associated with the Toowoomba second range crossing project are approximately 11 km west of the western extent of the Project (Schell and Stark pers. obs. 2017).			
Reptiles	*Furina dunmalli*	Dunmall's snake	V	The species was not detected during Project-associated surveys. No database records of the species exist east of Toowoomba (AoLA 2020). DAWE habitat mapping for the species (2020) across the MNES study area indicate the species habitat may occur. Dunmall's snake has been found in a broad range of habitats, and is most often associated with forests and woodlands containing the following species: *Acacia harpophylla*, *Callitris glaucophylla, Allocasuarina luehmannii* and *Casuarina cristata* on black alluvial cracking clay and clay loams or sandstone derived soils. The species occurs in the Brigalow Belt and is not known to occur east of Toowoomba.	The following remnant vegetation communities (REs) from SEQ are considered as potential habitat for the species based on the presence of *Acacia harpophylla*, *Callitris glaucophylla, Allocasuarina luehmannii* and *Casuarina cristata*: 12.3.10a, 12.8.23, 12.8.26, 12.9-10.6. *Note: Any specimen backed records (buffered to a 1 km radius) that fall outside of the REs identified above are considered to constitute potential habitat.*	The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011) describe 'important habitat' under Section 5 of the guidelines. The entire MNES study area has been identified as habitat in which Dunmall's snake 'may occur' (Map 10 of the Guidelines). Therefore, no important habitat occurs in the Project as defined in guidelines.	Not applicable

Table notes:

E = Endangered V = Vulnerable

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Appendix A
Regional Ecosystem descriptions used in the predictive habitat mapping

HELIDON TO CALVERT ENVIRONMENTAL IMPACT STATEMENT

IR_1381

Table A1 Descriptions of Regional ecosystems (Remnant and Regrowth) within the MNES study area

Regional ecosystems (REs)	Description (REDD Version 11) – applicable to remnant and regrowth vegetation communities
12.3.2	*Eucalyptus grandis* +/- *E. microcorys*, *Lophostemon confertus* tall open forest with vine forest understorey ('wet sclerophyll'). Patches of *Eucalyptus pilularis* sometimes present especially in vicinity of sedimentary rocks (e.g. around Palmwoods). Fringing streams and in narrow gullies in high rainfall areas.
12.3.3	*Eucalyptus tereticornis* woodland. *Eucalyptus crebra* and *E. moluccana* are sometimes present and may be relatively abundant in places, especially on edges of plains and higher-level alluvium. Other species that may be present as scattered individuals or clumps include *Angophora subvelutina* or *A. floribunda, Corymbia clarksoniana, C. intermedia, C. tessellaris, Lophostemon suaveolens* and *E. melanophloia*. Occurs on Quaternary alluvial plains, terraces and fans where rainfall is usually less than 1,000 mm/y.
12.3.3d	*Eucalyptus moluccana* woodland. Other frequently occurring species include *Eucalyptus tereticornis*, *E. crebra*, *E. siderophloia*, *Corymbia citriodora* subsp. *variegata*, *Angophora leiocarpa* and *C. intermedia*. Occurs on margins of Quaternary alluvial plains often adjacent sedimentary geologies. May also occur on stranded Pleistocene river terraces. Floodplain (other than floodplain wetlands).
12.3.7	Narrow fringing woodland of *Eucalyptus tereticornis*, *Casuarina cunninghamiana* subsp. *cunninghamiana* +/- *Melaleuca viminalis*. Other species associated with this RE include *Melaleuca bracteata*, *M. trichostachya*, *M. linariifolia*. North of Brisbane *Waterhousea floribunda* commonly occurs and may at times dominate this RE. *Melaleuca fluviatilis* occurs in this RE in the north of the bioregion. *Lomandra hystrix* often present in stream beds. Occurs on fringing levees and banks of rivers and drainage lines of alluvial plains throughout the region.
12.3.8	Swamps with characteristic species including *Cyperus* spp., *Schoenoplectus* spp., *Philydrum lanuginosum*, *Eleocharis* spp., *Leersia hexandra*, *Cycnogeton procerus*, *Nymphaea* spp., *Nymphoides indica*, *Persicaria* spp., *Phragmites australis*, *Typha* spp. and a wide range of sedges grasses or forbs. Emergent *Melaleuca* spp. may sometimes occur. Occurs in freshwater swamps associated with floodplains.
12.3.10a	*Acacia harpophylla* open forest to woodland. Occurs on Quaternary alluvial plains where minor areas of cracking clay soils prevail.
12.3.18	*Melaleuca irbyana* low open forest or thicket. Emergent *Eucalyptus moluccana*, *E. crebra*, *E. tereticornis* or *Corymbia citriodora* subsp. variegata may be present. Occurs on Quaternary alluvial plains where drainage of soils is impeded.
12.3.19	*Eucalyptus moluccana* and/or *Eucalyptus tereticornis* and *E. crebra* open forest to woodland, with a sparse to mid-dense understorey of *Melaleuca irbyana*. Occurs on margins of Quaternary alluvial plains.
12.9-10.2	*Corymbia citriodora* subsp. variegata open forest or woodland usually with *Eucalyptus crebra*. Other species such as *Eucalyptus tereticornis*, *E. moluccana*, *E. acmenoides* and *E. siderophloia* may be present in scattered patches or in low densities. Understorey can be grassy or shrubby. Shrubby understorey of *Lophostemon confertus* (whipstick form) often present in northern parts of bioregion. Occurs on Cainozoic and Mesozoic sediments.
12.9-10.3	*Eucalyptus moluccana* open forest. Other canopy species include *Eucalyptus siderophloia* or *E. crebra*, *E. tereticornis* and *Corymbia citriodora* subsp. *variegata*. Understorey generally sparse but can become shrubby in absence of fire. Occurs on Cainozoic and Mesozoic sediments, especially shales. Prefers lower slopes.
12.9-10.5	Shrubby woodland complex. More widely distributed and abundant species include *Corymbia trachyphloia* subsp. *trachyphloia*, *C. citriodora* subsp. *variegata*, *Eucalyptus crebra*, *E. fibrosa* subsp. *fibrosa,* E. *major*, *Angophora leiocarpa*, *E. helidonica*. Understorey of sclerophyllous shrubs. Localised occurrences of *Eucalyptus baileyana*, *E. pilularis*, *Corymbia henryi*, *E. dura*, *E. decorticans* (extreme west of bioregion), *E. taurina*, *Angophora woodsiana*, *Lysicarpus angustifolius* and *Lophostemon confertus*. Tends to shrubland or monospecific woodland of species such as *Eucalyptus dura* on shallow lithosols. Occurs on quartzose sandstone scarps and crests.
12.9-10.5a	*Eucalyptus helidonica*, *Corymbia citriodora* subsp. *variegata* open forest +/- *C. trachyphloia* subsp. *trachyphloia*, *Eucalyptus fibrosa* subsp. *fibrosa*, *E. taurina*, *E. dura*, *E. baileyana*, *C. gummifera*, *Angophora woodsiana* and *Lysicarpus angustifolius*. Occurs on quartzose sandstone scarps and crests.
12.9-10.6	*Acacia harpophylla* open forest +/- *Casuarina cristata* and vine thicket species. Occurs on Cainozoic and Mesozoic sediments, especially fine-grained rocks.

Regional ecosystems (REs)	Description (REDD Version 11) – applicable to remnant and regrowth vegetation communities
12.9-10.7	*Eucalyptus crebra* +/- *E. tereticornis*, *Corymbia tessellaris*, *Angophora leiocarpa*, *E. melanophloia* woodland. Occurs on Cainozoic and Mesozoic sediments.
12.9-10.17a	*Lophostemon confertus* or *L. suaveolens* dominated open forest usually with emergent Eucalyptus and/or Corymbia species. Occurs in gullies and southern slopes on Cainozoic and Mesozoic sediments.
12.9-10.19	*Eucalyptus fibrosa* subsp. *fibrosa* woodland +/- *Corymbia citriodora* subsp. *variegata*, *E. acmenoides* or *E. portuensis*, *Angophora leiocarpa*, *E. major*. Understorey often sparse. Localised occurrences of *Eucalyptus sideroxylon*. Occurs on Cainozoic and Mesozoic sediments.
12.9-10.27	*Corymbia citriodora* subsp. *variegata*, *Eucalyptus crebra* and/or *E. moluccana*, *E. tereticornis* open forest with a sparse to mid-dense understorey of *Melaleuca irbyana*. Occurs on lower slopes and elevated flats with impeded drainage on Mesozoic sediments.

Table notes:

LC = Least concern NC = No concern at present OC = Of concern E = Endangered BD = Biodiversity

APPENDIX

J

Matters of National Environmental Significance Technical Report

Appendix B Species and Community Profiles

Contents

1 Flora species

1.1 Austral cornflower (*Rhaponticum australe*)

1.1.1 Status

EPBC Act – Vulnerable

1.1.2 Biology and ecology

1.1.2.1 Characteristic

Austral cornflower (*Rhaponticum australe)* is an erect perennial herb that grows to 60 cm in height (refer Photograph 1.1). The branches are slightly woolly. Leaves are oblanceolate and toothed to deeply pinnatifid. The lower leaves are up to 18 cm long and 6 cm wide, reducing in size up the stem. The upper leaves are few, small and nearly sessile (DotEE 2018).

Photograph 1.1 Austral cornflower (*Rhaponticum australe*)

Source: Howe (2016)

1.1.2.2 Known distribution

Austral cornflower is currently confined to Queensland. The species was known to previously occur in NSW and Victoria but is now presumed extinct in those states. The current distribution of *R. australe* extends from Allora (north of Warwick) to Callide (northwest of Biloela), Queensland (TSSC 2008) (refer Figure 1.1).

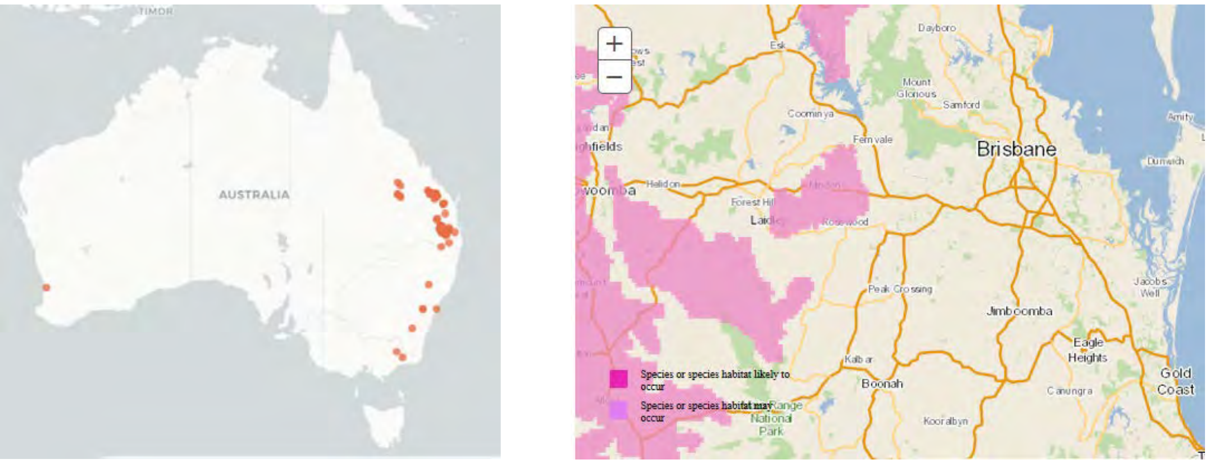

Figure 1.1 Distribution range of the Austral cornflower

Source: ALA (2018); DotEE 2018

1.1.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Rhaponticum australe* has been identified as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species occurs at the edge of the MNES study area to the east of Forest Hill along Old Laidley – Forest Hill Road which is located between Lagoon Creek and Laidley Creek. However, this occurrence was recorded more than 76 years ago, reducing the relevancy of the record. A second record, dated 1920 occurs at the township of Laidley between Railway Street and the Main Line rail corridor 160 m from the edge of the MNES study area (refer Figure 1.2). This record also has a large degree of spatial uncertainty which, along with the age of the record, reduces its potential accuracy and relevancy. The records appear to occur in areas where there is now urban development and infrastructure. Two other records occur to the north and south of Laidley however are also very old and have a large degree of spatial uncertainty. The nearest reliable and recent recorded less than 20 year ago (2006) occurs within the Long Grass Nature Refuge located approximately 20 km from the disturbance footprint. The record is located within the refuge between Spinach Creek Road and Ma Ma Creek. A record of similar age exists to the north of Dwyers Scrub Conservation Park adjacent to East Egypt Road. Several other records within a 50 km buffer of the Project disturbance footprint occur at Toowoomba Range (ALA 2020).

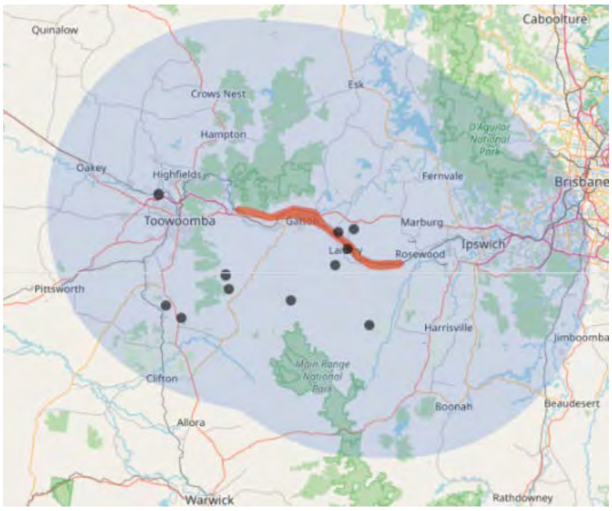

Figure 1.2 Distribution range of the Austral cornflower in relation to the Project

Source: ALA (2020)

1.1.2.4 Biology and reproduction

The flowering and fruiting period for Austral cornflower typically occurs in Spring, through to Autumn. The dead flowering stems can remain on the plant for several months after the seeds have dispersed (DotEE 2018).

1.1.3 Habitat

Austral cornflower typically grows in Eucalypt open forests, with grassy understory. This species often occurs on roadsides and on road reserves alongside Rhodes grass *(Chloris gayana*), Spear thistle *(Cirsium vulgare*), Queensland blue gum *(Eucalyptus tereticornis*) and Rough-barked apple *(Angophora floribunda*) on black clay soil derived from basalt. This species is considered to be a poor competitor and prefers habitat where grass competition has been reduced by fire, or other forms of disturbance. However, Austral cornflower is unlikely to benefit from disturbance that allows the development of a dense cover of exotic grasses (DotEE 2018).

1.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Austral cornflower:

- Woodland clearing for agriculture and urban development and livestock grazing has caused the local extinction of the Austral Cornflower in Victoria and NSW
- The invasion of exotic grass species into Austral Cornflower habitat may also threaten extant populations. As most populations occur on highly disturbed roadsides, they must compete with introduced species (DotEE 2018).

1.1.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

1.1.6 References

Atlas of Living Australia (ALA). (2020). Distribution of *Rhaponticum australe,* Available from: https://spatial.ala.org.au/. [Accessed: 7 May 2020].

EMM Consulting (2019). Ecology Pre-clearance Report - Geotechnical investigation sites. Report prepared for ARTC, June 2019.

Eco logical Australia (2019). Calvert to Kagaru Pre-clearance Survey Report Extended Geotechnical Program – Inland Rail. Report prepared for ARTC, 11 June 2019.

Howe, M. Atlas of Living Australia (2016). *Rhaponticum australe*. [image] [online] Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2908264#gallery [Accessed 13 August 2018].

Department of the Environment and Energy (2018). *Rhaponticum australe* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=23949 [Accessed 27 August 2018].

Queensland Herbarium (2007). Department of Science, Information Technology and Innovation (DSITI), Queensland Government.

Threatened Species Scientific Committee (2008). *Approved Conservation Advice for Rhaponticum australe (Austral cornflower)*.

1.2 Austral toadflax (*Thesium australe*)

1.2.1 Status

EPBC Act – Vulnerable

1.2.2 Biology and ecology

1.2.2.1 Characteristic

Austral toadflax is a small, straggling herb growing to 40 cm tall. Leaves are pale green to yellow-green, somewhat succulent, 1 to 4 cm long and 0.5 to 1.5 mm wide (refer Photograph 1.2). Flowers are minute and white, emerging where the leaves meet the stems and appearing in spring. The fruit is small and nut-like, developing in summer. This species is often hidden amongst grasses and herbs (OEH 2017).

Photograph 1.2 Austral toadflax (*Thesium australe*)

Source: Hunter (2018)

1.2.2.2 Known distribution

Austral toadflax occurs in NSW, the Australian Capital Territory (ACT), Queensland and Victoria (refer Figure 1.3). It is also known from eastern Asia. Its current distribution is sporadic but widespread, occurring between the Bunya Mountains in southeast Queensland to northeast Victoria and as far inland as the southern, central and northern tablelands in NSW and the Toowoomba region (ALA 2018; OEH 2017; DotEE 2018).

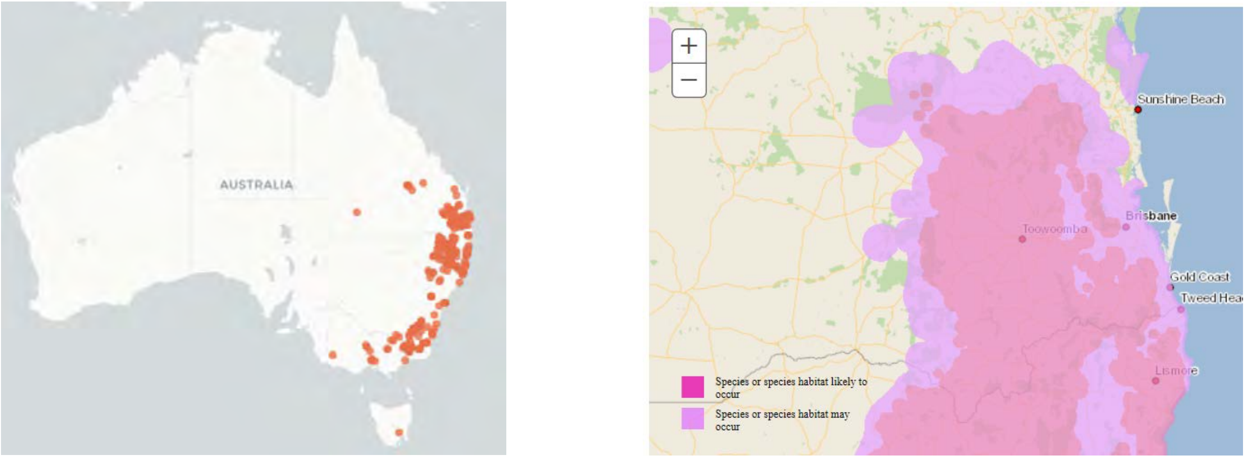

Figure 1.3 **Distribution range of the Austral toadflax**

Source: ALA (2018); DotEE (2018)

1.2.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). The species has been recorded (i.e. AoLA) within the MNES study area (dated 1985) from two records located between the Project disturbance footprint and the University of Queensland Gatton Campus (approximately 500 m from the footprint) on lands that appear to be currently used for irrigated agriculture. There are 1930 records from the Forest Hill area (4.5 km north of the Project) and Ipswich area (23 km east), and a 1993 record from Harrisville (21 km south-east). The nearest recent records (2009 and 2012) are from the Toowoomba Range (10 km south-west of the western extent of the Project). Other records within a 50 km buffer of the Project include the Toowoomba area, D'Aguilar National Park, Main Range National Park and Crows Nest with records ranging between 1930 to 2009 (refer Figure 1.4) (ALA 2020).

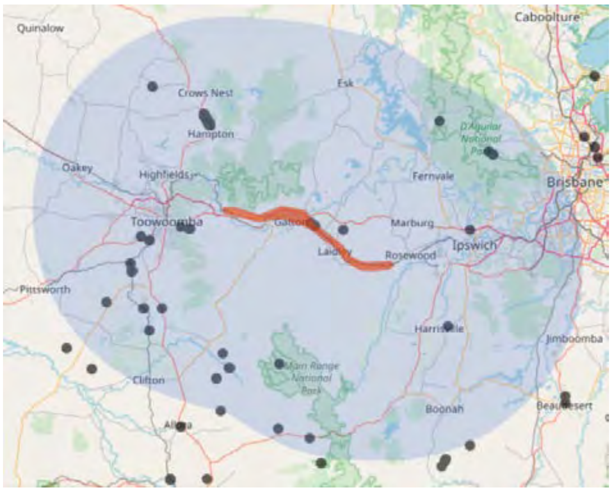

Figure 1.4 **Distribution range of the Austral toadflax in relation to the Project**

Source: ALA (2020)

1.2.2.4 Biology and reproduction

Austral toadflax flowers and fruits throughout the year on the coast, and during summer at higher altitudes. In subalpine and tableland climates, the species dies back to rootstock during winter and resprouts in spring. In coastal areas, the species persists all year round and may live for longer than two years. The existence of buds near the soil surface allows the species to resprout after disturbance. It is observed to germinate well after fire; however, fire is not essential for germination (DotEE 2018).

1.2.3 Habitat

It is semi-parasitic on the roots of certain grass species; occurring in shrubland, grassland or woodland, often on damp sites. It occurs in subtropical, temperate and subalpine climates over a wide range of altitudes. It occurs on soils derived from sedimentary, igneous and metamorphic geology on a range of soils, including black clay loams to yellow podzolics and peaty loams (Leigh et al.1984; Hunter et al. 1999; Cohn 2004).

Vegetation types include open grassy heath dominated by Swamp myrtle (*Leptospermum myrtifolium*), Small-fruit hakea (*Hakea microcarpa*), Alpine bottlebrush (*Callistemon sieberi*), Woolly grevillea (*Grevillea lanigera*), Coral heath (*Epacris microphylla*) and *Poa* spp.; Kangaroo grass grassland surrounded by Eucalypt woodland; and grassland dominated by Barbed-wire grass (*Cymbopogon refractus*) (DotEE 2018).

1.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Austral toadflax:

- Lack of fire/disturbance
- Existing and intensified grazing by livestock, native herbivores and feral herbivores
- Residential, infrastructure and agricultural development
- Weed invasion
- Infrastructure (road and rail) maintenance (DotEE 2018; NSW OEH 2018).

1.2.5 Threat abatement/recovery plans

The following Threat Abatement/Recovery Plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2016). *Threat abatement plan for competition and land degradation by rabbits*. Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016**. In effect under the EPBC Act from 07-Jan-2017.

1.2.6 Summary of threat abatement/recovery plan

Threats identified in the threat abatement plan for competition and land degradation by rabbit relevant to Austral toadflax include:

- Preventing plant regeneration
- Overgrazing and general damage to plant species
- Reversing the normal processes of plant succession
- Altering ecological communities and changing soil structure and nutrient cycling, leading to significant erosion.

Relevant management strategies relevant to Austral toadflax include population control. Following the plan, control efforts should be:

- targeted to protect sites where rabbits pose the greatest threat to biodiversity
- undertaken in a strategic manner to take advantage of the environmental conditions and other complementary activities
- monitored to ensure that objectives are met and allow management options to be adapted to changing circumstances.

1.2.7 References

Atlas of Living Australia (ALA). (2020). Distribution of *Thesium australe,* Available from: https://spatial.ala.org.au/. [Accessed: 7 May 2020].

EMM Consulting (2019). Ecology Pre-clearance Report - Geotechnical investigation sites. Report prepared for ARTC, June 2019.

Eco logical Australia (2019). Calvert to Kagaru Pre-clearance Survey Report Extended Geotechnical Program – Inland Rail. Report prepared for ARTC, 11 June 2019.

Hunter, J. Atlas of Living Australia (2018). *Thesium australe*. [image] [online] Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2891975#gallery [Accessed 13 September 2019].

Department of the Environment and Energy (2018). *Thesium australe* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=23949 [Accessed 27 August 2018].

Office of Environment and Heritage, NSW (2018). Austral toadflax. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10802 [Accessed 30 August 2018].

1.3 Bluegrass (*Dichanthium setosum*)

1.3.1 Status

EPBC Act – Vulnerable

1.3.2 Biology and ecology

1.3.2.1 Characteristic

Bluegrass (*Dichanthium setosum*) is an upright perennial grass less than 1 m tall. It has mostly hairless leaves about 2 to 3 mm wide. The flowers are densely hairy and clustered together along a stalk in a cylinder shape (refer Photograph 1.3) and appear mostly during summer. The species can form pure swards or occur as scattered clumps (DotEE 2018).

Photograph 1.3 Bluegrass (*Dichanthium setosum*)

Source: Rose (2013)

1.3.2.2 Known distribution

Bluegrass occurs on the northern tablelands in the Saumarez area, west of Armidale, and 18 to 30 km east of Guyra. It has been found sparsely on the northwestern slopes, central western slopes and north-western plains of NSW, extending west to Narrabri. In Queensland, it has been documented to occur from the Leichhardt, Morton, North Kennedy and Port Curtis regions (refer Figure 1.5). This species occurs in the Mistake Range, in Main Range National Park, and possibly in Glen Rock Regional Park, adjacent to the Main Range National Park (DotEE 2018).

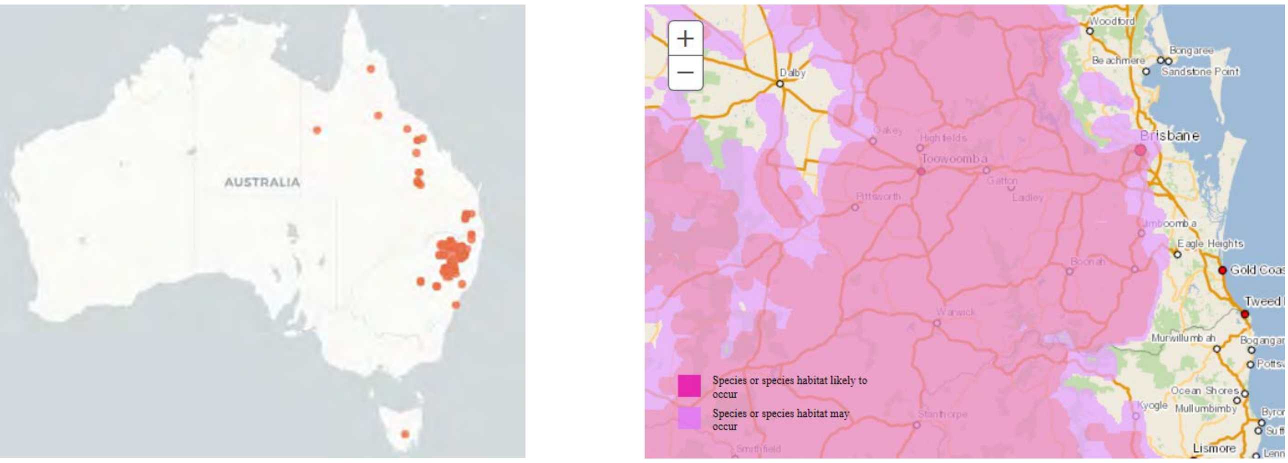

Figure 1.5 **Distribution range of bluegrass**

Source: ALA (2018), DotEE (2018)

1.3.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Dichanthium setosum* has been identified as potentially occurring within the MNES study area however, database records (i.e. AoLA) did not indicate records within the Project footprint or the study area. The nearest database records exist approximately 13 km north-west of the disturbance footprint and are less than 30 years old (1996). The location of these two records occur between the Main Line rail corridor and Lorikeet Lane to the east of Highfields at Toowoomba Range. A second occurrence record exists a similar distance from the Project at Picnic Point, Toowoomba from 2009 (refer Figure 1.6). The record details 30 individuals at the location which was on the edge of an escarpment on basalt amongst grassy woodland. Other records exist within the vicinity between Toowoomba and Crows Nest whilst another record exists approximately 40 km north-east of the Project at Lake Wivenhoe.

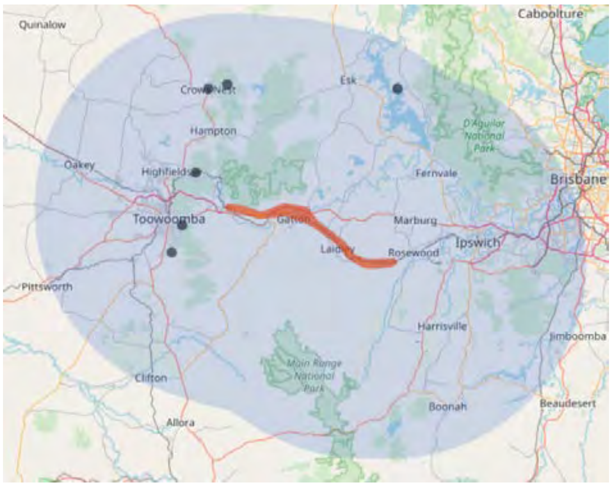

Figure 1.6 **Distribution range of bluegrass in relation to the Project**

Source: ALA (2020)

1.3.2.4 Biology and reproduction

Bluegrass is a warm season perennial grass, that commences growing in springs, flowers in summer and becomes dormant in late autumn. A fire frequency of greater than five years has been recommended for the species (DotEE 2019).

1.3.3 Habitat

Bluegrass is associated with heavy basaltic black soils and stony red-brown hard setting loam with clay subsoil and is found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The extent to which this species tolerates disturbance is unknown. The species occurs within the Border Rivers−Gwydir, Central West, Namoi, Northern Rivers (NSW), South East and Fitzroy (Queensland) Natural Resources Management regions (DotEE 2018; DEC 2005).

1.3.4 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Department of Environment, Climate Change and Water NSW (2010). *National Recovery Plan for White Box - Yellow* Box - *Blakely's Red Gum Grassy Woodland and Derived Native Grassland*. Department of Environment, Climate Change and Water NSW, Sydney. Available from: . **http://www.environment.gov.au/biodiversity/threatened/recovery-plans/white-box-yellow-box-blakelys-red-gum-grassy-woodland-and-derived-native-grassland-national**. In effect under the EPBC Act from 22-Mar-2013.

The following threat abatement plans have been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=1192&ReportProfileID=10221**. In effect under the BC Act 2016.
- Department of the Environment and Energy (2016). *Threat abatement plan for competition and land* degradation *by rabbits*. Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016**. In effect under the EPBC Act from 07-Jan-2017.

1.3.5 Summary of threat abatement/recovery plan

The *Saving our Species* conservation strategy for *Dichanthium setosum* identifies five priority management sites in NSW:

- East of Guyra in Armidale Regional LGA
- Apex Lookout in Armidale Regional LGA
- Armidale Arboretum in Armidale Regional LGA
- Saumarez North TSR in Armidale Regional, Uralla LGA
- Wallabadah Cemetery in Liverpool Plains LGA.

Threats identified at the management sites include:

- Heavy grazing by domestic stock
- Invasion by introduced grasses such as Coolatai, African Lovegrass, Phalaris and ox-eye daisy.
- Inappropriate slashing regimes
- Distribution and recruitment/germination issues due to low species numbers.

Management activities to protect *Dichanthium setosum* at the *Saving our Species* sites are:

- Appropriate grazing management, including excluding stock from the sites September-December or following rainfall events and fencing off areas of high density plants from stock

- Targeted, physical removal of invasive grasses
- Track species abundance/condition over time, including assessment of reproduction/seed set, weed encroachment and grazing/mowing or slashing impacts.
- Liaise with local government to ensure awareness of the species' locations and importance
- Collect and sow seeds during the species' flowering/seeding period to enhance recruitment and population density.

Threats identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Land use and management change
- Agricultural and horticultural development
- Public Infrastructure upgrades in travelling stock routes (TSRs)
- Firewood collection and 'tidying up'
- Changed fire regimes
- Increase in soil nutrients and use of chemicals
- Mowing and slashing regimes
- Revegetation management
- Weed invasion
- Climate change
- Salinity
- Acid soils
- Declining tree health and regeneration
- Increased grazing pressure from invasive herbivores
- Disease – *Phytophthora cinnamomi*
- Collection and removal of native flora.

Recovery actions identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Collect baseline data on the locations, quality and management regimes of remnant sites
- Extent and condition mapping
- Component species surveys
- Protection of existing habitat in priority areas including on private land
- Engagement with the community, particularly where remnants occur on private land to provide information on appropriate management and with Aboriginal communities.

Summary of baseline information actions undertaken to date:

- The establishment of databases comprising of information on CMN members (land managers with Box-Gum Grassy Woodland remnants), remnant locations, composition of flora and fauna species and remnant condition from surveys of CMN members' sites and other sites
- Minimum condition criteria and assessment method developed to assist land managers in identification of listed ecological communities
- Development of regional models using remote sensing
- Mapping of Box-Gum Grassy Woodland extent
- Surveys conducted during research programs through various organisations.

Threats identified in the threat abatement plan for competition and land degradation by rabbit relevant to *Dichanthium setosum* include:

- Preventing plant regeneration
- Overgrazing and general damage to plant species
- Reversing the normal processes of plant succession
- Altering ecological communities and changing soil structure and nutrient cycling, leading to significant erosion.

Management strategies relevant to *Dichanthium setosum* in the threat abatement plan for rabbits include population control. Following the plan, control efforts should be:

- targeted to protect sites where rabbits pose the greatest threat to biodiversity
- undertaken in a strategic manner to take advantage of the environmental conditions and other complementary activities
- monitored to ensure that objectives are met and allow management options to be adapted to changing circumstances.

1.3.6 References

Atlas of Living Australia (2018). Distribution of *Dichanthium setosum,* viewed 24 August 2018, available: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2905357.

EMM Consulting (2019). Ecology Pre-clearance Report - Geotechnical investigation sites. Report prepared for ARTC, June 2019.

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Harry, R. (2013). *Dichanthium setosum*. [image] [online] Available from: https://www.flickr.com/photos/73840284@N04/8675273472. [13 September 2019]

Department of the Environment and Energy (2018). *Dichanthium setosum* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=78349 [Accessed 30 August 2018].

Department of Environment and Conservation New South Wales (2005), *Dichanthium setosum* – Profile, viewed 11 December 2007, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10221.

1.4 Four-tailed grevillea (*Grevillea quadricauda*)

1.4.1 Status

EPBC Act – Vulnerable

1.4.2 Biology and ecology

1.4.2.1 Characteristic

Grevillea quadricauda (Four-tailed grevillea) is a dense shrub growing up to 2 m high. The leaves are elliptical to oblong. There is a fine covering of hairs on both sides of the leaves, and on the stems and flowers (refer Photograph 1.4).

Photograph 1.4 **Four-tailed grevillea (*Grevillea quadricauda*)**

Source: Bennett (2017)

1.4.2.2 Known distribution

Grevillea quadricauda occurs in northeast NSW and near Toowoomba, in southeast Queensland. In Queensland, the species has been recorded from Helidon Hills, in the Murphy's Creek area, near Toowoomba. The species occurs in the Northern Rivers (NSW) and Condamine (Queensland) Natural Resource Management regions (refer Figure 1.7).

The distribution of this species overlaps with the following EPBC Act-listed White Box-Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland threatened ecological community (ALA 2018).

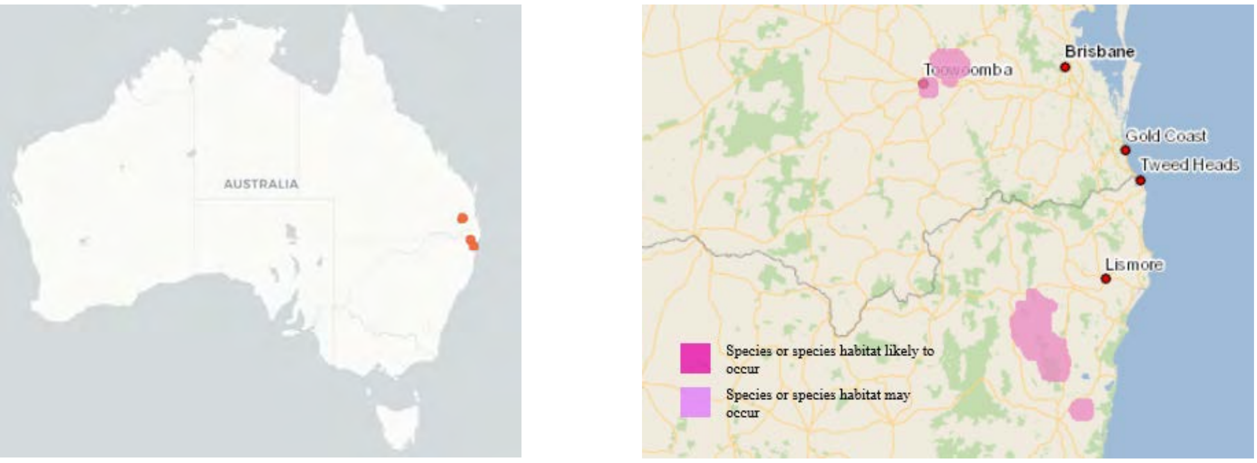

Figure 1.7 **Distribution range of the Four-tailed grevillea**

Source: ALA (2018); DotEE 2018

1.4.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment where this species occurs (Ecological 2019a; 2019b; EMM 2019). Database records (i.e. AoLA) indicate that this species occurs within the MNES study area to the north of the alignment between Helidon and Gatton the south-eastern corner of the Lockyer Resource Reserves area. These records are recent (2018) and note up to 28 individual plants at the location. Other records exist within 500 m of the MNES study area to the south of the alignment at Helidon dated 1992. A number of other records exist to the north associated with the Lockyer Forest Reserves area. Other records occur to the south-west between the Disturbance footprint and Toowoomba dated between 1968 to 2000 (refer Figure 1.8). The species only occurs in north-east NSW and the Helidon-Toowoomba area (DEWHA 2008). DAWE (2020) mapping indicates the species as likely to occur in the Helidon Hills area including habitat intersected by the Project footprint.

Figure 1.8 **Distribution range of the Four-tailed grevilia in relation to the Project**

Source: ALA (2020)

1.4.2.4 Biology and reproduction

Flowering in this species occurs between August to September, appearing as groups of two to four pink or red flowers with green bases. New growth often appears pink or purple, especially on the tips of the leaves (DECC 2005; Makinson 2000).

1.4.3 Habitat

The species occurs on gravelly loam soils or in sandy soils. It inhabits the understorey of dry Sclerophyll forest or Eucalypt woodland, usually along creeks or drainage lines. Associated plant communities include creek line forest dominated by Turpentine (*Syncarpia glommulifera*) and Brush-box (*Lophostemon confertus*) (Makinson 2000; NSW NPWS 2005; Olde and Marriott 1995).

1.4.4 Threatening processes

The following have been identified as potentially threatening processes to the Four-tailed grevillea:

- Timber harvesting activities
- Frequent fires
- Road widening and maintenance activities
- Clearing for development and agriculture
- Invasive weeds (DECC 2005).

1.4.5 Threat abatement/recovery plan

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10375**. In effect under the BC Act 2016.

No threat abatement plan has been identified as being relevant for this species.

1.4.6 Summary of threat abatement/recovery plan

The *Saving our Species* conservation strategy for *Grevillea quadricauda* identifies two priority management sites:

- Mount Belmore State Forest in Clarence Valley, Richmond Valley LGA
- Mount Neville Nature Reserve in Richmond Valley LGA
- The conservation strategy identifies too-frequent fire as the key threat to this species.

Management activities to protect this species at the sites are:

- Maintain appropriate fire regime for the species/community by liaising with neighbouring landholders to ensure planned fires are not too frequent and burning occurs under appropriate conditions
- Monitor species recruitment and adult condition post fire events
- Track species abundance and condition over time through plant counts.

1.4.7 References

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Olde, PM and Marriott, NR (1995), The Grevillea Book, Volume 2, Kenthurst, NSW, Kangaroo Press.

Queensland Land and Resources Tribunal (2005), Hearing of applications and objections, file number AML95/03 ENO96/03, viewed 11 March 2015.

1.5 Lloyd's native olive *(Notelaea lloydii)*

1.5.1 Status

EPBC Act – Vulnerable

1.5.2 Biology and ecology

1.5.2.1 Characteristic

Lloyd's native olive (*Notelaea lloydii*) is a shrub that grows to an approximate height of 1 to 4 m, with many smooth, pale grey barked stems arising from the base. Stems are approximately 2 to 4 cm in diameter and leaves are hairless and leathery with a linear or slight sickle-shape. Leaves are approximately 7 to 14 cm long and 2 to 5.5 mm wide with the main veins clearly visible, and slightly raised on the upper leaf surface (refer Photograph 1.5). Up to 20 flowers grow in groups in leaf axils (upper angle between leaf stalk and stem) (DotEE 2018).

Photograph 1.5 Lloyd's native olive (*Notelaea lloydii*)

Source: Hochen (2017)

1.5.2.2 Known distribution

Lloyd's native olive is endemic to southeast Queensland between Mt Brisbane, near Somerset Dam, to just south of Beaudesert and as far west as Mt Berryman near Laidley, a range of approximately 120 km, occupying an area of approximately 37,000 km ^{2}. The species is known to occur on well-drained slopes in Boonah and Ipswich areas (Halford 1998; Leiper et al. 2008) (refer Figure 1.9).

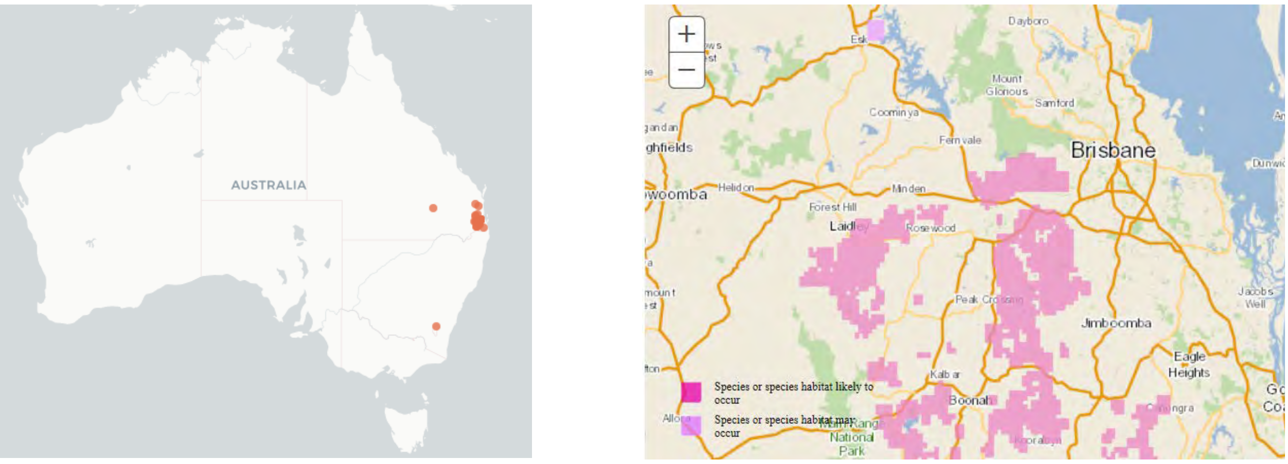

Figure 1.9 **Distribution range of Lloyd's native olive**

Source: ALA (2018)

1.5.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). Database records (i.e. AoLA & Wildlife Online) indicate that Lloyd's olive has been identified within the Project disturbance footprint to the east of Laidley dated from 2018. Another record from 1990 exists further east near Grandchester within the MNES study area (refer Figure 4.1). The nearest record outside of the MNES study area exists to the north of Grandchester within approximately 5 km of the alignment and dated 2011 (refer Figure 1.10)

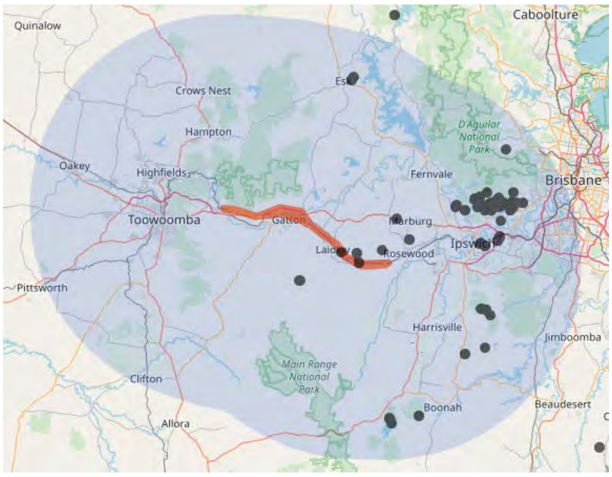

Figure 1.10 **Distribution range of Lloyd's native olive in relation to the Project**

Source: ALA (2020)

1.5.2.4 Biology and reproduction

Lloyd's native olive flowers from autumn to winter with flower size roughly 3 mm. Flowers are generally a pale yellow or cream colour, on stalks 3 to 5 mm long. The fruits are spherical to oval shape approximately 5 to 8 mm in diameter and consist of a hard-woody nut with a thin, dark blue skin that is also known to be reddish to black in colour when ripe (DEWHA 2008; Leiper et al. 2008).

1.5.3 Habitat

The species is known to occur in open eucalypt forest, often near the margins of vine thickets, vine forests and softwood scrub. It is usually found on stony, shallow and rocky soils derived from sandstone or acid volcanic rocks, often on steep slopes, or near drainage lines. It is recorded from three national parks in the area, but most populations occur on road verges or freehold land. Most known populations occur in areas of remnant vegetation as defined under the *Vegetation Management Act 1999* (QLD) and are therefore currently protected from broad-scale clearing. This species occurs within the southeast Queensland Natural Resource Management region (Halford 1998).

1.5.4 Threatening processes

The following have been identified as potentially threatening processes to the Lloyd's native olive:

- Habitat fragmentation for urban development and associated infrastructure (Halford 1998)
- Inappropriate fire regimes. Mature Lloyd's native olive are known to withstand fire, but frequent fire kills juvenile plants and seedlings, supressing species recruitment (Halford 1998)
- Road maintenance
- Weed invasion, notably Lantana (*Lantana camara).* Lantana is known to invade forest margins, smothering plants, reducing light and increasing fuel loads
- Some remnant populations occur on roadsides and therefore are potentially affected by road widening and maintenance (DEWHA 2008).

1.5.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species (DotEE 2018).

1.5.6 References

Atlas of Living Australia (2020), Occurrence records map, accessed 23 August 2018, available https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2902777.

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Department of the Environment and Energy (2018). *Notelaea lloydii* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 23 August 2018

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Hochen, C. (2017). Lloyd's native olive (*Notelaea lloydii*). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=6dbc9307-84e7-451f-b87c-22940b54a7db. [16 September 2019]

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1.6 Lychnothamnus barbatus

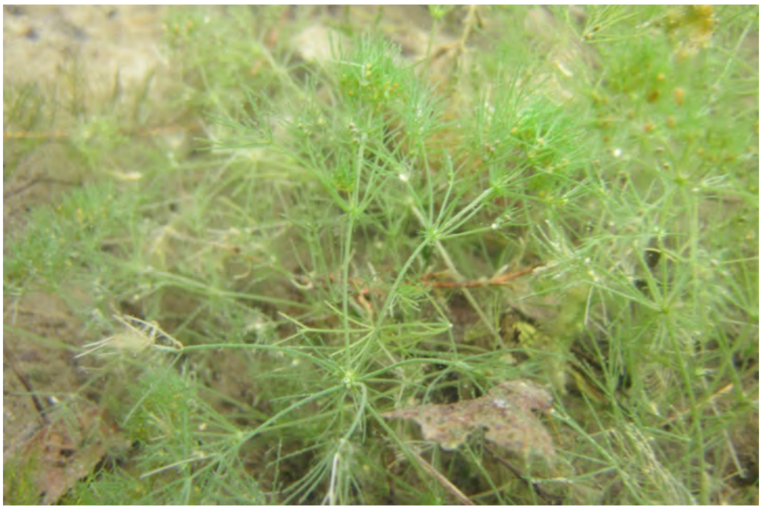
1.6.1 Status

EPBC Act – Endangered

1.6.2 Biology and ecology

1.6.2.1 Characteristic

Lychnothamnus barbatus is a submerged aquatic freshwater macrophyte (algae). Plants usually grow 12 to 25 cm high, are greyish-green, somewhat branched and moderately encrusted. There are 7 to 10 branchlets in a whorl that are up to 5 cm long, with 3 to 5 segments and an elongated primary segment (refer Photograph 1.6). Spores are orange-brown to dark brown, usually 1 to 1.15 mm long and 0.6 to 0.72 mm wide, with 8 to 10 prominent ridges (DotEE 2018).



Photograph 1.6 ***Lychnothamnus barbatus***

Source: Skawinski (2017)

1.6.2.2 Known distribution

Lychnothamnus barbatus has been collected from sites in Europe, India, China, Australia and Papua New Guinea. In Australia, it is only found in Queensland in Warrill Creek, west of Boonah and Wallace Creek, south of Boonah (Balevicius 2001; McCourt et al. 1999; Osborne 1989; Queensland Herbarium 2009).

Figure 1.11 **Distribution range of the *L. barbatus***

Source: DotEE (2018)

1.6.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Lychnothamnus barbatus* has been identified as potentially occurring within the MNES study area. The nearest database record occurs approximately 27 km south-east of the Project however this record is dated 1960. This record is likely associated with Warrill Creek at this location as the species requires clear flowing water. The most recent record is located approximately 45 km south-east of the Project. Details of this record indicate the species was found at Wallace Creek at the end of The Head Road off the Boonah – Rathdowney Road in pools more than one metre in depth and shaded by melaleuca and casuarina species. The Project intersects a number of waterways so whilst specimen backed records do not exist within the vicinity of the Project suitable habitat may occur for the species.

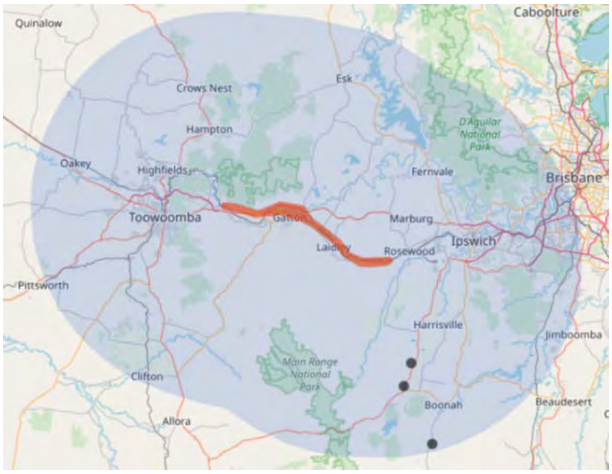


Figure 1.12 **Distribution range of the *L. barbatus* in relation to the Project**

Source: ALA (2020)

1.6.2.4 Biology and reproduction

Lychnothamnus barbatus is an alga, and hence does not flower or fruit but instead releases spores into the water it inhabits. Not much else is known about its reproduction (DotEE 2018).

1.6.3 Habitat

Lychnothamnus barbatus occurs in clear flowing water (DotEE 2018).

1.6.4 Threatening processes

The following have been identified as potentially threatening processes to *L. barbatus*:

- Increased turbidity from land clearance upstream of its habitat
- Sand or gravel extraction
- Reduced stream flows from increased water extraction
- Changes in flow conditions from impoundments
- Eutrophication (DotEE 2018).

1.6.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

1.6.6 References

Atlas of Living Australia (2020). *Lychnothamnus barbatus.* Australia's species Database, Available from: https://bie.ala.org.au/species/https://id.biodiversity.org.au/name/apni/195128 [Accessed 26 August 2020].

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1.7 Mt. Berryman phebalium (*Phebalium distans*)

1.7.1 Status

EPBC Act – Critically Endangered

1.7.2 Biology and ecology

1.7.2.1 Characteristic

The Mt. Berryman phebalium (*Phebalium distans*) is a small tree growing to 8 m and up to 15 cm in diameter. The bark is grey mottled and distinctly rough and flaky with a strong aromatic scent (DotEE 2018). The flowers of the species are cream, and the leaves are 1.5 to 5 cm long, 2 to 10 mm wide, and more or less smooth on the upper surface (refer Photograph 1.7). The leaves have a variable shape and are usually linear to oblong or lance-shaped but may also be elliptic to broad-elliptic or egg-shaped (DotEE 2018; Forster 2003).

Photograph 1.7 Mt. Berryman phebalium (*Phebalium distans*)

Source: Simmonds (2003)

1.7.2.2 Known distribution

Mt. Berryman phebalium is endemic to south-eastern Queensland, where it is currently known from ten populations at three locations. Five of the known populations are in close proximity at Mt. Berryman (Lockyer Valley Regional Council), four are near Kingaroy (South Burnett Regional Council) and the tenth at Mt Walla, near Coalstoun Lakes (North Burnett Regional Council) (DotEE 2018) (refer Figure 1.13).

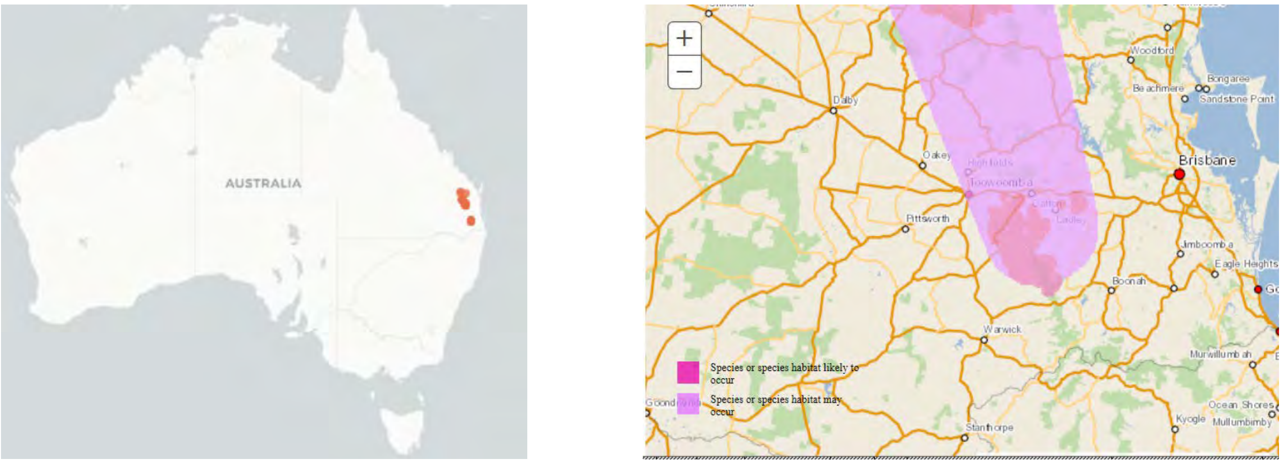

Figure 1.13 **Distribution range of Mt. Berryman phebalium**

Source: ALA (2018), DotEE (2018)

1.7.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Phebalium distans* has been identified from database searches as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species occurs approximately 13 km south of the Project in a cluster surrounding the Berlin Scrub Nature Refuge (refer Figure 1.14). Of the five known populations this is the only one identified within a 50 km buffer of the Project and there are no other records associated with the Project.

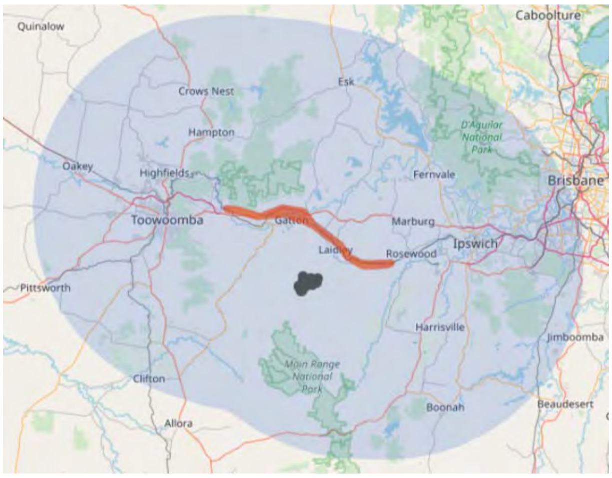

Figure 1.14 **Distribution range of Mt. Berryman phebalium in relation to the Project**

Source: ALA (2020)

1.7.2.4 Biology and reproduction

Mt. Berryman phebalium generally flowers during spring, however, opportunistic flowering can occur at other times after moderate falls of rain. Fruiting generally occurs during late summer and early autumn. The capsular fruit produce small seeds that have a limited dispersal ability. Plants become sexually mature after they reach 1 to 2 m in height. The plant has not been recorded as reproducing vegetatively, and monitoring indicates that this species does not readily reproduce under disturbance regimes (DEWHA 2008).

1.7.3 Habitat

Mt. Berryman phebalium is found in semi-evergreen vine thicket on red volcanic soils, or in communities adjacent to this vegetation type in small groups or as solitary specimens. Soils were the species occurs range from red-brown earths to brown clays (derived from siltstone and mudstones), and lithosols to shallow, gravelly krasnozems (very dark brown loam), derived from the Main Range Volcanics of the Tertiary period (DotEE 2018; DEWHA 2008;).

1.7.4 Threatening processes

The following have been identified as potentially threatening processes to the Mt. Berryman phebalium:

- Habitat fragmentation and clearing
- Road works and roadside maintenance
- Irregular fire events
- Weed invasion
- Drift of agricultural chemicals
- Erosion and soil compaction due to human traffic
- Dumping of rubbish (DotEE 2018).

1.7.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

1.7.6 References

Atlas of Living Australia (2020). *Phebalium distans.* Australia's species Databas, available: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2908293 [Accessed 26 August 2020].

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1.8 Ooline (*Cadellia pentastylis*)

1.8.1 Status

EPBC Act – Vulnerable

1.8.2 Biology and ecology

1.8.2.1 Characteristic

Ooline (*Cadellia pentastylis*) is a very slow growing medium-sized tree that generally grows to 10 m high, but occasionally reaching 25 m. The species has glossy leaves with prominent venation that grow to 2 to 4 cm long, 1.5 to 2 cm wide and with broadly rounded tips (refer Photograph 1.8). The upper sides of the leaves are darker and glossier than the undersides. The white flowers are small and usually single. Each flower produces a cluster of up to five rounded, brown berries, 3 to 5 mm wide (OEH 2018).

Photograph 1.8 Ooline (*Cadellia pentastylis*)

Source: McMaster (2008)

1.8.2.2 Known distribution

Ooline occurs on the northwest slopes of NSW and in central and southern Queensland (refer Figure 1.15). The species occurs between 23° S to 30° S within the 500 mm and 750 mm rainfall isohyets. In Queensland, Ooline occurs from Balcomba (west of Rockhampton) south to the NSW border and west to near Blackall. In NSW, Ooline occurs in an area bounded by Gunnedah, Tenterfield and the Queensland border (ALA 2018; Leigh and Briggs 1992).

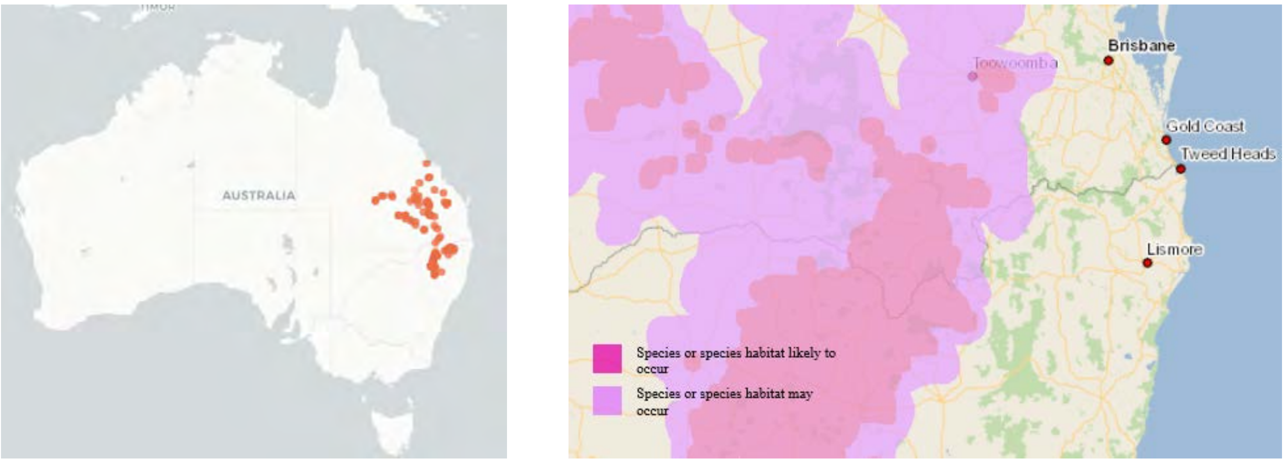

Figure 1.15 **Distribution range of Ooline**

Source: ALA (2018); DotEE (2018)

1.8.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Cadellia pentastylis* has been identified from database searches as potentially occurring within the MNES study area. The only record within a 50 km buffer of the Disturbance footprint is from the Sherwood Arboretum in Brisbane dated 2020 (refer Figure 1.16). The nearest reliable record is dated 1993 located west of Sundown National Park more than 100 km from the Disturbance footprint. No other reliable database records exist within the vicinity of the Project.

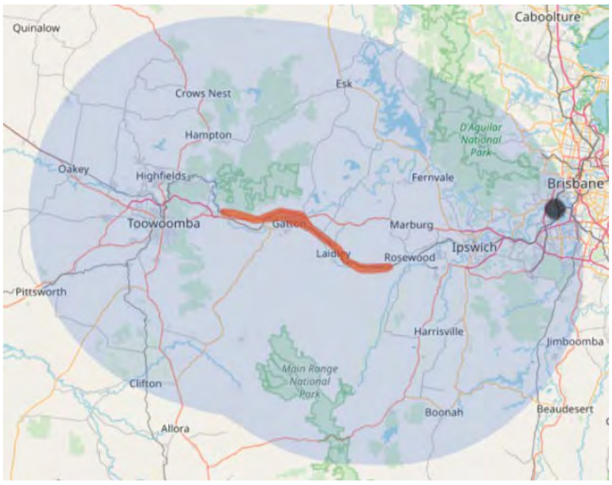

Figure 1.16 **Distribution range of Ooline in relation to the Project**

Source: ALA (2020)

1.8.2.4 Biology and reproduction

Ooline flowers sporadically. In NSW, flowering events occur in spring and summer and, in Queensland, flowering events occur in spring through to autumn. Fruits are borne in November to December and seed dispersal is probably via passive fall or birds. Seeds have shown a high rate of infertility at all sites. Fire germination is known to occur and vegetative growth has been noted as being very common. Ooline also has the capacity to re-sprout from rootstock and coppice vigorously from stumps. (Benson 1993; Harden 1991; QDNR 2000).

1.8.3 Habitat

Ooline grows in semi-evergreen vine thickets and sclerophyll vegetation on undulating terrain of various geology, including sandstone, conglomerate and claystone (Harden 1991). Soils generally have low to medium nutrient content and are normally associated with upper and mid-slopes in the landscape. The altitude is generally 300 to 460 m above sea level, with some stands known to occur at 600 m above sea level. Ooline has also been found in semi-evergreen vine thickets, pure stands and Brigalow-Belah communities (Benson 1993; Harden 1991).

1.8.4 Threatening processes

The following have been identified as potentially threatening processes to Ooline:

- Fragmentation and vegetation clearing
- Logging of tree species, such as Callitris, within habitat may have affected the microclimate in the understorey of the forest
- Inbreeding depression
- Inappropriate fire regimes
- Intensive grazing (i.e. where stocking is high, seedling recruitment is likely to be hampered due to grazing and soil compaction)
- Risk of local extinction due to small, scattered populations
- Tunnel and sheet erosion
- Low seed viability
- Damage to roadside populations during roadworks (OEH 2017).

1.8.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10118. In effect under the BC Act 2016.

The following threat abatement plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2017). *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs* (Sus scrofa) (2017). Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017. In effect under the EPBC Act from 18-Mar-2017.

1.8.6 Summary of threat abatement/recovery plan

Cadellia pentastylis is assigned as a keep-watch species under the NSW *Saving our Species Program* as relatively large populations are known to occur within reserves (Kaputar National Park and Gamillaroi Nature Reserve) where current management is sufficient to ensure their long-term security. State wide conservation actions identified for this species include:

- Identify a minimum of 3 sites for implementation of recovery actions and monitoring. The Tenterfield Creek population is of particular interest for investigated
- Establish a comprehensive monitoring program to determine the effectiveness of recovery actions
- Control feral goats in areas of known and potential habitat
- Erect signage and fence off roadside remnants to protect from damage and disturbance from road works and traffic

- Liaise with landholders where the species occurs on private property to discuss issues, management actions and fencing
- Restrict areas of habitat with fencing to protect from stock and feral animal grazing
- Improve knowledge and understanding of the species' ecology by conducting research into population dynamics, genetic variation and establishment & recruitment of new individuals
- Ensure the Threatened Species Hazard Reduction List is updated with the requirements of this species and that personnel undertaking burns are educated on its presence and fire sensitivity
- Provide advice and assistance for the removal of weed species within Ooline habitat such as Tiger Pear
- Review/include operational guidelines for Mt Kaputar NP and Gamilaroi NR Reserve Fire Management Strategies to protect this species from fire.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pics (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

1.8.7 References

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Department of the Environment and Energy (2018). *Cadellia pentastylis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=9828. Accessed Sun, 26 August 2018

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1.9 Paspalidium grandispiculatum

1.9.1 Status

EPBC Act – Vulnerable

1.9.2 Biology and ecology

1.9.2.1 Characteristic

Paspalidium grandispiculatum is a perennial, tufted grass growing to 1.5 m tall. This species can be distinguished from other Australian *Paspalidium* by its large spikelets, 3.5 to 4.8 mm long and characteristic woody culms arising from robust woody rhizomes. Most other species of *Paspalidium* possess contracted rootstocks and sometimes contracted rhizomes but not the elongated rhizomes of *P. grandispiculatum* (Sharp and Symon 2002; Simon 1982; DEWHA 2008).

Leaf sheaths are glabrous, ligules ciliate, about 1 mm long. Leaf blades are linear, flat or incurved, to 10 cm long and 4 mm wide, glabrous or minutely scabrous (Simon 1982; Sharp and Simon 2002; Jacobs 2004).

1.9.2.2 Known distribution

Paspalidium grandispiculatum occurs in southeast Queensland in a band from Canungra to Kingaroy, over a range of approximately 100 km (refer Figure 1.17). It occurs in mixed Eucalypt forest, mixed open forest, and native pasture occurring as a result of land clearing for agriculture. One population has been recorded in the Crows Nest Falls National Park, the remaining known populations occur in either state forest or on private land (Boyes 2001; DotEE 2018; Halford 1998; Queensland Herbarium 2008).

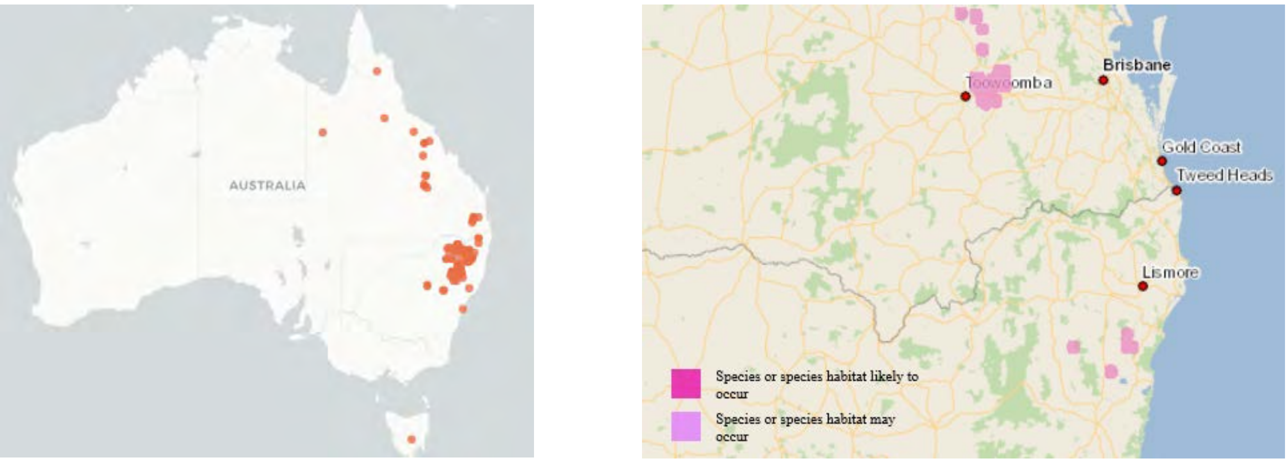

Figure 1.17 Distribution range of *P. grandispiculatum*

Source: ALA (2018); DotEE (2018)

1.9.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment where this species occurs (Ecological 2019a; 2019b; EMM 2019). *Paspalidium grandispiculatum* was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment where this species occurs (Ecological 2019a; 2019b; EMM 2019). Database records (i.e. AoLA) indicate this species occurs to the north of the western end of the Project disturbance footprint in the Lockyer Forest Reserves area. The nearest records dated 1997 and 1998 are located 3.3 km and 2.8 km (respectively) from the Project disturbance footprint. A 2016 record is located 4.2 km north of the Project. All other records (from 1980 to 2013) in the vicinity of the Project occur further north throughout the Lockyer Forest Reserves and Crows Nest area (refer Figure 1.18).

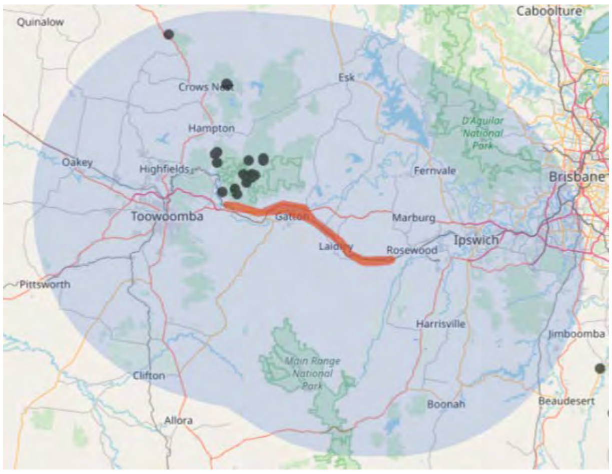

Figure 1.18 Distribution range of *P. grandispiculatum* in relation to the Project

Source: ALA (2020)

1.9.2.4 Biology and reproduction

Paspalidium grandispiculatum is a perennial grass which is assumed to be wind-pollinated. The flowering and fruiting period of *P. grandispiculatum* is from January to May for Queensland populations. The above ground parts of the grass are killed by fire, but it is capable of regenerating from the rhizome. No information is available on seed viability or longevity (DotEE 2018; Halford 1998; NSW OEH 2013; Queensland CRA/RFA Steering Committee 1998).

1.9.3 Habitat

In Queensland, *P. grandispiculatum* occurs in mixed forest with *Corymbia citriodora*, on sub-coastal, old loamy and sandy plains (RE 12.5.1) and mixed open forest often with *Corymbia trachyphloia*, *Corymbia citriodora, Eucalyptus crebra*, and *Eucalyptus fibrosa* (RE 12.9-10.5). Records also exist from native pastures and open-forest communities. The soil type where *P. grandispiculatum* is generally found are shallow with a sandy texture, dark in colour, well drained and derived from sandstone rocks (DotEE 2018; DEWHA 2008; Halford 1998).

1.9.4 Threatening processes

The following have been identified as potentially threatening processes to *P. grandispiculatum*:

- Destruction and fragmentation of habitat by clearing
- Habitat disturbance by timber harvesting
- Inappropriate grazing regimes
- Inappropriate fire regimes

- Grazing by stock
- Competition from introduced groundcover species (NSW OEH 2013).

1.9.5 Threat abatement/recovery plan

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=20151**. In effect under the BC Act 2016.

No threat abatement plan has been identified as being relevant for this species.

1.9.6 Summary of threat abatement/recovery plan

Paspalidium grandispiculatum is assigned as a keep-watch species under the NSW *Saving our Species Program* as relatively large populations are known to occur within reserves (for example 1000's of individuals are estimated in Bundjalung State Conservation Area) where current management is sufficient to ensure their long-term security.

1.9.7 References

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Boyes, B. (2001), Recovery Plan for the Threatened Species and Ecological Communities of Gatton and Laidley Shires Southeast Queensland 2001- 2005. Lockyer Landcare Group

Department of the Environment and Energy (2018). *Paspalidium grandispiculatum* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Fri, 24 August 2018

Department of the Environment, Water, Heritage and the Arts (2008). Approved Conservation Advice for *Paspalidium grandispiculatum*. Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/10838-conservation-advice.pdf. In effect under the EPBC Act from 01 October 2008.

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Simon, B.K. (1982), New Species of Gramineae from south-eastern Queensland. Austrobaileya. 1(5):455-467.

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1.10 Quassia (*Samadera bidwillii*)

1.10.1 Status

EPBC Act – Vulnerable

1.10.2 Biology and ecology

1.10.2.1 Characteristic

Quassia (*Samadera bidwillii*) is a small shrub or tree that grows to about 6 m in height, with red flowers and red fruit. Branchlets are ribbed, with fine, pale-brown hairs. The leaves are 4.5 to 9 cm long, 6 to 12 mm wide, glossy and hairless above, silky to pubescent on the lower surface and have secondary veins that are numerous and regularly arranged. The leaves are also stiff and leathery, narrow-elliptic or lanceolate, blunt or bluntly pointed with the margins bent under. Quassia flowers occur in clusters of 1 to 4, and each flower has 8 to 10 stamens, with filaments densely villous on the outer surface (refer Photograph 1.9). The sepals are 0.75 to 1 mm long and the red petals are approximately 2.5 mm in length. The fruit are ovid-ellipsoid, 1 cm long, hairy and sometimes appear winged (DotEE 2018).

Photograph 1.9 Quassia (*Samadera bidwillii*)

Source: Gavin (2019)

1.10.2.2 Known distribution

Quassia is currently known to occur in coastal localities between Scawfell Island, near Mackay, and Goomboorian, north of Gympie. Quassia is also likely to be found further south around Brisbane and Jimboomba (DotEE 2018) (refer Figure 1.19).

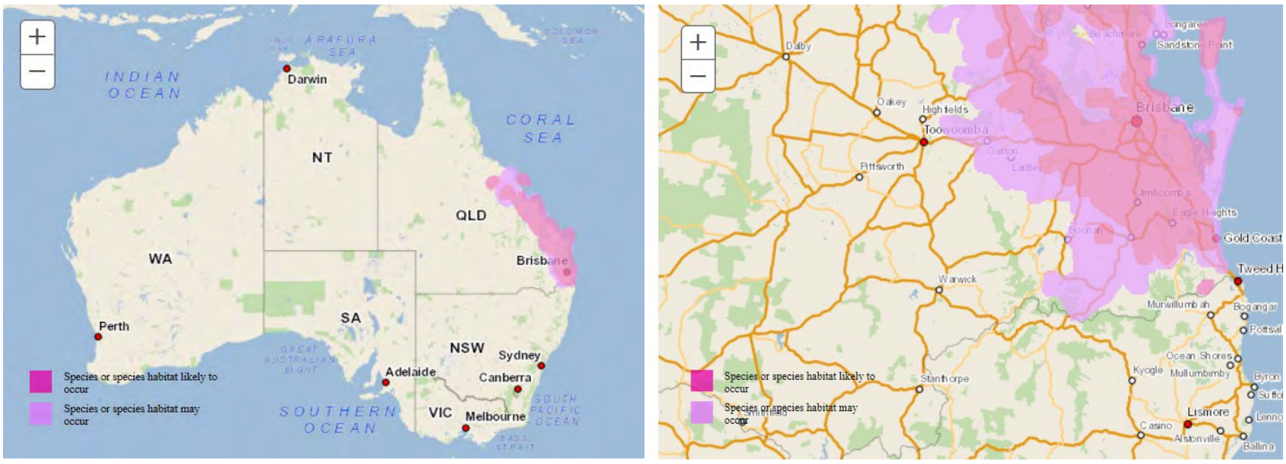

Figure 1.19 **Distribution range of the Quassia**

Source: DotEE (2018)

1.10.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Samadera bidwillii* has been predicted to occur within the region and associated habitat within the MNES study area. However, there are no current records for this species within 50 km of the temporary and permanent Disturbance footprint (refer Figure 1.20). The nearest record exists from an area between Springbrook and Currumbin Valley approximately 100 km from the Disturbance footprint.

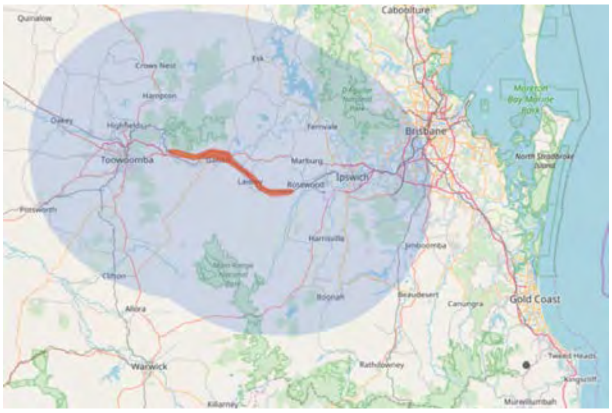

Figure 1.20 **Distribution range of the Quassia in relation to the Project**

Source: ALA (2020)

1.10.2.4 Biology and reproduction

Quassia flowers have been recorded in November, December, January and March. Fruit has been recorded from February to April (TSSC 2008).

1.10.3 Habitat

Quassia commonly occurs in lowland rainforest or on rainforest margins, but it can also be found in other forest types, such as open forest and woodland. Quassia is commonly found in areas adjacent to both temporary and permanent watercourses in locations up to 510 m altitude. The species occurs on lithosols, skeletal soils, loam soils, sands, silts and sands with clay subsoils (DotEE 2008, TSSC 2018)).

1.10.4 Threatening processes

The following have been identified as potentially threatening processes to the Quassia:

- Soil erosion and habitat clearing (e.g. agriculture, forestry, urban development and recreational activities)
- Inappropriate fire regimes and weed encroachment (TSSC 2008).

1.10.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

1.10.6 References

Department of the Environment and Energy (2018). *Samadera Bidwillii* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=29708 [Accessed 31 August 2018].

Eco logical Australia (2019). Calvert to Kagaru Pre-clearance Survey Report Extended Geotechnical Program – Inland Rail. Report prepared for ARTC, 11 June 2019.

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Gavins, S. W. (2019). *Samadera bidwillii*. [image] [online] Available from: https://biocache.ala.org.au/occurrences/88cb72d2-8082-49f5-aeb1-1eea15566a39 [16 September 2019].

Threatened Species Scientific Committee (2008). Approved Conservation Advice for *Quassia bidwillii* (Quassia). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/10094-conservation-advice.pdf. In effect under the EPBC Act from 03 July 2008.

1.11 Queensland nut tree (*Macadamia integrifolia*)

1.11.1 Status

EPBC Act – Vulnerable

1.11.2 Biology and ecology

1.11.2.1 Characteristic

Queensland nut tree (*Macadamia integrifolia*) is a medium sized tree that grows to 20 m in height with a 20 m wide crown. This species produces cream or creamy-white flowers that have been recorded in January, March and June to November. Flowers occur on the end of 30 cm long racemes (refer Photograph 1.10). Fruit is a hard-brown spherical nut encased in a green leathery outer shell with a diameter of 2 to 3 cm (DotEE 2018).

Photograph 1.10 Queensland nut tree (*Macadamia integrifolia*)

Source: McMaster (2019)

1.11.2.2 Known distribution

Queensland nut tree occurs from Mt Bauple, near Gympie, to Currumbin Valley in the Gold Coast hinterland, southeast Queensland (refer Figure 1.21). The species occurs as a scattered rare to occasional tree, and population sizes have been noted as difficult to estimate (Barry and Thomas 1994).

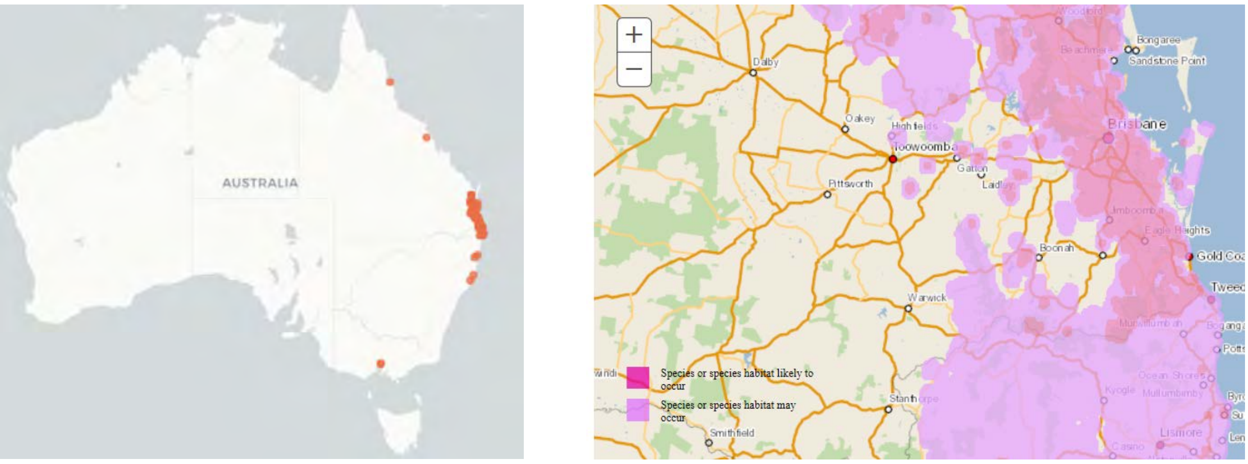

Figure 1.21 Distribution range of Queensland nut tree

Source: ALA (2018), DotEE (2018)

1.11.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Macadamia integrifolia* has been identified as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species is known from within 50 km of the temporary and permanent Disturbance footprint with the closest records occurring within approximately 45 km at Mount Elphinstone, Brisbane dated 2000. Other records for this species within a 50 km buffer of the Disturbance footprint exist between Ipswich and Brisbane, throughout D'Aguilar National Park and north to Toogoolawah (refer Figure 1.22.)

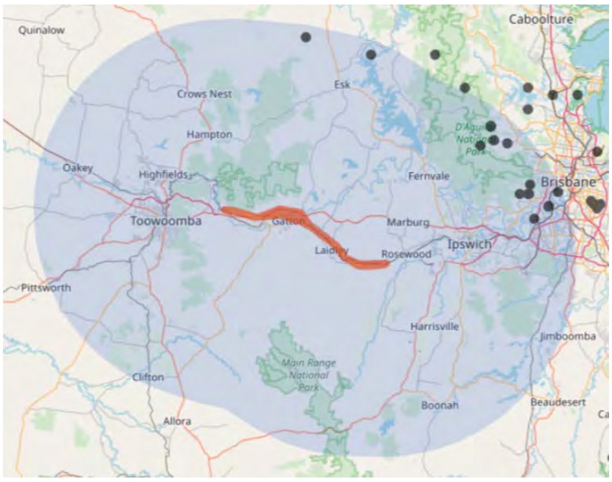

Figure 1.22 Distribution range of Queensland nut tree in relation to the Project

Source: ALA (2020)

1.11.2.4 Biology and reproduction

Queensland nut tree flowers in January, March and June to November. Fruits have been recorded from November to January and March to April. Macadamia nuts begin to produce viable nut loads at around 10 years of age. Reproduction is by seed, with a seed viability of 3 to 6 months. The species has a juvenile period of over six years. The seeds are eaten by mammals and are dispersed by stream. The plant re-sprouts when damaged (DotEE 2018, DEWHA 2008).

1.11.3 Habitat

Queensland nut tree grows in remnant rainforest, including complex mixed notophyll forest, and prefers partially open areas such as rainforest edges (DEWHA 2008). This species occurs within the Northern Rivers (NSW) and southeast Queensland Natural Resource Management regions.

Queensland nut tree is known to prefer to grow in mild frost-free areas with a reasonably high rainfall. There have been records of planted specimens bearing fruit as far south as Sydney (DotEE 2018).

Vegetation communities in which the Queensland nut tree is found range from complex notophyll mixed forest, extremely tall closed forest, simple notophyll mixed very tall closed forest to simple microphyll-notophyll mixed mid-high closed forest with *Araucaria* and *Argyrodendron* emergents (DotEE 2018).

1.11.4 Threatening processes

The following have been identified as potentially threatening processes to the Queensland nut tree:

- Land clearing for urban and agricultural development (DotEE 2018).
- Inappropriate fire regimes (DotEE 2018)
- Land clearing making them more susceptible to wind damage, as well as reducing the availability of natural pollinators (DotEE 2018)
- Invasive weed species
- Compaction of the soil layer (DotEE 2018).

1.11.5 Threat abatement/recovery plans

No threat abatement plan has been identified as being relevant for this species. The following recovery plan is relevant to this species:

- Costello, G., M. Gregory & P. Donatiu (2009). Southern Macadamia Species Recovery Plan. Report to Department of the Environment, Water, Heritage and the Arts, Canberra by Horticulture Australia Limited, Sydney. Available from: **http://www.environment.gov.au/biodiversity/threatened/recovery-plans/southern-macadamia-species-recovery-plan**. In effect under the EPBC Act from 13-Nov-2009 as *Macadamia integrifolia*.

1.11.6 Summary of threat abatement/recovery plans

The threats outlined in the Southern Macadamia Species Recovery Plan include:

- Land clearing, fragmentation and loss of connectivity
- Inappropriate fire regimes
- Habitat modification by weeds
- Lack of appropriate gazing regimes
- Reduce gene flow
- Climate change.

Current recovery actions include:

- Restoration of rainforest habitat for private landholders under SEQ Rainforest Recovery Project
- Designation of ecologically appropriate fire regimes under the Hotspots Fire Project
- Rebates for fencing under Australian Government funding programs to assist in managing grazing
- Studies on the genetic characterisation of macadamia species and impacts of habitat fragmentation.

Future actions proposed by the Southern Macadamia Species Recovery Plan include:

- Assist landholders in accessing resources to protect macadamia habitat on their property through grazing control, weed management and rehabilitation strategies
- Provide fire and biodiversity workshops to land managers
- Continue research on population genetics
- Model the projected impact of climate change on the ecology, distribution and habitat of southern macadamia species.

1.11.7 References

Atlas of Living Australia (2018), *Macadamia integrifolia,* accessed 24 August 2018, available: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2890419.

Barry, S. and Thomas, G. (1994), Threatened vascular rainforest plants of south-east Queensland, Queensland Department of Environment and Heritage, pp. V38–V40.

Department of the Environment and Energy (2018). *Macadamia integrifolia* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Fri, 24 August 2018

Department of the Environment, Water, Heritage and the Arts (2008). Approved Conservation Advice for *Macadamia integrifolia* (Macadamia Nut). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/7326-conservation-advice.pdf. In effect under the EPBC Act from 16 December 2008.

McMaster, I. (2019). *Macadamia integrifolia*. [image] [online] Available from: **https://biocache.ala.org.au/occurrences/88cb72d2-8082-49f5-aeb1-1eea15566a39** [16 September 2019].

Queensland CRA/RFA Steering Committee (1997). Forest taxa at risk, threats, conservation needs and recovery planning in southeast Queensland. Queensland Government and Commonwealth of Australia.

1.12 Tall velvet sea-berry (*Haloragis exalata* subsp. *velutina*)

1.12.1 Status

EPBC Act – Vulnerable

1.12.2 Biology and ecology

1.12.2.1 Characteristic

Tall velvet sea-berry (*Haloragis exalata* subsp. *velutina*) is a shrub growing to 1.5 m, with a red, square-shaped stem that is covered with fine velvety hairs. It has narrow, opposite leaves which are 50 to 60 mm long, 6 to 8 mm wide, finely toothed and red to yellowish green. The flowers are small and are usually in clusters of three to seven towards the end of the branchlets. Individual flowers are stalked and have four sepals and four petals. The sepals are approximately 0.6 mm long, reddish in colour and are persistent on the fruit. The petals are also reddish, hooded and about 2.5 to 3.5 mm long (refer Photograph 1.11). Each flower has eight stamens, with the anthers 1.5 to 2 mm long. The fruit are small and pear-shaped, they are slightly wrinkled. Each fruit is approximately 2 mm long (DECC NSW 2005; Harden 2002; ALA 2018).

Photograph 1.11 Tall velvet sea-berry (*Haloragis exalata* subsp. *velutina*)

Source: Queensland Herbarium 1976

1.12.2.2 Known distribution

Tall velvet sea-berry occurs on the north coast of NSW and in southeast Queensland. It occurs from near Kempsey, north to Carnarvon National Park inland of Bundaberg (refer Figure 1.23). This species is locally common in some areas such as Bunya Mountains NP but is often recorded in low numbers (NSW DECC 2005; Queensland Herbarium 2008).

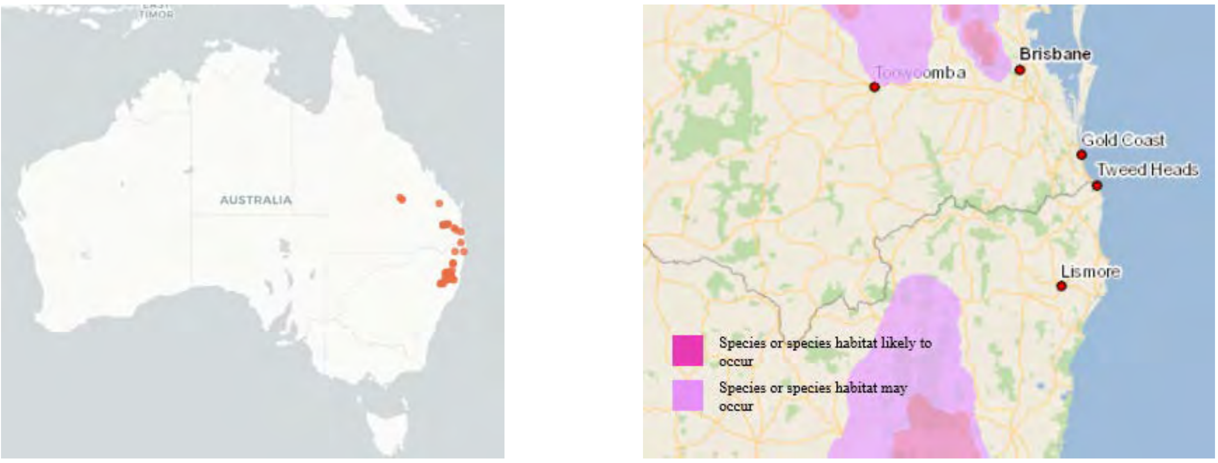

Figure 1.23 **Distribution range of the Tall velvet sea-berry**

Source: ALA (2018); DotEE (2018)

1.12.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Haloragis exalata* subsp. *velutina* has been identified as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species is known from within 50 km of the temporary and permanent Disturbance footprint. A record dated from 1999 exists at the D'Aguilar National Park approximately 45 km to the north-east of the Project. No other records occur within a 50 km buffer of the Disturbance footprint. Other records for this species outside of a 50 km buffer exist at Border Ranges National Park, north at Deer Reserve National Park and north-west at Bunya Mountains National Park and Yarraman State Forest (refer Figure 1.24).

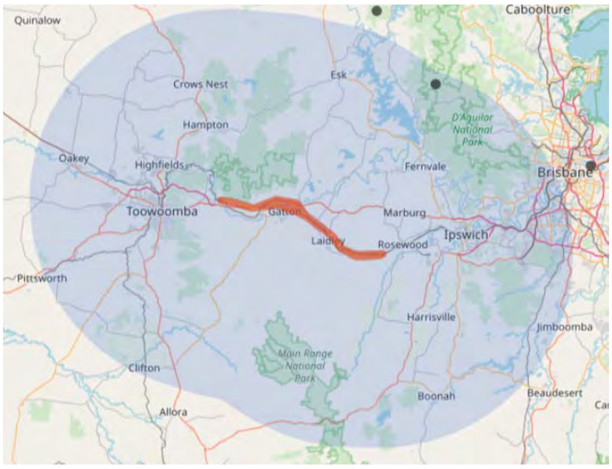

Figure 1.24 **Distribution range of the Tall velvet sea-berry in relation to the Project**

Source: ALA (2020)

1.12.2.4 Biology and reproduction

The Tall velvet sea-berry flowers from January to April and fruits in April (OEH 2018).

1.12.3 Habitat

In Queensland, Tall velvet sea-berry occurs in rainforest and rainforest margins and adjacent grassland and open grassy woodland above 500 m altitude. Species it is often found in association with include Broad-leaved apple (*Angophora subvelutina*), Forest redgum (*Eucalyptus tereticornis*), Green wattle (*Acacia irrorata*), and *Scutellaria humilis* (Queensland CRA/RFA Steering Committee 1998; Queensland Herbarium 2008).

1.12.4 Threatening processes

The following have been identified as potentially threatening processes to the Tall velvet sea-berry:

- Weed invasion of streamside areas
- Road work
- Erosion
- Inappropriate/ frequent fire regimes
- Degradation of habitat by feral pigs (OEH 2018).

1.12.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10393**. In effect under the BC Act 2016.

No threat abatement plan has been identified as being relevant for this species.

1.12.6 Summary of threat abatement/recovery plans

Haloragis exalata subsp. *velutina* is assigned as a keep-watch species under the NSW Saving our Species Program. State wide conservation actions identified for this species include:

- Validate old database records and amend those that are spatially incorrect
- Map extent of known populations.
- Survey areas of potential habitat in nearby areas for further populations
- Determine and monitor current population size and demography and monitor, habitat condition and threats at known sites.
- Conduct research to determine ecological requirements, including fire ecology, and undertake field studies to monitor seedling establishment and survivorship. May involve autecological study or literature search for information on similar species.
- Control weeds (esp. blackberry) in known habitat of species.

1.12.7 References

Atlas of Living Australia (2018). *Haloragis exalata* subsp. *velutina*. Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2903322#overview [Accessed 30 August 2018].

Department of Environment and Climate Change NSW (2005). *Haloragis exalata subsp velutina* – profile [Accessed 30 August 2018].

Department of the Environment and Energy (2018). *Haloragis exalata subsp. velutina* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=16839. Accessed Fri, 24 August 2018

Harden GJ (Ed.) (2002). *Flora of New South Wales*, vol. 2, University of New South Wales Press, Sydney.

Office of Environment and Heritage, NSW (2018). Tall velvet sea-berry. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10393 [Accessed 21 August 2018].

Queensland CRA/RFA Steering Committee. (1998). Survey of Threatened Plant Species in South East Queensland Biogeographical Region [Accessed 30 August 2018].

Queensland Herbarium. (2008). HERBRECS, Queensland Herbarium, Brisbane.

Queensland Herbarium. (1976). Tall velvet sea-berry (*Haloragis exalata subsp. velutina*). [image] [online] Available from: https://biocache.ala.org.au/occurrences/43d70452-9eee-4b0e-9310-c434a5179f85. [16 September 2019].

Ruming S. (n.d.). *Haloragis exalata* subsp. *velutina* (Image) [Online] Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2903322#gallery [Accessed 30 August 2018].

1.13 Hairy-joint grass (*Arthraxon hispidus*)

1.13.1 Status

EPBC Act – Vulnerable

1.13.2 Biology and ecology

1.13.2.1 Characteristic

Hairy-joint grass (*Arthraxon hispidus*) is a slender tufted creeping grass that roots at the nodes, with erect to semi-erect stems. The leaves are reddish to purplish, with long white hairs around the edge, broad at the base and tapering abruptly to a sharp point (refer Photograph 1.12). Flowers appear in March to July and summer to autumn. The fruit is a caryopsis (simple, dry single seeded fruit, with seed fused to the wall of the fruit and remaining closed at maturity). The seed-heads are held above the plant on a long fine stalk. Once thought to be an annual species, more recent information suggests it is a perennial that tends to die down in winter (TSSC 2008).

Photograph 1.12 Hairy-joint grass (*Arthraxon hispidus*)

Source: Dalgial (2015)

1.13.2.2 Known distribution

Hairy-joint grass has been recorded from scattered locations throughout Queensland and on the northern tablelands and north coast of NSW. In Queensland, the species occurs north to Port Douglas, and west to disjunct occurrences around mound springs in Carnarvon National Park. However, the most common occurrences are from Noosa southwards. This species has been recorded within the Border River–Gwydir, Northern Rivers (NSW), Fitzroy, Border Rivers–Maranoa Balonne, Condamine, South East, Burnett Mary and Wet Tropics (Queensland) Natural Resource Management regions (refer Figure 1.25). It is also known to be reserved in Carnarvon Cooloola NP, Noosa NP, Carnarvon NP, and Daintree NP (DotEE 2018).

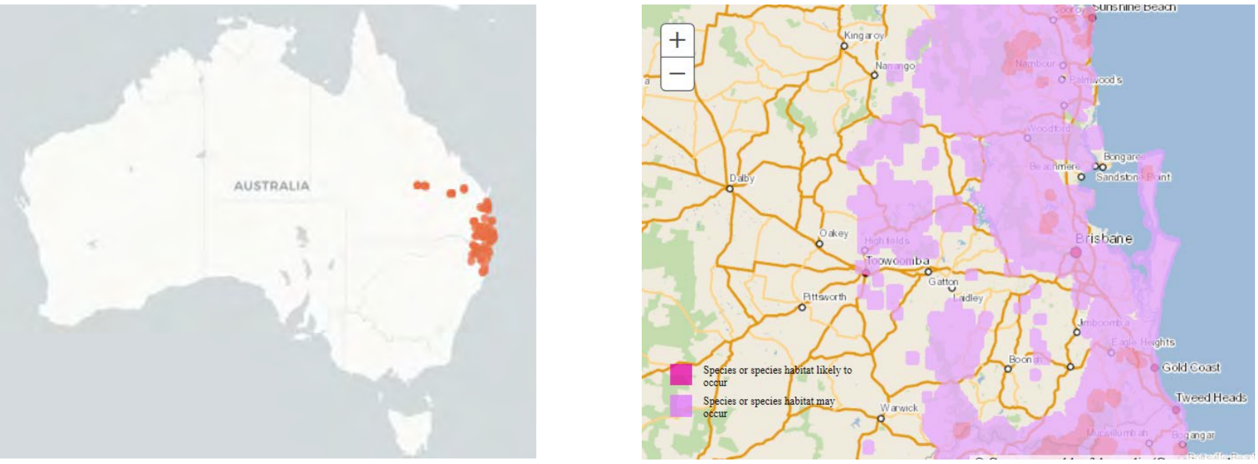

Figure 1.25 **Distribution range of Hairy-joint grass**

Source: ALA (2018), DotEE (2018)

1.13.2.3 Distribution in relation to the Project

Arthraxon hispidus has been identified as potentially occurring within the MNES study area. This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019a; EMM 2019). There are no database records of this species within or adjacent to the Project footprint. Database records indicate the species has been recorded in the wider region surrounding the Project. The nearest database records are recent (post 2000) and located in the Toowoomba Range area approximately 14.5 km west of the Project disturbance footprint. There are a few other records within a 50 km radius located to the south, east and north-east. These include a recent record (2009) from Main Range National Park (30 km south of the MNES study area), an old record (1941) from Mount Chinghee (46 km south-east), and a 1993 record from the Samford area (45 km north-east) (refer Figure 1.26).

DAWE (2020) mapping indicates the species as may occur in sporadic areas surrounding the Project footprint. The species occurs from Port Douglas (north Queensland) south to Kempsey in NSW (DEWHA 2008). The MNES study area is not located near the limit of the species range.

Figure 1.26 **Distribution range of Hairy-joint grass in relation to the Project**

Source: ALA (2020)

1.13.2.4 Biology and reproduction

Fertile material of Hairy-joint grass has been collected from March to May, and July. The species has been reported as flowering during summer-autumn. Hairy-joint grass was once considered an annual but is now thought to be a perennial that tends to die down in winter (TSSC 2008).

1.13.3 Habitat

Hairy-joint grass is found in or on the edges of rainforest and in wet Eucalypt forest, often near creeks or swamps, as well as woodland. The species has been recorded growing around freshwater springs on coastal foreshore dunes, in shaded small gullies, on creek banks, and on sandy alluvium in creek beds in open forests. It has also been recorded with bog mosses in mound springs (TSSC 2008).

1.13.4 Threatening processes

The following have been by identified by DotEE as potentially threatening processes to the Hairy-joint grass:

- Trampling and over grazing by stock
- Clearing for agriculture and development
- Inappropriate fire regimes
- Competition from introduced grasses.

1.13.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10066**. In effect under the BC Act 2016.

No threat abatement plan has been identified as being relevant for this species.

1.13.6 Summary of threat abatement/recovery plan

Arthraxon hispidus is assigned as a keep-watch species under the NSW *Saving our Species Program* as it is widespread with many small populations across NSW. State wide conservation actions identified for this species include:

- Educate the public on *Arthraxon hispidus*, particularly landowners adjacent to areas of known occurrence
- Reserve Fire Management Strategy to include operational guidelines to protect this species from fire
- Develop and implement site management plans for some of the known populations
- Establish monitoring sites to determine trends in habitat condition and population size
- Maintain populations ex situ at suitable botanic gardens, regional gardens or nurseries
- Map extent of known populations and survey areas of potential habitat near known occurrences for additional populations
- Assess weed threats to populations, manage as necessary. Implement Bitou bush control as described in the approved TAP
- Control feral animals in known habitat for this species.

1.13.7 References

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Dalgial. (2015). Hairy-joint grass (*Arthraxon hispidus*). [image] [online] Available from: **https://biocache.ala.org.au/occurrences/43d70452-9eee-4b0e-9310-c434a5179f85**. [16 September 2019].

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DEWHA (2008), *Approved Conservation Advice for Arthraxon hispidus (Hairy-joint Grass).* Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/9338-conservation-advice.pdf

Office of the Environment and Heritage, (2015a), Threatened Species Website, image of: *Arthraxon hispidus* - Hairy-joint grass, accessed 23 August 2018, available https://images.ala.org.au/image/viewer?imageId=3c1642c2-522e-495d-95cc-f8f60a4f2f9a.

Office of the Environment and Heritage, (2015b), Threatened Species Website, image of: *Arthraxon hispidus* - Hairy-joint grass, accessed 23 August 2018, available https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2902385#gallery.

Threatened Species Scientific Committee (2008). *Commonwealth Listing Advice on* Arthraxon hispidus. Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/9338-conservation-advice.pdf.

1.14 Miniature moss-orchid (*Bulbophyllum globuliforme*)

1.14.1 Status

EPBC Act – Vulnerable

1.14.2 Biology and ecology

1.14.2.1 Characteristic

Miniature moss-orchid or Hoop pine orchid (*Bulbophyllum globuliforme*) is a tiny rhizomatous orchid that grows only on the bark of Hoop pine trees, (*Araucaria cunninghamii*), forming a dense mat. It produces green, globular, bulb-like stems 1 to 2 mm in diameter. Leaves are narrow-triangular, 1 to 2 mm long, 0.2 to 0.3 mm wide, papery and concave. The inflorescence is 1 to 1.5 cm long, bearing one flower (refer Photograph 1.13). The sepals and petals are white to pale yellow. Miniature moss-orchid flowers from September to November (DotEE 2018).

Photograph 1.13 Miniature moss-orchid (*Bulbophyllum globuliforme*)

Source: ALA (2018)

1.14.2.2 Known distribution

Endemic to eastern Australia, the species is recorded from near Paluma, northeast Queensland, south to the McPherson Range on the Queensland/NSW border (refer Figure 1.27). This species is known to occur in four locations including Puzzle Creek near Paluma (northeast Queensland), Kroombit Tops near Calliope (central Queensland), Cainbable Creek in Lamington National Park (southeast Queensland) and Levers Plateau (northeast NSW) (DotEE 2018).

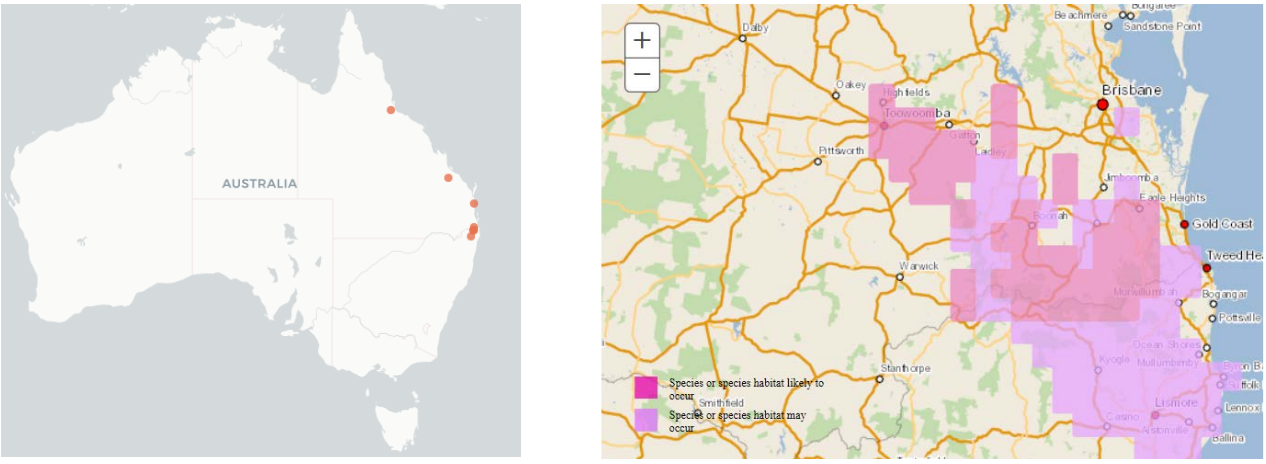

Figure 1.27 Occurrence record of Miniature moss-orchid

Source: ALA (2018), DotEE (2018)

1.14.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Bulbophyllum globuliforme* has been predicted to occur within the region and associated habitat within the MNES study area. However, there are no current records for this species within 50 km of the temporary and permanent Disturbance footprint. The nearest record is dated from 1997 from Lamington National Park approximately 80 km from the eastern section of the Disturbance footprint. Other records for this species occur at Border Ranges National Park from 1945/46 (refer Figure 1.28).

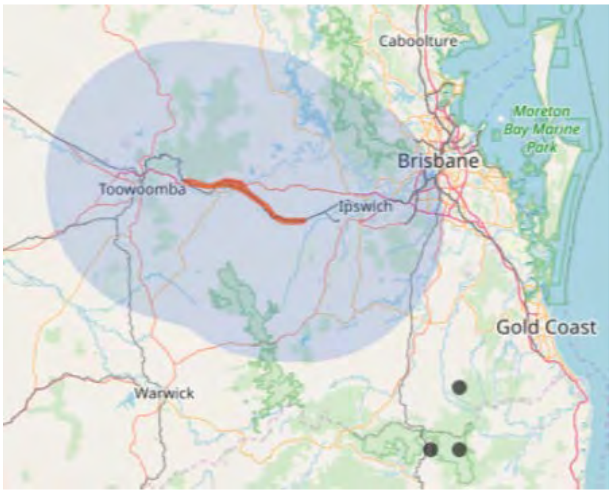

Figure 1.28 Occurrence record of Miniature moss-orchid distribution in relation to the Project

Source: ALA (2020)

1.14.2.4 Biology and reproduction

Miniature moss-orchid flowers in May to November. The growth form of this species is unusual, as it forms mats of tiny bulbs (leaves) on the wrinkled bark of hoop pine, making it very difficult to identify in the field. Generation length is unknown however, as the plant forms colonies by rhizome growth, each clump may be very long-lived (DotEE 2018).

1.14.3 Habitat

This species has been previously recorded in the Bunya Mountains. The species grows only on Hoop pines, colonising the upper branches of mature trees in upland rainforest. Miniature moss-orchid are conserved in Noosa National Park, Lamington National Park and Bunya Mountains National Park, Queensland, and the Border Ranges National Park, NSW (DotEE 2018; Harrison 2002).

1.14.4 Threatening processes

The following have been identified as potentially threatening processes to the Miniature moss-orchid:

- Destruction of habitat by clearing of Hoop pine host-trees
- Disturbance of habitat by timber harvesting and road works
- Inappropriate fire regimes
- Disturbance of habitat by weeds
- Damage and collection by orchid enthusiasts (DotEE 2018).

1.14.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10112. In effect under the BC Act 2016.

No threat abatement plan has been identified as being relevant for this species.

1.14.6 Summary of threat abatement/recovery plan

Bulbophyllum globuliforme is assigned as a keep-watch species under the NSW *Saving our Species Program* as relatively large populations are known to occur within reserves where current management is sufficient to ensure their long-term security. State wide conservation actions identified for this species include:

- Assess all known sites for population condition, habitat quality and threats
- Ensure that managers are aware of populations, habitat and threats and that fire plans, pest management plans take account of requirements for the recovery of the orchid
- Ensure confidentiality is applied to information about locations of the orchid to protect against illegal collection
- Avoid damage to and lopping of Hoop Pines within the habitat and range of the orchid investigate and apply appropriate method for estimating populations.

1.14.7 References

Atlas of Living Australia (2018), *Bulbophyllum globuliforme*. [image] [online] Available from: https://images.ala.org.au/image/viewer?imageId=050ae1de-9eb1-4f7d-926f-073d9e7ab02c. , [23 August 2018].

Department of the Environment and Energy (2018). *Bulbophyllum globuliforme* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 23 August 2018

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Harrison, M (2002), ‘Bulbophyllum species of Australia’, Australian Orchid Review Dec 2001/Jan 2002, pp. 4–19.

1.15 Wandering pepper-cress (*Lepidium peregrinum*)

1.15.1 Status

EPBC Act – Endangered

1.15.2 Biology and ecology

1.15.2.1 Characteristic

Wandering pepper-cress (*Lepidium peregrinum*) is a perennial plant that grows to 10 to 80 cm tall, sometimes ascending to 2 m in surrounding vegetation. The lower cauline leaves are deeply divided with a large broad-lanceolate terminal lobe and measure 6 to 10 cm long by 15 to 25 mm wide (refer Figure 1.29). Leaf edges are fringed with eyelash-like hairs. The mid-cauline leaves are lanceolate in outline with serrate to serrulate margins and measure 4 to 9 cm long by 4 to 9 mm wide. The small flowers are less than 1 mm long and arranged in hairy, terminal racemes (ALA 2018; Hewson 1982; OEH 2018; Scarlett 1999).

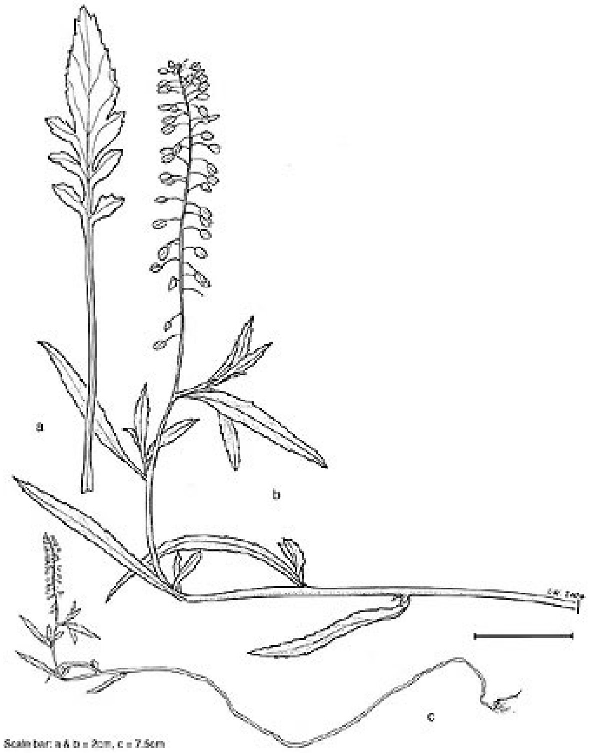

Figure 1.29 Wandering pepper-cress (*Lepidium peregrinum*)

Source: OEH (n.d.)

1.15.2.2 Known distribution

Wandering pepper-cress occurs from the Bunya Mountains, southeast Queensland, to near Tenterfield, in northern NSW. This species occurs within the New England Tableland and southeast Queensland Bioregions and the southeast Queensland, Condamine and Border-Rivers Maranoa-Balonne Natural Resource Management regions (OEH 2018; Queensland Herbarium 2007; Queensland Herbarium 2009) (refer Figure 1.30).

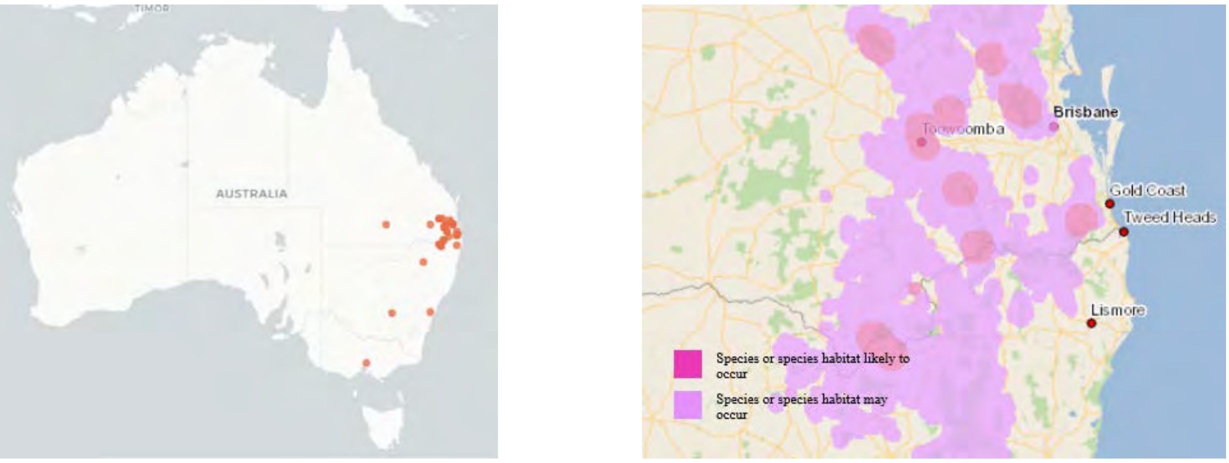

Figure 1.30 Distribution range of the Wandering pepper-cress

Source: ALA (2018); DotEE (2018)

1.15.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Lepidium peregrinum* has been identified as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate the nearest occurrences are recent located to the west of the Project in Toowoomba dated 2007. Other records exist within a 50 km buffer of the alignment to the north-west at Ravensbourne National Park, to the north-east at D’Aguilar National Park and to the south at Main Range National Park. Other records outside of 50 km from the Disturbance footprint occur at Border Ranges National Park, Paddy’s Knob and Bunya Mountains National Park (refer Figure 1.31).

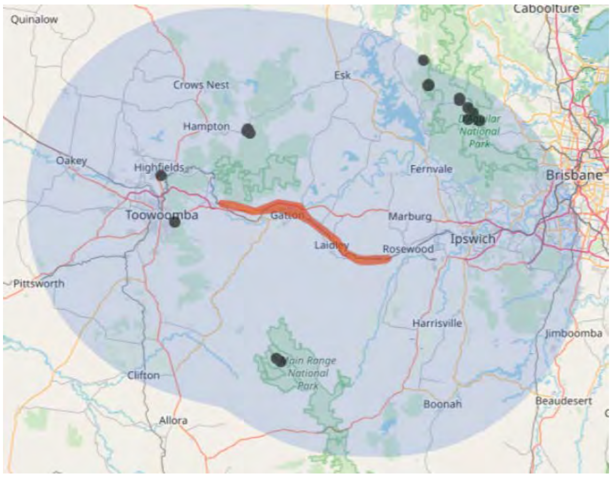

Figure 1.31 Distribution range of the Wandering pepper-cress in relation to the Project

Source: ALA (2020)

1.15.2.4 Biology and reproduction

Wandering pepper-cress flowers from January to April. Initial studies of Wandering pepper-cress subpopulations found some have little or no recruitment, while others have juvenile plants in the absence of mature plants. This could be indicative that the species requires specific triggers to break seed dormancy, and naturally experiences ‘boom and bust’ cycles in the number of mature plants. It is possible the species persists in some locations as dormant seed with no vegetative specimens being evident (OEH 2018).

1.15.3 Habitat

The species has been recorded growing in riparian open forest dominated by *Eucalyptus camaldulensis* and *Casuarina cunninghamiana* with variably dense shrubby understorey. The species was most abundant in the tussock grassland fridge of the riparian open forest, with some plants reaching a height of 2 m in thickets of *Hymenanthera*. It has also been recorded in shade under shrubs close to the creek bank, in which cases most plants have been small, approximately 30 cm in height. Herbarium records and observations in the wild suggest this species responds to disturbance events, due to observations along walking tracks, native pine plantations and car parks, and therefore population densities may fluctuate as a response to such events (Scarlett 1999; OEH 2018; Queensland Herbarium 2009).

1.15.4 Threatening processes

The following have been identified as potentially threatening processes to the Wandering pepper-cress:

- Populations are fragmented and generally very small, with recruitment spasmodic or limited
- Clearing of habitat for agriculture and grazing
- Grazing
- Introduced weeds
- Destruction of plants following misidentification
- Extended drought periods and other forms of land degradation (OEH 2018).

1.15.5 Summary of threat abatement/recovery plan

Threats identified in the threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Supress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

1.15.6 References

Atlas of Living Australia (2018). Wandering pepper-cress (*Lepidium peregrinum*). [image] [online] Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2896651# [Accessed 30 August 2018].

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Office of Environment and Heritage, NSW (2018). Wandering pepper-cress. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10464 [Accessed 30 August 2018].

Queensland Herbarium (2007). *Lepidium peregrinum*, nomination for re-classifying rare wildlife under the Nature Conservation Act 1992. Queensland Government, Environmental Protection Agency, Queensland National Parks and Wildlife Service. (unpublished)

Queensland Herbarium (2009). Specimen label information. [Accessed 30 August 2018].

Scarlett N.H. (1999). The identity of *Lepidium peregrinum* (Brassicaceae), an endangered Australian plant species. *Teleopea* 8: 337-350.

1.16 Brush sophora (*Sophora fraseri*)

1.16.1 Status

EPBC Act – Vulnerable

1.16.2 Biology and ecology

1.16.2.1 Characteristic

Sophora fraseri (Brush sophora), is a softly pubescent, sparsely branched leguminous shrub that grows to 1 to 2 m high. Leaves are pinnate and are 6 to 15 cm long with a 10 to 20 mm stalk. Leaves have 21 to 35 oblong to ovate leaflets 5 to 25 mm long, 3 to 10 mm wide, with smooth margins and stalks 1 to 2 mm long. Flowers occur in racemes about 10 cm long during spring (refer Photograph 1.14). Petals are pale yellow, about 10 mm long, and the sepals are about 5 mm long. The fruit, 3 to 10 cm long and up to 8 mm in diameter, is irregularly restricted between the seeds and does not open at maturity. There are 2 to 7 seeds, about 6 mm long (WetlandInfo 2018; TSSC 2008).

Photograph 1.14 Brush sophora *(Sophora fraseri)*

Source: Scott (2016)

1.16.2.2 Known distribution

Brush sophora is found north of Casino in northern NSW, where it is very rare, and into southeast Queensland (refer Figure 1.32), where it is widespread but not common. Brush sophora is conserved in Lamington National Park and Mount Mistake National Park (TSSC 2008).

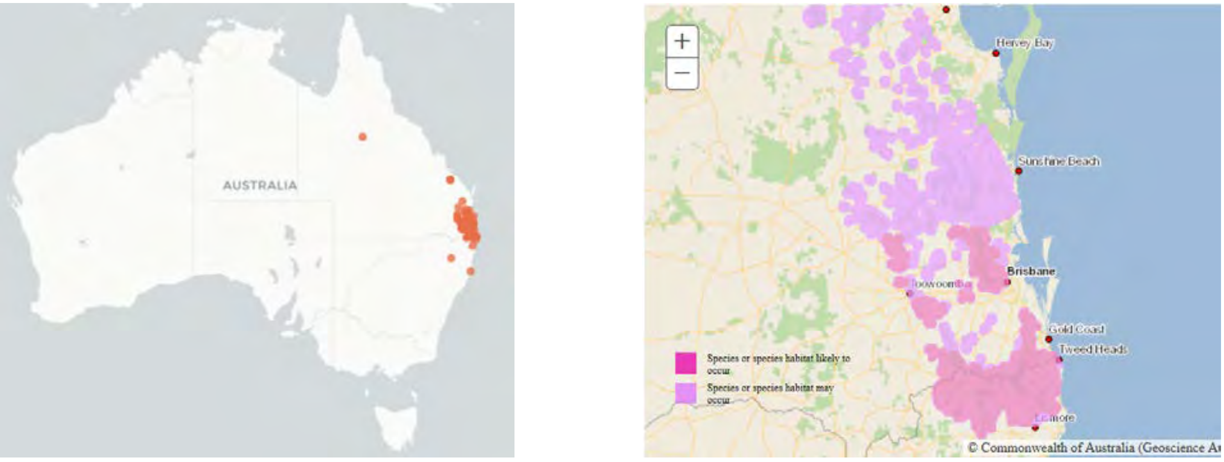

Figure 1.32 **Distribution range of the Brush sophora**

Source: ALA (2018), DotEE (2019)

1.16.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). Database records (i.e. AoLA) indicate the nearest occurrence exists 5 km north of the Project disturbance footprint to the north of the eastern end of the alignment (west of Rosewood) dated 1992. A very old record (1930) occurs 5 km south of Helidon at the western end of the alignment. A few scattered records exist to the north-west, west and south-west within a 50 km buffer of the Project disturbance footprint (refer Figure 1.33). The nearest recent records are from Toowoomba (2018 and located 14.5 km west of the western extent of the Project) and north of Marburg (2001 and 17 km north of the eastern extent of the Project). A large number of other records exist over 35 km to the north-east of the eastern section of the Project throughout the D’Aguilar National Park.

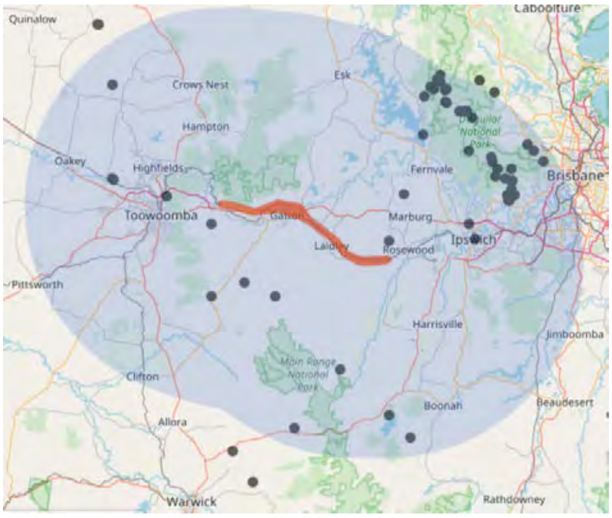

Figure 1.33 **Distribution range of the Brush sophora in relation to the Project**

Source: ALA (2020)

1.16.2.4 Biology and reproduction

Flowering of Brush sophora has been recorded in April and from late August to mid-November. Fruiting has been recorded in January, April, July, August and November (Barker and Borsboom 1997; WetlandInfo 2018).

1.16.3 Habitat

Brush sophora normally grows in wet sclerophyll forest and a range of rainforest types. It has been reported growing in hilly terrain on hillslopes at altitudes at altitudes from 60 to 660 m, in mostly shallow stony to shaly soils, of loam to clay texture derived from sandstone or basalt rocks. The shrub appears to prefer growing along rainforest margins, in eucalypt forests in the vicinity of rainforests or in large canopy gaps in closed forest communities (Barker and Borsboom 1997; WetlandInfo 2018).

1.16.4 Threatening processes

The following have been identified as potentially threatening processes to the Brush sophora:

- Loss of habitat through clearing for agriculture and development
- Timber harvesting
- Weed infestation
- Inappropriate fire regimes
- Loss of individuals from road/track works or maintenance
- Grazing by domestic stock
- Risk of local extinction because populations are small (OEH 2018).

1.16.5 Threat abatement/recovery plans

The following recovery plans have been identified as being relevant for this species:

- Department of Environment and Energy (2010). National recovery plan for the Semi-evergreen vine thickets of the Bigalow Belt (North and South) and Nadewar Bioregions ecological community. Canberra, ACT: Australian Government. Available from: **http://www.environment.gov.au/resource/national-recovery-plan-semi-evergreen-vine-thickets-brigalow-belt-north-and-south-and**.
- Office of Environment and Heritage (2016), *Saving our Species Program.* Available from: **https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10764**. In effect under the BC Act 2016.

1.16.6 Summary of threat abatement/recovery plan

The threats outlined in the National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community include:

- Broad-scale land clearing of remnant vegetation
- Fire where SEVT is not protected by topography or substrate and where fuel characteristics have been altered by the introduction of introduced pasture grasses
- Incursion by exotic flora including Buffel grass *Pennisetum ciliare*, Green panic *Megathyrsus maximus var. pubiglumis*, Parthenium weed *Parthenium hysterophorus*, Velvet tree pear *Opuntia tomentosa*, Lantana *Lantana camara*, Rubber vine *Cryptostegia grandiflora* and Brazilian nightshade *Solanum seaforthianum*. Of these *L. camara* and *C. grandiflora* pose the most serious threat to this TEC.
- Trampling from cattle grazing opening up the understorey of SEVT habitat facilitating the incursion of invasive flora
- Invertebrate pest species including feral pigs, foxes, rabbits and cane toads impacting the vegetation structure and associated native fauna
- Coastal development where remnant vine thicket occurs on coastal beach ridges.

Threat abatement actions outlined in the National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community include:

- Identify and evaluate the extent, biodiversity value and condition of remnant and regrowth areas of this TEC in the Brigalow Belt (North and South) and Nandewar Bioregions
- Complete mapping of this TEC in New South Wales and refine mapping of remnants in Queensland
- Establish a condition assessment methodology establishing benchmark sites for each component regional ecosystem
- Determine the extent and condition of SEVT areas that have been impacted by invasive flora, particularly weeds of national significance
- Survey data deficient species within SEVT communities
- Identify key ecosystem components and processes determining their response to management actions
- Monitor selected populations of EPBC-Act listed species that occur within SEVT communities including *Cadellia pentastylis, Cossinia australiana, Denhamia parvifolia, Macropus dorsalis, Paradelma orientalis, Turnix melanogaster* and *Zieria verrucose*
- Establish a comprehensive, adequate and representative system of SEVT ecological community across the Brigalow Belt (North and South) and Nandewar Bioregions, protected by either reservations or conservation agreements (including MOUs)
- Ensure best practice management to sites containing SEVT
- Involve landholders and community members in the conservation and management of SEVT ecological communities
- Enhance the ability of government and non-government organisations at the national, regional and local level (including consent authorities) to recognise and incorporate SEVT ecological community conservation issues into all planning processes.

The *Saving our Species* conservation strategy for *Sophora fraseri* identifies five priority management sites:

- Cougal in Kyogle LGA
- Toonumbar in Kyogle LGA
- Ettrick in Kyogle LGA
- Bungabee in Lismore LGA
- Richmond Range in Kyogle LGA.

Threats identified at the management sites include:

- Loss of habitat through clearing or agriculture
- Weed infestation, especially by Lantana
- Inappropriate fire regimes
- Loss of individuals from road/track works or maintenance.

Management activities to protect *Sophora fraseri* at the *Saving our Species* sites are:

- Encourage landholders to enter into voluntary management agreement to maintain or enhance the species and its habitat
- Physical and chemical control of weeds, including splatter gun and foliar spray to control Lantana
- Track species abundance/condition over time by counting individuals and juveniles, monitoring weed densities and other potential threats (species surveys to be conducted when flowering in Spring/Summer)
- Liaise with relevant agency to incorporate species requirements into the Flora Fire Response Database and Reserve Fire Management Strategy
- Monitor species recruitment and adult condition post fire event

- Install green posts to indicate locations of sensitive threatened species to reduce impacts of slashing and track maintenance and monitor for evidence of disturbance.

1.16.7 References

Atlas of Living Australia (2018). *Sophora fraseri*. Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2909150#overview [Accessed 30 August 2018].

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1.17 Blunt-leaved leionema (*Leionema obtusifolium*)

1.17.1 Status

EPBC Act – Vulnerable

1.17.2 Biology and ecology

1.17.2.1 Characteristic

Blunt-leaved leionema (*Leionema obtusifolium*) is a shrub growing to approximately 1 m high. The species branchlets are hairless, glossy, minutely glandular-warty and often reddish, with prominent acute angles. Leaves are without stalks, papery, narrowly oval-shaped to spoon-shaped, 25 to 55 mm long, 3 to 6 mm wide, smooth, glossy, and hairless. The apex is obtuse to rounded, the base narrow wedge-shaped, the margin slightly curved downwards, the midrib impressed above and prominent below. Flowers are in flat-topped inflorescences of 10 to 20 flowers at the ends of branches (refer Photograph 1.15). The calyx is hemispherical, glossy and hairless, with broadly triangular lobes 0.25 mm long. The petals are about 4 mm long, gland-dotted, yellowish-white (Wilson 1998).

Photograph 1.15 Blunt-leaved leionema (*Leionema obtusifolium*)

Source: Wilson (1998)

1.17.2.2 Known distribution

Leionema is known to occur in a small area of southeast Queensland, in the Helidon and Ravensbourne areas (Stanley and Ross, 1983) (refer Figure 1.34). Collections have been made at sites near Crows Nest in the upper reaches of Alice Creek, Helidon Hills, in the 17 Mile Road area, and White Mountain State Forest, northeast of Murphy's Creek. The species is reserved in Crows Nest National Park and White Mountain State Forest under forest reserve tenure (BRI collection records n.d.; QLD EPA 2007 as in DEWHA 2018).

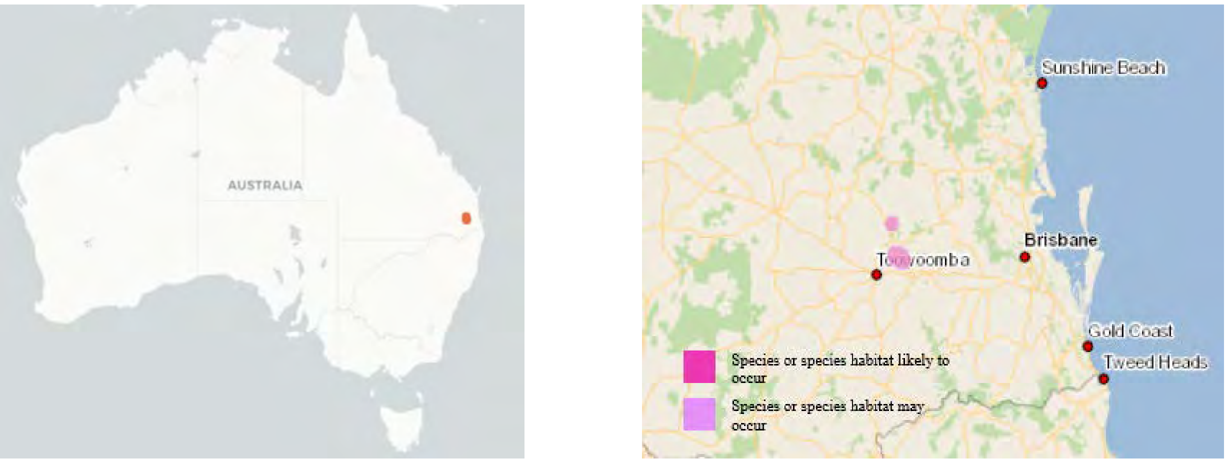

Figure 1.34 Distribution range of Blunt-leaved leionema

Source: ALA (2018); DotEE (2018)

1.17.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment where this species occurs (Ecological 2019a; 2019b; EMM 2019). Database records (i.e. AoLA) describe two older records approximately 300 m south of the western section of the MNES study area dated 1964 and 1978 in what is now cleared habitat. The majority of records for this species occur within the Lockyer Resource Reserve to the north of the Project (between 5 km and 13 km from the Project disturbance footprint) and are dated 1970 to 2016. The nearest recent record (2016) is located 5.5 km north of the Project. A single record from 1963 is located 5.5 km south of the western extent of the alignment, although this record has a high spatial uncertainty. Another group of records exist at Crows Nest located approximately 30 km north-west of the Project.

A number of other records exist to the north associated with the Lockyer Forest Reserves area (refer Figure 1.35). The species is only known from the Helidon-Ravensbourne area (DEWHA 2008). DAWE (2020) mapping indicates the species as likely to occur in the Helidon Hills adjacent to the north of the Project footprint.

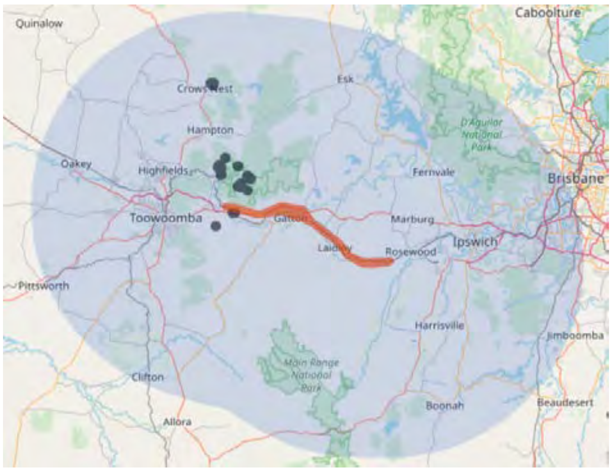

Figure 1.35 **Distribution range of Blunt-leaved Leionema in relation to the Project**

Source: ALA (2020)

1.17.2.4 Biology and reproduction

Little is known about the biology and reproduction of Blunt-leaved leionema, apart from the species is known to flower in spring (Stanley and Ross 1983).

1.17.3 Habitat

Blunt-leaved leionema is known to inhabit eucalypt forest, often with White mahogany (*Eucalyptus acmenoides*) and Brown bloodwood (*Corymbia trachyphloia*), on sandstone substrates in the Helidon Hills and White Mountain State Forest areas, and on granite at Crows Nest National Park (BRI collection records n.d.).

1.17.4 Threatening processes

The following have been identified as potentially threatening processes to the Blunt-leaved leionema:

- Habitat loss due to fragmentation, clearing and forest operations
- Inappropriate fire regimes
- Grazing pressures (Boyes 2004).

1.17.5 Threat abatement/recovery plan

No threat abatement/recovery plan has been identified as being relevant for this species.

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1.18 Bahrs scrub fontainea (*Fontainea venosa*)

1.18.1 Status

EPBC Act – Vulnerable

1.18.2 Biology and ecology

1.18.2.1 Characteristic

Bahrs scrub fontainea (*Fontainea venos*) grows a shrub or a tree reaching 18 m in height. The leaves are leathery tapering to a point at the base, range in length from 5 to 9.5 cm and have 7 to 9 pairs of secondary veins. The petiole of the leave is 3 to 13 mm in length with a swollen base. Flower display small hairs on the outside whilst these are absent from the inside. 20 to 24 stamens are present on male flowers of this species whilst the female flowers a 0.7 mm high disk, 0.5 mm styles and a hairless (glabrous) ovary. The globular fruit is firm, fleshy and yellow in colour. Fruit size is on average 2 to 2.6 cm in length and 1.7 to 2.6 cm in width. The endocarp has 3 to 4 ridges at the sutures with smooth intersutural faces that have scattered vascular foramina. The size of the endocarp is 1.5 to 2.4 cm in length and 1.2 to 1.7 cm in width (Jessup and Guymer 1985).

Photograph 1.16 Bahrs scrub fontainea (*Fontainea venosa*)

Source: QLD Herb (2018)

1.18.2.2 Known distribution

Fontainea venosa has a range that extends along the Kookooron Creek in the Boyne Valley from Beenleigh to Littlemore (Jessup and Guymer 1985, BRI collection records n.d.). There is a total of 200 individual plants distributed across five stable populations within the species' range (Queensland CRA/RFA Steering Committee 1997). The extent of the species' distribution is unknown however, it does occur within the Fitzroy, Burnett Mary and South East Queensland Natural Resource Management Regions (DAWE 2020).

Figure 1.36 Distribution range of Bahrs scrub fontainea

Source: ALA (2020)

1.18.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Fontainea venosa* has been identifies as potentially occurring within the MNES study area. Database records (i.e. AoLA) do not indicate occurrence records for this species within the Project footprint, study area of from within a 50 km buffer of the disturbance footprint. The nearest database records occur approximately 65 km from the Project area between Beenleigh and Tamborine Mountain (refer Figure 1.37). These records are dated from the 1980s and 90s with some recent records (2016).

Figure 1.37 Distribution range of Bahrs scrub fontainea in relation to the Project

Source: ALA (2020)

1.18.2.4 Biology and reproduction

Bahrs scrub fontainea is dioecious having separate male and female plants within the population. The male flowers of the species have 20 to 24 stamens and a disc 0.7 mm high whilst the female flowers have the same size disk, styles measuring 0.5 mm in length and an ovary that is hairless (glabrous) (Jessup and Guymer 1985).

1.18.3 Habitat

The species is associated with Araucarian microphyll vine forest occurring on alluvial soil along creeks in areas that receive an average of 1000 mm of rainfall a year (BRI collection records n.d.).

1.18.4 Threatening processes

The following have been identified as potentially threatening processes to the Bahrs scrub fontainea:

- The restricted, fragmented nature of the species means it is more susceptible to stochastic events
- Inappropriate fire regimes
- Encroachment by exotic flora (DAWE 2020).

1.18.5 Threat abatement/recovery plan

No threat abatement/recovery plan has been identified as being relevant for this species.

1.18.6 References

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2 Fauna species – Conservation significant species – Fish

2.1 Australian lungfish (*Neoceratodus forsteri*)

2.1.1 Status

EPBC Act – Vulnerable

2.1.2 Biology and ecology

2.1.2.1 Characteristics

The Australian lungfish (*Neoceratodus forsteri*) is a heavy-bodied and elongated freshwater fish with five pairs of gills and fins that resemble flippers (refer Photograph 2.1). An adult lungfish can weigh up to 48 kg with a total body length of 2 m. The large, overlapping scales of the fish is dark brown or olive brown on the back however pinkish white on the underbelly and underside of the head. Juvenile lungfish are dark olive, brown or yellow in colour with mottled patterns above the scales with a dull pink belly. Both juvenile and adult lungfish are equipped with sharp cone shaped teeth on the palate and lower jaw (DotEE 2018).

Photograph 2.1 ***Neoceratodus forsteri*** **(Australian lungfish)**

Source: Thomas (2019)

2.1.2.2 Known distribution

The lungfish is an endemic species to Australia and limited in distribution to southeast Queensland (refer Figure 2.1). River systems such as the Mary, Burnett and Brisbane Rivers are inhabited by the species and also been translocated successfully to the Condamine, Albert and Logan Rivers (DotEE 2018).

Figure 2.1 **Distribution range of the Australian lungfish**

Source: ALA (2018); DotEE (2018)

2.1.2.3 Distribution in relation to the Project

Database records (i.e. AoLA, Wildlife Online) indicate this species has been recorded within the MNES study area. There is a 2003 record from Lockyer Creek in the Gatton area (1.2 km north of the Project disturbance footprint). A second record from 1994 is from Lake Apex in Gatton (2 km south of the Project) and is very likely to be the result of human introduction to the lake. There are no records upstream of the Project. There are several further records on Lockyer Creek downstream of the Project although these are all older (pre-2000) until the confluence of the creek with the Wivenhoe Dam spillway (28 km north-east of the Project). The nearest recent record to the eastern extent of the Project (2017) is from the Bremer River located 10 km east of the Project in the Rosewood area (refer Figure 2.2). The densest population in the catchment is thought to be over 30 km downstream of the Project in the Brisbane River between Wivenhoe Dam and Mount Crosby Pumping Station (DotEE 2019).

Waterways crossed by the Project alignment are within the upper catchment of the Brisbane River and include Lockyer Creek. Habitat values across the catchment appeared poor with little canopy cover over creeks, heavily impacted riparian zones, and cattle access in some areas. Aquatic habitat assessment at the location of the Project crossing on the Lockyer Creek in September 2017 noted water as present with shallow pools being dominant with few deeper pooled areas likely to be suitable for Australian lungfish. Emergent macrophytes were present along approximately 5 per cent of the 100 m of reach assessed. Similar instream habitat elements were noted at a second site 300 m further upstream although macrophyte cover was generally higher (approximately 30 per cent cover). Lockyer Creek occurs in a heavily modified landscape and riparian cover at these sites was very poor. Downstream sites included the section of Lockyer Creek where the 2003 record noted above was approximately located. Habitat values were similar to the upstream sites and no water was present during the aquatic habitat assessment.

Surface water quality sampling for the EIS studies was carried out on three sampling occasions (October 2017, March 2018 and March 2019) at the 12 aquatic habitat assessment sites. Six of the sites could only be sampled on one occasion due to dry conditions (i.e. no water was present). The other six sites were sampled on only two of the three water sampling surveys due to dry conditions indicating waterways in the assessment catchment are ephemeral and less likely to be suitable for Australian lungfish (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further detail).

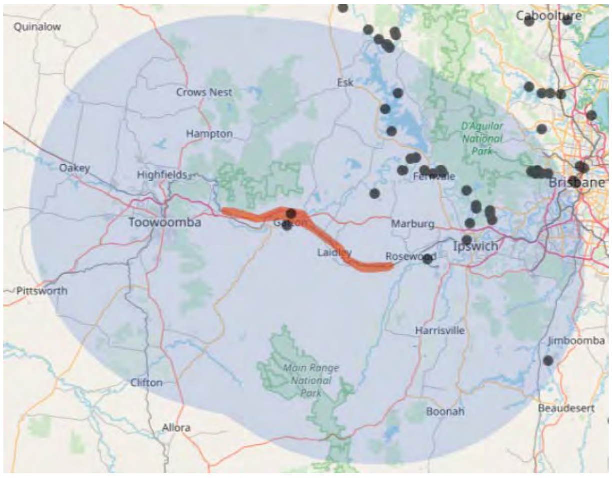

Figure 2.2 **Distribution range of the Australian lungfish in relation to the Project**

Source: ALA (2020)

2.1.2.4 Biology and reproduction

The primary source of food for the Australian lungfish is molluscs and other small animals. The species is known to be a low level benthic carnivore with hatchlings and juveniles feeding on small invertebrates as active predators during the developmental stage (Kemp 1996).

The breeding cycle of the lungfish occurs at around 15 years of age for the male and 20 years for the female with spawning at night between August and December in preferably clear waters. Spawning cycles are triggered by increased daylength with lungfish pairing spawn amongst aquatic macrophytes, producing a clutch size of 50 to 100 eggs. The species is known to abandon any spawning sites upon disturbance (DotEE 2018).

2.1.3 Habitat

The preferred habitat of the species is still or slow-flowing, shallow waters with clear, vegetated pools to allow feeding, shelter and spawning. Vegetation such as Red bottle-brush (*Callistemon saligna*), She-oak (*Casuarina* spp.) and aquatic macrophytes are the dominant species used by the lungfish. Despite the capability of the species to breath aerially using its single lung, it requires permanent water and cannot live in saline environments (Brooks and Kind 2002).

2.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Australian lungfish:

- Impoundment through development of dams, weirs and bridges
- Erratic recruitment
- Accidental targets by recreational anglers
- Predation of eggs by species such as the Tilapia (*Cichlidae)*
- Clearing of riverbanks (DotEE 2018).

2.1.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified for this species:

- DotEE Draft National Recovery Plan for the Australian Lungfish (*Neoceratodus forsteri*). Commonwealth of Australia 2017.

2.1.6 Summary of threat abatement/recovery plans

Threats outlined in the recovery plan for this species includes:

- Instream barriers
- Regulated flows
- Habitat degradation and reduced water quality
- Introduced native and non-native invasive species
- Fishing and boating activities
- Specific threats relevant to the catchments this species occurs in.

Recovery actions outlined in the recovery plan for this species includes:

- Ensuring that new waterway barrier works complies with fish passage requirements according to the Fishers Act 1994
- Record artificial barriers to the species movement within their range and develop mitigation measures
- Develop and implement measures to minimise Australian lungfish stranding events
- Determine and minimise injury and mortality rates resulting from stranding events and movement over weirs and dam walls
- Design fishway and storage management plans ensuring compliance with fishway management plans
- Provide ongoing maintenance and repairs of fishways
- Identify important breeding sites or the species and other key sites required for protection, restoration and management conserving key habitat
- Engage with land holders to reduce livestock access to priority shallow river margin sites
- Maintain water quality during storage and release
- Expand on existing aquatic weed removal programs
- Expand on existing community education programs throughout the species' distribution
- Where feasible manage the movement of invasive species preventing translocations within and between catchments
- Input research into stocking activities and how this impacts the species developing best practice protocols
- Maintain the 'no take' status of the species under the *Fisheries Act 1994*
- Estimate the extent of mortality from recreational fishing and boating
- Implement long term monitoring for the species, model population responses to adaptive management, impacts of poor water quality on recruitment, habitat requirements, survival and dispersal patterns and level of genetic variability
- Investigate ecology of aquatic macrophyte required for successful recruitment.

2.1.7 References

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2.2 Mary River cod (*Maccullochella mariensis*)

2.2.1 Status

EPBC Act – Endangered

2.2.2 Biology and ecology

2.2.2.1 Characteristics

The Mary River cod (*Maccullochella mariensis*) is a pale green to golden-yellow fish with dark brown mottled scales featuring heavily on the fish's body. This fish species has a protruding lower jaw, concaved head profile and soft dorsal fins as well as thin white edged anal and caudal fins (refer Photograph 2.2). The average weight of this species is approximately 5 kg with a total body length of 70 cm (DotEE 2018; DAF 2018).

Photograph 2.2 Mary River cod (*Maccullochella mariensis*)

Source: DAF (2018)

2.2.2.2 Known distribution

The Mary River cod is endemic to the Mary River catchment in southeast Queensland (refer Figure 2.3). Creek systems which feed off the Mary River such as Six Mile, Tinana-Coondoo and Obi Obi Creek are all well-known areas of distribution for the Mary River cod (Simpson and Jackson 1996).

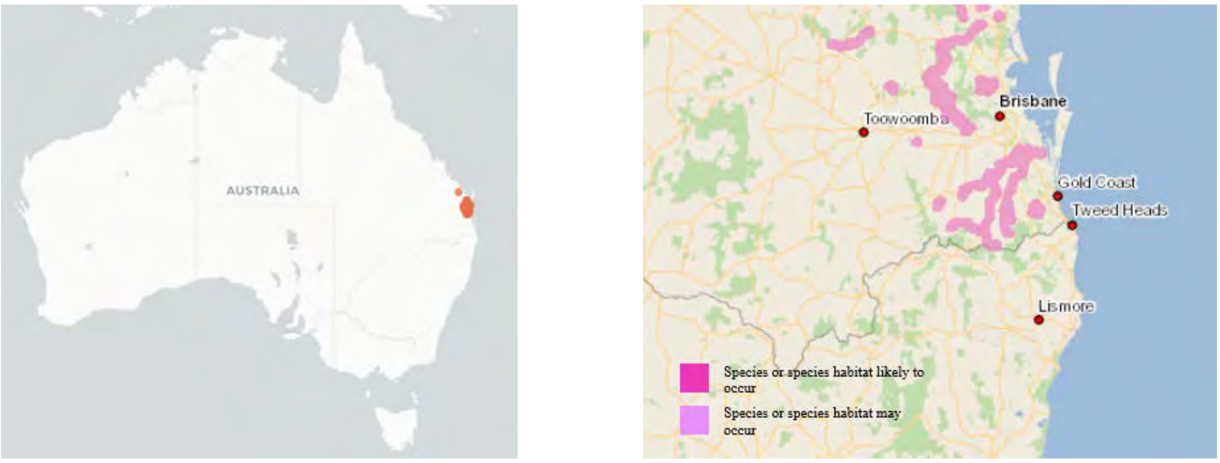

Figure 2.3 Distribution range of the Mary River cod

Source: ALA (2018); DotEE (2018)

2.2.2.3 Distribution in relation to the Project

Maccullochella mariensis has been predicted to occur within the region and associated habitat within the MNES study area. However, there are no current database records (i.e. AoLA) for this species within 50 km of the temporary and permanent Disturbance footprint. The nearest records occur to the north of the Project from Maleny to Gympie approximately 130 km from the Disturbance footprint (refer Figure 2.4).

Surface water quality sampling for the EIS studies was carried out on three sampling occasions (October 2017, March 2018 and March 2019) at the 12 aquatic habitat assessment sites. Six of the sites could only be sampled on one occasion due to dry conditions (i.e. no water was present). The other six sites were sampled on only two of the three water sampling surveys due to dry conditions indicating waterways in the assessment catchment are ephemeral and less likely to be suitable for Mary River cod (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further detail). Furthermore the Mary River cod is endemic to the Mary River catchment, which is not associated with the Project MNES study area.

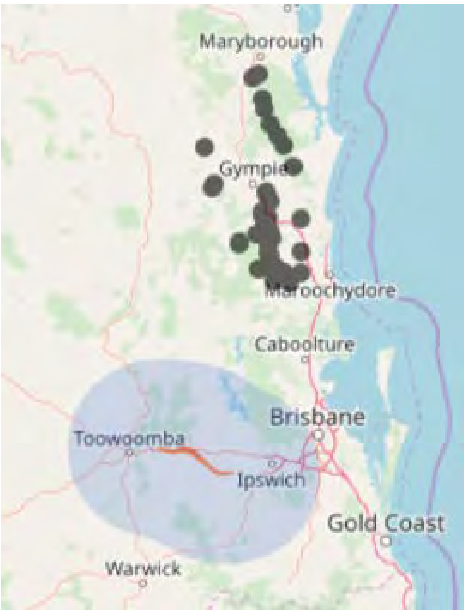

Figure 2.4 Distribution range of the Mary River cod in relation to the Project

Source: ALA (2020)

2.2.2.4 Biology and reproduction

Adult Mary River cod feed on a variety of prey such as fish, freshwater crayfish, shrimp, mussel, frogs and even small reptiles. Juvenile Mary River cod feed on crustaceans including crayfish and shrimp, insect larvae. Newly hatched cod consume zooplankton and aquatic insects such as chironomid larvae (Gomon and Bray 2018).

The Mary River cod form pairs and spawn annually around spring, as water temperature reaches 20°C with the male selecting and guarding the nest site which is thought to be hollow logs in the wild. Eggs, which may be as many as 2,000 eggs per kilogram of the female fish’s bodyweight, are deposited as a layer inside the log which are opaque in colour with hatching occurring towards the end of the fourth day and complete by the seventh day (TSSC 2016).

2.2.3 Habitat

The preferred habitat for the species is a high gradient, rocky, upland stream or slow-flowing pools in lowland areas. Deep, shaded areas of water with snags and log-piles are often inhabited as they provide good conditions of the species to spawn. The Mary River cod is known to migrate over 30 km into smaller tributaries in late winter either up or down stream and have a long home range returning after long absences (Simpson and Jackson 1996; TSSC 2016).

2.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Mary River cod:

- Impoundment of streams
- Loss of riparian vegetation
- Competition by invasive species (DotEE 2018).

2.2.5 Threat abatement/recovery plans

No threat abatement plan has been identified as being relevant for this species. The following recovery plan is applicable to this species:

- Simpson, R. & P. Jackson (1996). *The Mary River Cod Research and Recovery Plan*. Queensland Department of Primary Industries - Fisheries Group. Available from: http://www.environment.gov.au/resource/mary-river-cod-research-and-recovery-plan. In effect under the EPBC Act from 09-Mar-2001 as *Maccullochella mariensis*.

2.2.6 Summary of threat abatement/recovery plans

Important populations outlined in the National Recovery Plan for the *Mary River Cod Maccullochella mariensis* that could be relevant to the Project include:

- Tinana-Coondoo Creek
- Six Mile Creek
- Obi Obi Creek.

Threats identified in the National Recovery Plan include:

- Habitat change
- Overfishing
- Introduced fish species.

Recovery actions outlined in the National Recovery Plan include:

- Establishing a program of community involvement/education in order to foster public support or the conservation of the species
- Develop and implement regulations and administration actions to protect the species and their habitat
- Manage captive breeding and restocking efforts into suitable habitat
- Research biological requirements to improve captive-breeding techniques
- Implement programs to rehabilitate riparian and instream habitats in the Mary river system along with targeted restocking sites
- Develop and implement a long-term monitoring program for assessment of the species.

2.2.7 References

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2.3 Murray cod (*Maccullochella peelii*)

2.3.1 Status

EPBC Act – Vulnerable

2.3.2 Biology and ecology

2.3.2.1 Characteristics

The Murray cod (*Maccullochella peelii*) is the largest freshwater species of fish in Australia, measuring up to 1.8 m in length and weighing about 10 kg although some records indicate the species may reach over 100 kg in weight. The Murray cod has a broad head, rounded snout, equal length jaws and has a concaved facial profile. The light olive to dark green scales of the fish has mottled pattern, with a white ventral colouration. The pectoral fins of the fish are rounded and large with soft dorsal, anal and caudal fins with distinctive red or white edging (DotEE 2018) (refer Photograph 2.3).

Photograph 2.3 Murray cod (*Maccullochella peelii*)

Source: Flagstaffotos (2006)

2.3.2.2 Known distribution

The Murray cod was once a widespread species and abundant in the lower and mid reaches of the Murray-Darling Basin between Queensland and South Australia (refer Figure 2.5). However, the distribution of the species has now reduced to several bioregions between Queensland and Victoria, including the Brigalow Belt South Bioregion (National Murray Cod Recovery Team 2010).

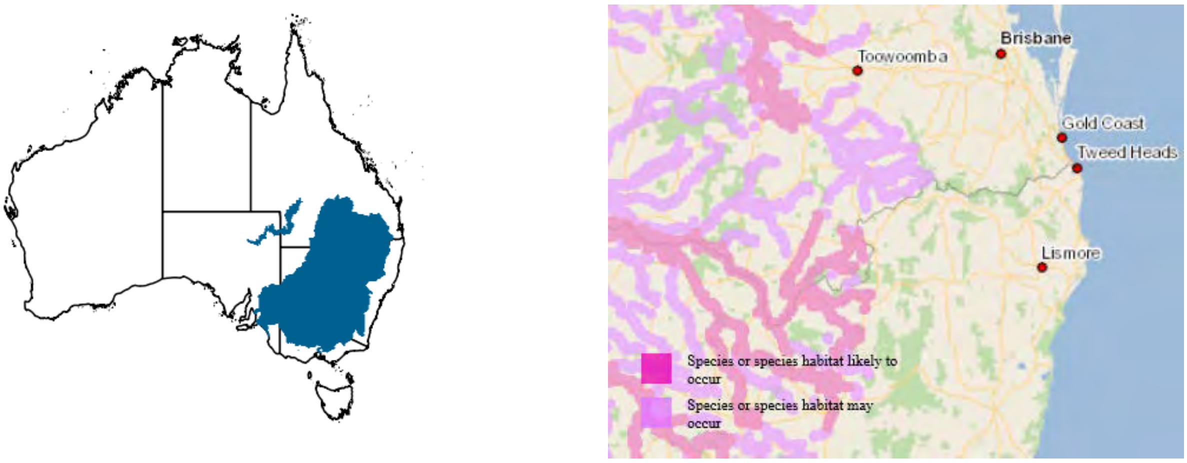

Figure 2.5 Distribution range of Murray cod

Source: ALA (2018); DotEE (2018)

2.3.2.3 Distribution in relation to the Project

Maccullochella peelii has been identified as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species occurs in Toowoomba, however this record failed the data quality test based on incorrect habitat for the species the only other record within a 50 km buffer of the Disturbance footprint failed the same data quality test (refer Figure 2.6). Based on this there are no reliable database records that exist within 50 km of the Disturbance footprint. Other records outside of a 50 km buffer exist to the west, south-west and south of the alignment.

Surface water quality sampling for the EIS studies was carried out on three sampling occasions (October 2017, March 2018 and March 2019) at the 12 aquatic habitat assessment sites. Six of the sites could only be sampled on one occasion due to dry conditions (i.e. no water was present). The other six sites were sampled on only two of the three water sampling surveys due to dry conditions indicating waterways in the assessment catchment are ephemeral and less likely to be suitable for Murray cod (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further detail).

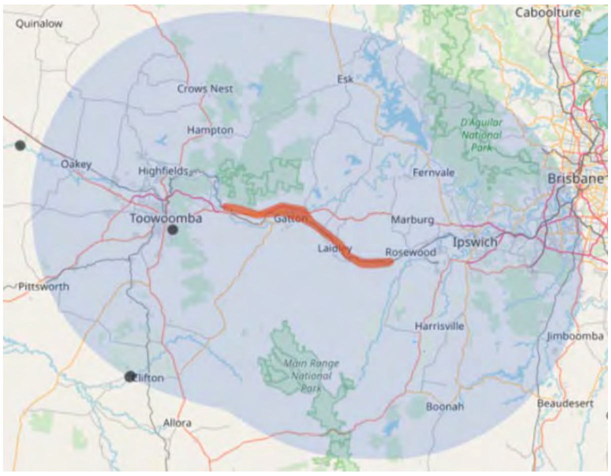

Figure 2.6 **Distribution range of Murray cod in relation to the Project**

Source: ALA (2020)

2.3.2.4 Biology and reproduction

Due to the size of the Murray cod, it is considered the apex predator of the Murray-Darling river system and known to ambush its prey. The demersal species is known to hunt from sunset to sunrise, feeding on spiny crayfish and shrimp as well as reptiles and other fish species including cod (DotEE 2018).

The Murray cod has relatively low fertility compared to many other freshwater fish with the species generally reaching sexual maturity, which is heavily dependent on size, at 5 years of age. Male Murray cod, who are known to guard and fan the eggs during incubation, mature at a larger size than females with the species breeding as a pair. A female cod weighing 3 kg can produce up to 10,000 eggs often laid in logs or snags after developing them through winter until spawning, which is triggered by an increase in temperature and day length (DotEE 2018).

Upon hatching larvae tend to remain clustered in their nest for up to 11 days with the male continually providing protection before the larvae leave the nest to drift downstream and feed on zooplankton as well as aquatic insects (DotEE 2018).

2.3.3 Habitat

The habitat of the species is diverse, ranging from clear rocky streams to slow-flowing, turbid lowland rivers or billabongs where the fish is found frequently in the main channel. Due to the species preferred breeding environment, it is often found in streams containing large rock, snags, overhanging vegetation, stumps or other woody structures (DotEE 2018).

The species is known to take long distance journeys prior to spawning travelling up to several hundred kilometres upstream despite their naturally sedentary nature (Koehn et al. 2009).

2.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Murray cod:

- Impoundment of streams and altered water flow
- Loss of riparian vegetation
- Habitat removal, modification and degradation (DotEE 2018).

2.3.5 Threat abatement/recovery plans

No threat abatement plan has been identified as being relevant for this species. The following recovery plan is applicable to this species:

- National Murray Cod Recovery Team (2010). National Recovery Plan for the Murray Cod *Maccullochella peelii peelii*. Department of Sustainability and Environment, Melbourne. Available from: http://www.environment.gov.au/resource/national-recovery-plan-murray-cod-maccullochella-peelii-peelii. In effect under the EPBC Act from 16-Dec-2010 as *Maccullochella peelii*.

2.3.6 Summary of threat abatement/recovery plans

Important populations outlined in the National Recovery Plan for the Murray Cod *Maccullochella peelii* that could be relevant to the Project include:

- New South Wales: Darling River main channel and tributaries
- New South Wales: Murray River main channel and tributaries
- New South Wales: Murrumbidgee River from Wagga to Hay
- New South Wales: Edwards River and tributaries
- New South Wales: Naomi River, Peel River junction to Wee Waa
- New South Wales: Gwydir River and major tributaries from Copeton Dam to Gwydir River
- New South Wales: Birder rivers (Barwon and Macintyre) including major tributaries in NSW
- Queensland: Border Rivers
- Queensland: Condamine River
- Queensland: Warrego River between Charleville and Cunnamulla
- Queensland: McIntyre River downstream of Texas.

Threats identified in the National Recovery Plan include:

- Flow regulation
- Habitat degradation
- Lowered water quality
- Barriers
- Exotic/alien species
- Commercial fishing
- Recreational fishing
- Illegal fishing
- Stocking and translocations
- Genetic issues
- Disease
- Climate change.

Objectives outlined in the National Recovery Plan include:

- Determine the distribution, structure and population dynamics across the MDB
- Manage river flows in a way that enhances recruitment
- Risk assess the threats and evaluate benefits of recovery actions
- Determine habitat requirements for various life stages

- Manage recreational fishing in a sustainable manner taking into account the social, economic and recreational value of the fishery
- Encourage community ownership of conservation for the species
- Manage recovery plan implementation.

2.3.7 References

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National Murray Cod Recovery Team (2010). National Recovery Plan for the Murray Cod Maccullochella peelii peelii. Department of Sustainability and Environment, Melbourne. Available from: http://www.environment.gov.au/resource/national-recovery-plan-murray-cod-maccullochella-peelii-peelii [Accessed 22 August 2018].

3 Fauna species – Conservation significant species – Reptiles

3.1 Collared delma (*Delma torquata*)

3.1.1 Status

EPBC Act – Vulnerable

3.1.2 Biology and ecology

3.1.2.1 Characteristics

The Collared delma (*Delma torquata*) is a flap-footed lizard that has no forelimbs but retains vestigial hind limbs in the form of small scaly flaps. The body of the Collared delma is brown to reddish-brown in colour becoming grey to bluish-grey on the tail. It has large black bands across the head and nape interspaced by four cream-yellow stripes. This species moves with a snake-like gait through the matrix but travel with a series of wriggling leaps over open ground. The Collared delma is a small cryptic species reaching a maximum size of 7 cm (snout-vent) and a maximum total length of approximately 190 mm (DotEE 2018; Santos 2012).

3.1.2.2 Known distribution

The Collared delma is endemic to southeast Queensland. The known distribution of the species occurs at Lockyer Forest Reserves, Western Creek near Millmerran, the Toowoomba Range eastward to Moggill on the western outskirts of Brisbane (refer Figure 3.1). The largest known occurrence of this species occurs on the Toowoomba range where large numbers of this species were subject to translocation activities associated with the Toowoomba second range crossing project (DotEE 2018; Schell and Stark pers. obs. 2017).

Figure 3.1 **Distribution range of the Collared delma**

Source: ALA (2018): DotEE (2018)

3.1.2.3 Distribution in relation to the Project

Delma torquata has been identified as potentially occurring within the MNES study area. The Collared delma has not been recorded within or adjacent to the Project footprint. The nearest database records are two from 1995 taken from the Lockyer Forest Reserves 4.5 km and 6 km north of the Project in the Helidon area. There is a 2019 record with a high spatial uncertainty located further north-west (16 km north of Gatton). Records associated with the population associated with the Toowoomba second range crossing project are approximately 11 km west of the western extent of the Project (Schell and Stark pers. obs. 2017) (refer Figure 3.2). Further north and west the species occurs in Bunya Mountains National park and Yarraman State Forest and surrounds (AoLA 2020). The Project footprint is located near the southern limit of the species range.

Project associated surveys noted potential habitat for the species (woodlands with loose surface rocks) as occurring where the Project disturbance footprint intersects the Little Liverpool Range and habitat connected to the south of the Lockyer Forest reserves in the Helidon area.

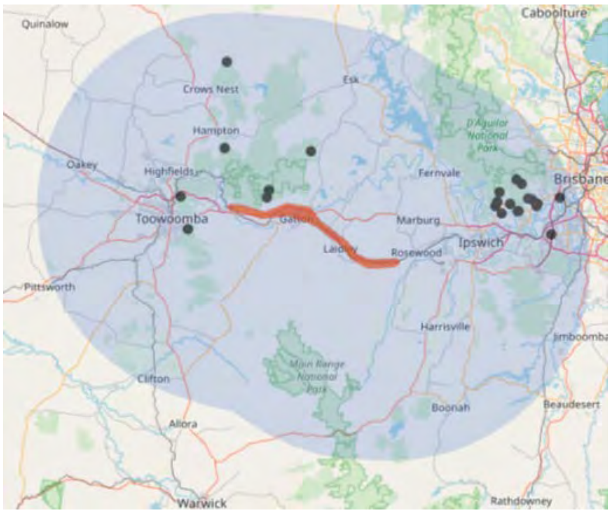

Figure 3.2 **Distribution range of the Collared delma in relation to the Project**

Source: ALA (2020)

3.1.2.4 Biology and reproduction

The Collared delma feeds on insects and spiders, with small cockroaches the most common prey item. Some individuals have been captured in subterranean termite colonies (Davidson 1993; Porter 1998; Schell and Stark pers. obs. 2017).

As with all members of the Pygopodidae family, the Collared delma produces two small white, elongated eggs in December. These hatch in February to March (Peck and Hobson 2007; Schell and Stark pers. obs. 2017).

3.1.3 Habitat

The Collared delma typically inhabits Eucalypt-dominated woodlands and open-forests in Queensland RE Land Zones 3, 9 and 10 (Brigalow Belt Reptiles Workshop 2010). However, recent studies associated with the species indicate that the species is most frequently associates with open *Eucalyptus crebra* woodland (canopy cover between 10 to 30 per cent) located on northwest facing slopes (Schell and Stark pers. obs. 2017).

The Collared delma has been recorded from rocky areas associated with dry open forests. This species occurs in open Eucalypt and acacia woodland with an understorey of native grasses and loose rocks. The Collared delma has also been recorded from Eucalypt woodland adjacent to semi-evergreen vine thicket. This species shelters under rocks, fallen timber, leaf litter and in soil cracks (Richardson 2006).

The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of the Collared delma microhabitat and is always present where the species occurs (Brigalow Belt Reptiles Workshop 2010; Davidson 1993; Schell and Stark pers. obs. 2017).

3.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Collared delma:

- Loss and modification of habitat due to urban and agricultural development
- Landscaping activities removing surface rocks
- Invasive weed species such as Dwarf lantana (*Lantana montevidensis*) (DotEE 2018).

3.1.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species. The Priority Threat Management for Imperilled Species of the Queensland Brigalow Belt has been identified as being relevant for this species. Available from: https://publications.csiro.au/rpr/download?pid=csiro:EP154521&dsid=DS5 (Ponce Reyes, R., J. Firn, S. Nicol, I. Chadès, D.S. Stratford, T.G. Martin, S. Whitten & J. Carwardine, 2016).

3.1.6 Summary of threat abatement/recovery plans

Given the difficulty in detecting the Collared delma (*Delma torquata*) the Commonwealth environmental department considers that the presence of suitable and important habitat for this species is a surrogate for an important population of the species. Important habitat as described in the Draft referral guidelines for the nationally listed Brigalow Belt reptiles (available from: http://www.environment.gov.au/system/files/resources/570964ac-15bf-4e07-80da-848fead7b0cd/files/draft-referral-guidelines-comment-brigalow-reptiles.pdf) includes:

- Open forest eucalypt woodland dominated by ironbarks
- Woodland adjacent to exposed rocky areas
- RE Land Zones 3, 9 and 10

Threats to the Brigalow belt environmental community outlined in the Threat Management for Imperilled Species of the Queensland Brigalow Belt includes:

- Grazing
- Cultivation of arable crops
- Coal mining
- Coal Seam Gas industry development and associated infrastructure
- Changes in hydrology and pollution
- Invasive animals
- Invasive flora
- Fire
- Climate change.

Conservation management outcomes identified in the Threat Management for Imperilled Species of the Queensland Brigalow Belt document includes:

- Management of 29 national parks through the Department of National Parks, Sport and Racing

- Management of four Conservation Parks and one Resource Reserve that protects the brigalow ecosystems through the Department of Natural Resources and Mines supporting conservation and rehabilitation of the natural environment
- Encouraging sustainable agriculture to improve biodiversity and farm practices
- 'Back on Track' initiative prioritising the conservation, management and recovery of Queensland's native species
- Indigenous land management practices implemented for weed and fire management by Traditional Owners
- Biodiversity offsets through voluntary or mandatory investments in conservation management.

3.1.7 References

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Santos. (2012). GLNG Project. Available from: https://www.santos.com/media/3820/significant-species-management-plan-smmp-part-2-p.pdf [Accessed 22 August 2018].

Schell, C and and J. Stark (2017). Personal observations of *Delma torquata* associated with the implementation of the Collared Delma translocation Management Plan for the Toowoomba Second Range Crossing Project.

3.2 Dunmall's snake (*Furina dunmalli*)

3.2.1 Status

EPBC Act – Vulnerable

3.2.2 Biology and ecology

3.2.2.1 Characteristics

Dunmall's snake (*Furina dunmalli*) is a small to medium-sized, venomous (family Elapidae), snake that typically grows to a length of up to 75 cm. It has a uniform dark grey-brown colour on the top of the body, which fades to white at its lower flanks and has 21 rows on the mid-section. Most of the scales near the upper lip exhibit pale blotches. The head is large and distinct from the neck (DES 2017).

3.2.2.2 Known distribution

Dunmall's snake is endemic to Australia and inhabits areas near the Queensland border within the Brigalow Belt South bioregion to the Nandewar bioregion in NSW (refer Figure 3.3). In Queensland, the snake is often found in areas 200 to 500 m above sea level with recorded sightings in Oakey and Inglewood. In NSW, the species is predominantly found in the northeast inland region (DotEE 2018).

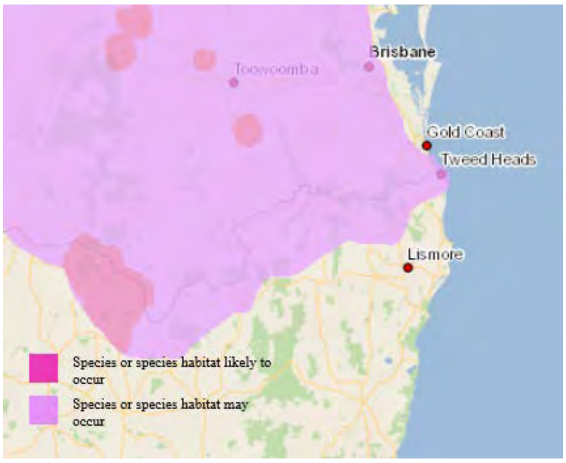

Figure 3.3 **Distribution range of the Dunmall's snake**

Source: ALA (2018); DotEE (2018)

3.2.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Furina dunmalli* has been identified from database searches as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species has been recorded approximately 45 km from the Project to the west at Oakey (refer Figure 3.4). This is the only database records available from within a 50 km buffer of the alignment, however there is no record date available bringing into question the reliability of the record. The modelled distribution in the *Draft Referral guideline for the nationally listed Brigalow Belt reptiles* for this species indicates habitat in which Dunmall's snake may occur exists within the MNES study area (DSEWPC 2011).

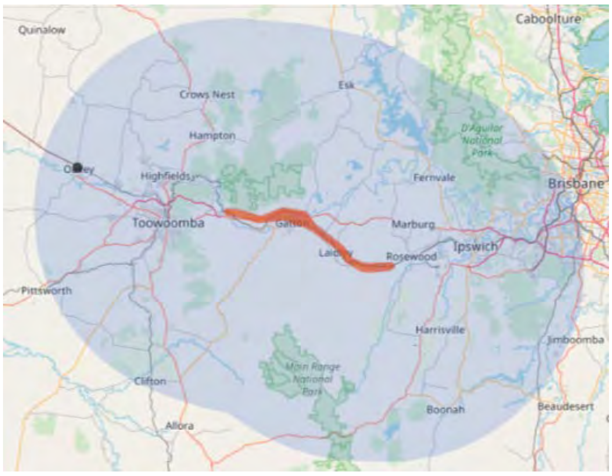

Figure 3.4 **Distribution range of the Dunmall's snake in relation to the Project**

Source: ALA (2020)

3.2.2.4 Biology and reproduction

Dunmall's snake are known to eat small lizards such as skinks and geckos. Analysis of the gut contents of this species yielded the remains of Tree skink (*Egernia striolata*). Limited knowledge is available on the snake's life cycle or reproductive behaviour; however, it is known that the species lays eggs rather than live young (DotEE 2018).

3.2.3 Habitat

Given the rarity, and difficulty of detecting Dunmall's snake, all suitable habitats (remnant or non-remnant vegetation) that are coincident with the known locations of the species are considered important habitats. Dunmall's snake has been found in a broad range of habitats, including:

- Forests and woodlands on black alluvial cracking clay and clay loams dominated by Brigalow (*Acacia harpophylla*), other Wattles (*A. burowii, A. deanii, A. leioclyx*), native Cypress (*Callitris* spp.) or Bull-oak (*Allocasuarina luehmannii*)
- Various Spotted gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra* and *E. melanophloia*), White cypress pine (*Callitris glaucophylla*) and Bull-oak open forest and woodland associations on sandstone derived soils
- The edge of dry vine scrub near Tarong Power Station, Queensland, and hard ironstone country (Queensland RE Land Zone 7) at Lake Broadwater near Dalby, Queensland.

There is a paucity of information related to ecological requirements of this species, however it has been observed sheltering under fallen timber and ground debris, and is known to utilise cracks in alluvial clay soils (DES 2017; DotEE 2018).

3.2.4 Threatening processes

The following have been identified as potentially threatening processes to Dunmall's snake:

- Habitat loss and fragmentation due to land clearing in core areas of the Darling Downs
- Predation by feral animals such as foxes, cats and pigs
- Inappropriate road side management (DES 2017).

3.2.5 Threat abatement/recovery plans

No threat abatement/recovery plans have been identified as being relevant for this species.

3.2.6 References

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3.3 Long-legged worm-skink (*Anomalopus mackayi*)

3.3.1 Status

EPBC Act – Vulnerable

3.3.2 Biology and ecology

3.3.2.1 Characteristic

The Long-legged worm-skink, also called the Five-clawed worm skink (*Anomalopus mackayi*), is a burrowing skink, which is characterised by three fingers and two toes. This species typically grows to 27 cm long. It has smooth scales with an overall greyish-brown upper body, with dark spots in longitudinal rows. Its ventral surface is yellow-green with dark flecking. In the southern region of its range, this species is unpatterned, while in the north, it has longitudinal rows of dark spots on the dorsal and lateral surfaces (Cogger 2000; DotEE 2018).

3.3.2.2 Known distribution

The known distribution of the Long-legged worm-skink is patchy in north-eastern NSW and south-eastern Queensland (refer Figure 3.5). In south-eastern Queensland, the species' known distribution is on the upper Condamine River floodplain, from Warwick in the south, to the Jimbour region in the north, and bordered by the western edge of the granite belt (Brigalow Belt Reptiles Workshop 2010; DotEE 2018).

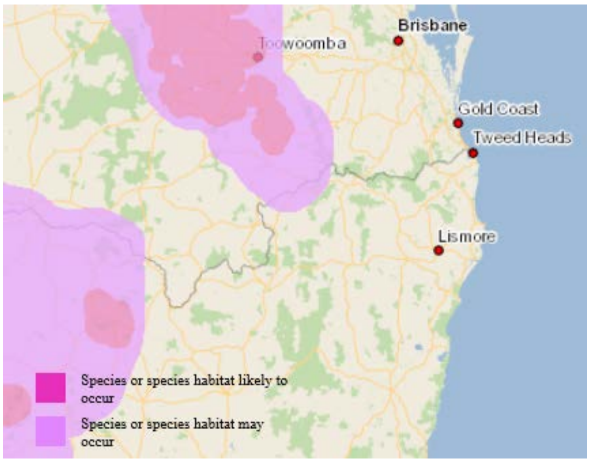

Figure 3.5 **Distribution range of the Long-legged worm-skink**

Source: ALA (2018); DotEE (2018)

3.3.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Anomalopus mackayi* has been identified from database searches as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species is known from a record approximately 25 km to the west of the Project at Toowoomba from 1983. Other more recent records dated within the last 20 years exist from within a 50 km buffer of the alignment to the south-west of the Project. The modelled distribution in the *Draft Referral guideline for the nationally listed Brigalow Belt reptiles* for this species indicates habitat in which the Long-legged work-skink may occur exists within the MNES study area (DSEWPC 2011).

Figure 3.6 **Distribution range of the Long-legged worm-skink in relation to the Project**

Source: ALA (2020)

3.3.2.4 Biology and reproduction

Very little is known about the Long-legged worm-skink's reproduction and diet. However, it is believed to feed on arthropods, such as white ants and captive specimens have been recorded eating mealworms (Cogger et al. 1983; Shea et al. 1987).

Long-legged worm-skinks lay up to three eggs per clutch during Spring (Shea et al. 1987; Wilson and Knowles 1988; Ehmann 1992).

3.3.3 Habitat

The Long-legged worm-skink is known to occur in both remnant and non-remnant woodlands and grasslands, and in areas modified by agriculture and other human activities. It is typically found under timber, leaf litter and other debris. It is also known to inhabit rotting tree base cavities, logs and tussock bases. This species has been found sheltering under artificial materials lying flat on the ground, such as discarded railway sleepers, sheet metal and hay bales. On the Darling Downs, the species occurs in Bluegrass (*Dichanthium sericeum*) and/or Mitchell Grass (*Astrebla* spp.) dominated grasslands, or mixed grasslands dominated by other grass species (Brigalow Belt Reptiles Workshop 2010; DotEE 2018).

3.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Long-legged worm-skink:

- Land clearing for agriculture has been particularly severe within the Long-legged worm-skink's range
- Overgrazing compacts soil making it difficult for the species to find suitable shelter
- Removal of logs and timber also reduces soil humidity and the amount of shelter available for the species. Agricultural chemicals may poison and pollute the soil which may adversely affect the species
- Predation by feral species, such as cats and foxes, is another threat facing much of Australia's native wildlife including the Long-legged worm-skink (Brigalow Belt Reptiles Workshop 2010; NSW NPWS 1999).

3.3.5 Threat abatement/recovery plans

No threat abatement/recovery plan exist for this species. The following recovery plans are relevant to this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10055**. In effect under the BC Act 2016.
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The following threat abatement plan is relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats**. In effect under the EPBC Act from 23-Jul-2015.

3.3.6 Summary of threat abatement/recovery plans

Anomalopus mackayi is assigned as a data-deficient species under the NSW *Saving our Species Program* as there is little known about the ecology and habitat requirements of this species. State wide conservation actions identified for this species include:

- Encourage community education, awareness and involvement
- Encourage landholders to enter voluntary conservation and site management agreements
- Create corridors to reduce isolation of known population sites
- Protect or fence areas to create high quality habitat that sustains a significant population or foraging area
- Develop and test artificial refuge habitat as an interim protection measure

- Monitor the species for movement patterns, habitat range, success of management actions and for new threats at the site, movement pa
- Develop a successful technique to survey
- Identify two targeted populations annually to focus recovery actions on
- Conduct fox baiting

Threats identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Land use and management change
- Agricultural and horticultural development
- Public Infrastructure upgrades in travelling stock routes (TSRs)
- Firewood collection and ‘tidying up’
- Changed fire regimes
- Increase in soil nutrients and use of chemicals
- Mowing and slashing regimes
- Revegetation management
- Weed invasion
- Climate change
- Salinity
- Acid soils
- Declining tree health and regeneration
- Increased grazing pressure from invasive herbivores
- Disease – *Phytophthora cinnamomi*
- Collection and removal of native flora.

Recovery actions identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Collect baseline data on the locations, quality and management regimes of remnant sites
- Extent and condition mapping
- Component species surveys
- Protection of existing habitat in priority areas including on private land
- Engagement with the community, particularly where remnants occur on private land to provide information on appropriate management and with Aboriginal communities.

Summary of baseline information actions undertaken to date:

- The establishment of databases comprising of information on CMN members (land managers with Box-Gum Grassy Woodland remnants), remnant locations, composition of flora and fauna species and remnant condition from surveys of CMN members’ sites and other sites
- Minimum condition criteria and assessment method developed to assist land managers in identification of listed ecological communities
- Development of regional models using remote sensing
- Mapping of Box-Gum Grassy Woodland extent
- Surveys conducted during research programs through various organisations.

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

3.3.7 References

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3.4 Three-toed snake-tooth skink (*Coeranoscincus reticulatus*)

3.4.1 Status

EPBC Act – Vulnerable

3.4.2 Biology and ecology

3.4.2.1 Characteristic

The Three-toed snake-tooth skink (*Coeranoscincus reticulatus*) has reduced limbs, each with three digits and a total length of approximately 483 to 565 mm. Adults are usually dark around the eyes and ears with a distinct wedge-shaped, pointed pale snout. Dorsal colour in adults is generally brown to yellowish brown or grey with a dark brown collar. Individual flecked scales have dark brown streaks and there are small, dark brown scattered spots on the back and streaks on the throat. Ventral scales are normally greyish and dark-edged to form a fine reticulum-like pattern (DotEE 2018).

Juveniles are cream to brown dorsally with prominent, irregular transverse dark bands that are more conspicuous on the anterior and often absent on the posterior. In juveniles the scales on the sides of the body are dark-edged, forming irregular longitudinal streaks (DotEE 2018).

3.4.2.2 Known distribution

The Three-toed snake-tooth skink occurs from Crescent Head in northeast NSW to Fraser Island in southeast Queensland. Most records are from the Border Ranges in the vicinity of the NSW/Queensland border (refer Figure 3.7). In Queensland, the Three-toed Snake-tooth skink has a disjunct north-south distribution, with the species absent from apparently suitable habitat in the D'Aguilar Ranges, between the lowland areas of Fraser Island and Cooloola and upland records from Blackall Range and Conondale Range (DotEE 2018).

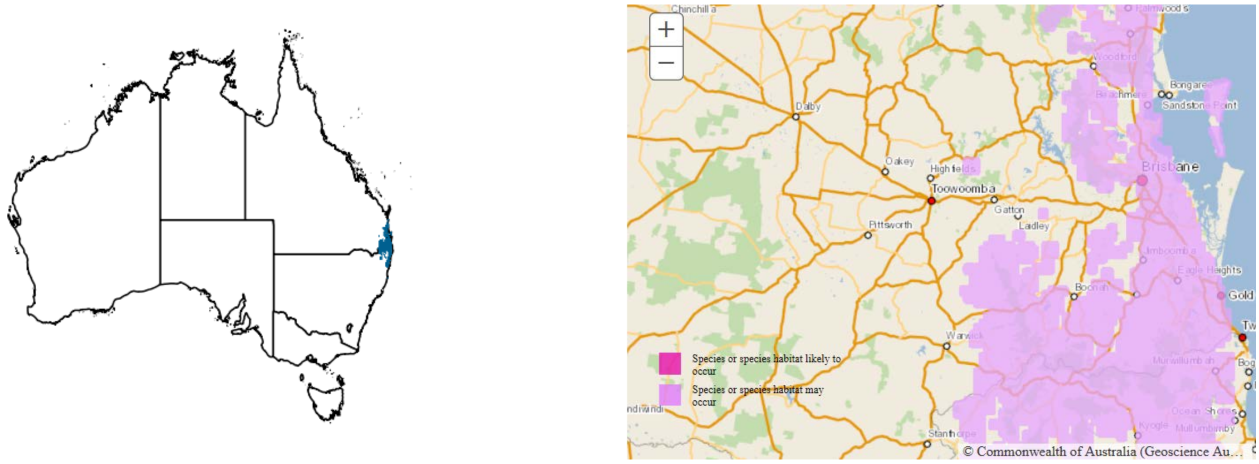

Figure 3.7 **Distribution range of the Three-toed snake-tooth skink**

Source: ALA (2018), DotEE (2018)

3.4.2.3 Distribution in relation to the Project

This species was not identified within any Project-associated field surveys including limited protected plant surveys within the alignment (Ecological 2019; EMM 2019). *Coeranoscincus reticulatus* has been identified as potentially occurring within the MNES study area from database searches. Database records (i.e. AoLA) indicate this species exists approximately 40 km south of the Disturbance footprint at Main Range National Park with records dated older than 30 years (refer Figure 3.8). Other records outside of a 50 km buffer exist to the south of the Project at Mount Barney, Lamington and Border Ranges National Parks.

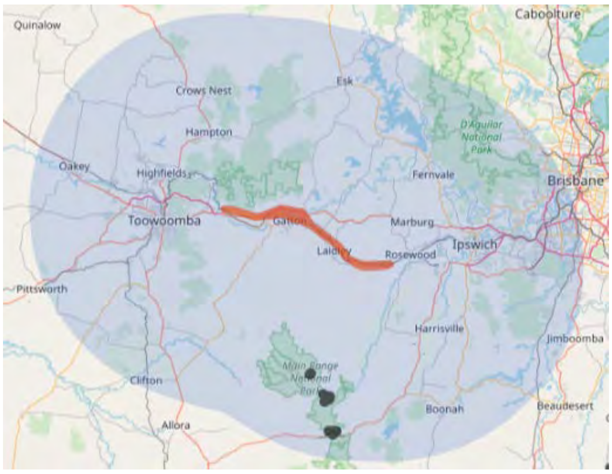

Figure 3.8 **Distribution range of the Three-toed snake-tooth skink in relation to the Project**

Source: ALA (2020)

3.4.2.4 Biology and reproduction

Examination of the Three-toed snake-tooth skink's stomach contents indicates that they eat earthworms, beetle larvae and insects. It is believed that they encounter earthworms on the forest floor at night and in the loose soil that the skink burrows (DotEE 2018).

Females of the Three-toed snake-tooth skink have been recorded with 2 to 6 oviducal eggs. Records show that eggs (23.7 to 28.9 mm) are large for a skink of this size (DotEE 2018).

3.4.3 Habitat

The Three-toed snake-tooth skink has been found in loose, well mulched friable soil, in and under rotting logs, forest litter, bark and under decomposing cane mulch. In Queensland, the Three-toed snake-tooth skink has been recorded in rainforest, closed forest, wet sclerophyll forest, tall open Blackbutt forest, tall layered open eucalypt forest and closed Brush Box forest and regrowth in heavily logged areas. In NSW, the Three-toed snake-tooth skink has been recorded in dry rainforest, northern warm temperate rainforest, subtropical rainforest, grassy wet sclerophyll forest and shrubby sclerophyll forest (DotEE 2018; OEH 2018).

3.4.4 Threatening processes

The following have been identified as potentially threatening processes to the Three-toed snake-tooth skink:

- Clearing of habitat for agriculture and grazing,
- Removal of fallen logs and leaf litter through frequent fire
- Soil compaction from livestock grazing
- The domestic cat and the red fox are also known to prey on skinks (DotEE 2018; OEH 2018).

3.4.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=316&ReportProfileID=10131. In effect under the BC Act 2016.

3.4.6 Summary of threat abatement/recovery plans

Coeranoscincus reticulatus is assigned to the landscape species management under the NSW *Saving our Species Program* as it is distributed over a large area and is subject to threatening processes that effect at the landscape scale.

Threats identified in the Saving our Species program include:

- Alterations to fire regime resulting in a loss of habitat within rainforest (considered to be an emerging threat due to climate change)
- Grazing stock causing loss of leaf litter and compaction of soil
- Firewood collection resulting in reduced habitat in fallen logs and leaf litter
- Habitat degradation, loss of shelter and forage habitat through feral pig activity

Management activities to protect this species at the sites are:

- Raise awareness with relevant landholders and reduce deliberate burning that is likely to affect this species
- Promote strategic grazing that maintains the structure and function of the ground layer
- Educate private and commercial firewood collectors on the importance of retaining woody debris in areas of known habitat
- Identify important areas of habitat within state forests so disturbance to the ground layer can be minimised
- Monitor pig activity in the species habitat and control via cage trapping and/or poison ground-baiting.

3.4.7 References

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4 Fauna species – conservation significant species – mammals

4.1 Brush-tailed rock-wallaby (*Petrogale penicillata*)

4.1.1 Status

EPBC Act – Vulnerable

4.1.2 Biology and ecology

4.1.2.1 Characteristic

The male Brush-tailed rock-wallaby (*Petrogale penicillata*) is typically larger than the female and generally weigh 5.5 to 10.9 kg with females weighing 4.9 to 8.2 kg. Males grow to 529 to 586 mm and females to 510 to 570 mm in head-body length. Individuals are brown above, tending to be rufous on the rump and grey on the shoulders. Typically, the chest and belly is paler, with some individuals possessing a white blaze on the chest. The Brush-tailed rock-wallaby has a white to buff cheek stripe and a black dorsal stripe from the forehead to the back of the head. The exterior of the ears is black, and inside the ears is buff (refer Photograph 4.1). Individuals from the north of the species range tend to be lighter and have a less prominent tail brush (DotEE 2018).

Photograph 4.1 Brush-tailed rock-wallaby

Source: Bryant (2019)

4.1.2.2 Known distribution

Populations of the Brush-tailed rock-wallaby occur throughout the Great Dividing Range from the border with NSW to Nanango, 100 km northwest of Brisbane (refer Figure 4.1). Although there are no recent surveys published from Queensland, this species is considered to be declining and vulnerable, with the population in Lamington National Park now considered to be extinct (Clancy and Close 1997; Eldridge and Close 1992; Maxwell et al. 1996).

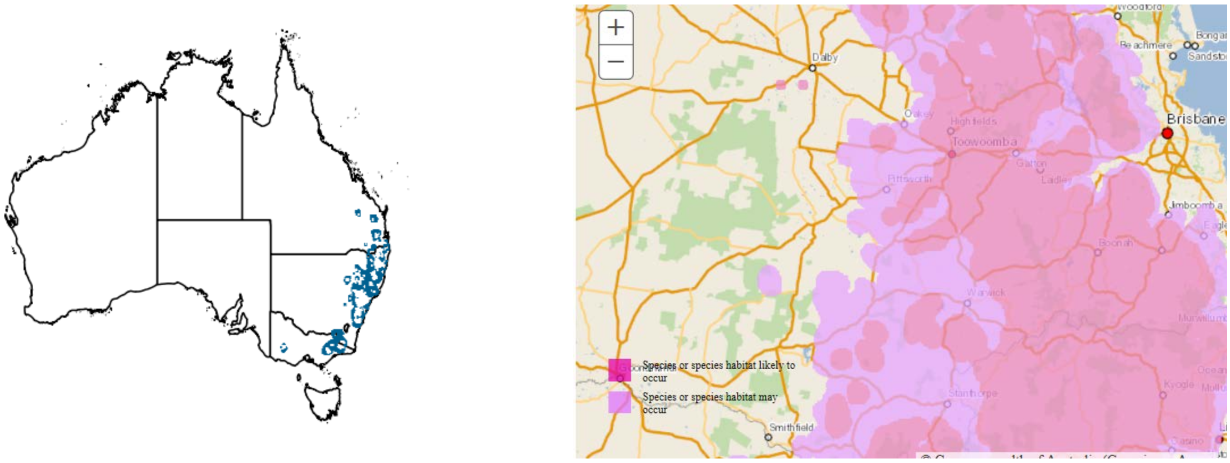

Figure 4.1 **Distribution range of the Brush-tailed rock-wallaby**

Source: ALA (2018), DotEE (2018)

4.1.2.3 Distribution in relation to the Project

Database records indicate Brush-tailed rock-wallaby has been recorded adjacent to the Project disturbance footprint in the Helidon area, although this is an older record (1996). There are records (1997 and 2004) from the Lockyer Forest Reserves area further north (6 km and 10 km respectively from the Project) and a 2001 record 20 km north of Gatton. Other database records occur to the north of the Project in the Crows Nest area. To the west there are two older records (1973) from the Toowoomba Range.

The species is also known from the Little Liverpool Range (ICC 2018) although the nearest record (2019) is 16 km south of the Project (refer Figure 4.2). The population in the Little Liverpool Range has been subject to limited onsite assessment since 2013 under activities implemented by Ipswich City Council as part of the *Brush-tailed rock wallaby recovery plan* (ICC 2018). Observations on the local population have been focused on the Mount Beau Brummell Conservation park and adjacent lands (16 km south of the Project). It is unknown to what extent the species may occur further north where the Project occurs, if at all. It is noted this area is already highly modified with existing road and rail infrastructure and rural housing occurring in the area.

Habitat assessments carried out for the Project EIS studies identified no rocky shelter habitat suitable for Brush-tailed rock-wallaby within the sites visited within the MNES study area or Project disturbance footprint. Analysis of aerial imagery shows the database records located north of the Project are mostly associated with rocky areas located in the Lockyer Forest Reserves, Toowoomba Range and Crow’s Nest areas. This habitat was not observed within the Project disturbance footprint.

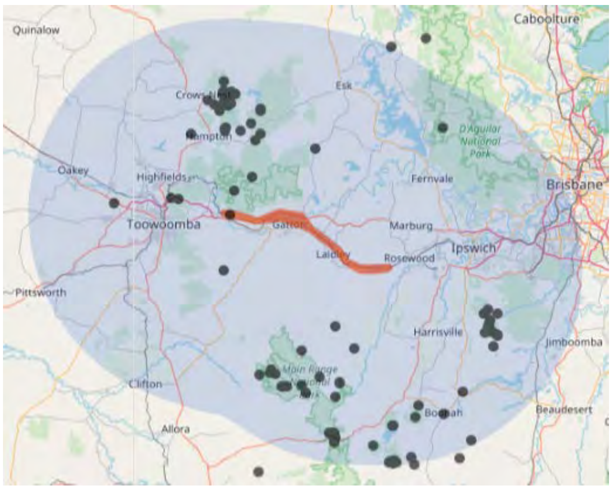

Figure 4.2 **Distribution range of the Brush-tailed rock-wallaby in relation to the Project**

Source: ALA (2020)

4.1.2.4 Biology and reproduction

The diet of the Brush-tailed rock-wallaby consists primarily of grasses (35 to 50 per cent), forbs (25 to 40 per cent) and "browse" (shrubs, trees and climbers) (12 to 30 per cent) with ferns and sedges constituting a very minor component. Brush-tailed rock-wallabies typically forage at night (DotEE 2018).

Sexual maturation of females occurs at 18 months and males at 20 to 24 months. Brush-tailed rock-wallabies are a polygamous species and a dominant male will be found with up to four females. They appear to live in family groups of two to five adults and usually one or two juveniles and sub-adult individuals but are also known to occur in male-female pairs (DotEE 2018).

Females give birth to one pouch young at a time, after a gestation period of approximately 30 days. The young remain in the pouch for six months. Weaning is believed to occur 86 days after leaving the pouch, when the joey is nine months old (DotEE 2018).

4.1.3 Habitat

The Brush-tailed rock-wallaby prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges and isolated rock stacks. However, it is also known to use tree limbs (DotEE 2018)

Rocky outcrops appear crucial to current habitat selection by rock-wallabies; however, vegetation structure and composition is also considered to be an important factor determining habitat suitability. In many parts of their range, including at the Warrumbungles, Brush-tailed rock-wallabies are closely associated with dense arboreal cover, especially fig trees. The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases may provide some protection from predation. A range of vegetation types are associated with Brush-tailed rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest (DotEE 2018).

Brush-tailed rock-wallabies are known to shelter during the day in rock crevices, caves and overhangs, but have been observed to bask in exposed sunny spots. Within their home range, rock-wallabies habitually use the same refuges, sunning spots, feeding areas and pathways and these are often defended vigorously (DotEE 2018).

Brush-tailed rock-wallabies select foraging locations that tend to be more open and with a greater abundance of short green grasses and forbs than other locations nearby. Foraging Brush-tailed rock-wallabies do not favour areas that are concealed by tussocks or near to the cliffs (DotEE 2018).

4.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Brush-tailed rock-wallaby:

- Habitat modification continues due to rural, residential and tourist developments have led to changes in vegetation structure, extent, species assemblages and species proportions (DEC 2005)
- Other impacts also include changed fire regimes, competition from exotic herbivores, land degradation, altered nutrient status, and even altered behaviour and numbers of other native animals (DEC 2005)
- The invasion of grassy feeding areas by weed species such as Lantana is thought to reduce habitat quality for the species (DotEE 2018)
- Predation from domestic cats, red foxes and wild dogs are known threats to *P. penicillata* (DotEE 2018)
- Brush-tailed rock-wallabies are found in small, fragmented populations which exhibit low migration rates and are highly vulnerable to local catastrophes, predations, inbreeding and the associated loss of genetic variation (DEC 2005)
- Bioclimatic changes resulting in lower rainfall and a decline in rainforest vegetation, may have contributed to the recently contracting distribution of *P. penicillata* throughout its range (DEC 2005).

4.1.5 Threat abatement/recovery plans

The following threat abatement Plan have been identified as being relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016. In effect under the EPBC Act from 07-Jan-2017.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox. In effect under the EPBC Act from 01-Oct-2008.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for competition and land degradation by unmanaged goats. DEWHA, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-unmanaged-goats. In effect under the EPBC Act from 01-Oct-2008.

The following Recovery plan has been identified as being relevant to this species:

- Menkhorst, P. & E. Hynes (2010). National Recovery Plan for the Brush-tailed Rock-wallaby Petrogale penicillata. Department of Sustainability and Environment, East Melbourne. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/brush-tailed-rock-wallaby-petrogale-penicillata. In effect under the EPBC Act from 10-Feb-2012.

4.1.6 Summary of threat abatement/recovery plan

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Supress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

Threats identified in the threat abatement plan for competition and land degradation by unmanaged goats relevant this species include:

- Overgrazing by goats and resulting soil erosion
- Introduction of weeds through seeds carried in their dung.

The primary focus of the abatement plan is the control of unmanaged goat populations. The main objectives of controlling unmanaged goats are:

- Prevent unmanaged goats from occupying new areas in Australia and eradicate them from high-conservation value areas
- Promote the maintenance and recovery of native species and ecological communities that are affected by competition and land degradation by unmanaged goats
- Improve knowledge and understanding of unmanaged goat impacts and interactions with other species and other ecological processes
- Improve the effectiveness, target specificity, integration and humaneness of control options for unmanaged goats
- Increase awareness of all stakeholders of the objectives and actions of threat abatement plan, and of the need to control unmanaged goats.

The conservation strategy for National Recovery Plan for the Brush-tailed Rock-wallaby Petrogale penicillata identifies the following priority management sites:

- Victoria: Grampians Range - Moora Moora Creek (Grampians National Park)
- Victoria: East Gippsland – Little River Gorge (Snowy River National Park)
- New South Wales: Warrumbungle Range
- New South Wales: Mt Kaputar
- New South Wales: Wollemi National Park and Jenolan Caves
- New South Wales: Nattai National Park
- New South Wales: Shoalhaven
- New South Wales: Macleay Gorges region.

Threats outlined in the conservation strategy for National Recovery Plan for the Brush-tailed Rock-wallaby *Petrogale penicillate* include:

- Historical hunting and persecution for fur and meat
- Habitat degradation and loss
- Predation from native and feral species
- Competition with native and introduced herbivores
- Decline in genetic diversity.

Objectives and actions outlined in the conservation strategy for National Recovery Plan for the Brush-tailed Rock-wallaby *Petrogale penicillate* include:

- Determine threats faced by the species

- Determine current distribution, abundance and population trends
- Establish and maintain a captive population
- Perform translocations to improve the genetic robustness of existing populations
- Investigate key ecological and biological aspects of the species for conservation management
- Increase community awareness and support for the species' conservation.

4.1.7 References

Atlas of Living Australia (2018), *Petrogale penicillata.* Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7a7a2817-26e7-44bd-bb34-1dc9c1ed4d38 [Accessed 21 August 2018].

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4.2 Greater glider (*Petauroides volans*)

4.2.1 Status

EPBC Act – Vulnerable

4.2.2 Biology and ecology

4.2.2.1 Characteristic

The Greater glider (*Petauroides volans*) is the largest species of gliding possum with a head-body length of 350 to 460 mm and a long furry tail measuring 450 to 600 mm. It has large ears fringed with thick fur and a gliding membrane which attaches to the elbows and ankles. Its thick fur is white or cream below but the upperparts can vary from dark grey to dusky brown through to light mottled grey and cream (refer Photograph 4.2). It also has strongly reflective eyeshine in the beam of a spotlight (DotEE 2018; OEH 2018).

Photograph 4.2 **Greater glider (*Petauroides volans*)**

Source: Bowell (2019)

4.2.2.2 Known distribution

The Greater glider occurs in Eucalypt forests along the ranges and coastal plains of eastern Australia from Central Victoria near Daylesford to the Windsor Tablelands in far northern Queensland (refer Figure 4.3). It has an elevational range from sea level to 1,200 m above sea level (DotEE 2018, OEH 2018; TSSC 2016).

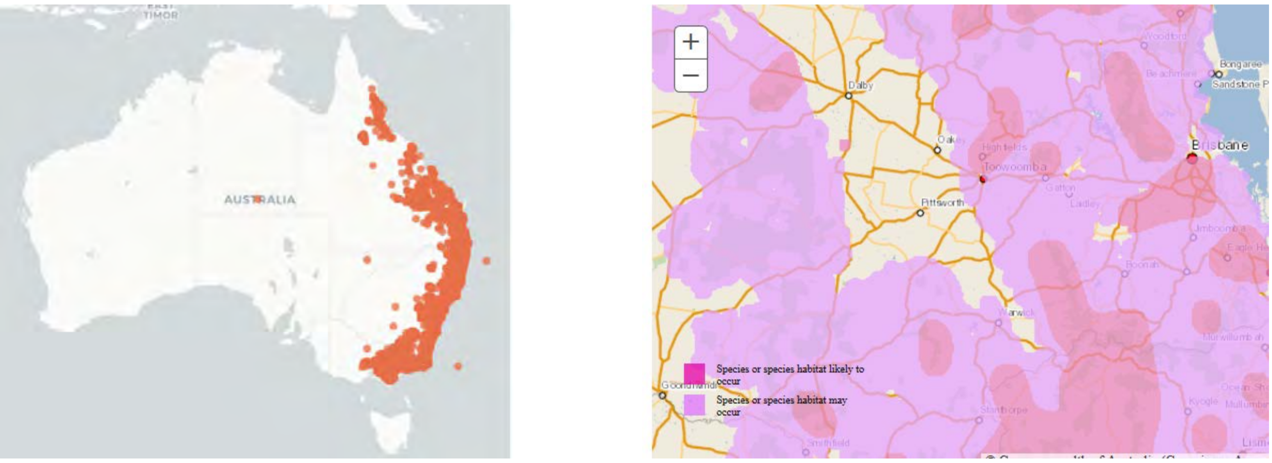

Figure 4.3 **Distribution range of the Greater glider**

Source: ALA (2018), DotEE (2018)

4.2.2.3 Distribution in relation to the Project

The species has not been recorded during Project-associated surveys and there are no database records (AoLA) within the MNES study area. The nearest database records are several (all from the 1990s) and located in the Lockyer Forest Reserves (all between 5 km and 8 km north of the Project). Another 1989 record is from the Rosewood area located 8 km north-east of the eastern extent of the Project (AoLA 2020). The nearest recent records are from 2010 and 2016 and located north of Toowoomba (16 km west and 22 km north-west of the Project) (refer Figure 4.4).

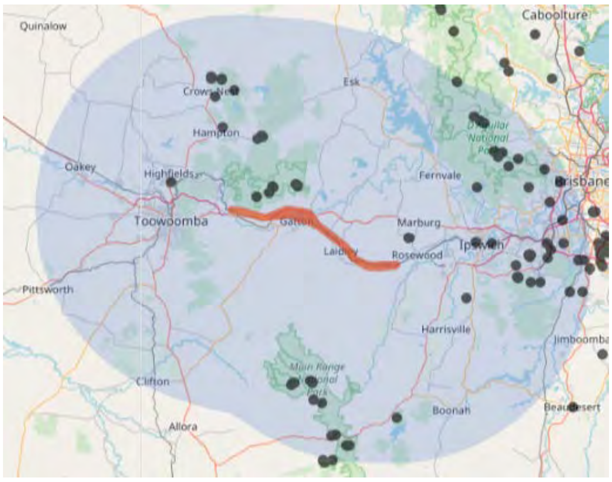

Figure 4.4 **Distribution range of the Greater glider in relation to the Project**

Source: ALA (2020)

4.2.2.4 Biology and reproduction

The Greater glider is nocturnal and feeds solely on young leaves and flower buds of specific eucalypts. Similarly to koalas, what eucalypt species Greater gliders feed on depends on what species are available to the specific populations in the immediate area. For example, in the Redlands, Queensland, their species of preference are *Eucalyptus tereticornis, Eucalyptus pilularis, Eucalyptus racemosa, Eucalyptus siderophloia, Eucalyptus resinifera, Eucalyptus carnea, Eucalyptus crebra, Eucalyptus major, Eucalyptus propinqua, Eucalyptus microcorys* and *Corymbia maculata* (Menkhorst and Knight 2011; RCC 2008).

They are usually solitary, though mated pairs and offspring will share a den during the breeding season and until the young are independent. Mating occurs from March to June and the female gives birth to a single young in late autumn or early winter. The young remain in the pouch for approximately 4 months and then rides on the mothers back until the age of 9 months when it is considered independent. Sexual maturity is reached in the second year. Longevity is estimated at 15 years and they have a relatively low reproductive rate (DotEE 2018; OEH 2018; TSSC 2016).

4.2.3 Habitat

The Greater glider is largely restricted to eucalypt forests and woodlands. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows, but the distribution may be patchy even in suitable habitat. The greater glider favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species. They tend to prefer more open woodlands with larger spaces between trees, so they have room to glide (DotEE 2018).

During the day they shelter in large hollows in large, old trees. In southern Queensland, greater gliders require at least 2 to 4 live den trees for every 2 ha of suitable forest habitat. Home ranges are relatively small (1 to 4 ha), with male home ranges being largely non-overlapping. They are known to be very loyal to their territory (DotEE 2018).

4.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Greater glider:

- Habitat loss and fragmentation from development and clear fell operations are major issues for the Greater glider
- Fires that are too frequent or intense and unsustainable timber production can lead to direct impacts and or loss of habitat
- Changes in vegetation due to climate change, barbed wire fencing and increased predation from native and introduced predators are also threats facing the Greater glider populations (TSSC 2016).

4.2.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

4.2.6 References

Atlas of Living Australia (2018). *Petauroides volans*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7e891f26-c72e-4b29-98db-1cd10c4eaa6d#overview [Accessed 24 August 2018].

Bowell, J. (2019). *Petauroides volans* – Greater glider. [image] [online] Available from: https://images.ala.org.au/image/details?imageId=d277f106-c1fe-4d0d-a625-f0c424190f70. [16 September 2019].

Department of the Environment and Energy (2018). *Petauroides volans* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=254 [Accessed 21 August 2018].

Menkhorst P. & Knight F. (2011). *A Field Guide to the Mammals of Australia, 3rd Edition*. Oxford University Press.

Office of Environment and Heritage, NSW (2017). Greater Glider *Petauroides volans* in the Seven Mile Beach National Park area - profile. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20324 [Accessed 24 August 2018].

Redlands City Council (2008). Biodiversity Research Projects: Greater Gliders. Available from: http://www2.redland.qld.gov.au/EnvironmentWaste/EnvironmentPlans/Documents/Greater%20Gliders.pdf [Accessed 24 August 2018].

Threatened Species Scientific Committee (2016). Conservation Advice on greater glider (*Petauroides volans*). Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/254-conservation-advice-05052016.pdf [Accessed 24 August 2018].

4.3 Grey-headed flying-fox (*Pteropus poliocephalus*)

4.3.1 Status

EPBC Act – Vulnerable

4.3.2 Biology and ecology

4.3.2.1 Characteristic

The Grey-headed flying-fox (*Pteropus poliocephalus*) weighs approximately 600 g to 1 kg, and typically measures 23 cm to 28 cm from head to body. The Grey-headed flying fox exhibits a collar of orange/brown around its neck, whilst its head is covered in light grey. The fur on the body is grey, often with flecks of white and ginger (refer Photograph 4.3). The fur on the back exhibits two morphs, which are possibly related to age, moult, or sub-population. Winter fur is typically darker than summer fur, and pronounced moulting is known to occur in June (DotEE 2018).

Photograph 4.3 Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Leo (2010)

4.3.2.2 Known distribution

The Grey-headed flying-fox occurs in the coastal belt of Eastern Australia, typically ranging from Rockhampton in central Queensland to Melbourne in Victoria (refer Figure 4.5). It is noted that only a small portion of this range is used at any one time, as the species selectively forages where resources are available (DotEE 2018).

The availability of food resources has a direct influence on the occurrence and relative abundance within the Grey-headed flying foxes distribution in various seasons and years (DotEE 2019).

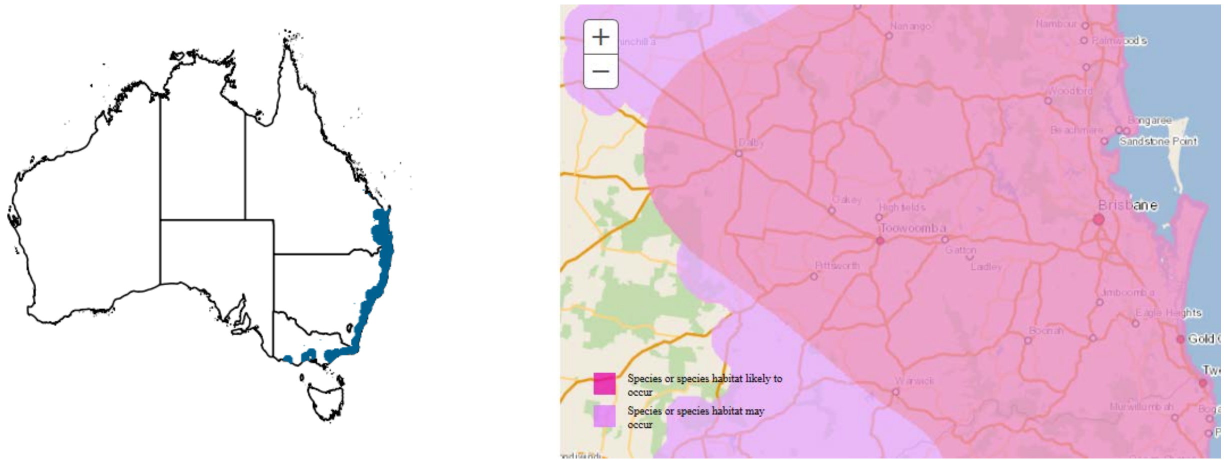

Figure 4.5 Distribution range of the Grey-headed flying-fox

Source: ALA (2018), DotEE (2018)

Distribution in relation to the Project

This species was detected during Project-associated surveys in the vicinity of a known roost site for the species in Gatton (1.5 km south of the Project disturbance footprint) (refer Figure 4.6). The nearest database records are from Laidley (2009 and 2011) and are located within the MNES study area (refer Figure 4.6). There is a 2009 Gatton record form the approximate location of the Project survey observation. In the wider area there are a large number of records occurring in all directions around the Project, although these are largely concentrated to the east of the Project (from Ipswich to Brisbane) and to the west around Toowoomba (AoLA 2020) (refer Figure 4.6). Based on quarterly flying-fox data collected by DES in the south-east Queensland region (extending from 2007 to November 2019) there are three Flying-fox camps located within 15 km of the Project which regularly comprise Grey-headed flying-fox: one each in Laidley, Gatton and the Murphy’s Creek areas. The camps at Laidley and Gatton are located 600 m and 1.2 km south of the Project disturbance footprint respectively.

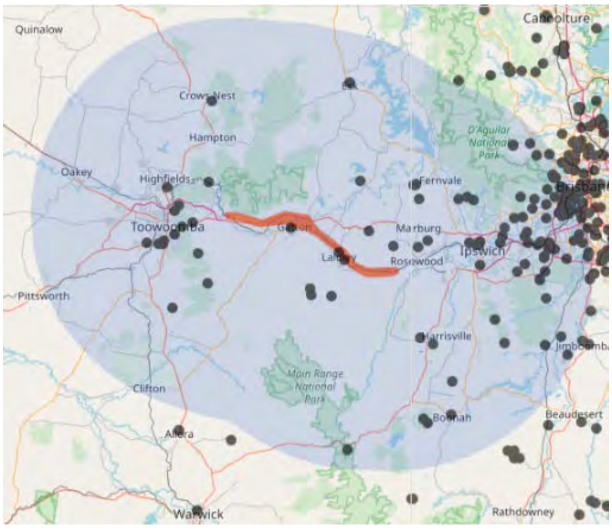

Figure 4.6 **Distribution range of the Grey-headed flying-fox in relation to the Project**

Source: ALA (2020)

4.3.2.3 Biology and reproduction

Nectar and pollen from *Eucalyptus*, *Corymbia, Angophora, Melaleuca*, and *Banksia* species are considered the primary food source for Grey-headed flying foxes. This species is known to supplement its diet with a wide range of rainforest fruits and introduced species (Duncan et al. 1999; DotEE 2019).

Mating is known to occur in the early autumn months, after which time the larger camps begin to separate, reforming in late spring/early summer when food resources become more abundant. Males and females typically separate in October, when the young are born. Each year, following six months of gestation, females bear a single young. For one month after giving birth, the mother carries her offspring on her ventral surface to feeding sites. When completely furred, the young are left in maternal camps, and are nursed until they are independent, at approximately 12 weeks of age. Sexual maturity typically occurs at about three years of age (DotEE 2018).

4.3.3 Habitat

The Grey-headed flying-fox is a canopy-feeding species that eats fruit and nectar. This species utilises a range of vegetated habitats, including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. In an urban setting, this species is known to feed on commercial fruit crops, and on introduced tree species (DotEE 2018).

Roost sites are generally located near water bodies. This species is known to roost in vegetation ranging from rainforest, *Melaleuca* stands, mangroves and riparian vegetation. The species has a high level of roost site fidelity, although new sites have been known to be colonised (DotEE 2018).

4.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Grey-headed flying-fox:

- Clearing of native vegetation for agriculture and forestry operations has accelerated the destruction and disturbance of roosting and foraging habitats of the species in eastern Australia (DotEE 2018; Duncan et al. 1999; SEAC 1996; Teagle 2002)
- Lack of foraging resources can also force Grey-headed flying-foxes into commercial fruit crops, increasing conflict with growers and subsequent culling of individuals (DotEE 2018)
- Urban-dwelling Grey-headed flying-foxes can accumulate lethal levels of lead from the environment and are prone to electrocution on powerlines (DotEE 2018)
- Displacement leading to competition and hybridisation with the Black Flying-fox (*P. alecto*) is also a known threat (DotEE 2018).

4.3.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as being relevant for this species:

- Office of Environment and Heritage (2017). Saving our Species: Help save the Grey-headed Flying-fox. New South Wales Government. Available from: https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=785&ReportProfileID=10697.

4.3.6 Summary of threat abatement/recovery plan

Threats identified in the Saving our Species plan includes:

- Loss of roosting and foraging sites
- Human animal conflict
- Heat stress.

Management actions outline in the Saving our Species plan includes:

- Increase extent and viability of foraging and roosting habitat through habitat creation and restoration
- Liaise with landholders to strike agreements to protect and retain high quality foraging and roosting habitat
- Rehabilitate degraded nesting and foraging habitat managing invasive flora and understorey vegetation to provide suitable microclimate conditions establishing a buffer between bat camps to avoid conflict with people
- Provide education and awareness around the species to foster acceptance and reduce anti-sentiment
- Develop site-based heat stress management strategies recording and sharing data for future heat stress events.

4.3.7 References

Atlas of Living Australia (2018). *Pteropus poliocephalus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:a2553aed-383a-4c9b-9534-c6058bcee81b# [Accessed 24 August 2018].

Department of the Environment and Energy (2018). *Pteropus poliocephalus* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186 [Accessed 24 August 2018].

Duncan, A., Baker, G.B and Montgomery, N. (1999), *The Action Plan for Australian Bats.* [Online]. Canberra: Environment Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/index.html. [Accessed 24 August 2018].

Leo (2010). *Pteropus poliocephalus* - Grey-headed flying-fox. [image] [online] Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:a2553aed-383a-4c9b-9534-c6058bcee81b [24 August 2018].

4.4 Koala (*Phascolarctos cinereus*)

4.4.1 Status

EPBC Act – Vulnerable

4.4.2 Biology and ecology

4.4.2.1 Characteristics

The Koala (*Phascolarctos cinereus*) is an arboreal marsupial, with a stocky body, large rounded ears, sharp claws and has grey-coloured fur (refer Photograph 4.4). This species displays sexual dimorphism (males generally are larger than females), with male Koalas weighing approximately 6.5 kg (DotEE 2018).

Photograph 4.4 Koala (*Phascolarctos cinereus*)

Source: Walker (2017)

4.4.2.2 Known distribution

The Koala is distributed along the east coast of Australia extending from Queensland to NSW (refer Figure 4.7). In Queensland, the Koala's distribution extends across several bioregions, encompassing a great diversity of habitats with the greatest concentration on southeast Queensland. In NSW, the species occurs mostly in central and north coasts with populations known to inhabit the area west of the Great Dividing Range (DES 2017; OEH 2018).

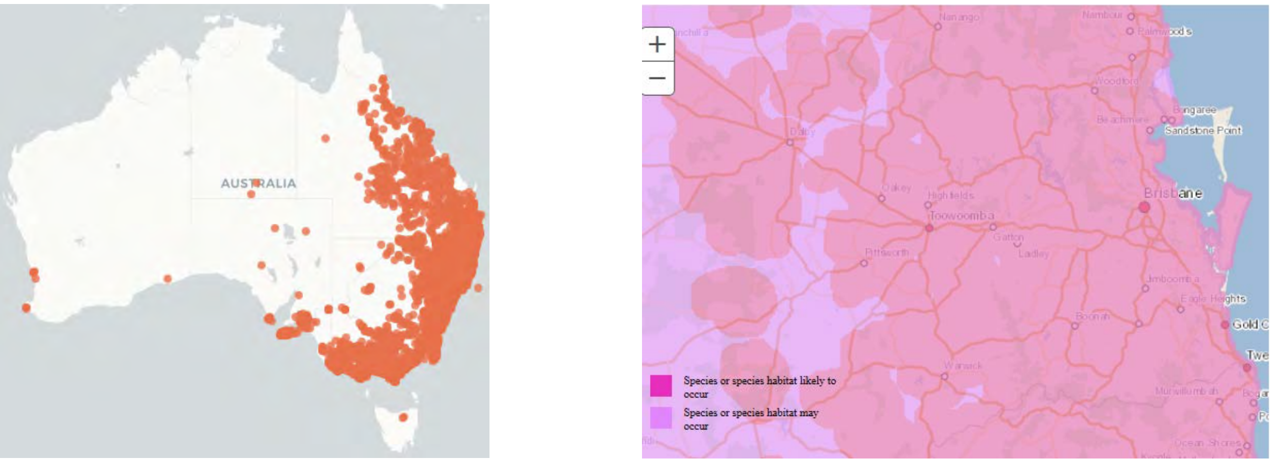

Figure 4.7 Distribution range of Koala

Source: ALA (2018), DotEE (2018)

4.4.2.3 Distribution in relation to the Project

There are numerous database records (i.e. AoLA & Wildlife Online) indicating Koala occurring within the MNES study area and surrounds. A single 2014 record occurs on the edge of the Project disturbance footprint 1.5 km west of Gatton. There are several records within the MNES study area from Helidon to Gatton (refer Figure 4.8). There are records throughout the surrounding area with clusters to the north of the Project in the Lockyer Forest Reserves area, to the immediate south of Helidon, and north of Calvert (refer Figure 4.8). Project associated surveys have recorded Koala scats through much of the alignment including within the Project footprint.

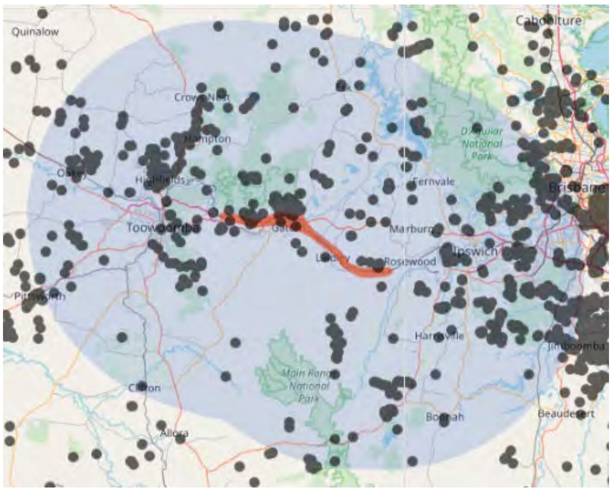

Figure 4.8 **Distribution range of Koala in relation to the Project**

Source: ALA (2020)

4.4.2.4 Biology and reproduction

The Koala is a leaf-eating specialist feeding primarily during dawn, dusk or during the night. Its diet is restricted mainly to foliage of Eucalyptus spp.; however, it may also consume foliage of related genera, including *Corymbia* spp.*, Angophora* spp. and *Lophostemon* spp. The Koala may, at times, supplement its diet with other species, including Leptospermum spp. and Melaleuca spp. (DotEE 2018).

Female Koalas can potentially produce one offspring each year with births occurring between October and May. The newly-born Koala lives in its mother's pouch for six to eight months and, after leaving the pouch, remain dependent on the mother, riding on her back. Young Koalas are independent from about 12 months of age (DotEE 2018).

4.4.3 Habitat

Koala habitat can be broadly defined as any environment containing Koala food tree species (*Eucalyptus* spp., *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp.) or shelter trees. Preferred food and shelter trees are naturally abundant on fertile clayey soils (DotEE 2018).

Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands mostly dominated by Eucalyptus species. Koalas are also known to occur in highly modified (e.g. urbanised) or regenerating native vegetation communities (DotEE 2018).

4.4.4 Threatening processes

The following have been identified as potentially threatening processes to the Koala:

- Habitat loss, modification or fragmentation as a result of urbanisation
- Secondary threats such as predation by domestic dogs, vehicle strikes and stress
- *Chlamydia* which reduces the life expectancy of the species (OEH 2018; DES 2018).

4.4.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified for this species. The following management strategy has been identified as being relevant for this species:

- National Koala Conservation and Management Strategy 2009-2014 (Natural Resource Management Ministerial Council (NRMMC), 2009) [Information Sheet]. Available from: **http://www.environment.gov.au/system/files/resources/165139fc-3ab5-4c96-8b15-d11a1ad882ab/files/koala-strategy.pdf**.

4.4.6 Summary of threat abatement/recovery plan

Threats identified in the conservation and management strategy includes:

- Habitat loss, fragmentation and degradation
- Over-browsing
- Natural disasters
- Disease
- Vehicle collisions
- Predation by dogs
- Climate change.

Management actions outline in the conservation and management strategy includes:

- Identify key habitat with a high priority for protection
- Prioritise populations under immediate pressure
- Revegetate corridors between fragments to facilitate natural dispersal
- Establish a national database mapping habitat, distribution and density
- Establish and support existing surveying and monitoring programs
- Incorporate causes of habitat loss outside of land clearing into planning for habitat conservation
- Identify areas susceptible to severe tree defoliation early and regulate koala density
- Develop a national guideline for road design
- Implement strategies that minimise the impacts of dogs on koala populations
- Assess and develop appropriate methods to reduce vulnerability of populations to disease
- Encourage retention and restoration of koala habitat on private land
- Develop and distribute educational material
- Develop national guidelines that outline appropriate care, handling and management of captive koalas, sick, injured or orphaned koalas
- Identify the direction of research required to address the impacts of climate change on the species.

4.4.7 References

Atlas of Living Australia. (2018). *Phascolarctos cinereus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:e9d6fbbd-1505-4073-990a-dc66c930dad6 [Accessed 22 August 2018].

Department of Environment and Energy (2018). Phascolarctos cinereus (Koala) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=85104 [Accessed 22 August 2018].

Department of Environment and Science (2017). Koala facts. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/koalas/koala-ecology.html [Accessed 22 August 2018].

Office of Environment and Heritage (2018). Koala - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10616 [Accessed 22 August 2018].

Walker, B. (2017). *Phascolarctos cinereus* - Koala. [image] [online] Available from: https://images.ala.org.au/image/details?imageId=72044d32-05fc-47ef-96fd-cd5968d0ed03 [16 September 2019].

4.5 Large-eared pied bat (*Chalinolobus dwyeri*)

4.5.1 Status

EPBC Act – Vulnerable

4.5.2 Biology and ecology

4.5.2.1 Characteristic

The Large-eared pied bat (*Chalinolobus dwyeri*) is a medium-sized insectivorous bat measuring approximately 100 mm in length, and weighing 7 to 12 g. This species exhibits a shiny black coat, with a white stripe on the flank (underside) of each wing. The ears are large and the facial lobes are located on the lower lip, between the corner of the mouth and the bottom of the ear (refer Photograph 4.5). Its short, broad wings suggest that this species flies slowly, and with considerable manoeuvrability (DERM 2011; DotEE 2018).

Photograph 4.5 Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Musser (2017)

4.5.2.2 Known distribution

The former and current distribution of the Large-eared pied bat is poorly known. Records for current distribution exist from Shoalwater Bay and inland to Carnavon in Queensland, through to Ulladulla, in NSW (refer Figure 4.9). It is thought that this species is uncommon and has a patchy distribution (DotEE 2018).

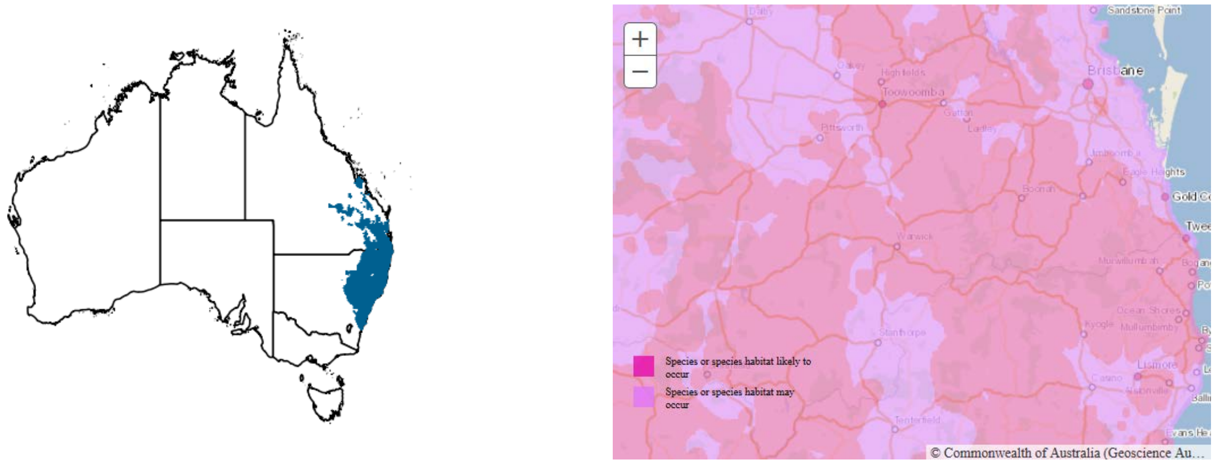

Figure 4.9 **Distribution range of the Large-eared pied bat**

Source: ALA (2018), DotEE (2018)

4.5.2.3 Distribution in relation to the Project

This species was not detected during Project associated surveys. *Chalinolobus dwyeri* has been identified as potentially occurring within the MNES study area from database searches. Database records (i.e. AoLA) indicate the closest record exists from within approximately 30 km west of the Disturbance footprint recently at Toowoomba dated from 2011 (refer Figure 4.10). This record has been flagged as misidentified taxa and refers to *Chalinolobus picatus* (pers. Comm. R Hobson) A second record exists to the south from 1994 at Main Range National Park. No other records exist from within a 50 km buffer of the alignment. Other records exist outside of the 50 km buffer to the south of the alignment from the southern end of Main Range National Park and to the south-east at Lamington National Park.

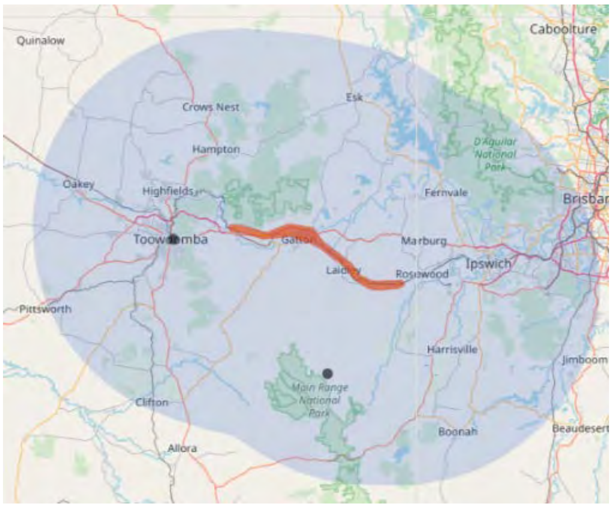

Figure 4.10 **Distribution range of the Large-eared pied bat in relation to the Project**

Source: ALA (2020)

4.5.2.4 Biology and reproduction

The Large-eared pied bat feeds on insects flying at 6 to 10 m off the ground and along creek lines. It is unknown if it targets particular groups of insects (DotEE 2018; DERM 2011).

Females can give birth at one year of age, and males also appear capable of breeding at this age. Mating appears to occur in early winter. A nursery colony is typically established in September by both adult females and males, with the majority of adult males leaving by the time the young are born in early summer. Females are known to give birth to one or two young per year. By the end of March, the juveniles have left the roost. The adult females leave the roost after the juveniles, and the site is abandoned during the winter months. Life expectancy and natural mortality have not been determined (DotEE 2018).

4.5.3 Habitat

Available roosts are unevenly distributed throughout the landscape. Large-eared pied bats require a combination of sandstone cliffs/escarpments to provide roosting habitat that is adjacent to higher fertility sites (particularly box gum woodlands or river/rainforest corridors which are used for foraging) (DotEE 2018).

Large-eared pied bats have been observed in disused mine shafts, caves, overhangs and disused Fairy martin (*Hirundo ariel*) nests for shelter and to raise young. This species possibly also roosts in tree hollows, within dry and wet sclerophyll forest, Cyprus-pine dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland, Brigalow and sandstone outcrop country. In southeast Queensland, the species has primarily been recorded from higher altitude, among moist tall open forest adjacent to rainforest (DotEE 2018).

4.5.4 Threatening processes

The following have been identified as potentially threatening processes to the Large-eared pied bat:

- Disturbance and damage to primary nursery sites by animals (particularly goats) and humans (DotEE 2018; TSSC 2012)
- Populations can be easily displaced as they roost in disused mines which often become active if commodity prices make them economical or they can be filled for safety reasons (DotEE 2018; TSSC 2012).

4.5.5 Threat abatement/recovery plans

The following threat abatement/recovery plans have been identified as relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/Project.aspx?results=c&ProfileID=10157**. In effect under the BC Act 2016.

The following recovery plan is relevant for this species:

- Department of Environment and Resource Management (2011). National recovery plan for the large-eared pied bat Chalinolobus dwyeri. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: **http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-large-eared-pied-bat-chalinolobus-dwyeri**. In effect under the EPBC Act from 10-Feb-2012.

4.5.6 Summary of threat abatement/recovery plan

Chalinolobus dwyeri is assigned as a data-deficient species under the NSW *Saving our Species Program* as there is insufficient information on ecology and distribution for effective management. Vegetation clearing for agricultural purposes is identified as the key threat. The key priority action is to address key knowledge gaps for this species through survey and investigating threat dynamics.

Major threatening processes for this species have not been clearly established, however threats to the *Chalinolobus dwyeri* in the National recovery plan for the large-eared pied bat are:

- Destruction of and interference to subterranean roosts and maternity sites
- Mining of roosts and mine induced subsidence of cliff lines

- Disturbance from human recreational activities such as bushwalking, caving and abseiling
- Habitat disturbance by other animals, including livestock and feral animals such as goats
- Predation by introduced predators such as cats, foxes and possibly rats
- Vegetation clearance in proximity of roosts causing habitat loss and fragmentation and reducing foraging resources
- Fire in proximity to roosts, potentially causing direct mortality from heat stroke and smoke.

Recovery objectives of the plan are:

- Identify priority roosts and maternity sites for protection and map known colonies in NSW and QLD
- Implement conservation and management strategies for priority sites, including foraging habitats
- Install bat gates to protect populations and stabilise site entrances (e.g. old mines)
- Implement fire prescriptions for areas around each identified priority roost or maternity site
- Control introduced species such as goats
- Undertake monitoring to assess the success of management strategies
- Conduct research to improve knowledge on species habitat requirements, roost and maternity sites, diet and foraging strategy and threatening process.

4.5.7 References

Atlas of Living Australia (2018). *Chalinolobus dwyeri*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:cddd224d-40ed-49d9-bb88-dcbfe064a35e#gallery [Accessed 24 August 2018].

Department of Environment and Resource Management (2011). National recovery plan for the Large-eared pied bat *Chalinolobus dwyeri*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of the Environment and Energy (2018). *Chalinolobus dwyeri* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=183 [Accessed 24 August 2018].

Hobson, R. 2020. Atlas of Living Australia Taxon misidentification flagged – *Chalinolobus dwyeri* record. Available from: https://biocache.ala.org.au/occurrences/64382069-7302-4100-9b58-830d499daf9a. [Accessed: 7 May 2020].

Musser, A. (2017). Large-eared pied bat (*Chalinolobus dwyeri*). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=d05ddeaf-7807-489b-9269-50f79951560d. [16 September 2019].

Threatened Species Scientific Committee (2012). *Commonwealth Listing Advice on* Chalinolobus dwyeri *(Large-eared Pied Bat)*. Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/183-listing-advice.pdf. In effect under the EPBC Act from 29 June 2012.

4.6 Long-nosed potoroo (SE mainland) (*Potorous tridactylus tridactylus*)

4.6.1 Status

EPBC Act – Vulnerable

4.6.2 Biology and ecology

4.6.2.1 Characteristic

The Long-nosed potoroo (*Potorous tridactylus tridactylus*) (SE Mainland) is a medium sized marsupial. Males and females have a body length (excluding the tail) between 287 to 410 mm and 259 to 378 mm respectively. Males have longer tails and are typically heavier than females (740 to 1,640 g for males and 660 to 1,350 g for females). They can be identified by a brown-grey upper body and paler underbody. They have small round ears and a long nose that tapers with a small patch of skin extending from the snout to the nose (refer Photograph 4.6). Their tail is sparsely furred, tapered and marked with a white tip. They have only two pads on their hindfeet (DotEE 2018).

Photograph 4.6 Long-nosed potoroo (*Potorous tridactylus tridactylus*)

Source: Augier (2015)

4.6.2.2 Known distribution

In NSW and Queensland, the Long-nosed potoroo (SE Mainland) has scattered populations east of the Great Dividing Range extending from south-eastern Queensland through to NSW (refer Figure 4.11). In Queensland the species has been recorded from southeast of Gladstone to Lamington National Park and the Border Ranges. The species is also found in southern Victoria (DotEE 2018).

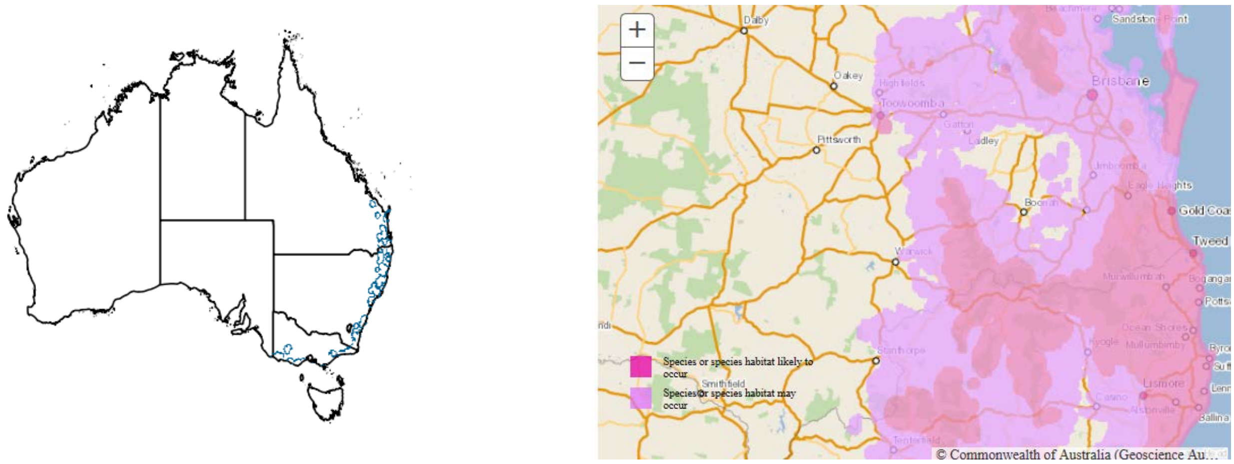

Figure 4.11 Distribution range of the Long-nosed potoroo (SE Mainland)

Source: ALA (2018), DotEE (2018)

4.6.2.3 Distribution in relation to the Project

Species mapping on the SPRAT database shows the species or species habitat as ‘may occur’ only (DAWE 2020). *Potorous tridactylus* has been identified as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicates the nearest database record is from 1990 approximately 15 km north of the Disturbance footprint at Lockyer National Park. Other database records occur within the 50 km buffer including Crows Nest National Park (2012), Ravensbourne National Park (1977) and Deongwar State Forest (2014) to the north-west of the Disturbance footprint. There is also a 2015 record from the Toowoomba Range 17 km south-west of the Project. Numerous records exist at the D’Aguilar National Park from 1955 to 2016 located within approximately 40 to 50 km from the Disturbance footprint (refer Figure 4.12).

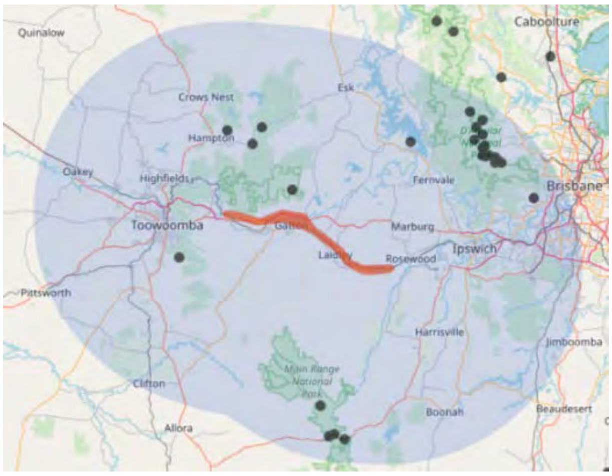

Figure 4.12 **Distribution range of the Long-nosed potoroo (SE Mainland) in relation to the Project**

Source: ALA (2020)

4.6.2.4 Biology and reproduction

The Long-nosed potoroo (SE Mainland) is known to consume flowers, fruits, seeds, leaves, stems, roots and bulbs. They also feed on both hypogeous and epigeous components of fungal fruit bodies as well as invertebrates (DotEE 2018).

The Long-nosed potoroo (SE mainland) breeds all year round a single joey is born after a gestation of 37 days and they remain in their mother’s pouch for 100 to 125 days reaching sexual maturity at about 12 months. They have a lifespan of about 10 years (DES 2017, DotEE 2018).

4.6.3 Habitat

In NSW and Queensland, there is no consistent pattern to the habitat of the Long-nosed potoroo (SE Mainland); it can be found in wet eucalypt forests to warm temperate rainforest and coastal heaths and scrubs. The main habitat requirements appear to be some form of dense vegetation for shelter and the presence of light soils and an abundance of fungi (DotEE 2018; DES 2017).

4.6.4 Threatening processes

The following have been identified as potentially threatening processes to the Long-nosed potoroo:

- The main threat to the Long-nosed potoroo (SE Mainland) is predation by European Red Foxes and Feral Cats (DotEE 2018)
- Residential and industrial development has also caused habitat loss, degradation and fragmentation (DotEE 2018).

4.6.5 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this species. The following threat abatement plans are relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox. In effect under the EPBC Act from 01-Oct-2008.

4.6.6 Summary of threat abatement/recovery plans

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

4.6.7 References

Augier, J. (2015). Long-nosed potoroo (Potorous tridactylus tridactylus). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=895e4d37-18f9-4c62-ae37-5af6803085c8. [Accessed 16 September 2019].

Atlas of Living Australia (2018). *Potorous tridactylus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:76cb4b83-1a55-4ff8-98ff-4e7eb6fc0c9b [Accessed 23 August 2018].

Department of the Environment and Energy (2018). *Potorous tridactylus* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66645 [Accessed 23 August 2018].

Department of the Environment and Science (2017). Long-nosed potoroo. Available from: https://www.ehp.qld.gov.au/wildlife/threatened-species/vulnerable/longnosed_potoroo.html [23 August 2018].

4.7 New Holland mouse (Pseudomys novaehollandiae)

4.7.1 Status

EPBC Act – Vulnerable

4.7.2 Biology and ecology

4.7.2.1 Characteristics

The New Holland mouse (*Pseudomys novaehollandiae*) is a native small, burrowing rodent. The grey-brown mouse has a dusk-brown tail which is darker on the dorsal side with a head to body length of approximately 65 to 90 mm and a tail reaching 105 mm (DotEE 2018; OEH 2017) (refer Photograph 4.7).

Photograph 4.7 New Holland mouse (*Pseudomys novaehollandiae*)

Source: Beckers (2011)

4.7.2.2 Known distribution

The known distribution of the New Holland mouse is fragmented along the east coast of Australian from Queensland through to Tasmania (refer Figure 4.13). The exact whereabouts of the New Holland mouse in Queensland, NSW, Victoria and Tasmania is still unknown however with further research currently being undertaken (DotEE 2018).

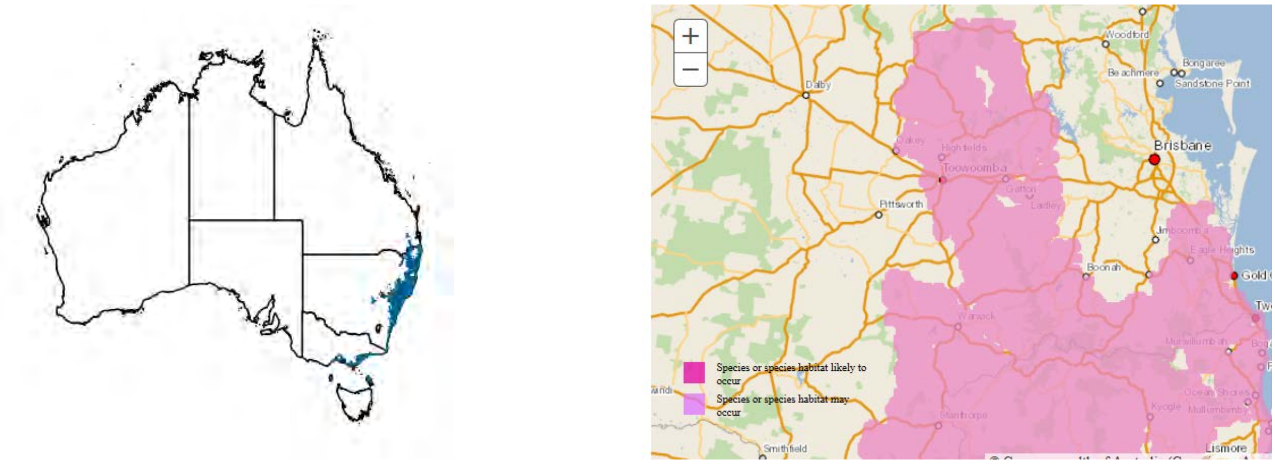

Figure 4.13 **Distribution range of New Holland mouse**

Source: ALA (2018), DotEE (2018)

4.7.2.3 Distribution in relation to the Project

Pseudomys novaehollandiae has been identified as potentially occurring within the MNES study area. The nearest database record (AoLA) is from 1982 taken from 1 km south of the Project in Gatton. This is based on remains found in an excavated owl pellet from a rocky overhang. The location data associated with this record is likely to be wrong. Van dyck and Lawrie (1997) note the location of the find as likely to be from an area south of Flagstone Creek (approximately 10 km south of the western extent of the MNES study area). More recent database records occur north of the western extent of the alignment in the Lockyer Forest Reserves (two records from 2000) and the Crow's Nest areas (records from 2000, 2001 and 2012) (6 km and 17 km north of the Project respectively) (AoLA 2020) (refer Figure Figure 4.14). The only other Queensland records are from 1997 and are located in Main Range National Park over 35 km south of the Project.

Figure 4.14 **Distribution range of New Holland mouse in relation to the Project**

Source: ALA (2020)

4.7.2.4 Biology and reproduction

The New Holland mouse is a nocturnal and omnivorous species feeding on seeds, insects, leaves, flowers as well as fungi. This social species lives in shared burrows, spending considerable time foraging above ground for food (DotEE 2018).

The known breeding period for the species occurs between August and January but can extend to autumn with slight variation between years producing litters ranging from 2 to 6. Female New Holland mouse are capable of producing two litters in a breeding season, with first year females produce one litter per season, and reach sexual maturity after 13 weeks than males, who take 20 weeks, with a generation length assumed to be 1.5 years. Reproduction however is strongly dependent on rainfall, resource availability, adult survival and recruitment (Woinarski and Burbidge 2016; DotEE 2018).

4.7.3 Habitat

The New Holland mouse is known to inhabit open heathlands, woodlands and forests with heathland understorey as well as vegetated sand dunes with peak abundance though to be early to mid-stages of vegetation succession typically induced by fire. However, in areas such as Tasmania and Victoria the species has been found living amongst landscapes not burnt for 16 to 30 years post fire in dunes vegetated by *Banksia allocasuarina* woodland with understorey dominated by sedges and low shrubs. The mouse also has a large home range between 0.44 to 1.4 ha (DotEE 2018; OEH 2017; Woinarski and Burbidge 2016).

4.7.4 Threatening processes

The following have been identified as potentially threatening processes to the New Holland mouse:

- Inappropriate fire regimes, as the species heavily depends on early to mid-stages of vegetation recovery post fire
- Predation by feral and domestic cats
- Fragmentation caused by clearing and reduced rainfall activity (Woinarski and Burbidge 2016).

4.7.5 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this species. The following threat abatement plans are relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment and Energy (2018). Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi. Canberra: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/threat-abatement-plan-disease-natural-ecosystems-caused-phytophthora-cinnamomi-2018. In effect under the EPBC Act from 22-Feb-2019.

4.7.6 Summary of threat abatement/recovery plans

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

The consequences of potential infection outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Inability of infected plants to develop new shoots, flowers, fruit and seed
- Complete loss of some flora populations
- Dramatic alteration to the structure and composition of native plant communities
- A severe reduction in primary productivity and functionality

- Irreversible habitat loss and degradation of dependent flora and fauna
- Loss of shelter and nesting sites and food sources resulting in major declines of fauna.

Objectives and actions outlined in the threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi include:

- Identifying and prioritising the protection of biodiversity assets that are, or may be, impacted by Phytophthora including listed threatened species, ecological communities and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act occur
- Reduce the spread and mitigate the impacts of Phytophthora to protect priority biodiversity assets and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act
- Inform the community through education on the impacts that Phytophthora has on biodiversity and actions to mitigate these impacts
- Encourage research on Phytophthora species and option to manage infestations and protect biodiversity assets.

4.7.7 References

Atlas of Living Australia (2018). Pseudomys novaehollandiae. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:47a50ee8-7678-4d8e-8f8a-e11d12a46ec5 [Accessed 22 August 2018].

Beckers, B. (2011). New Holland Mouse, Pseudomys novaehollandiae. [image] [online] Available from: **https://commons.wikimedia.org/wiki/File:Pseudomys_novaehollandiae.jpg**. [17 September 2019].

Department of the Environment and Energy (2018). Pseudomys novaehollandiae (New Holland Mouse, Pookilain) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=96 [Accessed 22 August 2018].

Office of Environment and Heritage (2017). New Holland Mouse - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20253 [Accessed 22 August 2018].

Woinarski, J. and Burbidge, A.A. (2016). Pseudomys novaehollandiae. The IUCN Red List of Threatened Species 2016. Available at: http://www.iucnredlist.org/details/18552/0. [Accessed 26 August 2018].

4.8 Northern quoll (*Dasyurus hallucatus*)

4.8.1 Status

EPBC Act – Endangered

4.8.2 Biology and ecology

4.8.2.1 Characteristic

Male Northern quolls (*Dasyurus hallucatus*) have a head-body length of 270 to 370 mm, weighing between 340 to 1,120 g. Females are smaller with a head-body length of 250 to 310 mm, and weighing between 240 to 690 g. Northern quolls have reddish brown fur with white spots on their back and a cream underside. It has a long, sparsely-furred, unspotted tail (refer Photograph 4.8). Their tail length ranges between 202 and 345 mm and their hindfeet have striated pads and five toes (Oakwood 2008).

Photograph 4.8 Northern quoll (*Dasyurus hallucatus*)

Source: Gould (1863)

4.8.2.2 Known distribution

Historically common across northern Australia, occurring almost continuously from the Pilbara, Western Australia, to near Brisbane, Queensland, the Northern quoll now occurs in five regional populations across Queensland, the Northern Territory and Western Australia (refer Figure 4.15). Known Queensland populations occur as far south as Gracemere and Mt Morgan, to Weipa in the north and west into central Queensland near Carnarvon Range National Park. The species is highly fragmented with severe reductions from the species' former distribution. There are occasionally records as far south as Maleny on the sunshine coast hinterland and the species and or species habitat is likely to extend as far south as Millmerran (DotEE 2018; DES 2018; McGoldrick 2013; Woinarski et al. 2008).

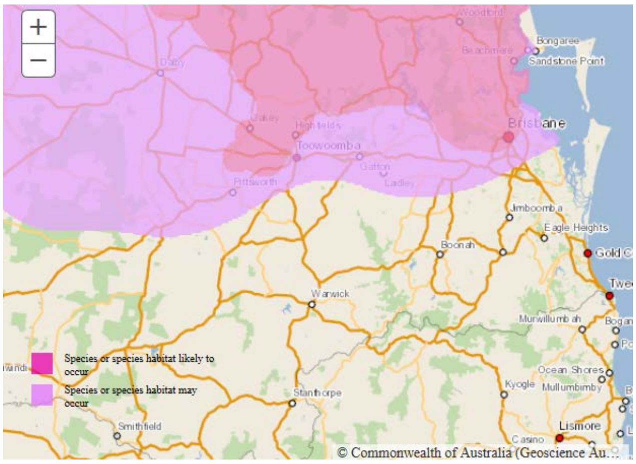

Figure 4.15 Distribution range of the Northern quoll

Source: ALA (2018), DotEE (2018)

4.8.2.3 Distribution in relation to the Project

Dasyurus hallucatus has been predicted to occur within the region and associated habitat within the MNES study area. Database records (i.e. AoLA) exist in the wider region surrounding the MNES study area. The nearest record is from 1975 in the Rosewood area (located just outside of the MNES study area (7 km east of the Disturbance footprint) (refer Figure 4.16. There are no post 1990s records within 35 km of the Disturbance footprint. The nearest recent records (post 2000) are located in the Greenbank area (40 km east) and the Wivenhoe/D'Aguilar Range (over 40 km north of the eastern extent of the Project).

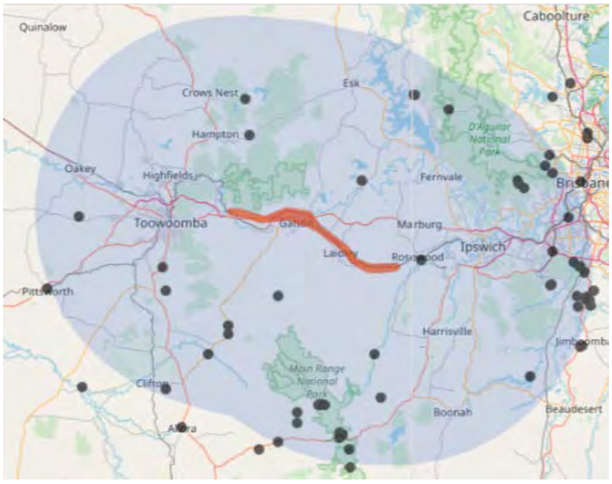

Figure 4.16 **Distribution range of the Northern quoll in relation to the Project**

Source: ALA (2020)

4.8.2.4 Biology and reproduction

Northern quolls are nocturnal predators of invertebrates such as beetles, grasshoppers, spiders, scorpions and centipedes, but they also eat small mammals, reptiles, amphibians, birds, carrion, nectar and fruit (DotEE 2018).

Northern quolls become sexually mature at one year of age. Around June to August, during the mating season, persistent fighting means males do not survive to breed a second year whilst females may live for two or three years. As a result, the Northern quoll population is comprised almost entirely of mature females and their young by the end of the breeding season. Females can raise a litter of up to eight young in tree hollows, hollow logs and rock crevices (DotEE 2018).

4.8.3 Habitat

The Northern quoll can be found in various habitats across its range including rocky areas, eucalypt forest and woodlands, sandy lowlands and beaches, rainforests, shrubland, grasslands and desert. They tend to require a habitat with some form of rocky area for denning purposes and surrounding vegetation used for foraging and dispersal. They are also known to inhabit areas around human dwellings and campgrounds (TSSC 2005).

4.8.4 Threatening processes

The following have been identified as potentially threatening processes to the Northern quoll:

- Lethal toxic ingestion caused by Cane toads (DotEE 2018)
- The removal, degradation and fragmentation of Northern quoll habitat - transport infrastructure, mining, offshore petroleum or gas processing facilities or agricultural activities such as land clearing, pasture improvement or grazing (DotEE 2018)
- The decline in shelter availability and habitat heterogeneity by fire (DotEE 2018)

- The invasion of northern Australia by Gamba grass (*Andropogon gayanus*) and other introduced grasses and increased fuel loads (DotEE; TSSC 2009)
- Predation by Feral cats (*Felis catus*) and European red foxes (*Vulpes vulpes*) and competition for food (DEWHA 2008; DotEE 2018).

4.8.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Hill, B.M. & S.J. Ward (2010). National Recovery Plan For the Northern Quoll *Dasyurus hallucatus*. Department of Natural Resources, Environment, The Arts and Sport, Darwin. Available from: **http://www.environment.gov.au/resource/national-recovery-plan-northern-quoll-dasyurus-hallucatus**. In effect under the EPBC Act from 16-Dec-2010.

The following threat abatement plans are relevant for this species:

- Department of Sustainability, Environment, Water, Population and Communities (2011). Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads. Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/resource/threat-abatement-plan-biological-effects-including-lethal-toxic-ingestion-caused-cane-toads**. In effect under the EPBC Act from 06-Jul-2011.
- Department of Sustainability, Environment, Water, Population and Communities (2012). Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses. Department of Sustainability, Environment, Water, Population and Communities. Available from: **http://www.environment.gov.au/resource/threat-abatement-plan-reduce-impacts-northern-australias-biodiversity-five-listed-grasses**. In effect under the EPBC Act from 11-Dec-2012.
- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats**. In effect under the EPBC Act from 23-Jul-2015.

4.8.6 Summary of threat abatement/recovery plan

Cane toads are identified as the main threat to the Northern quoll in the National Recovery Plan. Other threats identified include:

- Feral predators through direct predation and competition for food
- Inappropriate fire regimes
- Habitat degradation and destruction
- Weeds, particularly exotic pasture grasses
- Increased risk of disease due to isolation of populations
- Illegal hunting by humans
- Population isolation

Recovery actions outlined in the National Recovery Plan include:

- Protect populations on offshore islands from invasion and establishment of invasive pests including cane toads and cats
- Support the recovery of sub-populations that have survived cane toad establishment
- Maintain secure populations and source animals for potential reintroductions/introductions, including maintaining captive breeding populations
- Reduce risk of disease by improving knowledge of and monitoring for disease
- Improve public awareness of the species and the need for biosecurity control

The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads include:

- Predation by cane toads
- Larval competition with frog tadpoles or mosquitoes
- Parasite transfer
- Competition for terrestrial food
- Competition for shelter sites.

Threat abatement actions for cane toads (*Rhinella marina*) include:

- $11 million in funding from the Australian Government provided for the development of a broad-scale control method
- $9 million in funding from the Australian Government for research and management activities
- Identification of native species, ecological communities and off-shore islands that are known to have a high to moderate risk
- Identify the impacts that toads have on listed native species and ecological communities
- Where the impact is expected to be high on native species and ecological communities establish support research techniques in aiding the recovery of priority native species and ecological communities
- Develop a prioritisation tool to aid in the direction of resources for the protection of native species and ecological communities.

Threats identified in threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses includes:

- These highly invasive grasses can increase fuel loads
- Alter nitrogen cycling and water availability
- Degrade ecosystems through loss of habitat and biodiversity declines.

Management actions outlined in the threat abatement plan include:

- Determine the extent and spread pathways of infestation by the five listed grasses outlined in the plan
- Support and facilitate coordination management strategies through the design of tools, systems and guidelines
- Identify and prioritise key asset and areas for the implementation of management strategies
- Implement on the ground management strategies that are cost effective in high priority areas
- Monitor, evaluate and report back on the effectiveness of management programs.

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

4.8.7 References

Atlas of Living Australia (2018). *Dasyurus hallucatus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:c4be3b87-b482-4b23-8086-a6634882fce1#overview [Accessed 21 August 2018].

Department of Environment and Science (2018). *Queensland's quolls*. Available from: https://www.ehp.qld.gov.au/wildlife/threatened-species/endangered/endangered-animals/queenslands_quolls.html [Accessed 21 August 2018].

Gould, J. (1863). Northern quoll (Dasyurus hallucatus). [image] [online] Available from: https://www.flickr.com/photos/biodivlibrary/27286385255/in/photolist-HzcRGc. [17 September 2019].

McGoldrick, I. (2013). *Weipa commissions Northern Quoll surveys*. Media Release. Rio Tinto Alcan.

Oakwood, M. (2008). Northern quoll *Dasyurus hallucatus*. In: Van Dyck, S. & R. Strahan, eds. *The Mammals of Australia (3rd ed).* Page(s) 57-59. Sydney, NSW: Reed New Holland.

Threatened Species Scientific Committee (2005). *NON-APPROVED Conservation Advice on Northern Quoll (Dasyurus hallucatus)*. Available from: http://www.environment.gov.au/biodiversity/threatened/species/dasyurus-hallucatus.html#conservation. [Accessed 21 August 2018]

Threatened Species Scientific Committee (2009). *Commonwealth listing advice on invasion of northern Australian by gamba grass and other introduced grasses*. Available from: www.environment.gov.au/biodiversity/threatened/ktp/pubs/northern-australia-introduced-grasses.pdf [Accessed 21 August 2018].

Woinarski, J.C.Z., Oakwood M., Winter J., Burnett S., Milne D., Foster P., Myles H. & Holmes B. (2008). Surviving the toads: patterns of persistence of the northern quoll *Dasyurus hallucatus* in Queensland. *Report submitted to the Natural Heritage Trust Strategic Reserve Program*.

4.9 Spotted-tail quoll (south-eastern mainland population) (*Dasyurus maculatus maculatus*)

4.9.1 Status

EPBC Act – Endangered

NC Act – Vulnerable

4.9.2 Biology and ecology

4.9.2.1 Characteristic

Male Spotted-tail quolls (south-eastern mainland population) (*Dasyurus maculatus maculatus*) have a head-body length of 380 to 759 mm, and females are 350 to 450 mm. Male tail lengths are between 370 to 550 mm and 340 to 420 mm for females. The average male Spotted-tail quoll weighs between 2.8 to 4.6 kg, whilst females average a weight of 1.5 to 2 kg. The fur on its back ranges in colour from rich red-brown to dark brown with white spots (refer Photograph 4.9). The Spotted-tail quoll is distinguished from other quolls by the spots running along the length of its tail. The fur on the underside is cream or white. They also have short, round ears which extend just above the outline of the head. Female Spotted-tail quolls have a poorly developed pouch (Belcher 2003; DotEE 2018; Green and Scarborough 1990; Jones 1997; Körtner et al. 2004; Queensland Museum 2015).

Photograph 4.9 **Spotted-tail quoll (*Dasyurus maculatus maculatus*)**

Source: Bennett (2012)

4.9.2.2 Known distribution

The Spotted-tail quoll (southern subspecies) was previously widely distributed from southeast Queensland, eastern NSW, Victoria, southeast South Australia and Tasmania (refer Figure 4.17), however, it is estimated that the range has reduced by 50 to 90 per cent. Detailed distribution records and abundance estimates are lacking, due to the scale and intensity of survey effort that is required to detect the species across its entire range (DotEE 2018).

In Queensland, the Spotted-tail quoll occurs in the southeast, coastally from Bundaberg to the NSW border, and inland to Monto and Stanthorpe. Spotted-tail quolls are known from five broad geographic: four from coastal ranges and the Great Dividing Range from the NSW border to Gladstone. The fifth is centred on the eastern Darling Downs-Inglewood Sandstone provinces of the Brigalow Belt South Bioregion. Unconfirmed reports suggest the subspecies may occur in the Clarke and Conway Range areas, eastern Queensland (DotEE 2018).

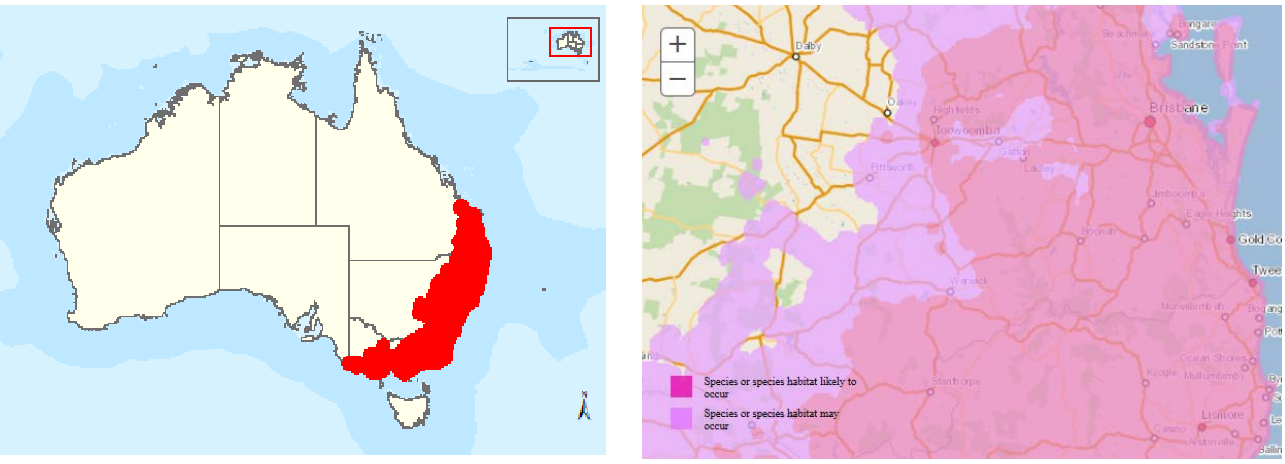

Figure 4.17 **Distribution range of the Spotted-tail quoll (southern subspecies)**

Source: DotEE (2018)

4.9.2.3 Distribution in relation to the Project

There are a number of older database records in the region surrounding the MNES study area. The nearest record is from 1975 in the Rosewood area (located 7 km east of the Project disturbance footprint). There is a 1989 record from the Atkinson's Dam area located 16 km north of the MNES study area. There are other scattered records within 50 km of the MNES study area, although no post 1995 records are within 35 km of the Project disturbance footprint (refer Figure 4.18). The nearest recent records (post 2000) are located in the Greenbank area (40 km east) and the Wivenhoe/D'Aguilar Range area (over 40 km north of the eastern extent of the Project).

Habitat assessments carried out for the EIS studies identified very little suitable rocky denning habitat within the MNES study area and none within the Project alignment itself. The most likely habitat for the species may be in the The Project intersects habitat connected to the southern portion of Lockyer Forest Reserves area which may comprise the most likely habitat for the species given the extensive habitat remaining in this area. Habitat within the Little Liverpool Range is subject to a large amount of disturbance including rural housing, and existing road and rail infrastructure. Suitable habitat for the species was not observed in this area during Project surveys.

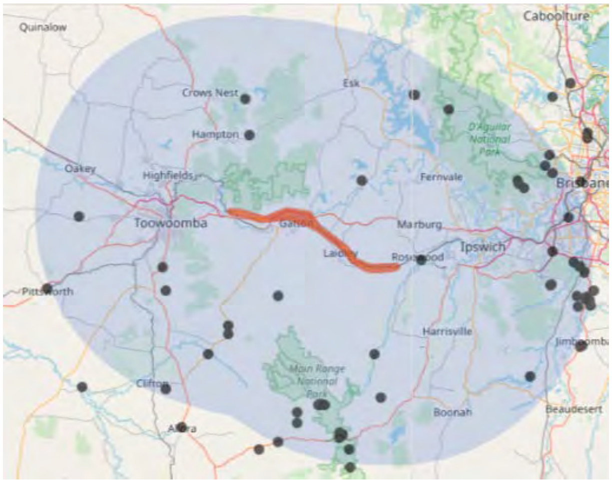

Figure 4.18 **Distribution range of the Northern quoll in relation to the Project**

Source: ALA (2020)

4.9.2.4 Biology and reproduction

Spotted-tail quolls are predominantly nocturnal and typically prey on medium-sized mammals. Typically, prey includes Ringtail possum (*Pseudocheirus pererinus*), Common brushtail possum (*Trichosurus vulpecula*), Mountain brushtail possum (*Trichosurus caninus*), Greater gilder (*Petauroides volans*) and Rabbit. Additionally, this species consumes insects, lizards, crayfish, poultry, birds, small mammals, frogs, fish, plant material and refuse that has been discarded by humans (DotEE 2018).

Mating and births for the Spotted-tail quoll occur over the winter months (June to August). It is possible for roaming males to mate with more than one female per year (DotEE 2018).

After a gestation period of 21 days, litters of between four and six are born, in late-July to mid-August. Young are attached to the teat for about eight weeks from birth. Subsequently, young may be left in the maternal den while the mother is hunting for food to provide to her young. At 18 to 21 weeks the young are fully independent and 33 per cent of the body size of the mother (Belcher 2003; DotEE 2018; Edgar and Belcher 2008; Fleay 1940; Green and Scarborough 1990; Jones et al. 2001).

4.9.3 Habitat

Spotted-tail quolls have been recorded from a wide range of habitats, including ttemperate and subtropical rainforests in mountain areas, wet sclerophyll forest, lowland forests, open and closed eucalypt woodlands, inland riparian and River red gum (*Eucalyptus camaldulensis*) forests, dry 'rain shadow' woodland, sub-alpine woodlands, coastal heathlands and occasionally in open country/other treeless areas. Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves. From a study in Kosciuszko National Park, home range estimates were 620 to 2560 ha for males, and 90 to 650 ha for females (DotEE 2018).

The Spotted-tail quoll is known to prefer mature wet forest habitat especially areas with rainfall 600 mm/year. Unlogged forest or forest that has had limited disturbance by timber harvesting is also preferable (TSSC 2004, DotEE 2018).

4.9.4 Threatening processes

The following have been identified as potentially threatening processes to the Spotted-tail quoll:

- The loss, fragmentation, disturbance and degradation of habitat through clearing of native vegetation, timber harvesting and other forest management practices (DotEE 2018)
- Predation from Red foxes, Dingos (Canis lupus dingo) and Domestic dogs. Dietary and habitat overlap with these species may also be leading to competitive effects (DotEE 2018)
- Spot-tailed quolls have been killed by landholders in response to poultry coop raids. The large home ranges of the Spotted-tail quoll, particularly males, also makes them susceptible to road mortality in forested areas fragmented by roads, and a tendency to scavenge carrion may increase this threat (DotEE 2018).
- Following various baiting programs using 1080 baits for invasive predators, the dosage for foxes and dogs is potentially fatal to the Spotted-tail quoll, particularly for smaller individuals, such as females and juveniles (DotEE 2018).

4.9.5 Threat abatement/recovery plans

The following threat abatement plans have been identified as being relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox. In effect under the EPBC Act from 01-Oct-2008.

The following recovery plan has been identified as being relevant for this species

- Department of Environment, Land, Water and Planning (2016). National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus*. Australian Government, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/spotted-tailed-quoll. In effect under the EPBC Act from 06-May-2016.

4.9.6 Summary of threat abatement/recovery plans

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

Important populations outlined in the National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus* that could be relevant to the Project include:

- New South Wales: Marylands National Park and adjacent freehold property 'Mowamba'
- New South Wales: Northern Tablelands: Tenterfield, Glen Innes, Armidale/Walcha, Dorrigo Plateau and Barrington
- New South Wales: Yuragir and Mariah
- New South Wales: Greater blue mountains
- New South Wales: Barren Grounds/Budderoo, Escarpment forest from Morton National Park to Victorian border, Tallaganda/Badja
- New South Wales: Kosciuszko National Park/Snowy Mountains Byadbo
- Queensland: Stanthorpe to Wallangarra, Granite Belt/New England Tablelands
- Queensland: Cherrabah Homestead (between Warwick and Killarney)
- Queensland: Main Range-McPherson Range west
- Queensland: Lamington Plateau-McPherson Range east
- Queensland: Burnett Range
- Queensland: Dalby region.

Threats identified in the National Recovery Plan include:

- Habitat loss and modification
- Fragmentation of habitat and populations
- Timber harvesting
- Poison baiting
- Competition and predation from introduced predators
- Deliberate killing
- Road mortality
- Bushfire and prescription burning

- Poisoning by Cane toads
- Climate change.

Recovery actions outlined in the National Recovery Plan include:

- Determine the distribution and status of populations throughout the species' range
- Investigate key aspects of the biology and ecology to acquire targeted information to aid recovery
- Reduce habitat loss and fragmentation on private land
- Evaluate and manage risk posed by silviculture
- Determine and manage impacts from introduced predators
- Reduce deliberate killing of Quolls
- Assess the threat Can toads pose to the species and develop threat abatement actions
- Determine the likely impact of climate change on populations
- Increase community awareness and involvement in the recovery program.

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5 Fauna species – Conservation significant species – Birds

5.1 Australasian bittern (*Botaurus poiciloptilus*)

5.1.1 Status

EPBC Act – Endangered

5.1.2 Biology and ecology

5.1.2.1 Characteristics

The Australasian bittern (*Botaurus poiciloptilus*) is a large stocky, partially nocturnal heron which can reach up to a total body length of 75 cm with a wingspan just over 1 m. The species has a long narrow neck, a straight brownish-yellow bill which transitions into a dark brown feathering on the side of its neck and becomes pale at the throat. The mottled brown upper surface of the bittern is supported by a buff dark brown striped under surface and pale green legs (refer Photograph 5.1). Bittern juveniles differ from adults due to their paler feathering and heavier buff flecking on the back. Sexes can be differentiated through size as female bittern weigh about 900 g compared to male bittern, who are significantly heavier weighing up to 1,400 g. The physical appearance of the bittern makes it very well camouflaged within its natural habitat and often go unspotted (Birdlife 2018; SWIFFT 2018; TSSC 2011).

Photograph 5.1 Australasian bittern (*Botaurus poiciloptilus*)

Source: Brown (2014)

5.1.2.2 Known distribution

The Australasian bittern is known to occur in south-eastern Australia, extending from Bundaberg through to northern Tasmania (refer Figure 5.1). In NSW, Australasian bittern is predominantly found in the Murray-Darling basin which once formed a stronghold for the species (Birdlife 2018; Birdlife International 2016).

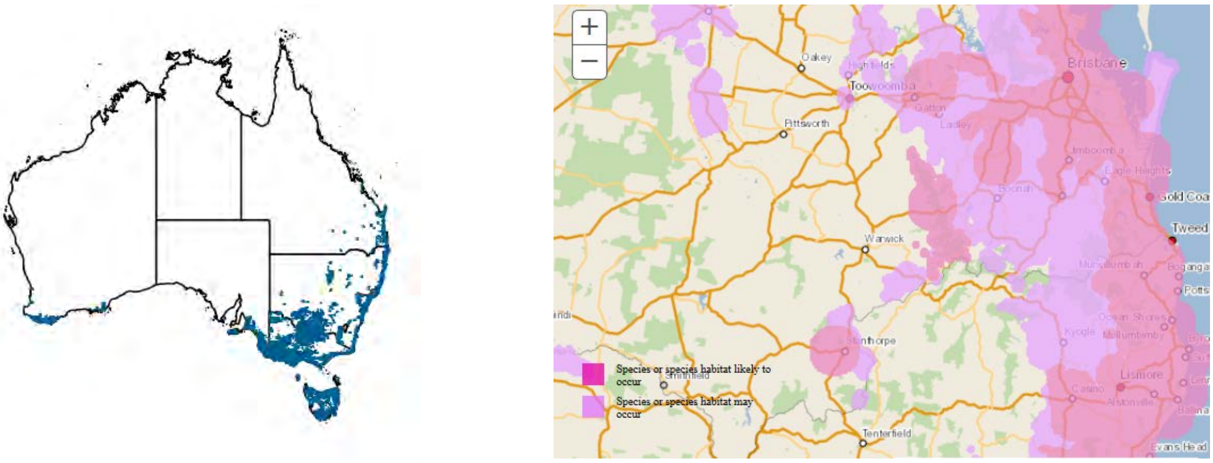

Figure 5.1 **Distribution range of the Australasian bittern**

Source: ALA (2018), DotEE (2018)

5.1.2.3 Distribution in relation to the Project

The species was not identified during Project surveys, although dry conditions at the time likely precluded the species from being present. The nearest database record is located 4.5 km to the north-west of the western extent of the Project disturbance footprint in the Lockyer Reserves area, however this record is older (pre-1980), does not have a recorded sighting date and is not spatially reliable. Location information refers only to the Lockyer Valley. This record has been generalised to protect the species and so may not reflect the actual occurrence location. There are a few similar records in the region to the north of the Project. The nearest dated records are from Lake Clarendon (north of Gatton) (2009 and 1990) located 6.5 km north of the Project footprint (refer Figure 5.2). Lake Clarendon is identified as a 'key area' for sightings of the species.

Figure 5.2 **Distribution range of the Australasian bittern in relation to the Project**

Source: ALA (2020)

5.1.2.4 Biology and reproduction

The Australasian bittern is crepuscular and known to hide during day time and come out after sun down. It feeds mainly on frogs, fish, crayfish, spiders, insects and snails. The species constructs a feeding platform over deeper water using reeds trampled by the bird and uses multiple hunting techniques to capture prey (Birdlife 2018; OEH 2017).

The species breed around summer, between October and January, as solitary pairs and begin building nests in secluded, densely vegetated wetlands on platforms of reeds approximately 30 cm above water level. The female Australasian bittern will lay six eggs of olive to brown colour to a clutch and known to have a short incubation period (Birdlife 2018; O'Donnell 2011; TSSC 2011).

5.1.3 Habitat

Preferred habitat for the Australasian bittern consists of permanent freshwater wetlands with tall dense vegetation including bulrushes (*Tyhpa* spp.), spikerushes (*Eleocharis* spp.) and tall emergent sedges. Rice paddies within the Murray-Darling basin are a known habitat for the species who disperse widely during periods of droughts to coastal wetlands and to ephemeral wetlands (Birdlife International 2016; OEH 2017).

5.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Australasian bittern:

- Wetland drainage for agriculture
- Changes brought on by high levels of grazing, drought and salinization of swamps
- Long term habitat destruction exposing species to predation
- Abandoning nests due to slight disturbances as a result of their sensitive nature (Birdlife International 2016).

5.1.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2019). Draft National Recovery Plan for the Australasian Bittern *Botaurus poiciloptilus*. Available from: **https://www.environment.gov.au/system/files/consultations/9a03b781-7f67-4874-a919-cf53cd1eee60/files/draft-recovery-plan-australasian-bittern.pdf**.
- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10105**. In effect under the BC Act 2016.

The following threat abatement plans have been identified as being relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats**. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox**. In effect under the EPBC Act from 01-Oct-2008.

5.1.6 Summary of threat abatement/recovery plan

Threats identified in the Draft National Recovery Plan for the Australasian Bittern *Botaurus poiciloptilus* include:

- Changes of water flow reducing the availability of wetland habitat
- Loss and alteration of wetland habitat from fire and livestock
- Climate change resulting in variability of environmental conditions, in particular a reduction in rainfall and increase in drought reducing water levels in wetland habitat
- Impacts to water quality from increased salinity, acidification, siltation and pollution
- Increased competition, habitat alteration and predation from hard hooved invasive herbivores and predators
- A lack of genetic diversity due to small population sizes.

Management actions outlined in the Draft National Recovery Plan for the Australasian Bittern *Botaurus poiciloptilus* include:

- Reduce threats to Australasian bittern and the species' habitat through the implementation of management strategies
- Better protect the species and provide improvements in the quality and extend of suitable habitat
- Gain an improved understanding of the species' ecology and biology and identify population trends through ongoing monitoring
- Increase the engagement of stakeholders in the conservation and management of the specie
- Ensure the recovery process is well coordinated, reviewed and reported on.

Threats identified by the *Saving our Species* program include:

- Drainage of wetlands and ponds and alteration of natural flow regimes
- Loss and degradation of wetland habitat, including artificial wetland habitat in rice growing areas, due to changes in water management and cropping practises
- Climate change driven seasonality changes such as amount of rainfall and associated changes in environmental water allocations
- Predation by foxes, pigs and cats.

Management activities in the *Saving our Species* program to protect this species are:

- Apply environmental water quality requirements (timing, depth, duration, frequency) in long-term environmental water plans (including Murrumbidgee, Murray, Lachlan, Macquarie, Gwydir) to maintain and restore habitat
- Develop and/or upgrade infrastructure to support environmental water delivery to priority bittern habitat areas
- Educate and encourage landholders to improve wetland management and awareness of bitterns, and report sightings (target landholders in Hunter, north and south coast, northern basin and Riverina/Murray areas)
- Undertake targeted control of predators at selected priority sites during breeding (summer) using techniques such as trapping and/or baiting
- Educate irrigation corporations in rice-growing areas and encourage sensitive management of canals
- Work with rice growers to develop a "bittern friendly" rice label that promotes best practice rice growing for maintaining bittern habitat
- Conduct targeted research into habitat use during non-breeding season and during drought.

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups

- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

5.1.7 References

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5.2 Australian painted snipe (*Rostratula australis*)

5.2.1 Status

EPBC Act – Endangered Marine (CAMBA)

5.2.2 Biology and ecology

5.2.2.1 Characteristic

The Australian painted snipe (*Rostratula australis*) is a stocky wading bird approximately 220 to 250 mm in length. It has a long pinkish bill and chestnut-coloured head, with a white ring around the eye and a crown stripe. The back and wings are metallic green and barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down the individuals upper back (refer Photograph 5.2). The adult female is slightly larger and more brightly coloured than the male (DotEE 2018).

Photograph 5.2 Australian painted snipe male (*Rostratula australis*)

Source: eBird Australia (20015)

5.2.2.2 Known distribution

The Australian painted snipe has been recorded at wetlands in all states and territories of Australia but is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia (refer Figure 5.3). Known distribution has likely declined by approximately 50 per cent in Australia since European settlement (DotEE 2018; Garnett & Crowley 2000).

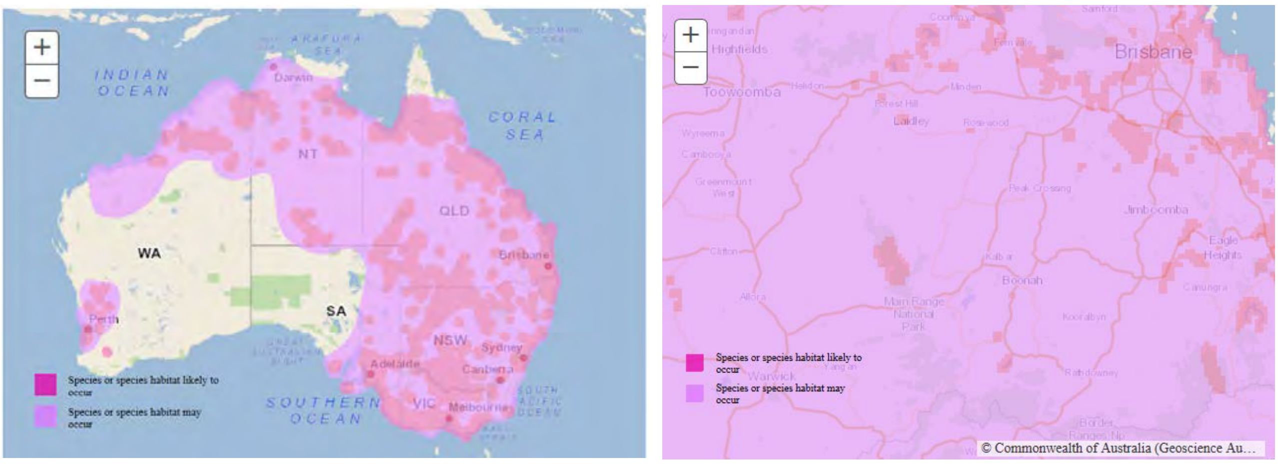

Figure 5.3 Distribution range of the Australian painted snipe

Source: DotEE (2018)

5.2.2.3 Distribution in relation to the Project

The species was not identified during Project surveys, although dry conditions in 2017 likely precluded the species potential presence. There are numerous database records within 50 km of the MNES study area. This includes several records within 5 km of the MNES study area. Australian painted snipe has been recorded 500 m south of the Project disturbance footprint at a site west of Gatton (1991 record) and 500 m north at a site near Helidon (1982 record). Recent records from nearby include 2013 records in the Helidon area (2 km and 4 km south of the Disturbance footprint), a 2012 record from the Gatton campus of the University of Queensland (2 km north), and records from the 2000s from Lake Dyer in the Laidley area (2.5 km south) (refer Figure 5.4).

Wetland habitats within the MNES study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (palustrine). Dams and reservoirs are generally unlikely to provide suitable dense aquatic vegetation for the species. Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants and Queensland bluegum (*Eucalyptus tereticornis*). Riverine wetlands through much of the Project footprint are highly degraded with little aquatic vegetation present suitable for Australian painted snipe (refer Section 5.2.3 and EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for further detail). Wetlands considered to be of 'high ecological significance under State mapping are intersected by the eastern extent of the Project disturbance footprint (north-west of Helidon) and are associated with the local hydrological catchment of Lockyer Creek.

Palustrine wetlands within the MNES study area typically occur on alluvial floodplains and may be dominated by grasses (Poaceae), rushes (Restionaceae) and/or sedges (Cyperaceae). Floodplain areas were all observed to be dry during the site surveys for the Project. Areas of remnant Palustrine wetland within the MNES study area are represented by RE 12.3.8 and are considered the most likely wetland habitat present with potentially suitable values for Australian painted snipe although these areas are highly ephemeral in nature. There are two wetlands corresponding to this RE at the western extent of the Project (east of Calvert) although both lie outside of the Project disturbance footprint (90 m and 300 m north respectively) (refer EIS Appendix I: Terrestrial and Aquatic Ecology Technical Report for further detail regarding wetland values).

Figure 5.4 **Distribution range of the Australian painted snipe**

Source: ALA (2020)

5.2.2.4 Biology and reproduction

The Australian painted snipe eats vegetation, worms, seeds, insects, molluscs, crustaceans and other invertebrates. They are mainly crepuscular and generally remain in dense cover when feeding, although they may forage over nearby mudflats and other open areas such as agricultural land or grassland (DotEE 2018).

The Australian painted snipe may breed in response to wetland conditions rather than during a particular season. The species has been recorded breeding in all months in Australia. Their breeding habitat requires shallow wetlands with areas of bare wet mud and with canopy cover nearby. The species nests usually occur on or near small islands in freshwater habitats. Females are known to lay two to six (typically three or four) eggs and may lay up to four clutches in a year and incubation takes 15 to 21 days. The females usually breed every two years (DotEE 2018).

This species is generally seen alone or in pairs or occasionally in small flocks. Flocking occurs during the breeding season but are also known to form after the breeding season and at some locations where small groups regularly occur (DotEE 2018).

5.2.3 Habitat

The Australian painted snipe generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. The species has also been observed to use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. The Australian painted snipe has been recorded nesting in and near swamps, canegrass swamps, flooded areas, including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch, saltbush (*Halosarcia* sp.) and grass, in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush (DotEE 2018).

The Australian painted snipe requires suitable wetland areas even in drought conditions, but the species can move to suitable habitat if necessary (DotEE 2018).

5.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Australian painted snipe:

- The loss and alteration of wetland habitat, particularly the drainage of wetlands and diversion of water to agriculture and reservoirs therefore reducing flooding and precluding the formation of temporary shallow wetlands (DotEE 2018)
- Grazing and trampling of wetland vegetation by livestock (DotEE 2018)
- The colonisation of invasive, noxious weeds could render habitats less suitable for the snipe and changes to fire regimes might be affecting savannah vegetation around wetlands in northern Australia (Garnett and Crowley 2000; DotEE 2018)
- Australian painted snipe nesting sites may also be vulnerable to introduced terrestrial predators such as the European red fox or feral cat (DotEE 2018).

5.2.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as being relevant for this species:

- Department of the Environment and Energy (2019) Draft National Recovery Plan for the Australian Painted Snipe. Available from: **https://www.environment.gov.au/system/files/consultations/5e6b3fbf-ef4d-4d0a-b9c8-c8e29bb11afc/files/draft-recovery-plan-australian-painted-snipe.pdf**.
- Office of Environment and Heritage (2017). Saving our Species: Help save the Australian Painted Snipe. New South Wales Government. Available from: **https://www.environment.nsw.gov.au/savingourspeciesapp/ViewFile.aspx?ReportProjectID=1292&ReportProfileID=10734**.

5.2.6 Summary of threat abatement/recovery plan

Threats identified in the Draft National Recovery Plan for the Australian Painted Snipe include:

- Historical threats include land use changes, particularly in the Murray-Darling Basin resulting in losses of temporary wetlands due to changes in water management

- Current threats include; degradation of wetlands resulting from drainage and water diversion
- Loss of breeding habitat due to reduced frequency of flooding
- Reduced fresh water availability through drainage, losses to irrigation and water diversion
- Increased cropping and fire regimes altering wetland vegetation in floodplains and wetlands
- Drought and changing climatic conditions intensifying impacts of degrading processes
- Dry season grazing in wetlands causing trampling of vegetation and nutrient enrichment
- Changes to the structure of wetland habitat and reduced water quality
- Encroachment from invasive weeds and changes in community structure of native vegetation reducing habitat suitability for the species
- Lack of genetic diversity

Management actions outlined in the Draft National Recovery Plan for the Australian Painted Snipe:

- Approach protection and management of breeding habitat from a landscape scale
- Implement measurement techniques to quantify population growth/decline to determine success of recovery actions
- Mitigate degradation of critical habitat for various life stages of the species
- Increase knowledge on the biology and ecology of the species and better understand habitat requirements
- Increase awareness of the species and conservation efforts being implemented amongst community stakeholders
- Compile and review results of the recovery process through coordinated efforts.

Threats identified in the Saving our Species plan includes:

- Drainage of wetland breeding sites
- Grazing and frequent fires in wetland habitat
- Herbicide, pesticide and other chemical use near wetlands
- Invasive native plants and exotic weeds reducing the health of wetland habitat
- Lack of knowledge on the reproduction of the species.

Management actions outline in the Saving our Species plan includes:

- Set environmental water quality parameters in long-term environmental water plans
- Control invasive vegetation
- Manage grazing and burning in wetlands creating a mosaic of habitat features
- Engage with landholders adjacent to wetlands providing education on the impact of chemical use, discuss non-toxic alternative and implement appropriate drainage management to avoid run-off
- Manage stock and fire regimes near wetlands
- Conduct research into the species to fill knowledge gaps
- Encourage the restoration of wetland habitat in an agricultural landscape
- Manage environmental water to ensure shallow muddy edge habitat during spring and summer.

5.2.7 References

Aviceda (2002). Photographic image of *Rostratula australis*. [Accessed 22 August 2018]

Department of the Environment and Energy (2018). *Rostratula australis* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=77037 [Accessed 22 August 2018].

eBird Australia. (2015). Australian painted snipe male (Rostratula australis). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=80919ccc-36ac-463a-9bd9-1462b7a05d1d. [17 September 2019].

Garnett, S.T. and Crowley G.M. (2000). *The Action Plan for Australian Birds 2000*. Canberra, ACT: Environment Australia and Birds Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/birds2000/index.html [Accessed 22 August 2018]

5.3 Black-breasted button-quail (*Turnix melanogaster*)

5.3.1 Status

EPBC Act – Vulnerable

5.3.2 Biology and ecology

5.3.2.1 Characteristic

The Black-breasted button-quail (*Turnix melanogaster*) is a relatively large, plump and pale-eyed quail. The males are about 18 cm long, with a wingspan of 32 to 35 cm, and weighing 65 g. The females tend to be larger weighing 100 g. Females are slightly larger than males and are the dominant sex. Female and male plumage also differs, with females having a black head and breast with white half-moon markings across the upper-breast and a chestnut marbled upper covered in black ladder markings and white streaks. Conversely, males have white markings on the face and neck covered with fine black dots and the upper-breast is a mottled chestnut and black (refer Photograph 5.3). Both sexes have grey bills, white-cream eyes and yellowish legs and feet (DotEE 2018; Pizzey and Knight 2007).

Photograph 5.3 Black-breasted button-quail (*Turnix melanogaster*)

Source: Dunis (2017)

5.3.2.2 Known distribution

Black-breasted button-quails are distributed across south-eastern Queensland from near Byfield in the north to the Border Ranges rainforests in the south, generally east of the Great Dividing Range (refer Figure 5.5); although there are records up to 300 km inland at locations at Palmgrove National Park and Barakula State Forest in Queensland. In north-eastern NSW, they are restricted to the Northern Rivers and Tablelands (DotEE 2018; Marchant and Higgins 1993).

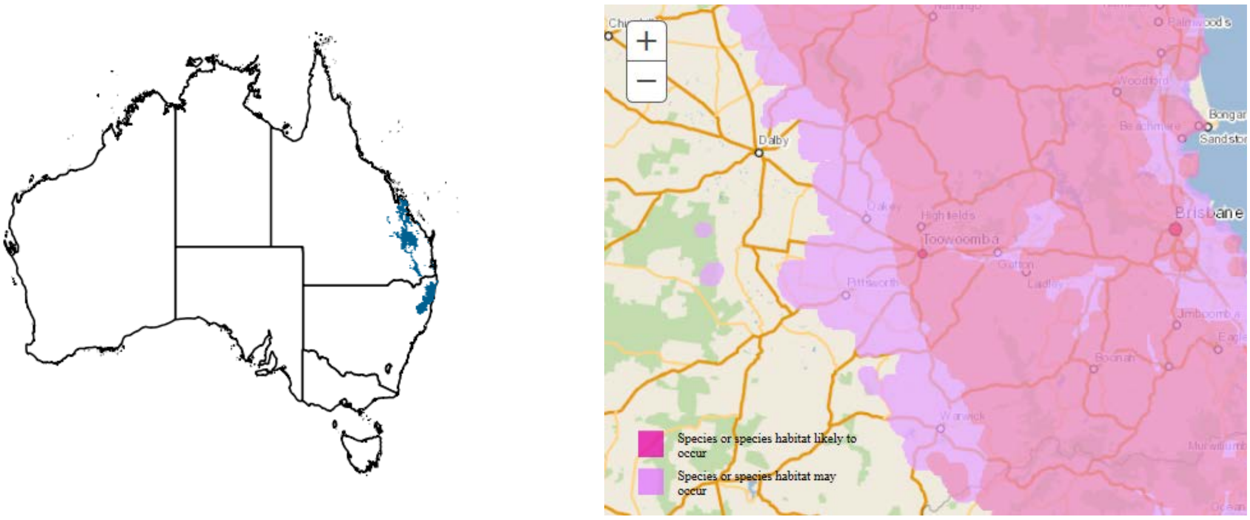

Figure 5.5 Distribution range of the Black-breasted button-quail

Source: ALA (2018), DotEE (2018)

5.3.2.3 Distribution in relation to the Project

The species was not recorded during Project surveys which included targeted searches for the distinctive platelets the species leaves when foraging. Database records (i.e. AoLA) indicate this species has occurred within 50 km of the Project. The nearest database record is from 2018 and located 8 km south of the western extent of the Project, although the location of has been generalised to 0.1 of a degree. There are a number of records to the west in the Toowoomba Range (approximately 15 km west) and to the north in the Ravensbourne area (approximately 18 km north). There is a recent record from the Rosewood area (2015) located 9 km north-west of the Project (refer Figure 5.6). There are 1993 records from Berlin Scrub Nature Refuge (12 km south-west of Laidley) (AoLA 2020).

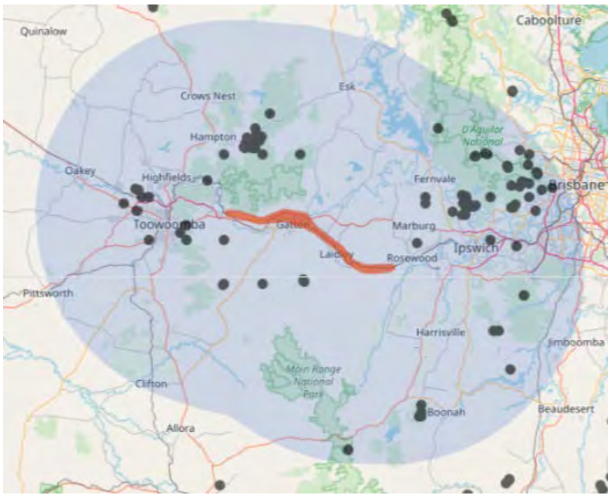

Figure 5.6 Distribution range of the Black-breasted button-quail in relation to the Project

Source: ALA (2020)

5.3.2.4 Biology and reproduction

Their principal food is invertebrates gathered from the leaf litter on the forest floor, however, seeds may also be consumed (DotEE 2018; Hughes and Hughes 1991).

The species is polyandrous (a single female mates with several males who incubate the eggs) and it has been seen in pairs or, more occasionally, in small groups. There is little known on the breeding habits of the Black-breasted button-quail, however they are assumed to breed throughout their range. Although they may exhibit limited migratory movements at night in response to resource availability. The breeding season occurs from September to April/May and between three and five eggs are laid. Nests consist of a scrape in the ground, lined with leaves, grass or moss. Nests are typically well-concealed and placed in the buttress root of a tree or sapling, the base of a fern or under a low bush or grass tussock (DotEE 2018).

5.3.3 Habitat

The Black-breasted button-quail is restricted to rainforests and forests, mostly in areas with 770 to 1,200 mm rainfall per annum in areas characterised by highly fertile soils. They prefer drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest. They may also be found in low, dense Acacia thickets and, in vegetation behind coastal sand dunes. In south-eastern Queensland, the Black-breasted button-quail has been recorded on rare occasions in open Eucalypt forest; for example, birds have been recorded in Grey ironbark (*Eucalyptus siderophloia*) with a low sparse shrub layer of Eucalypt and Acacia seedlings, and a sparse ground cover of short tussock grasses and leaf litter. This species also heavily utilises areas infested with *Lantana camara*, particularly where this produces a dense leaf-litter below a thigh woody shrub layer. A dense leaf-litter layer is required for foraging and possibly also roosting (DotEE 2018).

5.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Black-breasted button-quail:

- Massive clearance of forest for agriculture, forestry and urban development continues to be the biggest threat to the species. Sub-populations in the remaining fragmented habitats are affected by excessive grazing and trampling which may reduce the amount of understorey vegetation and deep leaf litter on which the species relies (Bennett 1985; Garnett and Crowley 2000).
- Frequent fire eliminates shrubby understorey in dry rainforest remnants and can also reduce the amount of leaf litter on the ground, rendering habitat unsuitable (Garnett and Crowley 2000)
- Being ground-nesters, they are also affected by predation by cats, foxes and pigs (Bennett 1985; Garnett and Crowley 2000).

5.3.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Mathieson, M.T. & G.C. Smith (2009). National recovery plan for the black-breasted button-quail Turnix melanogaster. Report to the Department of the Environment, Water, Heritage and the Arts, Canberra. Department of Environment and Resource Management, Brisbane. Available from: http://www.environment.gov.au/resource/national-recovery-plan-black-breasted-button-quail-turnix-melanogaster. In effect under the EPBC Act from 13-Nov-2009.

The following threat abatement plans have been identified as being relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.

- Department of the Environment and Energy (2017). Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (Sus scrofa) (2017). Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017. In effect under the EPBC Act from 18-Mar-2017.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox. In effect under the EPBC Act from 01-Oct-2008.

5.3.6 Summary of threat abatement/recovery plans

Threats specific to the Black-breasted button-quail in the strategy include:

- Very specific habitat requirements that are subject to development pressure
- Polyandrous breeding nature could result in genetic bottleneck given there are fewer females than males in the population
- Habitat loss, fragmentation and degradation
- Inappropriate fire regimes
- Predation by feral animals.

Objectives and actions outlined in the threat abatement plan for the Black-breasted button-quail include:

- Consolidate current information and define assessment and monitoring strategies determining where suitable habitat is occupied
- Protect key habitat for the species from human induced processes
- Maintain and improve the extent, condition and connectivity of suitable habitat
- Reduce the impacts of introduced predators and competitors
- Increase ecological knowledge of the species
- Review the operation of the recovery process.

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure

- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pics (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

Threats identified in the threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

5.3.7 References

Atlas of Living Australia (2018). *Turnix (Austroturnix) melanogaster*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:03a6ee3f-e227-41e2-b2f3-6f6aea694a83 [Accessed 23 August 2018].

Bennett, S. (1985). The distribution and status of the Black-breasted Button-quail *Turnix melanogaster. Emu*. 85:157-162.

Department of the Environment and Energy (2018). *Turnix melanogaster* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=923 [Accessed 23 August 2018].

Dunis, V. (2017). Black-breasted button-quail (Turnix melanogaster). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=ea3c5de8-f1f6-4c56-8567-f8a8db613669. [17 September 2019].

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Hughes, P. & Hughes B. (1991). Notes on the Black-breasted Button-quail at Widgee, Queensland. *Australian Bird Watcher*. 14:113-118.

Marchant, S. and Higgins, P.J. eds. (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings*. Melbourne, Victoria: Oxford University Press.

Pizzey, G. and Knight, F. (2007). *The Field Guide to the Birds of Australia*. Harper Collins publishing, Sydney.

5.4 Black-throated finch (*Poephila cincta cincta*)

5.4.1 Status

EPBC Act – Endangered

5.4.2 Biology and ecology

5.4.2.1 Characteristics

The Black-throated finch (southern sub-species) (*Poephila cincta cincta*) is a small stocky finch with a total body length of 12 cm and weighing about 15 g. The physical appearance of the finch is distinguishable by its bluish-grey head which features a short black stripe leading all the way through to the upper breast of the bird. The body of the finch is brown on the back, cinnamon on the breast and white on the rump which attaches to a black tail (refer Photograph 5.4). Plumage of both male and female finches are similar; however, female finches are smaller in size and have a slightly smaller throat patch compared to the male (DES 2018; OEH 2017).

Photograph 5.4 Black-throated finch (*Poephila cincta cincta*)

Source: Sherony (2016)

5.4.2.2 Known distribution

The known distribution of the Black-throated finch (southern sub-species) once extended from Inverell in northeast NSW, through eastern Queensland into the Atherton Tablelands as well as west to central Queensland (refer Figure 5.7). However, the species is considered to be locally extinct within the southern portion of its range. The species can now only be found in Queensland, near Townsville and in the Galilee Basin of Central Queensland, as the finch is likely extirpated in NSW (DES 2018; OEH 2017).

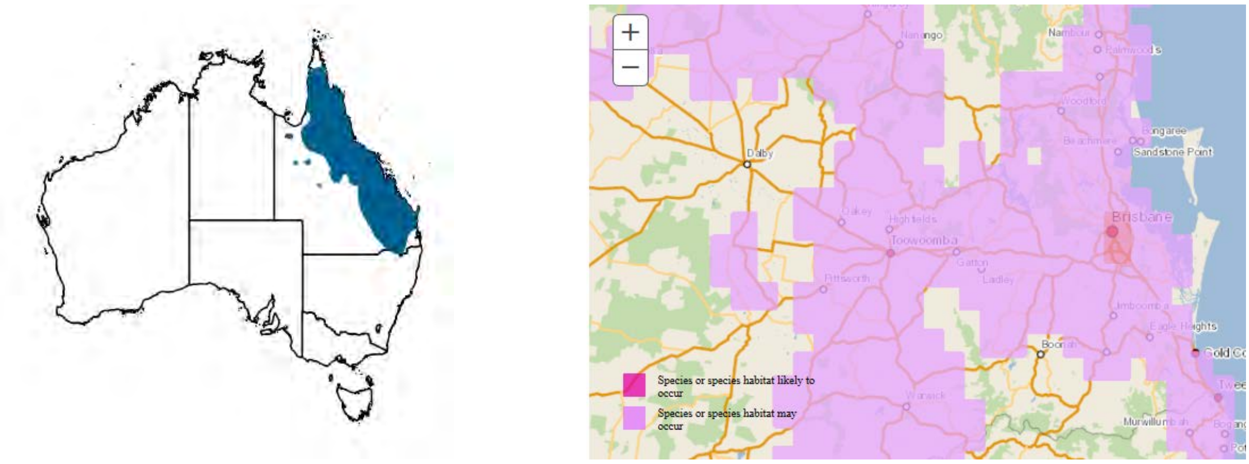

Figure 5.7 Distribution range of the Black-throated finch

Source: ALA (2018), DotEE (2018)

5.4.2.3 Distribution in relation to the Project

This species was not detected during Project associated field surveys. *Poephila cincta* has been identified as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species occurs within the Lockyer Reserves, however these records are not spatially reliable and do not have record dates. The only record with a date is old (>40 years) and occurs approximately 35 km south-east of the Project near Harrisville (refer Figure 5.8).

Figure 5.8 Distribution range of the Black-throated finch in relation to the Project

Source: ALA (2020)

5.4.2.4 Biology and reproduction

This finch species forages in small flocks, consuming seeds on the ground of native grasses as well as plucking seeds directly from the seedheads. During the breeding season, the finch is known to consume insects such as flying termites (Birdlife 2018; DES 2018).

Black-throated finches pair for life and separate from the flock during breeding season despite nesting in colonies due to their social nature. The species is known to reuse abandoned nests as well as build fresh dome shaped nests with a side entrance. Built nests are woven from grass stems and lined with soft seedheads, plant down and feathers which are placed in trees or tree hollows between spring into early autumn (Birdlife 2018; DES 2018).

The female will lay between five to nine eggs per brood and up to two broods may be produced per year, with an incubation period of up to 12 days. Fledging has been recorded to occur after 21 days with the young being independent only after 40 days (DES 2018; OEH 2017).

5.4.3 Habitat

This species of finch is a highly social bird, roaming in flocks of 40 or more. Black-throated finch (southern sub-species) require habitats that supply year-round seeds for feeding. Typical areas inhibited by the bird include grassy woodland dominated by eucalypts, paperbarks, tea-tree, Melaleuca or acacias along water courses (riparian habitats) due to their significance in providing shelter, specially within highly fragmented and modified environments. Despite being considered sedentary the species may move in response to droughts (DES 2018; OEH 2017).

5.4.4 Threatening processes

The following have been identified as potentially threatening processes to the Black-throated finch:

- Spread and intensification of pastoralism
- Changes to fire regimes
- Increases in the density of native woody weeds among grassy savannas (Birdlife International 2016; DES 2018).

5.4.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Black-throated Finch Recovery Team, Department of Environment and Climate Change (NSW) and Queensland Parks and Wildlife Service (2007). National recovery plan for the black-throated finch southern subspecies *Poephila cincta cincta*. Report to the Department of the Environment and Water Resources, Canberra. Department of Environment and Climate Change (NSW), Hurstville and Queensland Parks and Wildlife Service, Brisbane. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-black-throated-finch-southern-subspecies-poephila-cincta-cincta. In effect under the EPBC Act from 08-Jan-2008.

The following threat abatement plans have been identified as being relevant to this species:

- Department of Sustainability, Environment, Water, Population and Communities (2012). Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/resource/threat-abatement-plan-reduce-impacts-northern-australias-biodiversity-five-listed-grasses. In effect under the EPBC Act from 11-Dec-2012.
- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016. In effect under the EPBC Act from 07-Jan-2017.

5.4.6 Summary of threat abatement/recovery plans

Threats outlined in the National recovery plan for the black-throated finch southern subspecies *Poephila cincta cincta* include:

- Clearing and fragmentation of woodland, riverside, and wattle shrubland habitats
- Grazing impacts from livestock and rabbits
- Alteration of fuel load, vegetation structure and wet season food availability
- Fire causing alteration to habitat
- Invasive weed species including exotic grasses
- Illegal trapping of birds

- Predation by feral vertebrate pest species
- Hybridisation with escapees from sub-species.

Objectives and actions outlined in the National recovery plan for the black-throated finch southern subspecies *Poephila cincta cincta* include:

- Investigate and quantify threats faced by the species
- Determine distribution and abundance
- Protect and enhance habitat
- Investigate the viability of reintroducing captive breed stock
- Increase public awareness.

Threats identified in threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses includes:

- These highly invasive grasses can increase fuel loads
- Alter nitrogen cycling and water availability
- Degrade ecosystems through loss of habitat and biodiversity declines.

Management actions outlined in the threat abatement plan include:

- Determine the extent and spread pathways of infestation by the five listed grasses outlined in the plan
- Support and facilitate coordination management strategies through the design of tools, systems and guidelines
- Identify and prioritise key asset and areas for the implementation of management strategies
- Implement on the ground management strategies that are cost effective in high priority areas
- Monitor, evaluate and report back on the effectiveness of management programs.

Threats identified in the threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Supress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

5.4.7 References

Atlas of Living Australia (2017). Poephila (Poephila) cincta. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:26d93abf-b5bf-43ea-91f3-4187e30619c5 [Accessed 22 August 2018].

Birdlife Australia (2018). Black-throated Finch. Available from: http://www.birdlife.org.au/bird-profile/black-throated-finch [Accessed 22 August 2018].

BirdLife International (2016). Poephila cincta. The IUCN Red List of Threatened. Available from: http://www.iucnredlist.org/details/22719692/0 [Accessed 22 August 2018].

Department of Environment and Science (2018). Black-throated finch (southern subspecies). Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/blackthroated_finch_southern_subspecies.html [Accessed 22 August 2018].

Office of Environment and Heritage (2017). Black-throated Finch - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10641 [Accessed 22 August 2018].

Sherony, D. (2016). Black-throated finch (Poephila cincta cincta). [image] [online] Available from: https://www.flickr.com/photos/9765210@N03/31293004362/in/photolist-25zw5ov-LufB5o-PFfPXY. [17 September 2019].

5.5 Coxen's fig-parrot (*Cyclopsitta diophthalma coxeni*)

5.5.1 Status

EPBC Act – Endangered

5.5.2 Biology and ecology

5.5.2.1 Characteristics

Coxen's fig-parrot (*Cyclopsitta diophthalma coxeni*) is a small parrot measuring between 15 to 16 cm in body length (DES 2011).

The adults are predominantly bright green, with a prominent yellow line along the flanks and the sides of the breast. The primary feathers exhibit blue edges, and bright red markings occur on the tertial feathers. Broad cream bands and grey-black edging occur on the undersides of the wings, and dark grey edging around the underside of the tail. Coxen's fig-parrots have a distinctive facial pattern that consists of a patch of light-blue on the forehead, a curving band of red (edged and mottled with yellow) below the eye, and a curving band of violet-blue that borders the lower edge of the curving red band (DES 2011; OEH 2017) (refer Figure 5.9).

Both male and female species of Coxen's fig-parrot are very similar in appearance, however the female has a smaller blue patch as well as few to no red feathers on the forehead and a duller, less extensive orange-red cheek patch (DES 2011).

Figure 5.9 **Coxen's fig-parrot (*Cyclopsitta diophthalma coxeni*)**

Source: Coxen's Fig-Parrot Recovery Team (2001)

5.5.2.2 Known distribution

The Coxen's fig-parrot's known distribution is still evolving due to their hard to spot nature. However, historical records have localised scattered populations of the species to an area between Bundaberg, in Queensland, to Hastings River in NSW (DES 2011; OEH 2017) (refer Figure 5.10).

Figure 5.10 **Distribution range of the Coxen's fig-parrot**

Source: Birdlife International (2018), DotEE (2018)

5.5.2.3 Distribution in relation to the Project

This species was not detected during Project associated field surveys. *Cyclopsitta diophthalma coxeni* has been identified as potentially occurring within the MNES study area. Database records (i.e. AoLA) does not indicate any occurrence records from within 50 km of the temporary and permanent Disturbance footprint. The nearest records exist from norther NSW between Killarney to Tweed Heads and south to Richmond Range National Park (refer Figure 5.11).

Figure 5.11 **Distribution range of the Coxen's fig-parrot in relation to the Project**

Source: ALA (2020)

5.5.2.4 Biology and reproduction

Coxen's fig-parrots are omnivorous, mainly feeding on seeds of near ripe or ripe fruits of native figs, and/or insect larvae, which may include the fig wasp. Favoured species include Moreton Bay fig (*Ficus macrophylla*), Green-leaved strangler fig (*F. watkinsiana*), but a variety of other *Ficus* sp. and other native fruits also eaten (DES 2011; Pizzey and Knight 1997).

The breeding biology of Coxen's fig-parrot is almost entirely unknown. The breeding season is thought to extend from October to December or January. The nest is established in a chamber that is excavated in the rotting wood of a decaying limb or trunk of a living or dead tree. The appearance of the nest and eggs is unknown, and no information is available on the incubation or fledging periods (Birdlife International 2018; DES 2011; DotEE 2018).

Coxen's fig-parrot is usually observed singly, in pairs or in small flocks of up to 12 birds (especially during winter). Communal roosting has not been recorded for this species, however it has been speculated that communal roosting may formerly have occurred, when the population size was greater. No information is available on the breeding dispersion in this species, but it is likely that they breed in solitary pairs, like other subspecies of the Double-eyed fig-parrot (Coxen's Fig-Parrot Recovery Team 2001; DES 2011).

5.5.3 Habitat

The Coxen's fig-parrot's preferred habitat are environments with thriving fig trees in lowland rainforest especially in alluvial areas. More recently however the species has adapted to a spectrum of rainforest types including coniferous, warm and cold subtropical as well as cool temperate rainforests between sea level and approximately 1,000 m above sea level (Birdlife International 2018; DES 2011).

The species have also been known to inhabit riparian corridors through woodlands, cleared land as well as isolated fruiting trees in gardens or farms consuming both fig and other fruiting rainforest species such as lichen, nectar and grubs (DES 2011; OEH 2017).

5.5.4 Threatening processes

The following have been identified as potentially threatening processes to the Coxen's fig-parrot:

- Rapid clearance of lowland rainforest which has led to increased fragmentation of habitats and isolated fig trees
- Invasion of habitats by invasive weeds

- Challenges in locating sufficient food sources
- Competition from other species with larger populations (Birdlife International 2018; Coxen's Fig-Parrot Recovery Team 2001).

5.5.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- Coxen's Fig-Parrot Recovery Team (2001). Coxen's Fig-Parrot *Cyclopsitta diophthalma coxeni* Recovery Plan 2001-2005. Report to Environment Australia, Canberra, by Queensland Parks and Wildlife Service, Brisbane. Available from: http://www.environment.gov.au/resource/coxens-fig-parrot-cyclopsitta-diophthalma-coxeni-recovery-plan-2001-2005. In effect under the EPBC Act from 13-Oct-2003 as Cyclopsitta diophthalma coxeni.
- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from https://www.environment.nsw.gov.au/savingourspeciesapp/Project.aspx?results=c&ProfileID=10195. In effect under the BC Act 2016.

The following threat abatement plans have been identified as being relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.

5.5.6 Summary of threat abatement/recovery plan

The threats outlined in the Coxen's Fig-Parrot Recovery Plan include:

- Historical clearing of lowland subtropical rainforest for agricultural and housing in the 1860's causing decline in population numbers and range
- Inadequate extent and quality of habitat
- Fragmented habitat causing loss of connectivity between summer and winter areas, forcing birds to cross open areas and disjunct feeding grounds
- Disturbance to suspected breeding areas through logging and associated disturbance of subtropical rainforest/eucalypt ecotones
- Population decline resulting in a lack of social breading triggers, energy efficient communal food search effort and changes to social structures
- Higher susceptibility to disease and stochastic events such as drought
- Illegal robbing of nests for eggs, young and adults

Recovery plan actions plans include:

- Establish a survey protocol and implement an ecological assessment and monitoring strategy to improve knowledge on size, distribution, nesting and ecology
- Undertake predictive modelling of distribution to refine current understanding of the range and to indicate potential field survey targets
- Investigate wild red-browed fig-parrots for their direct relevant to Coxen's fig-parrot, including dietary preference, activity patterns, flock size, movement patterns and communal roosting behaviour
- Undertake captive breeding and release to reduce the chance of extinction to species
- Assess the quantity, distribution and spatial arrangement of remnant habitat through mapping and investigation of food plants
- Develop management prescriptions for logging and regulate land use within identified species habitat

- Implement a community awareness strategy, incorporating government agencies, forestry and farming industries, researchers, funding bodies and special interest groups

The Coxen's Fig-Parrot is assigned as a data-deficient species under the NSW *Saving our Species Program* and the objective of the strategy is to fill knowledge gaps in order to develop a targeted management strategy. State-wide conservation actions that have been identified for this species are:

- Encourage community participation to increase community awareness, opportunities for location of wild Coxen's Fig-Parrot populations and reduce opportunities for illegal trade of the species
- Develop a survey protocol with techniques to minimize disruption to individual birds
- Conduct training in and undertake nest surveys to increase survey skill, indicate existence of fig-parrots in areas, likely areas of home ranges
- Monitor fruiting fig trees with historical records of visiting fig-parrots, or abundant fruit in known or suspected localities for fig-parrots
- Analyse prey remains for evidence of fig-parrots
- Use decoy birds to assist in attempts to locate wild populations
- Collect ecological data to characterize known sites
- Develop a records database to facilitate analysis of ecological data and undertake predictive modelling of distribution
- Implement an ecological monitoring strategy at occupied sites
- Investigate Red-browed Fig Parrot biology/ecology to assist in understanding the likely biology/ecology of the Coxen's Fig-Parrot
- Develop captive breeding protocols and refine husbandry techniques for raising, maintaining and releasing
- Protect active nest locations disturbance and keep site locations confidential.
- Monitor nest post-acquisition of eggs or chicks for impact of eggs or chicks being removed for the captive breeding program.
- Protect known or probable habitat through land use planning legislation.
- Undertake habitat rehabilitation/expansion in areas of known or probable habitat
- Propagate known and presumed food trees and distribute to landholders and community.

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

5.5.7 References

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Coxen's Fig-Parrot Recovery Team. (2001). Coxen's fig-parrot *Cyclopsitta diophthalma coxeni* recovery plan 2001-2005. Report to Environment Australia, Canberra. Queensland Parks and Wildlife Service, Brisbane.

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Department of Environment and Science (2011). Double-eyed fig-parrot (Coxen's). Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/doubleeyed_figparrot_coxens.html [Accessed 22 August 2018].

Office of Environment and Heritage (2017). Coxen's Fig-Parrot - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10195 [Accessed 22 August 2018].

Pizzey, G. and Knight, F. (2007). *The Field Guide to the Birds of Australia*. Harper Collins publishing, Sydney.

5.6 Eastern bristlebird (*Dasyornis brachypterus*)

5.6.1 Status

EPBC Act – Endangered

5.6.2 Biology and ecology

5.6.2.1 Characteristics

The Eastern bristlebird (*Dasyornis brachypterus*) is a small ground dwelling bird with a large tail accounting for half of its 20 cm body length. The sturdy, grey-brown passerine has a dark cinnamon-brown upperpart, rufous-brown upperwing and uppertail which transitions into a grey-brown underpart which is faintly scalloped. Grey-brown feathering features on the bristlebird’s belly and flanks, with a red iris in adults distinguishing it from juveniles who have a pale brown iris. Female bristlebirds are very similar to males with the only distinguishable feature being there slightly smaller frame (Birdlife International 2016). The bristlebird is distinct in appearance due to its short wings, strong legs and bristles in front of the eyes that allow it to adapt perfectly to live amongst dense ground vegetation (DES 2013).

5.6.2.2 Known distribution

The Eastern bristlebird is endemic to the southeast of Australia and occurs in three geographically-separate regional populations in southeastern Australia (refer Figure 5.12). One of the regional populations is known to roam habitats between the southern Queensland and northern NSW border with four populations comprising of 35 individual birds (OEH 2017; DES 2013; DotEE 2018).

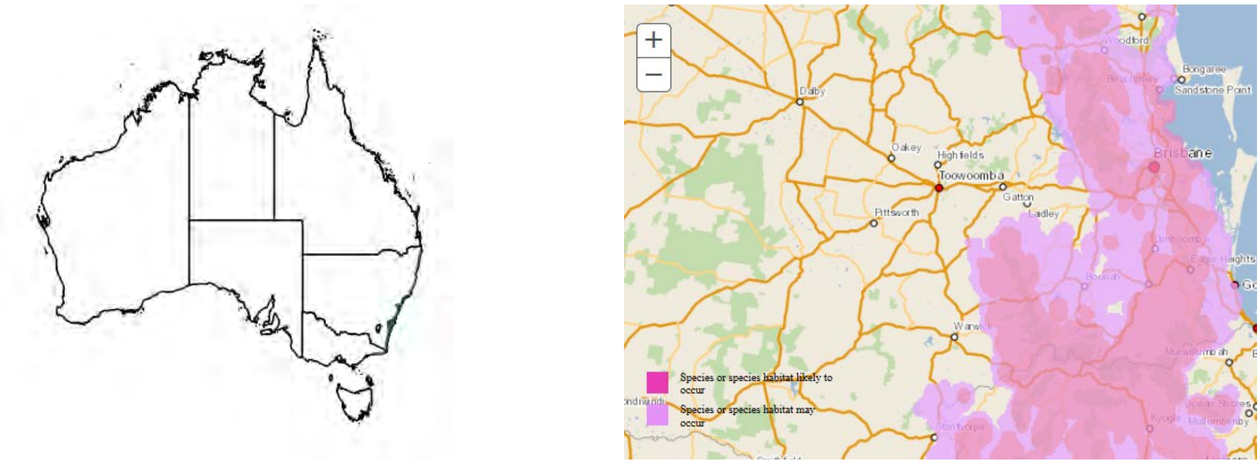

Figure 5.12 **Distribution range of the Eastern bristlebird**

Source: ALA (2017), DotEE (2018)

5.6.2.3 Distribution in relation to the Project

This species was not detected during Project associated field surveys. *Dasyornis brachypterus* has been predicted to occur within the region and associated habitat within the MNES study area. Database records (i.e. AoLA) indicate three records exist to the south from within 50 km of the Disturbance footprint. Only one of these records has a date available (1953) and the spatial certainty is not reliable for these records. The most recent records exist from 2013 located at Border Ranges National Park (refer Figure 5.13).

Figure 5.13 **Distribution range of the Eastern bristlebird in relation to the Project**

Source: ALA (2020)

5.6.2.4 Biology and reproduction

The Eastern bristlebird feed predominately on seeds, small fruits and invertebrates, but are also known to take fungi and occasionally nectar, food scraps and tadpoles. They are known to feed on the seeds or fruits of grasses and other plants (including *Acacia*, *Carex*, *Exocarpos* and, possibly, *Lycium ferocissimum*), and take nectar from *Banksia ericifolia* (DotEE 2018).

The Eastern bristlebird are known to breed from August to February. A small, globular nest is constructed with a side entrance, using grass, bark, sedges or reeds, and sometimes leaves. The nest is typically placed less than 1 m above the ground, in low dense vegetation, in or near the base of sedges, grasses, ferns and shrubs (DotEE 2018).

Clutches generally consist of two, or sometimes three, eggs. The eggs are incubated by a single parent (presumed to be the female), for at least three weeks. Both parents are known to feed the nestlings, during the fledging period of at least 16 days. Pairs readily desert their nests if disturbed, especially during the incubation period (Birdlife International 2016; DotEE 2018).

5.6.3 Habitat

The habitat of the bristlebird in Queensland has occurred within localised pockets of relatively open eucalypt forest located close to denser vegetation along creeks and rainforest, whilst in northern NSW, the bristlebird's known habitat is within open forest with understorey predominantly composed of dense tussock grass and sparse mid-storey, close to rainforest ecotone. The soil underlying these habitats are fertile and derived from basalts of the Main Range Volcanics (Birdlife International 2016; DES 2013; OEH 2017, DotEE 2018).

The species have also been known to inhabit shrubby montane heath vegetation on poorer soils consisting of *Melaleuca* spp., *Leptospermum grandifolium*, *Hakea teretifolia* and *Eucalyptus* woodland (Birdlife International 2016).

5.6.4 Threatening processes

The following have been identified as potentially threatening processes to the Eastern bristlebird:

- Inappropriate fire regimes leading to changes in habitat structure as the species requires frequent fires to ensure its preferred vegetation remains dense enough for cover and nesting, however, not frequent enough to eliminate tussocks, shrub and trees enabling invasion by weed species (Birdlife International 2016; DES 2013).

5.6.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant for this species:

- OEH (2012). National Recovery Plan for Eastern Bristlebird *Dasyornis brachypterus*. Office of Environment and Heritage, Department of Premier and Cabinet (NSW), Sydney. Available from: http://www.environment.gov.au/resource/national-recovery-plan-eastern-bristlebird-dasyornis-brachypterus. In effect under the EPBC Act from 30-Jan-2014.

The following threat abatement plans have been identified as being relevant to this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment and Energy (2017). Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (Sus scrofa) (2017). Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017. In effect under the EPBC Act from 18-Mar-2017.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox. In effect under the EPBC Act from 01-Oct-2008.

5.6.6 Summary of threat abatement/recovery plans

Threats specific to the Eastern bristlebird in the strategy include:

- Habitat clearing
- Fire
- Predation
- Disturbance of habitat by exotic herbivores
- Habitat degradation due to dieback or invasive weeds

- Small population size and genetic bottlenecks
- Climate change
- Human disturbance.

Objectives and actions outlined in the threat abatement plan for the Eastern bristlebird include:

- Prescribe appropriate fire regimes
- Control feral pest animals
- Control invasive weeds and plant-soil disease
- Conduct survey, monitoring and mapping to improve knowledge of all populations
- Understand population dynamics and monitor habitat conditions
- Locate potential habitat for new colonies
- Estimate accurately the population size for all populations
- Build populations up to a point of self-sustaining viability
- Increase knowledge of the ecology, threats and habitat management requirements for the species
- Increase community awareness and stakeholder engagement
- Ensure effective organisation and administration of recovery effort to ensure plan objectives are met.

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pics (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

Threats identified in the threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

5.6.7 References

Atlas of Living Australia (2017). *Dasyornis* (*Dasyornis*) *brachypterus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:d38d3f40-e9db-4acc-af04-d0ca566771c1 [Accessed 22 August 2018].

BirdLife International (2016). *Dasyornis brachypterus*. The IUCN Red List of Threatened. Available from: http://www.iucnredlist.org/details/22704507/0 [Accessed 22 August 2018].

Department of Environment and Energy (2018). *Dasyornis brachypterus* (Eastern Bristlebird) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=533 [Accessed 22 August 2018].

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Office of Environment and Heritage (2017). Eastern Bristlebird - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10206 [Accessed 22 August 2018].

5.7 Eastern curlew (*Numenius madagascariensis*)

5.7.1 Status

EPBC Act – Critically Endangered Marine and Migratory (CAMBA)

5.7.2 Biology and ecology

5.7.2.1 Characteristic

The Eastern curlew (*Numenius madagascariensis*) is the largest wading bird that visits Australia, with the larger sex being the female which reaches up to 66 cm tall. The wingspan is about 110 cm, weighing approximately 900 g. It has an elongated, curved bill with a pinkish base for probing in mudflats, and long olive-grey legs. The feathers of the upper parts of the body are brown, with dark centres, and have broad pale rufous or olive-brown edges (refer Photograph 5.5). The tail is grey-brown with narrow dark banding on the feathers. The under parts are dark brownish-buff, becoming paler on the rear belly. There is fine dark streaking on the fore-neck and breast, which become thicker arrow-shaped streaks and barring on the fore-flanks. The upper belly and rear flanks have finer and sparser dark streaking. The underneath of the wing is whitish but appears darker due to fine dark barring. Juveniles resemble adults but have a slightly shorter bill that grows with maturity and are typically paler with finer streaking on the breast. The Eastern curlew has a mournful, haunting yet melodious call (DES 2017; TSSC 2015).

Photograph 5.5 Eastern curlew (*Numenius madagascariensis*)

Source: Jollan (2019)

5.7.2.2 Known distribution

Within Australia, the Eastern curlew has a primarily coastal distribution. The species is found in all states and territories, particularly the north, east, and southeast regions, including Tasmania (refer Figure 5.14). Eastern curlews are rarely recorded inland. They migrate in late February to March to Russia and north-eastern China to breed (DES 2017; TSSC 2015).

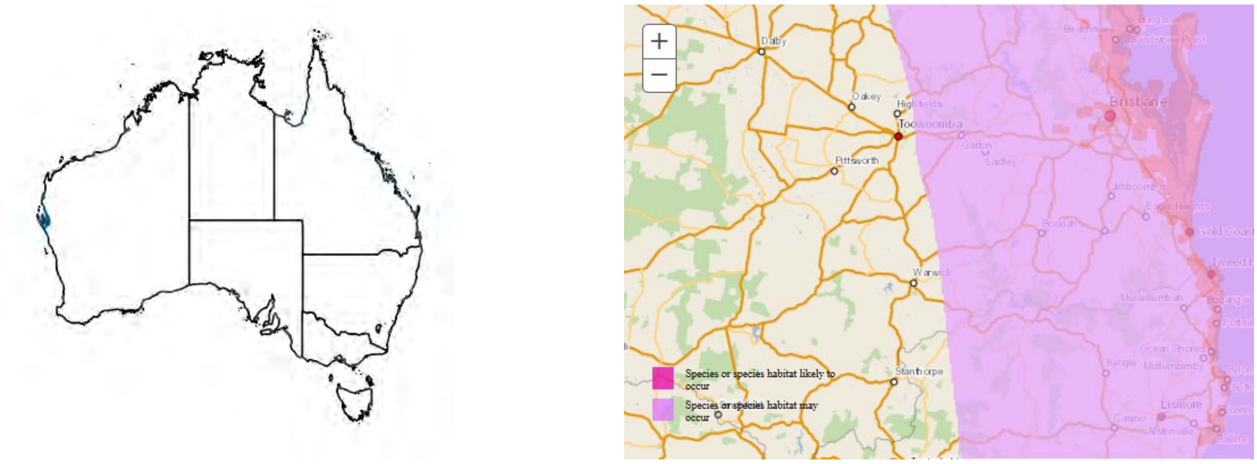

Figure 5.14 **Distribution range of the Eastern curlew**

Source: ALA (2018), DotEE (2018)

5.7.2.3 Distribution in relation to the Project

This species was not detected during Project associated field surveys. The period during which surveys were conducted was significantly dry and therefore conditions may not have been suitable for the species. *Numenius madagascariensis* has been predicted to occur within the region and associated habitat within the MNES study area. Database records (i.e. AoLA) indicate this species occurs approximately 35 km west of the Project at the Toowoomba Range dated between with records from within the last few years (2017). A recent record from 2012 exists to the south of D'Aguilar National Park from 2012 approximately 35 km east of the alignment (refer Figure 5.15).

Figure 5.15 **Distribution range of the Eastern curlew in relation to the Project**

Source: ALA (2020)

5.7.2.4 Biology and reproduction

The Eastern curlew primarily eats crustaceans, small molluscs, mudskippers and some insects. Foraging by day and night, stalking slowly on sandy and muddy flats and picking from the surface or probing deep with its long bill (Birdlife Australia 2018).

The Eastern curlew does not breed in Australia. They breed in the northern hemisphere summer, from early May to late June, often in small colonies of two to three pairs (del Hoyo et al. 1996).

5.7.3 Habitat

The Eastern curlew can be found foraging and roosting in sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (Zosteraceae). The species is known to inhabit ocean beaches, coral reefs, rock platforms, rocky islets, coastal saltworks and sewage farms. They are often recorded in saltmarshes and near mangrove forests (Marchant and Higgins 1993; TSSC 2015).

5.7.4 Threatening processes

The following have been identified as potentially threatening processes to the Eastern curlew:

- Human disturbance can cause shorebirds to interrupt their feeding or roosting and may influence the area of otherwise suitable feeding habitat. Disturbance to pre-migratory eastern curlews may adversely affect their capacity to migrate, as the birds will use energy reserves to avoid disturbance, rather than for migration (Close and Newman 1984).
- Coastal development, land reclamation, construction of barrages and stabilisation of water levels can disrupt water regimes and destroy feeding habitat (Australian Government 2009)
- Pollution and invasive plants around foraging areas may reduce the availability of food. These threats tend to be more extensive in eastern and southern Australia (Australian Government 2009; Close and Newman 1984; Garnett et al. 2011; Rogers et al. 2006).

5.7.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

5.7.6 References

Atlas of Living Australia (2018). *Numenius madagascariensis*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:21ab21e4-5cd7-4e68-9268-1b6db1a9c3aa [Accessed 22 August 2018].

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Rogers, D.I, Piersma, T., & Hassell, C.J. (2006). Roost availability may constrain shorebird distribution: exploring the energetic costs of roosting and disturbance around a tropical bay. *Biological Conservation* 133, 225-235.

Threatened Species Scientific Committee (2015). Conservation Advice on eastern curlew (*Numenius madagascariensis*). Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf [Accessed 22 August 2018].

5.8 Grey falcon (*Falco hypoleucos*)

5.8.1 Status

EPBC Act – Vulnerable

5.8.2 Biology and ecology

5.8.2.1 Characteristics

The Grey falcon (*Falco hypoleucos)* is a solitary falcon that grows to a total body length between 33 to 43 cm with an average male weighing around 400 g whilst females are heavier, weighing 550 g. The pale coloured falcon has a heavy, thick-set, deep-chested appearance with a light grey body featuring black shading on the primaries forming dark wing tips. The chin, throat and cheeks are white whilst the tail has narrow blackish bars. The eye-ring, cere and base of the beak are an orange-yellow (refer Photograph 5.6). Juvenile Grey falcons have fine dark streaks and do not have the orange-yellow eye-ring and feet the adults have (AWC 2018; OEH 2017).

Photograph 5.6 Grey falcon (*Falco hypoleucos*)

Source: Nicholas (2018)

5.8.2.2 Known distribution

The known distribution of the Grey falcon is over Australia's arid and semi-arid zones. It is absent from the Cape York Peninsula, south of the Great Diving Range in Queensland and NSW and south of the Great Dividing Range in Victoria (refer Figure 5.16). Throughout the Murray-Darling Basin the species is sparsely found with breeding occurring in the arid parts of the range and extinct in areas of more than 500 mm rainfall in NSW (Birdlife International 2016; OEH 2017).

Figure 5.16 **Distribution range of the Grey falcon**

Source: ALA (2018)

5.8.2.3 Distribution in relation to the Project

Falco hypoleucos has been predicted to occur within the region and associated habitat within the Ecology study area. Database records (i.e. AoLA) indicate this species occurs from 2013 within approximately 35 km west of the Disturbance footprint at Toowoomba Range. Other records within a 50 km buffer of the Disturbance footprint exist to the west between Toowoomba and Hampton, to the north near Lake Clarendon and to the east near Spring Mountain Forest Park.

Figure 5.17 **Distribution range of the Grey falcon in relation to the Project**

Source: ALA (2020)

5.8.2.4 Biology and reproduction

The Grey falcon is often undetectable, perching amongst foliage or sitting on branches prior to hunting prey at tree-top height attacking mainly bird species. Targets for the falcon include finches, doves, parrots and pigeon but also know to consume insects and small mammals and carrion (Birdlife International 2016).

Grey falcon are solitary nesters, laying one to four eggs in late winter to early spring. This species, like most falcons, utilise old nests of other birds such as other species of raptor and ravens, usually positioned high in eucalyptus trees close to water. During times of drought the species has been known to not breed (AWC 2018; Johnson 2011).

5.8.3 Habitat

The habitat of the Grey falcon is restricted to shrubland, grassland and wooded watercourses of arid or semi-arid regions, however, wetlands where surface water attracts potential prey is also capitalised on by the falcon. The falcon has a high affinity to habitats with high temperature and low rainfall of less than 500 mm. During periods of drought, this species moves towards the coast regions, where it frequents wooded watercourses (Birdlife International 2016; OEH 2017).

5.8.4 Threatening processes

The following have been identified as potentially threatening processes to the Grey falcon:

- Clearing and grazing of arid and semi-arid zones
- Secondary poisoning through mouse and locust control programs
- Collection of young and eggs for falconry (OEH 2017)

5.8.5 Threat abatement/recovery plans

No threat abatement/recovery plans have been identified as being relevant for this species.

5.8.6 References

Atlas of Living Australia (2018). Falco (Hierofalco) hypoleucos. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:5c4c5947-83a6-4a42-b861-8c408cfed4e7 [Accessed 2 September 2018].

Australian Wildlife Conservancy. (2018). Species Profile – Grey Falcon. Available from: http://www.australianwildlife.org/wildlife/grey-falcon.aspx [Accessed 22 August 2018].

BirdLife International (2016). Falco hypoleucos. The IUCN Red List of Threatened. Available from: http://www.iucnredlist.org/details/22696479/0 [Accessed 22 August 2018].

S, Johnson. (2011). Grey Falcon. Beauty of Birds. Available from: https://www.beautyofbirds.com/greyfalcons.html [Accessed 22 August 2018].

Nicholas, K. (2018). Grey falcon (Falco hypoleucos). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=569ffdf5-5560-454d-9dd0-f1d9e40a3c04. [17 September 2019].

Office of Environment and Heritage (2017). Grey Falcon - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10330 [Accessed 2 September 2018].

5.9 Painted honeyeater (*Grantiella picta*)

5.9.1 Status

EPBC Act – Vulnerable

5.9.2 Biology and ecology

5.9.2.1 Characteristic

Painted honeyeater (*Grantiella picta*) is a medium honeyeater, growing to a length of 14 to 15 cm in size. The Painted honeyeater weights around 20 to 25 g and has a black head and back, and bright yellow on the wings and upper tail and a bright pink bill (refer Photograph 5.7). The male is distinguished by white underparts with black streaks on flanks (above legs). The females are slightly smaller than the males and identified by brownish-black colouring with white underparts. Juveniles are browner and have a greyish coloured bill. The Painted honeyeater is known to use the same nest sites each season and are generally seen in pairs or singles, rarely in small flocks of up to six birds (DES 2018; DotEE 2018).

Photograph 5.7 Painted honeyeater (*Grantiella picta*)

Source: Knight (2009)

5.9.2.2 Known distribution

The Painted honeyeater is endemic to Australia and its distribution over summer and spring stretches from inland central Victoria through scattered parts of NSW, the ACT and southern Queensland (refer Figure 5.18). During winter the Painted honeyeater is known to migrate further to North Queensland, around Cape York Peninsula, and eastern areas of the Northern Territory. Opportunistic sightings have been recorded in far eastern parts of South Australia (DotEE 2018).

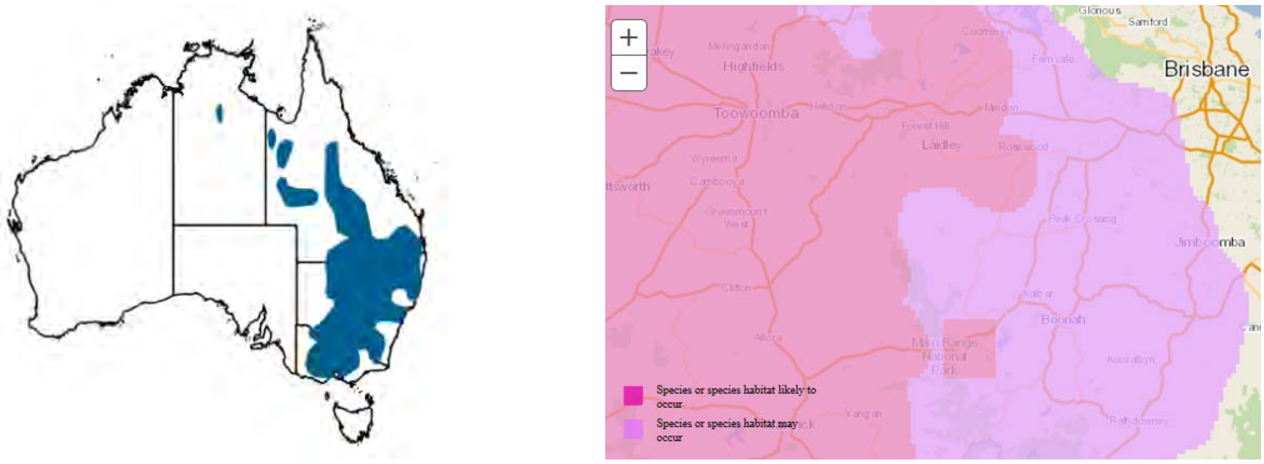

Figure 5.18 Distribution range of the Painted honeyeater

Source: ALA (2018), DotEE (2018)

5.9.2.3 Distribution in relation to the Project

This species was not detected during Project associated field surveys. Database records indicate this species does not occur within the MNES study area however has occurred within 50 km of the Project. There is a single nearby database record of uncertain provenance (no date) located 2 km south of the Project at Lake Apex, Gatton. Other database records occur largely to the west of the Project with the closest approximately 14 km west (refer Figure 5.19). The species population is sparsely dispersed across south-east Australia to north-west Queensland and eastern Northern Territory. There are a few scattered coastal records to the east of the Project but the vast majority of records lie on the western slopes of the Great Dividing Range. Coastal records may be considered as vagrant individuals. Rowland (2012) notes non-breeding individuals are recorded occasionally from coastal areas along the eastern seaboard.

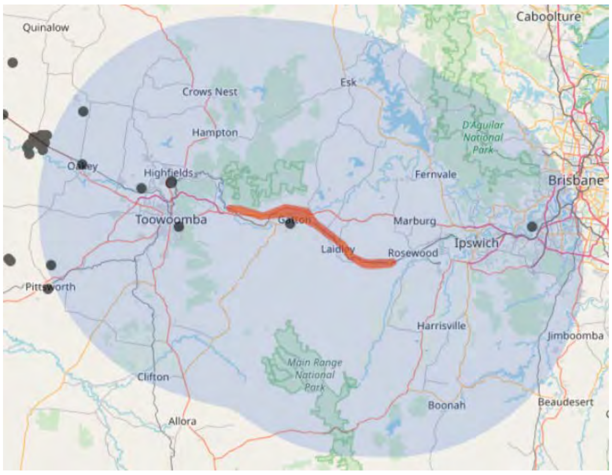

Figure 5.19 **Distribution range of the Painted honeyeater in relation to the Project**

Source: ALA (2020)

5.9.2.4 Biology and reproduction

The Painted honeyeater is typically seen individually or in pairs, less frequently seen in small flocks of up to six birds. This species is known to consume fruit. The species is predominantly observed in areas where mistletoe is abundant. The species is known to have a mixed diet consisting of nectar, berries and insects, defining them an omnivorous and an obligate nectarivore (DotEE 2018).

The species nests in a variety of trees and have been documented to favour mistletoe as a nesting site. The foliage of mistletoe helps with concealment of the nest to protect from predators and subsequent nest failure (DotEE 2018).

The breeding season generally takes place between October through to March and can be influenced by environmental conditions and the availability of food resources. Generally, the male Painted honeyeater will arrive at a nesting site several weeks before the female.

Both the male and female Painted honeyeaters maintain the nest, incubate the eggs, brood and feed the young. Nests are generally found approximately 15 m from the ground where the typical clutch consists of 2 eggs, but not uncommonly 1 to 3 eggs can be found. The species are known to raise 1 to 2 broods per season, where eggs are incubated for 13 to 15 days, and young fledge in 14 to 20 days. Box the female and male leave the nest at approximately the same time, generally five months after fledglings leave the nest and food resources decline (DES 2018; DotEE 2018).

5.9.3 Habitat

The Painted honeyeater is predominantly found in open forest, box-open woodland, eucalypt forest/woodlands, riparian woodlands and acacia woodlands. The Painted honeyeater inhabits environments that have a high prevalence of mistletoe which provides both nesting and food resources. Favourable species including needle-leaved mistletoe *(Amyema cabagei)* and grey mistletoe *(A. quandang)*. An identified key association between the Painted honeyeaters migration south-north is believed to be a result of mistletoe fruit availability and general mistletoe distribution and abundance (DotEE 2018).

5.9.4 Threatening processes

The following have been identified as potentially threatening processes to the Painted honeyeater:

- Habitat loss and fragmentation
- Grazing inhibiting tree recruitment for feed trees (DotEE 2018).

5.9.5 Threat abatement/recovery plans

The following threat abatement/recovery plan has been identified as relevant for this species:

- Office of Environment and Heritage (2016), *Saving our Species Programme*. Available from **https://www.environment.nsw.gov.au/savingourspeciesapp/Project.aspx?results=c&ProfileID=10357**. In effect under the BC Act 2016.

5.9.6 Summary of threat abatement/recovery plan

Threats identified in the Saving our Species plan includes:

- Degradation of open forest and woodland remnants along with the thinning of trees that bear mistletoe
- The loss of large, old trees that have heavy mistletoe infestations
- Habitat loss as a result of clearing woodlands and open forest
- Grazing pressure within grassy woodlands causing degradation and simplification of habitat
- Incursion from invasive weeds, particularly African boxthorn and invasive grasses
- Noisy minors causing aggressive exclusion in forest and woodland habitat.

Management actions identified in the Saving our Species plan includes:

- Encourage relevant landholders to enter into agreements that promote the protection, maintenance and recruitment of *Acacia* (*A. pendula* or *A. homalophylla*) woodland with mistletoe
- Incorporate into landholder agreements sensitive grazing regimes allowing suitable woodland habitat to regenerate
- Increase awareness with landholders of the importance of mistletoe as a resource for the Painted honeyeater and education around the fact that it is not harmful to healthy trees
- Revegetation of Brigalow, Boree and Yarran woodlands to provide connectivity between fragments, particularly in Painted honeyeater breeding habitat
- Encourage landholders to protect ground and mid-storey vegetation through the implementation of sensitive grazing techniques along with eliminating slashing or underscrubbing to retain floral and structural diversity
- Target removal of exotic grasses and promote regeneration of native grasses
- Measure the impact and abundance on Noisy miners implementing appropriate management strategies to reduce their impact
- Prioritise site protection in areas that function as drought refuges or source populations in programs that aim to protect, manage and restore habitat
- Implement research to fill knowledge gaps around restoring the structure and function of the ground layer, including soil structure in degraded habitat.

5.9.7 References

Atlas of Living Australia (2018), *Grantiella picta.* Viewed 17 August 2018, Available: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:de126daa-e11d-42e0-ace6-7873abe6c96b#.

BirdLife International (2018) Species factsheet: Grantiella picta. Downloaded from http://www.birdlife.org on 17/08/2018.

Department of Environment and Energy (2018). Conservation Advice *Grantiella picta* painted honeyeater. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conservation-advice.pdf. In effect under the EPBC Act from 08 July 2015.

Department of Environment and Science (DES), Painted honeyeater – *Grantiella picta*, Wetland*Info*, Queensland, viewed 17 August 2018, https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?grantiella-picta.

Knight, R. (2009). Painted honeyeater (Grantiella picta). [image] [online] Available from: https://www.flickr.com/photos/sussexbirder/8079677675/in/photolist-8Fw6ib-diYsFv-LDPPEM. [17 September 2019].

5.10 Red goshawk (*Erythrotriorchis radiatus*)

5.10.1 Status

EPBC Act – Vulnerable

5.10.2 Biology and ecology

5.10.2.1 Characteristics

The Red goshawk (*Erythrotriorchis radiatus*) is a large, swift and powerful rufous-brown goshawk. This species of raptor is estimated to be of 45 to 58 cm in total body length with a wingspan of 110 to 135 cm. The Red goshawk is boldly mottled and streaked, with rufous scalloping on the back and upper wings, and massive yellowish legs and feet. The head of the bird is pale and streaked with darker feathers (refer Photograph 5.8). Females are typically larger than males, more powerfully built, paler and more heavily streaked below, showing some white on the under body. Red goshawk juveniles are distinguished from adults due to their rufous head (DES 2017; DotEE 2018).

Photograph 5.8 Red goshawk (*Erythrotriorchis radiatus*)

Source: IAN (2016)

5.10.2.2 Known distribution

The Red goshawk is distributed along the east coast of Queensland, Cape York Peninsula and across into northern regions of Australia (refer Figure 5.20). In Queensland, is it estimated that the species population is limited to the bioregions of the Wet Tropics, Cape York Peninsula and Mount Isa Inlier. However, surveying of the species in another three bioregions has yet to occur. Some adults of Red goshawk in southeast Australia have been known to migrate annually from the ranges down into the lowlands during winter period. The species is thought to be extinct in southeast Queensland as well as being very rare in NSW extending south to about 30°S (DES 2017; OEH 2017).

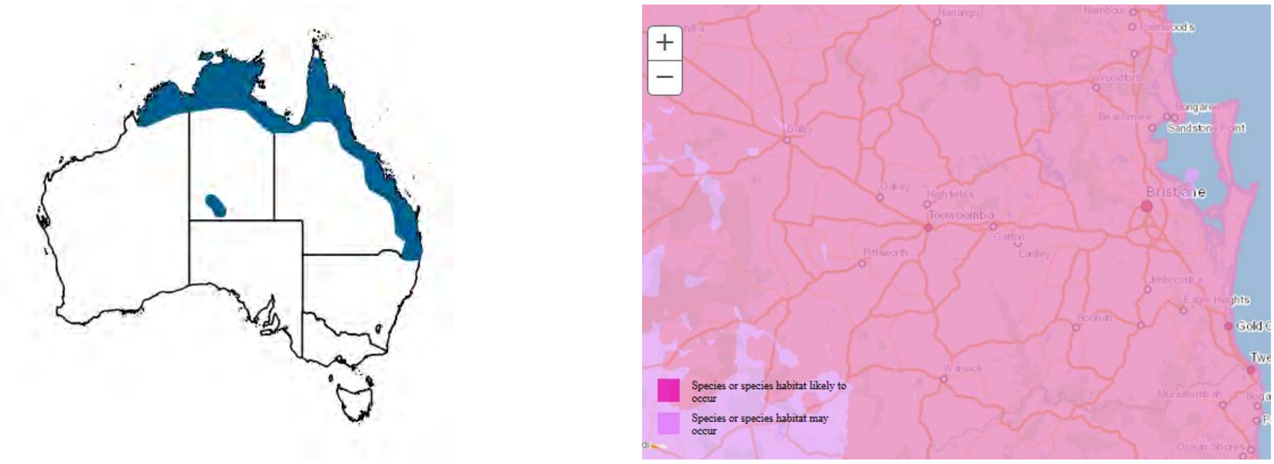

Figure 5.20 **Distribution range of Red goshawk**

Source: ALA (2016), DotEE (2018)

5.10.2.3 Distribution in relation to the Project

Erythrotriorchis radiatus has been identified as potentially occurring within the MNES study area. No individuals were observed during Project associated survey works, including targeted surveys for breeding places (nests) along the Project alignment (e.g. ELA and EMM). Database records indicate this species has been recorded within 50 km of the Project. It is noted available records (AoLA) have all been generalised in order to protect the species and so accurate locations have not been published. The nearest recent records include: a 2008 record located 3.7 km north-west of the western extent of the Project in the Lockyer Resources Reserve; 2002 and 2003 records located 5 km south in the Grantham area; a record from 2009 located 8 km north-east of the Project in the Rosewood area (although attached location data indicates Ipswich as the locality); and a 2012 record near Toowoomba (13 km south-west of the western extent of the Project) (AoLA 2020) (refer Figure 5.21).

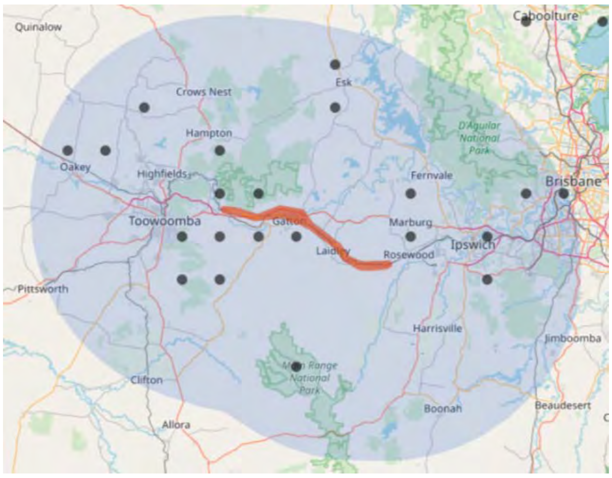

Figure 5.21 **Distribution range of Red goshawk in relation to the Project**

Source: ALA (2020)

5.10.2.4 Biology and reproduction

The solitary Red goshawk is known to prey on birds such as Australian brush-turkeys, Kookaburras and Rainbow lorikeet as well as small mammals, reptiles and insects. The species is known to attack its prey from the air, gliding straight down or chasing it down. The male of the species will build nests using dead sticks lined with twigs and green leaves within an exposed fork in the upper quarter of a tree between 10 to 20 m above ground and used each year (DES 2017; OEH 2017).

The breeding season for Red goshawk occurs from September to December with one to two eggs being laid by the females between August and October in the southeast regions. Females will incubate eggs for a period of 39 to 43 days with the young being fully fledged after eight weeks despite not being independent for at least another ten weeks (DES 2017).

5.10.3 Habitat

The Red goshawk typically occurs in both coastal and sub-coastal areas, in wooded and forested lands of tropical and warm-temperate Australia. Riverine forests are also used frequently. The Red goshawk nests in large trees, frequently the tallest and largest in a stand, which are typically within one kilometre of a permanent water source. This species typically avoids very dense, and very open habitats (Debus 1991; 1993; OEH 2017; Marchant and Higgins 1993).

In Queensland the species is known to inhabit cleared parts of eastern Queensland associated gorges and escarpment country whilst in NSW the preferred habitat includes mixed subtropical rainforest such as *Melaleuca* swamp forest as well as riparian *Eucalyptus* forest of coastal rivers (DES 2017; OEH 2017).

5.10.4 Threatening processes

The following have been identified as potentially threatening processes to the Red goshawk:

- Heavy habitat fragmentation caused by urban development, agriculture and forestry processes clearing extensive areas of forests
- Vulnerability of nests to storm damage and prey
- Development or noise dispersing food sources (DES 2017).

5.10.5 Threat abatement/recovery plans

No threat abatement plans have been identified as being relevant to this species.

The following recovery plan has been identified as being relevant for this species:

- Department of Environment and Resource Management (2012). National recovery plan for the red goshawk Erythrotriorchis radiatus. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra. Queensland Department of Environment and Resource Management, Brisbane. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-red-goshawk-erythrotriorchis-radiatus. In effect under the EPBC Act from 24-Jul-2012 as *Erythrotriorchis radiatus*.

5.10.6 Summary of threat abatement/recovery plan

Threats identified in the recovery plan for this species includes:

- Loss of habitat
- Fragmentation of existing habitat
- Reduction in nest sites through the loss of mature trees
- Reduction to the prey base
- Threats to prey availability

- Knowledge and communication gaps for this species
- Poor management practices.

Recover plan actions for this species include:

- Identify and map important Red goshawk habitat
- Protect and appropriately manage important habitat areas for the species to ensure its long-term survival
- Gain a better understanding regarding the reproductive success and survival for the Red goshawk
- Identify important populations for the species
- Increase community awareness and engagement in the conservation of the species.

5.10.7 References

Atlas of Living Australia (2016). Erythrotriorchis radiatus. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:1405a1d4-557c-40ac-9f44-a6d41e9136cd#overview [Accessed 22 August 2018].

Debus, S.J.S. (1991). An annotated list of NSW records of the Red goshawk. Australian Birds. 24:72- 89

Debus, S.J.S. (1993). The status of the Red goshawk (Erythrotriorchis radiatus) in New South Wales. Olsen, P., ed. Australasian Raptor Studies. Page(s) 182-191. ARA-RAOU, Melbourne

Department of Environment and Energy (2018). Erythrotriorchis radiatus (Red Goshawk) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=942 [Accessed 22 August 2018].

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Marchant, S. and P.J. Higgins, eds. (1993). Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings. Melbourne, Victoria: Oxford University Press.

Office of Environment and Heritage (2017). Red Goshawk – Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10279 [Accessed 22 August 2018].

5.11 Regent honeyeater (*Anthochaera phrygia*)

5.11.1 Status

EPBC Act – Critically Endangered

5.11.2 Biology and ecology

5.11.2.1 Characteristic

The Regent honeyeater (*Anthochaera phrygia*) is approximately 20 to 23 cm in total length, and weighs between 31 to 50 g. This species is characterised by its striking black and yellow appearance. The head, neck and upper breast of the species features black feathering which transitions into a lemon-yellow back and leads to black wings with conspicuous yellow patches. The tail of the bird is predominantly black with yellow edging (refer Photograph 5.9). Males of the species are distinguished by yellowish warty bare skin surrounding the eye whilst females are noticeably smaller in size with a bare yellowish patch under the eye as well as less black on the throat. Young Regent honeyeaters resemble females, however have a browner and paler bill (Birdlife 2018; Curtis et al. 2012).

Photograph 5.9 Regent honeyeater (*Anthochaera phrygia*)

Source: eBird Australia (2015)

5.11.2.2 Known distribution

The Regent honeyeater is a species endemic to southeast Australia, ranging from southeast Queensland to central Victoria (refer Figure 5.22). Despite historic records indicating that the species ranged widely, from Rockhampton, Queensland to Adelaide, the species is now restricted to the western slopes of the Great Diving Range (Birdlife 2018).

In southeast Queensland, the Regent Honeyeater's distribution ranges from the Cooloola Plains in the north to inland areas such as Dalby, and further south into areas such as Narrabri NSW. Regent honeyeater breeding occurs by a smaller number of the species regularly west of Warwick in Queensland (Curtis et al. 2012; DES 2017).

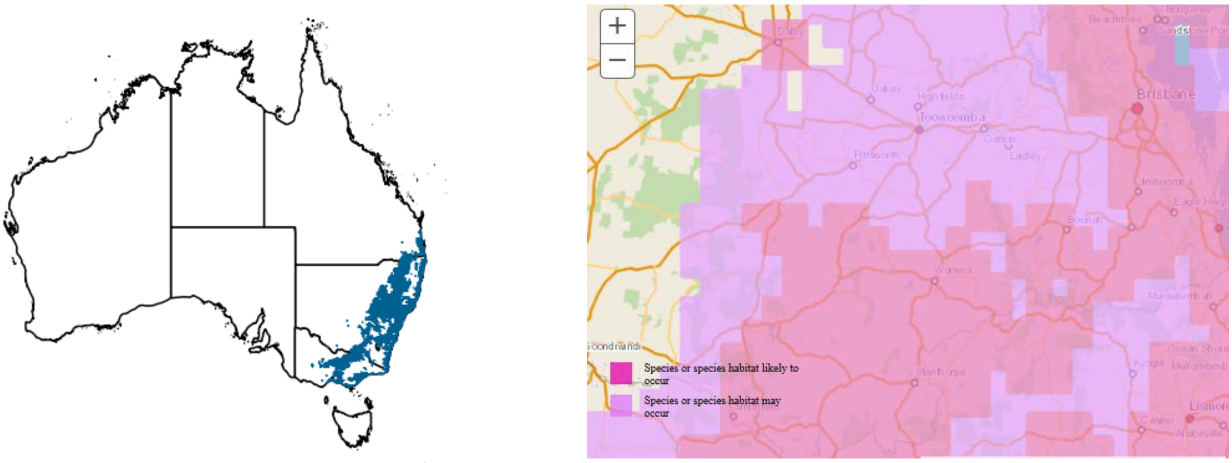

Figure 5.22 Distribution range of the Regent honeyeater

Source: ALA (2018), DotEE (2018)

5.11.2.3 Distribution in relation to the Project

Anthochaera phrygia has been predicted to occur within the region and associated habitat within the MNES study area. It is noted AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. Database records (i.e. AoLA) indicate this species has been recorded approximately 5 km north-west of the western extent of the Project disturbance footprint at the Lockyer Reserves however this record is older (pre-1980), does not have a recorded sighting date and is not spatially reliable. A second record exists further north within the Lockyer Reserves, however has the same date and spatial issues. There are a large number of records to the east of the Project from 2019 located over 25 km from the disturbance footprint. Many of these records are likely associated with a well known pair of birds that occurred in urban parklands in the Springfield Lakes area over an extended period of time in winter 2019 (pers. comm. B Taylor) (refer Figure 5.23). Records to the south of the Project include Main Range National Park (2000) and an older record (<1980) from Mount Alford area. Both of these records are over 30 km south of the Project footprint (AoLA 2020).

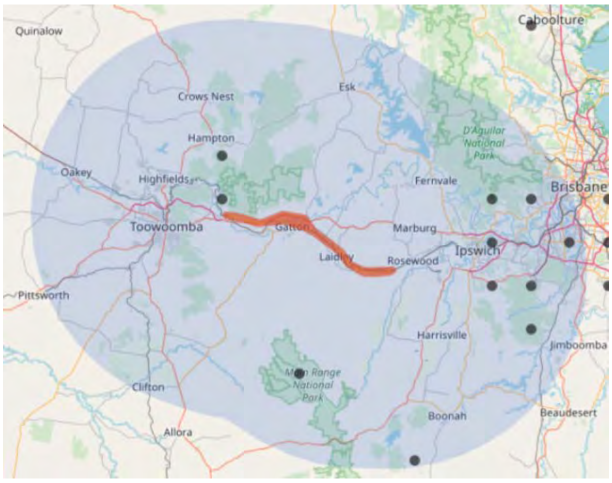

Figure 5.23 **Distribution range of the Regent honeyeater**

Source: ALA (2020)

5.11.2.4 Biology and reproduction

The Regent honeyeater's diet consists of nectar from key species such as Yellow Box (*Eucalyptus melliodora*), White Box (*Eucalyptus albens*) and Mugga Ironbark (*Eucalyptus sideroxylon*) as well as sugary exudates. The species is also known to consume insects particularly when breeding (Birdlife International 2016).

The species breeds as individual pairs or sometimes in loose colonies with the female honeyeater incubating eggs whilst both parents feed the young. The eggs are often laid in cup-shaped nest 1 m to 20 m above the ground in tree forks of eucalypts and sometimes among mistletoe. The nests are usually constructed of bark with soft material lining the nest (Birdlife 2018; Birdlife International 2016).

5.11.3 Habitat

The preferred habitat of the Regent honeyeater is wet areas containing fertile soils that provide reliable nectar seasonally in areas of creek flats, river valleys and lower slopes. They are also found in dry eucalypt woodland and open forest in both rural and urban environments with mature eucalypts (DES 2018).

Other habitats of the species include Swamp mahogany (E. *robusta*), Spotted gum (*Corymbia maculata*) and River she-oak (*Casuarina cunninghamiana*) with associated Mistletoe (*Amyena cambagei*) (DES 2018).

5.11.4 Threatening processes

The following have been identified as potentially threatening processes to the Regent honeyeater:

- Habitat loss, fragmentation and degradation as a result of clearing for agriculture and development
- Suppression of natural regeneration of overstorey tree species and shrub species as a result of overgrazing
- Competition from larger, aggressive species such as the Noisy miner, Noisy friarbird and Red wattlebird
- Disturbance to nesting sites leading to abandonment (OEH 2017).

5.11.5 Threat abatement/recovery plans

The following threat abatement plan has been identified as being relevant to this species.

- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016**. In effect under the EPBC Act from 07-Jan-2017.

The following recovery plan has been identified as being relevant for this species:

- Department of the Environment (2016). National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*). Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-regent-honeyeater-anthochaera-phrygia-2016**. In effect under the EPBC Act from 04-May-2016 as Anthochaera phrygia.

5.11.6 Summary of threat abatement/recovery plan

Threats identified in the threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Supress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

Threats identified in the National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*) include:

- A reduction in population size
- The loss of habitat and further fragmentation
- Degradation of remaining habitat
- Competition with other nectivorous birds and the honeybee (*Apis mellifera*).

Recover plan actions for this species include:

- Improve Regent honeyeater habitat in extent and quality
- Utilise captive-bred birds to bolster wild populations until they become self-sustaining
- Better understand wild Regent honeyeater population parameters including size, structure and population trends
- Increase and maintain existing community awareness, understanding and involvement in the recovery program.

5.11.7 References

Atlas of Living Australia (2018). Anthochaera (Xanthomyza) phrygia. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:af9380ee-2f65-4213-bb6f-ea6baf92ad3e#overview [Accessed 17 August 2018].

Birdlife Australia (2018). Regent Honeyeater. Available from: http://www.birdlife.org.au/bird-profile/regent-honeyeater [Accessed 17 August 2018].

BirdLife International (2016). Anthochaera phrygia. The IUCN Red List of Threatened. Available from: http://www.iucnredlist.org/details/full/22704415/0 [Accessed 17 August 2018].

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Department of Environment and Science (2017). Regent Honeyeater. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/regent_honeyeater.html [Accessed 17 August 2018].

eBird Australia. (2015). Regent honeyeater (Anthochaera phrygia). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=ad1bf8a3-56b4-4f31-ab23-4e19388eeeac. [17 September 2019].

5.12 Squatter pigeon (Geophaps scripta scripta)

5.12.1 Status

EPBC Act – Vulnerable

5.12.2 Biology and ecology

5.12.2.1 Characteristics

The Squatter pigeon (*Geophaps scripta scripta)* (southern sub-species) is a heavily built, medium sized ground dwelling pigeon, measuring approximately 26 to 32 cm in total length with a wing span of 45 cm. Adults are generally grey-brown in colour, with black and white stripes on the face and throat, blue-grey skin around the eyes, dark brown (with some patches iridescent green or violet) wings, a blue-grey lower breast, and white flanks and lower belly (refer Photograph 5.10). Both sexes are of similar appearance, whilst juveniles are duller in colour, with patchy and less distinctive black and white facial stripes and paler facial skin (DotEE 2018; OEH 2017; NPWS 1999).

Photograph 5.10 Squatter pigeon southern sub-species (*Geophaps scripta scripta*)

Source: Dew (2017)

5.12.2.2 Known distribution

The Squatter pigeon (southern sub-species) was once found widespread nationally extending from southern NSW to the Burdekin River in northern Queensland (refer Figure 5.24). However, the species is now limited to an area from north Queensland to the northwest slopes of NSW, including southeast Queensland, the western slopes of the Great Diving Range, the Gwydir River region and the Liverpool Plains (Cooper et al. 2014; OEH 2017).

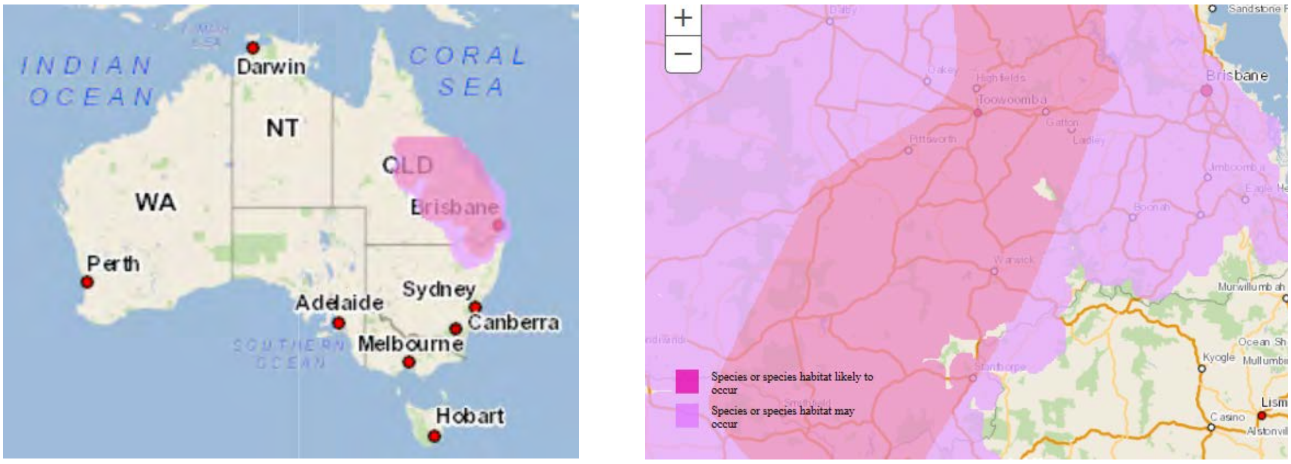

Figure 5.24 Distribution range of the southern Squatter pigeon

Source: DotEE (2018)

5.12.2.3 Distribution in relation to the Project

This species was not detected during Project associated field investigations. *Geophaps scripta scripta* has been identified in database searches as potentially occurring within the MNES study area. Database records (i.e. AoLA) indicate this species has been recorded within the MNES study area at the western section of the Disturbance footprint at Helidon from 1989 (refer Figure 5.25). This record occurs to the north of Airforce road located north-west of the Helidon township in the Lockyer Valley. Most records within a 50 km buffer of the Disturbance footprint occur to the north of the alignment from the Lockyer Reserves north to Crows Nest and east to Coominya and have been recorded in the last 15 to 40 years. Two records exist to the south-east of the alignment at Mount Alford.

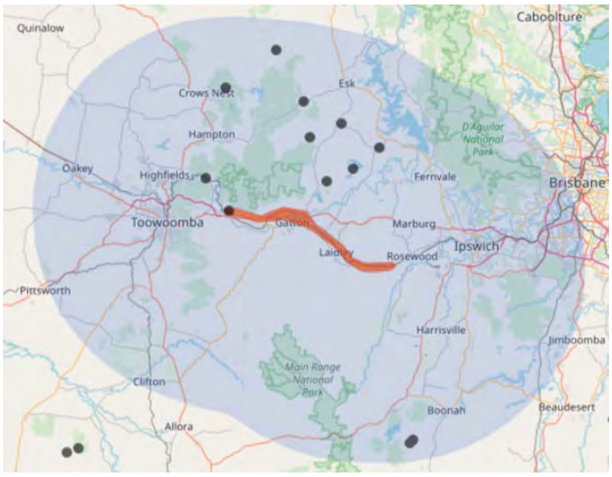

Figure 5.25 **Distribution range of the southern Squatter pigeon in relation to the Project**

Source: ALA (2020)

5.12.2.4 Biology and reproduction

The Squatter pigeon (southern sub-species) forages on the ground for grass seeds, herbs, shrubs and insects. The Squatter pigeon is typically seen in pairs, or in small groups of up to 20 or more individuals and breed throughout the year. Breeding however is influenced by heavy rainfall which most commonly occurs during the dry season between May and June (DotEE 2018; OEH 2017; Pizzey and Knight 2007).

Squatter pigeon nests are depressions scraped into the ground beneath a tussock of grass, bush, fallen tree or log and sparsely lined with grass. The female lays two eggs which are smooth, lustrous, pale cream and oval with an incubation period of approximately 17 days by both parents. Southern Squatter pigeon chicks will remain in the nest for a further 2 to 3 weeks after hatching (Australian Bush Birds 2018; AWC 2017; DotEE 2018).

5.12.3 Habitat

The Squatter pigeon (southern sub-species) is known to inhabit grassy understorey of open eucalypt woodlands and plains featuring sandy areas within close proximity to water. Areas of semi-arid or arid landscape with sandy, open and short grass cover dissected by gravel ridges is the preferred habitat for the species. The ground cover in foraging and breeding habitat is typically patchy, consisting of native, perennial tussock grasses or a mix of perennial tussock grasses and low shrubs or forbs. This vegetated ground layer rarely exceeds 33 per cent of the ground area. The remaining ground surface typically consists of bare patches of gravelly or dusty soil, and areas lightly covered in leaf litter and coarse, woody debris (e.g. fallen trees, logs and smaller debris). The species is also often found alongside tracks and roadsides (DotEE 2018; OEH 2017).

5.12.4 Threatening processes

The following have been identified as potentially threatening processes to the southern Squatter pigeon:

- Fragmentation and/or clearing of grassy woodland habitats for agriculture and development
- Overgrazing by domestic stock and feral rabbits of habitat
- Predation by feral cats and foxes
- Illegal shooting (OEH 2017).

5.12.5 Threat abatement/recovery plans

No recovery plan has been identified as being relevant to this species.

The following threat abatement plans has been identified as being relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats. In effect under the EPBC Act from 23-Jul-2015.
- Department of the Environment and Energy (2016). Threat abatement plan for competition and land degradation by rabbits. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/competition-and-land-degradation-rabbits-2016. In effect under the EPBC Act from 07-Jan-2017.
- Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008). Threat abatement plan for predation by the European red fox. DEWHA, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/predation-european-red-fox. In effect under the EPBC Act from 01-Oct-2008.

5.12.6 Summary of threat abatement/recovery plan

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

Threats identified in the threat abatement plan for competition and land degradation by rabbits includes:

- Competition with native wildlife for food and shelter
- Prevention of plant regeneration
- Increased grazing pressure and damage to native vegetation
- Altering the regular process of plant succession
- Altering ecological communities and impacting soil structure and nutrient cycling contributing to serious erosion
- Increasing predation and reducing reproduction for native arboreal mammals and birds through the removal of critical habitat.

Threat abatement actions for rabbits include:

- Supress rabbit populations at the landscape scale below thresholds in identified priority areas
- Gain a better understanding of the impacts rabbits have and their interactions with other species and ecological processes
- Increase the effectiveness of rabbit control programs
- Increase engagement within the local community to provide awareness of the environmental impact of rabbits and the need for integrated control.

Threats identified in the threat abatement plan for predation by the European red fox include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for the European red fox include:

- Baiting
- Biological control
- Barriers
- Habitat management
- Shooting and bounties.

5.12.7 References

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5.13 Swift parrot (*Lathamus discolor*)

5.13.1 Status

EPBC Act – Critically Endangered, Marine

5.13.2 Biology and ecology

5.13.2.1 Characteristics

The Swift parrot (*Lathamus discolor*) is a small lorikeet-like parrot with a long slender tail measuring approximately 25 cm in body length and weighing 77 g. The Swift parrot is predominately bright green in colour, with dark-blue patches on the crown, a prominent red face, and the chin and throat are narrowly bordered with yellow. One of most distinctive features from a distance is its long 12 cm, thin tail, which is dark red (refer Photograph 5.11). The female Swift parrot is distinguishable from the male as it has slightly duller feathering with a creamy underwing bar (Birdlife 2018; DES 2017; OEH 2017).

Photograph 5.11 Swift parrot (*Lathamus discolor*)

Source: eBird Australia (2015)

5.13.2.2 Known distribution

The Swift parrot is endemic to south-eastern Australia. This species breeds only in Tasmania and migrates during the autumn and winter months to southeast Queensland as well as both coastal and the southwest slopes of NSW (DotEE 2018; OEH 2017) (refer Figure 5.26).

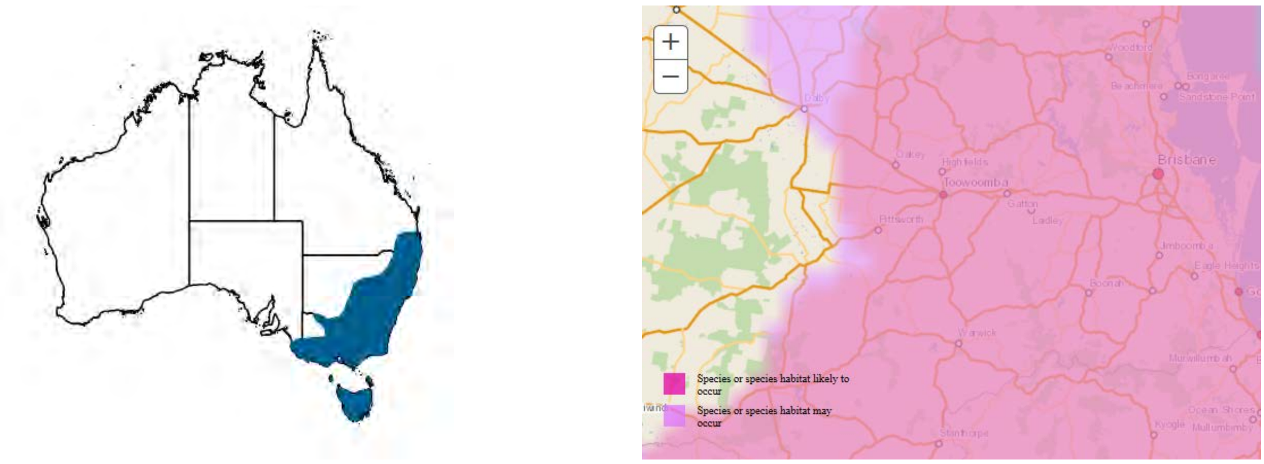

Figure 5.26 Distribution range of Swift parrot

Source: ALA (2018), DotEE (2018)

5.13.2.3 Distribution in relation to the Project

This species was identified in woodland in the Rosewood area (5 km east of the Project disturbance footprint) during protected plant surveys in June 2018 for a related project (EMM 2018). There are a number of database records (i.e. AoLA) within 10 km of the disturbance footprint in the western portion of the alignment. This includes a 2000 record 5 km north of Gatton, a 2010 record in the murphy's Creek area (6 km north-west of the western extent of the Project), a 1998 record (6 km west of the of the western extent of the Project) and a record of uncertain provenance (i.e. no date and location generalised to 0.1 degree) located 7 km south of the same area. Other records for this species occur to the west of the alignment from the Toowoomba Range, and to the north at Atkinson's Dam (refer Figure 5.27)

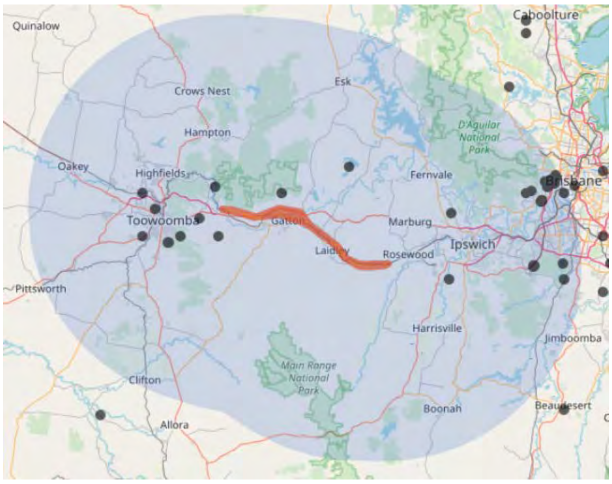

Figure 5.27 **Distribution range of Swift parrot in relation to the Project**

Source: ALA (2020)

5.13.2.4 Biology and reproduction

The Swift parrot feeds mostly on nectar, mainly from Eucalypts, but also eats psyllid insects and lerps (waxy secretion on Eucalypt leaves produced as a protection by young psyllid insects), seeds and fruit. Swift parrots are mostly arboreal foragers, foraging mainly in Eucalypts, but occasionally coming to the ground to feed on seeds, fallen flowers, fruit and lerp, and to drink (DotEE 2018; Higgins 1999; Mallick et al. 2004; Swift parrot Recovery Team 2011).

Swift parrot's breeding season occurs from mid-September to late-January in Tasmania. Nests are typically constructed in hollows of trunks, a branch or spout of a living or dead gum tree with nests known to be used each year. The typical nesting season begins in late September with females laying 3 to 5 eggs during October and November. The females incubate the eggs and fledging hatch from early December to late January (Birdlife 2018; DotEE 2018).

5.13.3 Habitat

The Swift parrot typically inhabits dry sclerophyll, Eucalypt forests, woodlands, suburban parks and even gardens with flowering fruit trees with records showing It occasionally inhabiting wet sclerophyll forests (Birdlife 2018; Swift parrot Recovery Team 2011).

In northern NSW and southeastern Queensland, Narrow-leaved ironbark (*Eucalyptus crebra*), Forest red gum (*E. tereticornis*) forests and Yellow box (*E. melliodora*) forest are commonly utilised by Swift parrots (OEH 2017). While on the western slopes Mugga ironbark (*E. sideroxylon*) and Grey Box (*E. microcarpa*) woodlands are used (DotEE 2018).

Habitats associated with the inland slopes of the Great Dividing Range, and along the eastern coastal plains, are considered the principal wintering grounds (DotEE 2018).

5.13.4 Threatening processes

The following have been identified as potentially threatening processes to the Swift parrot:

- Habitat loss associated with breeding sites as well as drought refugia habitat
- Habitat alteration through forestry operations, firewood collection and urbanisation in Tasmania
- Competition with noisy miner and aggressive honeyeaters
- Nest predation by gliders (DES 2017; OEH 2017).

5.13.5 Threat abatement/recovery plans

The following recovery plan has been identified as being relevant to this species:

- Saunders, D.L. & C.L. Tzaros (2011). National Recovery Plan for the Swift Parrot (Lathamus discolor). Birds Australia, Melbourne. Available from: **http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-swift-parrot-lathamus-discolor**. In effect under the EPBC Act from 10-Feb-2012.

The following threat abatement plans has been identified as being relevant for this species:

- Department of the Environment (2015). Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats**. In effect under the EPBC Act from 23-Jul-2015.

5.13.6 Summary of threat abatement/recovery plan

Threats identified in the National Recovery Plan for the Swift parrot include:

- Habitat loss and alteration from forestry activities including fire wood harvesting
- Residential and industrial development
- Agricultural tree senescence and dieback
- Suppression of tree regeneration
- Frequent fires
- Climate change
- Mortality resulting in collision with wire netting or mesh fences
- Competition from large, aggressive honeyeaters
- Psittacine Beak and Feather Disease (PBFD), which can have devastating impacts depending on general conditions and parrot health
- Illegal poaching of wildlife
- The cumulative impact of all threats.

Threat abatement actions for this species include:

- The identification of the quality and extent of suitable habitat
- Managing and protecting suitable Swift parrot habitat at the landscape level
- Monitor and manage the impact of collisions, competition and disease
- Monitor population and habitat
- Increase community awareness and involvement in the recovery program
- Report on and review the recovery process.

Threats identified in the threat abatement plan for predation by feral cats include:

- Predation on native species causing a critical decline in many species across animal groups
- Competition for food with species they share dietary overlap and disease transmission
- Contributed to the extinction of many ground nesting bird species and the decline of small mammals.

Threat abatement actions for feral cats include:

- Effectively control cats in different landscapes
- Improve effectiveness of existing control measures for feral cats
- Develop and maintain alternative strategies for the recovery of threatened species
- Gain public support for feral cat management and promote responsible cat ownership.

5.13.7 References

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eBird Australia. (2015). Swift parrot (Lathamus discolor). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=5fdc44e4-6dcf-4a63-955c-c6ae76f938a1. [17 September 2019].

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Office of Environment and Heritage (2017). Swift Parrot - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10455 [Accessed 22 August 2018].

Swift Parrot Recovery Team. (2011). Swift Parrot Lathamus discolor recovery plan 2011. Report to Environment Australia, Canberra. Queensland Parks and Wildlife Service, Brisbane.

5.14 Curlew sandpiper (*Calidris ferruginea*)

5.14.1 Status

EPBC Act – Critically Endangered Marine and Migratory (CAMBA)

5.14.2 Biology and ecology

5.14.2.1 Characteristic

The Curlew sandpiper (*Calidris ferruginea*) is a small sandpiper approximately 18 to 23 cm long with a wingspan of 38 to 41 cm and weighing about 57 g. The head is small and round with a black bill that is long and decurved with a slender tip, sometimes with a brown or green tinge at the base (refer Photograph 5.12). The sexes are similar, but females have a slightly larger and longer bill and a slightly paler underbelly in breeding plumage (DotEE 2018).

In breeding plumage, the head, neck and underbody are a rich chestnut-red with narrow black bars on the belly and flanks. There are black streaks on the crown, a dusky loral stripe, and white around the base of the bill. The feathers on the mantle and scapulars are black with large chestnut spots and grayish-white tips. The back and upper rump are dark brown, with a prominent square white patch across the lower rump and uppertail-covert (DotEE 2018).

During the breeding season the cap, ear-coverts, hindneck and sides of neck are pale brownish-grey with fine dark streaks changing to white on the lower face and throat. There is a narrow dark loral stripe and white supercilium from the bill to above the rear ear-coverts. The mantle, back, scapulars, tertials and innerwing-covert are pale brownish-grey with fine dark streaks. The underbody is white with a brownish-grey wash and fine dark streaks on the breast (DotEE 2018).

Photograph 5.12 Curlew sandpiper (*Calidris ferruginea*)

Source: Emilio (2014)

5.14.2.2 Known distribution

In Australia, Curlew sandpipers occur around the coasts and are also quite widespread inland (refer Figure 5.28). Records occur in all states and territories during the non-breeding season as well as the breeding season when immature birds remain in Australia rather than migrating north towards Siberia (DotEE 2018).

In Queensland, widespread records occur along the coast south of Cairns with sparsely scattered records inland. In NSW, they are widespread east of the Great Divide, especially in coastal regions. They are occasionally recorded in the Tablelands and are widespread in the Riverina and southwest NSW, with scattered records elsewhere (DotEE 2018).

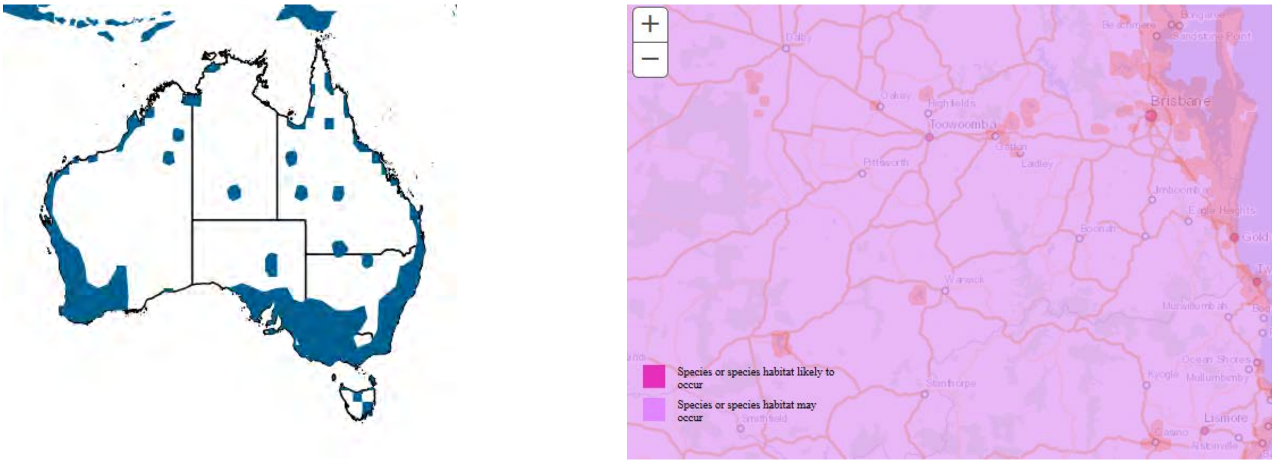

Figure 5.28 Distribution range of the Curlew sandpiper

Source: ALA (2018), DotEE (2018)

5.14.2.3 Distribution in relation to the Project

The nearest record (i.e. AoLA) of this species is from Lake Apex in Gatton located 2 km south of the Project disturbance footprint (the recorded date is uncertain based on the data associated with the record). The closest recent record (2001) of the species to the Project is from Lake Dyer (Bill Gunn Dam) in the Laidley area approximately 2 km south of the Project disturbance footprint (AoLA 2020). An older record (<1985) is located in the Plainlands area approximately 4 km north of the Project disturbance footprint. However, this record has a high spatial uncertainty attached and no location information and has been disregarded. There are also recent records from the wider Gatton area including 2017 and 2018 records from Lake Clarendon (6.5 km north of the Project), a 2009 record from Janke's Swamp (4 km north of the Project) and 2003 records from Atkinson's Lagoon in Gatton (20 km north of the Project). The majority of records from the region are coastal or from inshore islands in Moreton Bay (refer Figure 5.27).

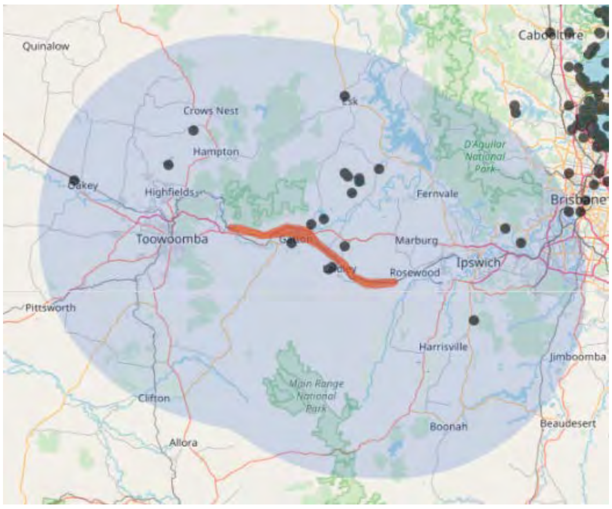

Figure 5.29 Distribution range of the Curlew sandpiper in relation to the Project

Source: ALA (2020)

5.14.2.4 Biology and reproduction

In Australia, the Curlew sandpiper forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Curlew sandpipers usually forage by pecking and probing in water, near the shore or on bare wet mud at the edge of wetlands. They glean from mud, from the surface of water, or in drier areas above the edge of the water. Curlew sandpipers may wade up to the belly, often with their heads submerged while probing. They often forage in mixed flocks, including with Red-necked stints (*Calidris ruficollis*). In tidal waters, the birds move onto the most recently exposed parts of the tidal flats and retreat in stages as the tide comes in. Supratidal feeding mainly occurs during the pre-migratory fattening periods (February- to April) (DotEE 2018).

This species does not breed in Australia and they move north to Siberia to breed and nest during June and July (Hayman et al. 1986).

5.14.3 Habitat

Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. Occasionally they are recorded around floodwaters and wet mats of algae or waterweed, or on banks of beachcast seagrass or seaweed (DotEE 2018).

Curlew sandpipers generally roost on bare dry shingle, shell or sand beaches, sandspits and islets around coastal and near-coastal lagoons and other wetlands. They occasionally roost in dunes and saltmarshes (DotEE 2018).

5.14.4 Threatening processes

The following have been identified as potentially threatening processes to the Curlew sandpiper:

- In non-breeding grounds in Australia, this species mostly occurs in highly populated areas and is therefore vulnerable to possible habitat alteration
- Threats to the Curlew sandpiper include the loss and fragmentation of feeding and roosting habitat from human development, human disturbance at roost and feeding sites, disturbance by wild dogs and pollution (DECC 2005; DotEE 2018).

5.14.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

5.14.6 References

Atlas of Living Australia (2018). *Calidris (Erolia) ferruginea*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:fa188c0e-68ba-4b3f-8e8f-48734608c7d1 [Accessed 23 August 2018].

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5.15 White-throated needletail (*Hirundapus caudacutus*)

5.15.1 Status

EPBC Act – Vulnerable, Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

5.15.2 Biology and ecology

5.15.2.1 Characteristic

The White-throated needletail (*Hirundapus caudacutus*) is a large swift with a thickset, cigar-shaped body, a stubby tail and pointed wings (refer Photograph 5.13). This species typically measures 20 cm in length and approximately 115 to 120 g in weight. Adults exhibit a dark-olive head and neck, with an iridescent gloss on the crown, whilst the mantle and the back are paler and greyish. The upperwings are blackish (often with a greenish gloss), with a contrasting white patch at the base of the trailing edge. The face is dark-olive with a narrow, white band across the forehead, and lores and a white patch on the chin and throat. The underparts are generally dark-olive except for a U-shaped band across the rear flanks, the vent and the undertail coverts, and the undertail is black with a greenish gloss (DotEE 2018).

Photograph 5.13 White-throated needletail (*Hirundapus caudacutus*)

Source: Knight (2007)

5.15.2.2 Known distribution

White-throated needletails breed in Asia, from central and south-eastern Siberia and Mongolia, east to the Maritime Territories of Russia, Sakhalin and the Kuril Islands and south to northern Japan and north-eastern China. Most White-throated needletails spend the non-breeding season in Australia, and occasionally in New Guinea and New Zealand (DotEE 2018).

The White-throated needletail is considered widespread in eastern and south-eastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains (DotEE 2018) (refer Figure 5.30).

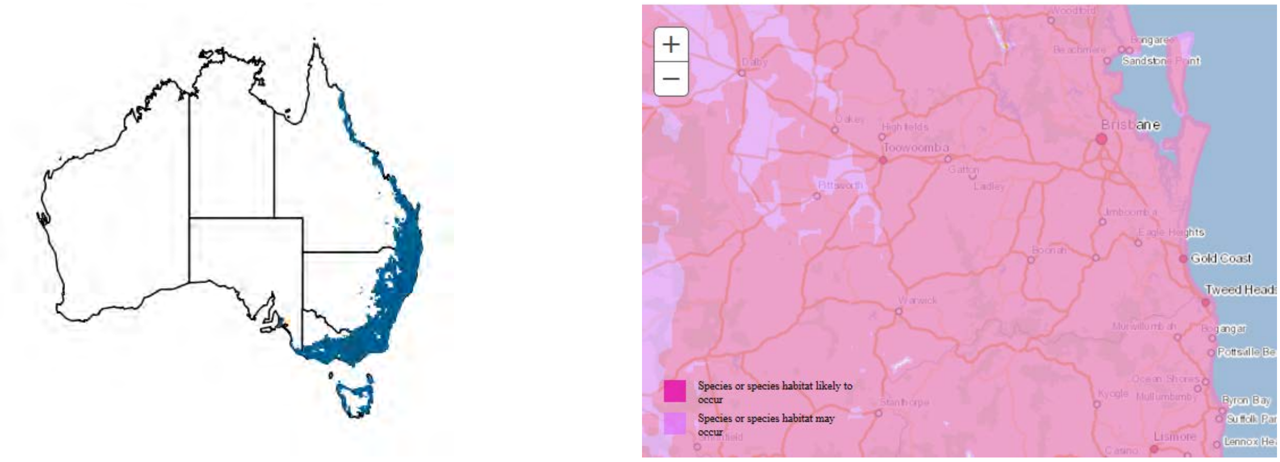

Figure 5.30 **Distribution range of the White-throated needletail**

Source: ALA (2018), DotEE (2018)

5.15.2.3 Distribution in relation to the Project

This species has not been detected during Project associated field investigations. *Hirundapus caudacutus* has been identified from database searches as potentially occurring within the MNES study area. Database records (i.e. AoLA & WildNet) indicate this species occurs within the MNES study area numerous times. At the western section of the Project four database records exist on the outskirts of the Helidon township recorded over the last 22 years. A record from Gatton occurs to the south of the disturbance footprint at the junction of Old Toowoomba Road and Gillespies Road however there is no date recorded for this sighting. Three records from within the last 11 years occur to the north of the disturbance footprint at Gatton to the west of Adare Road to the north of the Gatton landfill and transfer station. Outside of the MNES study area records are scattered and occur in all directions around the Project (refer Figure 5.31). These records become more dense closer to coastal areas to the east of the Project.

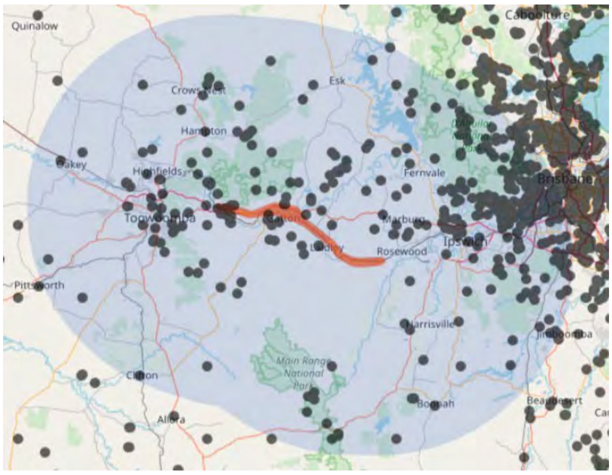

Figure 5.31 **Distribution range of the White-throated needletail in relation to the Project**

Source: ALA (2020)

5.15.2.4 Biology and reproduction

In Australia the White-throated needletail has been recorded eating a wide variety of insects, including beetles, cicadas, flying ants, bees, etc. (DotEE 2018).

White-throated needletails are non-breeding migrants in Australia. Breeding takes place in northern Asia from April to October (DotEE 2018).

5.15.3 Habitat

In Australia, the White-throated needletail is almost exclusively aerial, flying at heights of less than 1 m up to more than 1,000 m above the ground. White-throated needletails often forage along the edges of low pressure systems, which both lift their food sources, and assist with their flight. The species has been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows (DotEE 2018).

This species is known to occur over most types of habitat, however, they are most often recorded above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy. In coastal areas, they are soften seen flying over sandy beaches or mudflats, and often around coastal cliffs and areas with prominent updraughts, such as ridges and sand-dunes (DotEE 2018).

5.15.4 Threatening processes

There appear to be few threats to the populations of White-throated needletails in Australia, but there is always the potential threat of habitat destruction and predation by feral animals (DotEE 2018).

5.15.5 Threat abatement/recovery plans

No threat abatement/recovery plan has been identified as being relevant for this species.

5.15.6 References

Atlas of Living Australia (2018). *Hirundapus caudacutus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:21205690-54fd-452a-9772-d3e1f8780dff# [Accessed 24 August 2018].

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Knight, R. (2007). White-throated needletail (*Hirundapus caudacutus*). [image] [online] Available from: https://www.flickr.com/photos/sussexbirder/8077024804/in/photolist-dCzG2D-diJS5m-diJRGS-s1aH3F. [17 September 2019].

6 Threatened ecological communities

6.1 Brigalow (*Acacia harpophylla* dominant and co dominant)

6.1.1 Status

EPBC Act – Endangered

6.1.2 Ecology

6.1.2.1 Characteristic and defining features

Brigalow Threatened Ecological Community (TEC) is a low woodlands or forest communities dominated by Brigalow (*Acacia harpophylla*), with pockets of Belah (*Casuarina cristata*) and Poplar Box (*Eucalyptus populnea* subsp. *bimbil*). The canopy tends to be quite dense and the understorey and ground cover are only sparse (refer Photograph 6.1). The height of the tree layer varies from about 9 m in low rainfall areas (averaging around 500 mm per annum) to around 25 m in higher rainfall areas (averaging around 750 mm per annum). This community has been extensively cleared for agriculture, with most surviving remnants along roadsides and paddock edges (Butler 2007; OEH 2017).

Photograph 6.1 Brigalow TEC

In Queensland, Brigalow TEC occur within the following 16 regional ecosystems REs:

- 6.4.2 *Casuarina cristata +/- Acacia harpophylla* open forest on clay plains
- 11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains
- 11.4.3 *Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains
- 11.4.7 Open forest of *Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* on Cainozoic clay plains
- 11.4.8 *Eucalyptus cambageana* open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
- 11.4.9 *Acacia harpophylla* shrubby open forest with *Terminalia oblongata* on Cainozoic clay plains
- 11.4.10 *Eucalyptus populnea* or *E. pilligaensis*, *Acacia harpophylla*, *Casuarina cristata* open forest on margins of Cainozoic clay plains

- 11.5.16 *Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces
- 11.9.1 *Acacia harpophylla-Eucalyptus cambageana* open forest on Cainozoic fine-grained sedimentary rocks
- 11.9.5 *Acacia harpophylla* and/or *Casuarina cristata* open forest on Cainozoic fine-grained sedimentary rocks
- 11.9.6 *Acacia melvillei* ± *A. harpophylla* open forest on Cainozoic fine-grained sedimentary rocks
- 11.11.14 *Acacia harpophylla* open forest on deformed and metamorphosed sediments and interbedded volcanics
- 11.12.21 *Acacia harpophylla* open forest on igneous rocks; colluvial lower slopes
- 12.8.23 *Acacia harpophylla* open forest on Cainozoic igneous rocks
- 12.9-10.6 *Acacia harpophylla* open forest on sedimentary rocks
- 12.12.26 *Acacia harpophylla* open forest on Mesozoic to Proterozoic igneous rocks (TSSC 2001).

6.1.2.2 Known distribution

Brigalow TEC extend from south of Charters Towers in Queensland, in a broad swathe east of Blackall, Charleville and Cunnamulla, south to northern NSW near Narrabri and Bourke (refer Figure 6.1). In Queensland, it occurs predominantly within the Brigalow Belt North, Brigalow Belt South, Darling Riverine Plains and Southeast Queensland bioregions. In NSW, remnants of Brigalow TEC mostly occur north of Burke, west of Narrabri and north of Moree (Butler 2007).

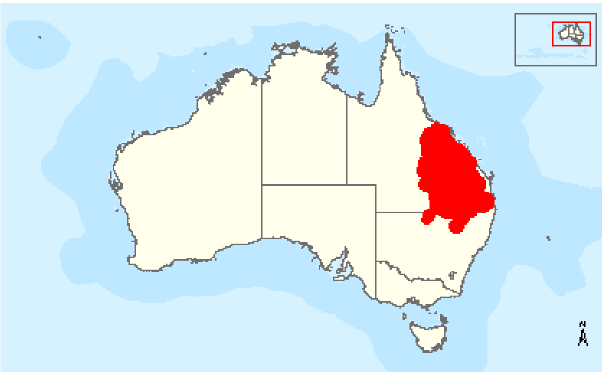

Figure 6.1 **Distribution range of Brigalow TEC**

Source: DotEE (2018)

6.1.2.3 Distribution in relation to the Project

The Brigalow TEC was identified as having the potential to occur within the MNES study area during desktop searches. The MNES study area between Forest Hill and Laidley encompasses several heterogeneous polygons (south of the Project disturbance footprint) comprising high-value regrowth communities including RE 12.9-10.6 which are analogous to the Brigalow TEC. This indicates there is potential for Brigalow TEC to be present within the MNES study area. There is no indication this TEC exists as remnant or regrowth within the Project disturbance footprint.

6.1.3 Threatening processes

The following have been identified as potentially threatening processes to Brigalow TEC:

- Land clearing and fragmentation
- Invasion and establishment of weed species
- Overgrazing by domestic stock

- Changes in hydrological regimes
- Spray drift of herbicides and pesticides
- Fragmentation resulting in edge effects and risk of loss of small, scattered remnants
- Clearing and damage from road and rail maintenance activities
- Lack of viability of seed set
- Lack of pollinators
- Logging for fence posts (OEH 2017).

6.1.4 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this community. The following approved conservation advice has been identified for this community:

- Department of the Environment (2013). Approved Conservation Advice for the Brigalow (Acacia harpophylla dominant and co-dominant) ecological community. Canberra: Department of the Environment. Available from: **http://www.environment.gov.au/biodiversity/threatened/communities/pubs/028-conservation-advice.pdf**. In effect under the EPBC Act from 17-Dec-2013.

6.1.5 Summary of threat abatement/recovery plans

The threats outlined in the conservation advice for Brigalow (*Acacia harpophylla* dominant and co dominant) include:

- Land clearing as most of the habitat occurs as fragments within substantially modified landscapes. Mining in the Bowen Basin and logging for fence posts in the Brigalow Belt South, Nandewar and Darling Riverine Plains bioregions of NSW continue to be major threats to this TEC
- Fire has become a risk for this TEC through the incursion of exotic pasture grasses. Fire has been historically rare in the type of vegetation. If climate change is to increase temperatures and create drier conditions this will increase the susceptibility of brigalow to the impacts of fire
- Weeds can adversely impact the structure and function of brigalow ecosystems making them less suitable for native species. Exotic grasses increase the fire load within brigalow drawing fire into the ecosystem during a fire event and increasing the fire severity
- Feral pigs are probably the most widespread and problematic pest animal within brigalow however goats, cane toads, cats and foxes also pose a serious threat. The Noisy miner (*Manorina melanocepla*) have become a native pest excluding other native bird species where they share habitat
- Inappropriate grazing regimes altering soil structure, leaf litter and woody debris. Grazing also alters the vegetation structure of herbs and shrubs in the understorey and prevent new recruitment and growth of shrubs and trees
- Climate change will present conditions different to those which have historically been encountered within the range of this TEC. Species associated with this TEC will be vulnerable to the effects of hotter, drier conditions with fragments so isolated with such little connectivity that species will struggle to move further afield to find more resources. Flora may be subject to increased frequency and intensity of fire in hotter and drier conditions.

Objectives and actions outlined in the conservation advice for Brigalow (*Acacia harpophylla* dominant and co dominant) include:

- Prevent the clearing of this TEC where it occurs as fragments and regrowth. If clearing of brigalow is required mitigate impacts by avoiding high quality fragments and avoid dissection of fragments
- Manage both vertebrate pests and exotic flora incursion targeting high biomass of exotic grasses within brigalow ecological communities and surrounding areas avoiding the application of fertiliser, tree thinning and soil disturbance

- Manage grazing pressure to allow regeneration of microhabitat that is provided from shrubs and understorey vegetation to give other woodland bird species the opportunity to avoid aggression from Noisy miners
- Encourage land managers to conserve native flora and fauna within and close to this TEC by managing stock rates, leaving trees and regrowth in paddocks to provide connectivity between patches, connecting shade-lines keeping them as wide as possible and allowing standing dead trees, ground timber and leaf litter to rot where it falls
- Undertake regeneration of high value sites and revegetation of degraded sites increasing the size of community managed land for conservation through conservation agreements with landholders and establishing adequate buffer zones to protect remnants
- Devise and implement water management, sediment erosion and pollution control along with monitoring plans
- Develop and disseminate conservation information in conjunction with land managers, local/state authorities and indigenous groups to establish sustainable management guidelines and technical material to address fire management, plant pathogens, invasive animal management and weed management.

6.1.6 References

Butler, D.W. (2007). Recovery plan for the "Brigalow (*Acacia harpophylla* dominant and co-dominant" endangered ecological community (draft of 1 May 2007). Report to the Department of the Environment and Water Resources, Canberra. Queensland National Parks and Wildlife Service, Brisbane.

Department of the Environment and Energy (2018). Brigalow (*Acacia harpophylla* dominant and co-dominant) in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=28 [Accessed 31 August 2018].

Office of Environment and Heritage, NSW (2017). Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10109 [Accessed 31 August 2018].

Threatened Species Scientific Committee (2001). Brigalow (*Acacia harpophylla* dominant and co-dominant), advice to the Minister for the Environment and Water Resources from the Threatened Species Scientific Committee on a public nomination for an ecological community listing on the *Environment Protection and Biodiversity Conservation Act 1999* [Accessed 31 August 2018].

DotEE

6.2 Lowland rainforest of subtropical Australia

6.2.1 Status

EPBC Act – Critically Endangered

6.2.2 Ecology

6.2.2.1 Characteristic and defining features

The ecological community occurs prominently on basalt and alluvial soils, including sand and old or elevated alluvial soils as well as floodplain alluvia. Lowland rainforest mostly occurs in areas less than 300 m above sea level, with high annual rainfall (>1,300 mm) and typically occurs more than 2 km from the coast, however, it can (and does) intergrade with littoral rainforest in some coastal areas (TSSC 2011).

The ecological community is generally a 20 to 30 m tall, closed forest (canopy cover 70 per cent). Tree species with compound leaves are common and leaves are relatively large (notophyll to mesophyll). Plant species diversity and richness is very high (refer Photograph 6.2). The canopy comprises a range of tree species but in some areas a particular species may dominate e.g. Bangalow palm (*Archontophoenix cunninghamiana*) or Cabbage palm (*Livistona australis*). The canopy is often multilayered consisting of an upper, discontinuous layer of emergents, over the main canopy and subcanopy. Below the canopy is an understorey of sparse shrubs and seedlings. Canopy emergents such as Hoop pine (*Araucaria cunninghamii*) and *Ficus* spp. may be 40 to 50 m tall and have large spreading crowns. The understorey contains a sparse layer of species such as Narrow-leaved palm lily (*Cordyline stricta*), Walking stick palm (*Linospadix monostachya*), Lawyer vine (*Calamus muelleri*) and Rough maidenhair fern (*Adiantum hispidulum*) (TSSC 2011).

Photograph 6.2 Lowland rainforest TEC

Source: Royal (2019)

In Queensland, Lowland rainforest TEC occur within the following REs:

- 12.3.1 Complex to simple notophyll vine forest- Gallery rainforest (notophyll vine forest) on alluvial plains (endangered)
- 12.5.13 Microphyll to notophyll vine forest +/- *Araucaria cunninghamii* (endangered)
- 12.8.3 Complex notophyll vine forest – complex notophyll vine forest on Cainozoic igneous rocks (no concern)
- 12.8.4 Complex notophyll vine forest with *Araucaria* spp. on Cainozoic igneous rocks (no concern)
- 12.8.13 Araucarian complex microphyll vine forest on Cainozoic igneous rocks (of concern)
- 12.11.1 Simple notophyll vine forest often with abundant *Archontophoenix cunninghamiana* (“gully vine forest”) on metamorphics +/- interbedded volcanics (no concern)
- 12.11.10 Notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics (no concern)
- 12.12.1 Simple notophyll vine forest usually with abundant *Archontophoenix cunninghamiana* (“gully vine forest”) on Mesozoic to Proterozoic igneous rocks (of concern)
- 12.12.16 Notophyll vine forest on Mesozoic to Proterozoic igneous rocks (no concern) (TSSC 2011).

6.2.2.2 Known distribution

The ecological community primarily occurs from Maryborough in Queensland to the Clarence River (near Grafton) in NSW. The ecological community also includes isolated areas between the Clarence River and Hunter River such as the Bellinger and Hastings valleys (TSSC 2011) (refer Figure 6.2).

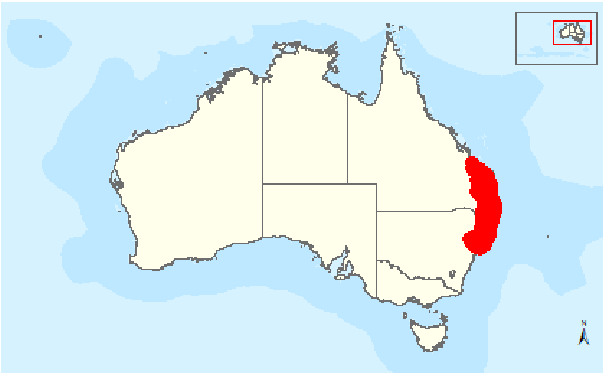

Figure 6.2 Distribution range of Lowland rainforest TEC

Source: DotEE (2018)

6.2.2.3 Distribution in relation to the Project

The Lowland rainforest of subtropical Australia TEC was identified as having the potential to occur within the MNES study area during desktop searches. Predictive habitat mapping for the TEC indicates that potential habitat does not occur within or directly adjacent to the MNES study area. There is no indication this TEC exists as remnant or regrowth within the Project disturbance footprint.

6.2.3 Threatening processes

The following have been identified as potentially threatening processes to Lowland rainforest TEC:

- Land clearing
- Impacts associated with fragmentation of remnants
- Weeds
- Private native forestry (TSSC 2011).

6.2.4 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this community.

The following threat abatement plan has been identified as being relevant for this community:

- Department of the Environment and Energy (2018). Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*. Canberra: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/threat-abatement-plan-disease-natural-ecosystems-caused-phytophthora-cinnamomi-2018. In effect under the EPBC Act from 22-Feb-2019.

6.2.5 Summary of threat abatement/recovery plans

The consequences of potential infection outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Inability of infected plants to develop new shoots, flowers, fruit and seed
- Complete loss of some flora populations
- Dramatic alteration to the structure and composition of native plant communities

- A severe reduction in primary productivity and functionality
- Irreversible habitat loss and degradation of dependent flora and fauna
- Loss of shelter and nesting sites and food sources resulting in major declines of fauna.
- Objectives and actions outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:
- Identifying and prioritising the protection of biodiversity assets that are, or may be, impacted by Phytophthora including listed threatened species, ecological communities and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act occur
- Reduce the spread and mitigate the impacts of Phytophthora to protect priority biodiversity assets and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act
- Inform the community through education on the impacts that Phytophthora has on biodiversity and actions to mitigate these impacts
- Encourage research on Phytophthora species and option to manage infestations and protect biodiversity assets.

6.2.6 References

Department of the Environment and Energy (2018). Lowland Rainforest of Subtropical Australia in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=101 [Accessed 31 August 2018].

Royal, R. Lowland rainforest of subtropical Queensland. [image] [online] Available from: https://www.instagram.com/p/B1vvAoZAf6J/. [17 September 2019]

Threatened Species Scientific Committee (2011). *Commonwealth Listing Advice on Lowland rainforest of subtropical Australia*. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/101-conservation-advice.pdf In effect under the EPBC Act from 25 November 2011DotEE.

6.3 Swamp tea-tree (*Melaleuca irbyana)* forest of southeast Queensland

6.3.1 Status

EPBC Act – Critically Endangered

6.3.2 Ecology

6.3.2.1 Characteristic and defining features

The Swamp tea-tree TEC is characterised by high densities of Swamp Tea-trees *(Eucalyptus irbyana)*, usually about 8 to 12 m high underneath an open canopy of eucalypt trees. Commonly found eucalypt trees in Swamp tea-tree forests include Narrow-leaved ironbark (*Eucalyptus crebra*), Silver-leaved ironbark (*E. melanophloia*), Grey box (*E. moluccana*) or Queensland blue gum (*E. tereticornis*). The understorey is comprised of grass, sedges, herbs, sparse shrubs and vines (refer Photograph 6.3).

Photograph 6.3 Swamp Tea-tree TEC

Source: Bennett (2019)

In Queensland, Swamp tea-tree TEC occur within the following regional ecosystems REs:

- 12.9-10.11 *Melaleuca irbyana* low open forest or thicket. Emergent *Eucalyptus moluccana, E. crebra, E. tereticornis* or *Corymbia citriodora* subsp. *variegata* may be present. Occurs on Mesozoic sediments where drainage of soils is impeded
- 12.3.3c *Eucalyptus tereticornis* woodland. *Eucalyptus crebra* and *E. moluccana* are sometimes present and may be relatively abundant in places, especially on edges of plains and higher-level alluvium. Other species that may be present as scattered individuals or clumps include *Angophora subvelutina* or *A. floribunda, Corymbia clarksoniana, C. intermedia, C. tessellaris, Lophostemon suaveolens* and *E. melanophloia*. Occurs on Quaternary alluvial plains, terraces and fans where rainfall is usually less than 1,000 mm per year (TSSC 2005).

6.3.2.2 Known distribution

Swamp Tea-tree TEC are endemic to south-eastern Queensland and are known to occur in the local government areas of Beaudesert, Boonah, Logan, Ipswich, Laidley and Esk (refer Figure 6.3). The Swamp Tea-tree forests are found to grow on poorly draining clay soils, on the plains and low hills of the Moreton basin. The clay soils drain slowly and are known to become waterlogged after heavy rains, resulting in numerous temporary ponds. Swamp Tea-tree forests are associated with seasonally cracking clays, known as Tea-tree clays and generally have a pH of 5.6 to 6.0 that area low in nutrient levels (DEH 2005; DotEE 2018).

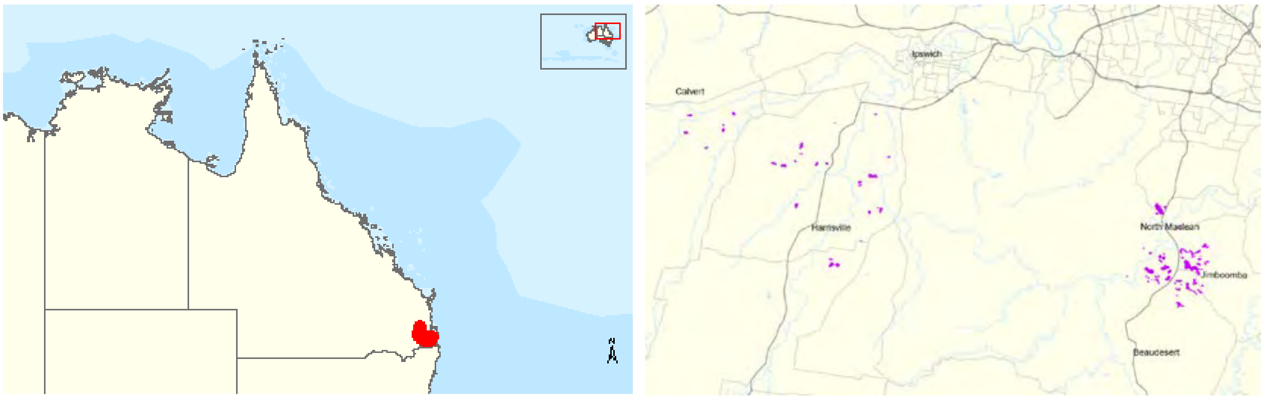

Figure 6.3 Distribution range of Swamp tea-tree TEC

Source: DotEE (2018)

6.3.2.3 Distribution in relation to the Project

The Swamp tea-tree forest of southeast Queensland TEC was identified as having the potential to occur within the MNES study area during desktop searches. Predictive habitat mapping for the TEC indicates that 4.59 ha of potential habitat occurs within the MNES study area, outside of the disturbance footprint. This TEC has the potential to occur within the MNES study area south-west of Calvert on the south side of Hiddenvale Road (south of the Project disturbance footprint). Remnant and high-value regrowth communities mapped as RE 12.3.18 are analogous to the Swamp tea-tree TEC and have been detected at this location. There is no indication this TEC exists as remnant or regrowth within the Project disturbance footprint.

6.3.3 Threatening processes

The following have been identified as potentially threatening processes to the Swamp tea-tree TEC:

- Very restricted geographic distribution
- Modification of waterways which disrupt seed dispersal and germination
- Fragmentation from urban and pastoral land, clearing, grazing, invasion by weeds and feral animals
- Clearing of mature trees (DotEE 2005).

6.3.4 Threat abatement/recovery plans

No recovery plan has been identified as being relevant for this community.

The following threat abatement plan has been identified as being relevant for this community:

- Department of Sustainability, Environment, Water, Population and Communities (2011). Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/resource/threat-abatement-plan-biological-effects-including-lethal-toxic-ingestion-caused-cane-toads. In effect under the EPBC Act from 06-Jul-2011.
- Department of the Environment and Energy (2018). Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*. Canberra: Commonwealth of Australia. Available from: **http://www.environment.gov.au/biodiversity/threatened/publications/threat-abatement-plan-disease-natural-ecosystems-caused-phytophthora-cinnamomi-2018**. In effect under the EPBC Act from 22-Feb-2019.

6.3.5 Summary of threat abatement/recovery plans

The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads include:

- Predation by cane toads
- Larval competition with frog tadpoles or mosquitoes
- Parasite transfer
- Competition for terrestrial food
- Competition for shelter sites.

Threat abatement actions for cane toads (*Rhinella marina*) include:

- $11 million in funding from the Australian Government provided for the development of a broad-scale control method
- $9 million in funding from the Australian Government for research and management activities
- Identification of native species, ecological communities and off-shore islands that are known to have a high to moderate risk

- Identify the impacts that toads have on listed native species and ecological communities
- Where the impact is expected to be high on native species and ecological communities establish support research techniques in aiding the recovery of priority native species and ecological communities
- Develop a prioritisation tool to aid in the direction of resources for the protection of native species and ecological communities.

The consequences of potential infection outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Inability of infected plants to develop new shoots, flowers, fruit and seed
- Complete loss of some flora populations
- Dramatic alteration to the structure and composition of native plant communities
- A severe reduction in primary productivity and functionality
- Irreversible habitat loss and degradation of dependent flora and fauna
- Loss of shelter and nesting sites and food sources resulting in major declines of fauna.

Objectives and actions outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Identifying and prioritising the protection of biodiversity assets that are, or may be, impacted by Phytophthora including listed threatened species, ecological communities and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act occur
- Reduce the spread and mitigate the impacts of Phytophthora to protect priority biodiversity assets and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act
- Inform the community through education on the impacts that Phytophthora has on biodiversity and actions to mitigate these impacts
- Encourage research on Phytophthora species and option to manage infestations and protect biodiversity assets.

6.3.6 References

Accad, A., Nelder, V.J., Wilson, B.A. and Neihus, R.E. (2003). Remnant Vegetation in Queensland: Analysis of Remnant Vegetation 1997-1999-2000-2001, including Regional Ecosystem Information. Brisbane: Queensland Herbarium, Environmental Protection Agency.

Bennett, M. (2019). Swamp Tea-tree TEC. [image] [online] Available from: https://images.ala.org.au/image/details?imageId=74a3bcad-80ee-48c6-95e0-75bc1fd414f5. [17 September 2019].

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Cooper, S, Walker B and Low, T (1995). Conservation survey, status and management of *Melaleuca irbyana* and freshwater wetland communities. Unpublished report prepared for Ipswich City Council, Ipswich, 86 pages

Department of the Environment and Energy (2005). *Swamp Tea-tree (Melaleuca irbyana) Forest of Southeast Queensland,* accessed 20 August 2018, available: <www.environment.gov.au/node/14555>.

Department of the Environment (2018), Swamp Tea-tree (*Melaleuca irbyana*) Forest of Southeast Queensland in Community and Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 2018-08-21T20:26:39AEST.

Department of the Environment and Heritage (2005), Swamp Tea-tree (*Melaleuca irbyana*) Forest of Southeast Queensland, accessed 18 August 2018, available: http://www.environment.gov.au/system/files/resources/ca330310-bb3f-4651-b83f-40f30140378f/files/swamp-tea-tree-forest-information-sheet.pdf.

Firn, J (unknown), *Melaleuca irbyana* project, Queensland University for Technology, Brisbane Austrailia, accessed 18 August 2018, available: https://jenniferfirn.wordpress.com/melaleuca-irbyana-project/.

Ipswich City Council (1998). Purga Nature Reserve Fact Sheet, Ipswich City Council Department of Conservation, Parks and Sport, Ipswich, Queensland.

Queensland Department of Primary Industries (2001). Swamp Tea Tree Protection at Mutdapilly Research Station. Queensland Department of Primary Industries News, Queensland.

Queensland Government, (2014), *Species profile – Melaleuca irbyana (Myrtaceae),* accessed 20 August 2018, available: https://environment.ehp.qld.gov.au/species-search/details/?id=26403.

Threatened Species Scientific Committee (2005). *Commonwealth Listing Advice on Swamp Tea-tree* (*Melaleuca irbyana*) *Forest of Southeast Queensland*. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/swamp-tea-tree-forest.html. In effect under the EPBC Act from 16 April 2005DotEEDotEE.

6.4 White box-yellow box-Blakely’s red gum grassy woodland and derived native grassland (also known as Box-gum grassy woodland and derived grassland)

6.4.1 Status

EPBC Act – Critically endangered

6.4.2 Ecology

6.4.2.1 Characteristic and defining features

White box-yellow box-Blakely’s red gum grassy woodland and derived native grassland TEC is a open woodland communities, which have a tussock grass layer, patchy shrub layer and tree layer predominantly made up of *Eucalyptus albens*, *E. melliodora* and *E. blakelyi*. Intact sites contain a high diversity of trees, shrubs, climbing plants, grasses and especially herbs. Tree cover is generally discontinuous and consists of widely-spaced trees of medium height (refer Photograph 6.4). This ecological community occurs on moderate to highly fertile soils at altitudes of 170 m to 1,200 m (NSWSC 2002; OEH 2017; Yates and Hobbs 1997).

Photograph 6.4 White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC

In Queensland, White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC is considered to be analogous to the following regional ecosystems REs:

- 11.3.23 *Eucalyptus conica, E. tereticornis, Angophora floribunda* ± *E. melliodora* ± *E. nobilis grassy* woodland
- 11.8.2a *Eucalyptus tereticornis* and *E. melliodora* occurring on low hills
- 11.8.8 *Eucalyptus albens* ± *E. crebra* ± *E. tereticornis* ± *Callitris baileyi* grassy woodland
- 11.9.9a *Eucalyptus albens* ± *E. crebra* ± *E. tereticornis* ± *Callitris baileyi* woodland
- 12.8.16 *Eucalyptus crebra*, generally with *E. tereticornis* and *E. melliodora* ± *E. albens* grassy woodland (only at the far western edge of the bioregion)
- 13.3.4 *Eucalyptus conica, E. microcarpa or E. moluccana, E. melliodora* grassy woodland
- 13.3.1 *Eucalyptus blakelyi* grassy woodland or open forest +/- *E. bridgesiana +/- E. melliodora* on Cainozoic alluvial plains
- 13.11.3 *Eucalyptus crebra, E. dealbata, E. albens* grassy woodland
- 13.11.4 *Eucalyptus melanophloia, E. dealbata, E. albens* ± *Callitris glaucophylla* grassy woodland.
- 13.11.8 Woodland of *E. melliodora* and/or *E. microcarpa/moluccana* on rolling hills, depressions and lower slopes around drainage lines
- 13.12.8 Woodland of *E. melliodora* and/or *E. microcarpa/ moluccana +/- conica*, on undulating plains and lower slopes in granite basins
- 13.12.9 Woodland to open forest of *E. blakelyi* and/or *E. calignosa* or *E. mckieana* on plains and rolling hills in granite basins (TSSC 2006).

6.4.2.2 Known distribution

White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC occur in an arc along the western slopes and tablelands of the Great Dividing Range from southern Queensland through NSW to central Victoria (Beadle 1981) (refer Figure 6.4).

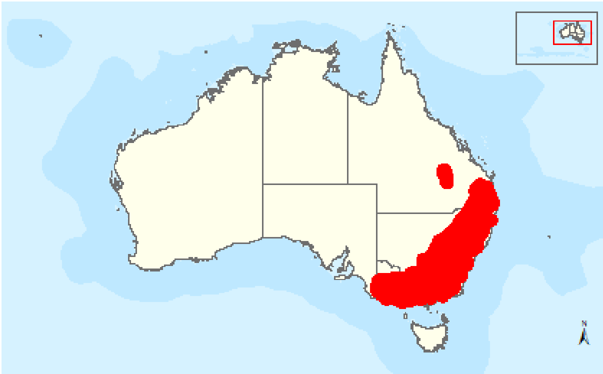

Figure 6.4 **Distribution range of White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC**

Source: DotEE (2018)

6.4.2.3 Distribution in relation to the Project

White box-Yellow box-Blakely's red gum grassy woodland and derived native grassland TEC was identified as having the potential to occur within the MNES study area during desktop searches. Predictive habitat mapping for the TEC indicates that potential habitat does not occur within or directly adjacent to the MNES study area. There is no indication this TEC exists as remnant or regrowth within the Project disturbance footprint.

6.4.3 Threatening processes

The following have been identified as potentially threatening processes to White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC:

- Habitat loss, degradation and fragmentation from agricultural, forestry, mining, infrastructure and residential development
- Degradation by over grazing and trampling
- Degradation of remnants by non-native plant species
- Increased nutrient status due to application of fertilisers to native groundcover
- Altered fire regimes.
- Lack of community knowledge
- Human disturbance by off road vehicles, camping, other recreational activities (OEH 2017).

6.4.4 Threat abatement/recovery plans

The following recovery plan has been identified for this community:

- Department of Environment, Climate Change and Water NSW (2010). *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland*. Department of Environment, Climate Change and Water NSW, Sydney. Available from: http://www.environment.gov.au/biodiversity/threatened/recovery-plans/white-box-yellow-box-blakelys-red-gum-grassy-woodland-and-derived-native-grassland-national. In effect under the EPBC Act from 22-Mar-2013.

The following threat abatement plans has been identified as being relevant for this community:

- Department of Sustainability, Environment, Water, Population and Communities (2011). Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/resource/threat-abatement-plan-biological-effects-including-lethal-toxic-ingestion-caused-cane-toads. In effect under the EPBC Act from 06-Jul-2011.

- Department of the Environment and Energy (2017). Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (Sus scrofa) (2017). Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017. In effect under the EPBC Act from 18-Mar-2017.
- Department of the Environment and Energy (2018). Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*. Canberra: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/threat-abatement-plan-disease-natural-ecosystems-caused-phytophthora-cinnamomi-2018. In effect under the EPBC Act from 22-Feb-2019.

6.4.5 Summary of threat abatement/recovery plans

Threats identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Land use and management change
- Agricultural and horticultural development
- Public Infrastructure upgrades in travelling stock routes (TSRs)
- Firewood collection and 'tidying up'
- Changed fire regimes
- Increase in soil nutrients and use of chemicals
- Mowing and slashing regimes
- Revegetation management
- Weed invasion
- Climate change
- Salinity
- Acid soils
- Declining tree health and regeneration
- Increased grazing pressure from invasive herbivores
- Disease – *Phytophthora cinnamomi*
- Collection and removal of native flora.

Recovery actions identified in the National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland include:

- Collect baseline data on the locations, quality and management regimes of remnant sites
- Extent and condition mapping
- Component species surveys
- Protection of existing habitat in priority areas including on private land
- Engagement with the community, particularly where remnants occur on private land to provide information on appropriate management and with Aboriginal communities.

Summary of baseline information actions undertaken to date:

- The establishment of databases comprising of information on CMN members (land managers with Box-Gum Grassy Woodland remnants), remnant locations, composition of flora and fauna species and remnant condition from surveys of CMN members' sites and other sites

- Minimum condition criteria and assessment method developed to assist land managers in identification of listed ecological communities
- Development of regional models using remote sensing
- Mapping of Box-Gum Grassy Woodland extent
- Surveys conducted during research programs through various organisations.

The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads include:

- Predation by cane toads
- Larval competition with frog tadpoles or mosquitoes
- Parasite transfer
- Competition for terrestrial food
- Competition for shelter sites.

Threat abatement actions for cane toads (*Rhinella marina*) include:

- $11 million in funding from the Australian Government provided for the development of a broad-scale control method
- $9 million in funding from the Australian Government for research and management actitivies
- Identification of native species, ecological communities and off-shore islands that are known to have a high to moderate risk
- Identify the impacts that toads have on listed native species and ecological communities
- Where the impact is expected to be high on native species and ecological communities establish support research techniques in aiding the recovery of priority native species and ecological communities
- Develop a prioritisation tool to aid in the direction of resources for the protection of native species and ecological communities.

The threats outlined in the threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) include:

- Impacts on plant species composition and succession
- Alterations to nutrient, water cycling and water quality
- Predation of native fauna and flora including small mammals, birds, reptiles, frogs, crayfish, eggs, invertebrates, fungi and all part of plants including fruit, seeds, roots, tubers, bulbs and foliage
- Digging and disturbance to substrate resulting in the destruction of plants threatening their survival and recruitment of new plants altering the floral composition and soil structure
- Disturbance caused by pigs can increase the incursion and recruitment of weeds and provide reservoirs for endemic animal diseases.

Threat abatement actions for feral pics (*Sus scrofa*) include:

- Implementation of control measures including trapping, aerial and ground shooting, poisoning and fencing
- Using tracking dogs to detect and flush out feral pigs by commercial harvesters
- Manipulating habitat by reducing watering points and crop waste
- Manage feral pigs within a policy, legislative and planning framework.

The consequences of potential infection outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Inability of infected plants to develop new shoots, flowers, fruit and seed
- Complete loss of some flora populations

- Dramatic alteration to the structure and composition of native plant communities
- A severe reduction in primary productivity and functionality
- Irreversible habitat loss and degradation of dependent flora and fauna
- Loss of shelter and nesting sites and food sources resulting in major declines of fauna.

Objectives and actions outlined in the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* include:

- Identifying and prioritising the protection of biodiversity assets that are, or may be, impacted by Phytophthora including listed threatened species, ecological communities and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act occur
- Reduce the spread and mitigate the impacts of Phytophthora to protect priority biodiversity assets and areas where non-listed species or ecological communities that may become eligible for listing under the EPBC Act
- Inform the community through education on the impacts that Phytophthora has on biodiversity and actions to mitigate these impacts
- Encourage research on Phytophthora species and option to manage infestations and protect biodiversity assets.

6.4.6 References

Department of the Environment and Energy (2018). White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=43 [Accessed 4 September 2018].

Office of Environment and Heritage, NSW (2017). White Box Yellow Box Blakely's Red Gum Woodland. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10837 [Accessed 4 September 2018].

Threatened Species Scientific Committee (2006). Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the List of Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* [Accessed 4 September 2018].

Beadle, N.C.W. (1981). The Vegetation of Australia. Cambridge University Press, Cambridge.

Yates, C.J. and R.J. Hobbs (1997). Temperate Eucalypt Woodlands: a review of their status, processes threatening their persistence and techniques for restoration in Australian Journal of Botany 45: 949-973

NSW Scientific Committee (2002). White Box Yellow Box Blakely's Red Gum Woodland – endangered ecological community listing. Final Determination. Available from: http://www.nationalparks.nsw.gov.au/npws.nsf/content/boxgum+woodland+endangered+ecological+community+listing [Accessed 4 September 2018].

6.5 Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community

6.5.1 Status

EPBC Act – Endangered

6.5.2 Ecology

6.5.2.1 Characteristic and defining features

The ecological community occurs on unconsolidated sediments, including alluvium deposits, and is typically found on hydrosols saturated with water for long periods. It can be found in areas with either saline, brackish or relatively fresh groundwater. Coastal Swamp Oak Forest mostly occurs in areas less than 20 m above sea level, and typically occurs with 30 km from the coast, however, this can vary depending on the catchment (TSSC 2011).

The ecological community can be either woodland or forest depending on location and disturbance history. Canopy is typically dominated by Coastal Swamp Oak (*Casuarina glauca*) with a sparse mid canopy/shrub layer (refer Photograph 6.5). Some Eucalypt species can emerge from the canopy but are characterically sparse. The groundlayer is often dominated by native grasses and sedges. Climbing and epiphytic plants are characteristic of the community type. In areas where drainage is impeded the community may manifest primarily as sedgeland with a sparse canopy of predominately Coastal Swamp Oak. In areas of freshwater inundation *Melaleuca* species may occur in the canopy, sub-canopy or as emergents.

Photograph 6.5 Coastal Swamp Oak forest

Source: M White (DotEE) 2011

In Queensland, Coastal Swamp Oak Forest TEC occur within the following REs:

- RE 12.1.1 (Casuarina glauca woodland on margins of marine clay plains) (listed as 'of concern'),
- RE 12.3.20 (Melaleuca quinquenervia, Casuarina glauca +/- Eucalyptus tereticornis, E. siderophloia open forest on low coastal alluvial plains) (listed as 'endangered'), where the canopy is dominated by Casuarina glauca. (Queensland Herbarium 2016)

6.5.2.2 Known distribution

The ecological community primarily occurs from south-east Queensland to southern NSW, within the South Eastern Queensland (TSSC 2011) (refer Figure 6.5).

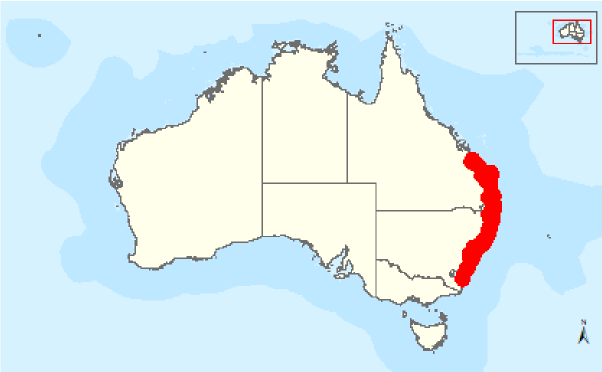

Figure 6.5 Distribution range of Coastal Swamp Oak Forest TEC

Source: DotEE (2018)

6.5.2.3 Distribution in relation to the Project

The Coastal swamp oak forest of NSW and south-east Queensland TEC was identified as having the potential to occur within the MNES study area during desktop searches. Predictive habitat mapping for the TEC indicates that potential habitat does not occur within or directly adjacent to the MNES study area. There is no indication this TEC exists as remnant or regrowth within the Project disturbance footprint.

6.5.3 Threatening processes

The following have been identified as potentially threatening processes to Swamp Oak Forest TEC:

- Land clearing
- Loss of habitat due to climate change
- Invasive weeds and pest species
- Introduction and spread of diseases such as Chytrid fungus and Psittacine Circoviral disease

6.5.4 Threat abatement/recovery plans

No threat abatement/recovery plan has been determined for this TEC as the main threats and priority actions required to address them are largely understood. These are addressed as follows:

- Department of the Environment and Energy (2018). Conservation advice (incorporating listing advice) for the Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community. Canberra: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/141-conservation-advice.pdf. In effect under the EPBC Act from 20-Mar-2018.

6.5.5 Summary of threat abatement/recovery plans

The threats outlined in the conservation advice for the Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community include:

- Clearing and fragmentation
- Weeds
- Invasive fauna including feral pigs, feral cats, the European red fox, rabbits
- Impacts from agriculture including from grazing

- Changes to hydrology resulting from flood mitigation and drainage works
- Inappropriate fire regimes
- Impacts as a result of recreational activities
- Impacts of climate change through sea level rise
- These threats rarely occur in isolation often interacting with one another.

Objectives and actions outlined in the conservation advice for the Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community include:

- Protect the ecological community
- Planning to minimise further clearing
- Manage actions to minimise impact
- Minimise the indirect impacts on this TEC
- Prevent the introduction and spread of exotic species
- Manage recreational pressures
- Restore the ecological community
- Manage invasive flora and fauna pest species
- Mitigate trampling, browsing and grazing
- Introduce appropriate fire regimes
- Undertake restoration
- Communicate and support key stakeholders
- Research and monitor remnant patches.

6.5.6 References

Department of the Environment (2019). Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community in Community and Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 2019-05-28T09:35:05AEST.

Queensland Herbarium (2016). Regional Ecosystem Description Database (REDD) Version 10.0. Queensland Department of Science, Information Technology and Innovation. Brisbane.

Threatened Species Scientific Committee (2011). Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community, advice to the Minister for Sustainability, Environment, Water, Population and Communities from the Threatened Species Scientific Committee on an Amendment to the List of Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) [Accessed 28 May 2019].