CHAPTER 10

Biodiversity

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10. Biodiversity

This chapter is a summary of the potential impacts of the Illabo to Stockinbingal project (the proposal) on terrestrial and aquatic biodiversity. It describes the existing environment, assesses the impacts of construction and operation of the proposal, and outlines recommended mitigation and management measures. The full assessment results are in Technical Paper 1: Biodiversity Development Assessment Report and Technical Paper 2: Aquatic Biodiversity Assessment.

10.1 Overview

The potential for biodiversity impacts has been avoided and/or minimised during design development by providing bridges to preserve habitat with high biodiversity value, siting bridges to avoid riparian habitat, and avoiding areas that provide connectivity, where possible. The suitability and compliance of the proposed bridge designs with ARTC standards and fish-friendly crossing designs would be considered during detailed design, as far as practicable.

The landscape in the proposal site is predominately cleared and has been heavily fragmented due to agricultural practices, with existing habitat connectivity to remnant vegetation to the east and west limited to creek lines and road reserves.

To mitigate the potential impacts to biodiversity, a comprehensive Biodiversity Offset Strategy has been prepared in accordance with the *NSW Biodiversity Conservation Act 2016* (BC Act) and is set out in Technical Paper 1: Biodiversity Development Assessment Report. This strategy considers potential offset sites and opportunities to purchase biodiversity credits to offset the impacts of the proposal, according to the requirements for major projects under the BC Act, and to offset impacts on *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) matters.

During construction, the key potential impacts and proposed measures to address them are as follows:

- The proposal would remove and/or disturb about 73 hectares (ha) of native vegetation, including 23.5 ha of Inland Grey Box Woodland threatened ecological community (TEC) and about 20 ha of White Box Yellow Box Blakely's Red Gum Woodland TEC. Both TECs are listed under the BC Act and the EPBC Act. White Box Yellow Box Blakely's Red Gum Woodland TEC is identified as a candidate serious and irreversible impact (SAII) entity. The proposal would not result in SAII as the overall biodiversity value of this SAII entity has been reduced through agricultural practices; fragmentation would not be significantly increased; direct impacts would be avoided further through detailed design and indirect impacts would be managed through mitigation measures, e.g. weed management protocols.
- The impact to TECs would affect areas used as foraging and breeding habitat for fauna species, including the loss of approximately 42 hollow-bearing trees and 58 scattered trees. In addition, a species credit obligation is required to offset the loss of about 60 ha of habitat for two of the threatened fauna species recorded and listed under the BC Act, the Superb Parrot and Squirrel Glider. A credit species obligation is also required for two more species, the Southern Myotis and Key's Matchstick Grasshopper, which have been assumed as present based on the presence of potential habitat, to offset the loss of about 8 ha and 31 ha of habitat, respectively. These impacts would be offset under the Biodiversity Offset Strategy.
- The construction of new watercourse crossing structures would be the main impact on aquatic ecological systems, including through the removal of about 5 ha of riparian corridor (on sensitive waterfront land). Where possible, practices would be implemented to minimise disturbance of the banks. Bank stabilisation would also be undertaken after installation of water crossing structures, as part of the rehabilitation strategy.

During operation, the key potential impacts and proposed measures to address them are as follows:

- The proposal is likely to result in minor increases in localised fragmentation of regional wildlife patches along the watercourses and road reserves. This is considered unlikely to result in fragmentation on a regional or landscape scale. To mitigate these impacts, the proposal includes implementation of a fauna connectivity strategy, which would define fauna connectivity measures, including drainage structures, glider poles and barrier poles and outline appropriate monitoring and reporting requirements.
- There would be risk of vehicle strike to fauna species such as the Squirrel Glider due to the presence of road and rail infrastructure, and associated movement of trains and vehicles. Measures to enhance connectivity would also assist in minimising the potential for train-strike impacts.
- There is potential for debris during flooding to cause blockages to rail infrastructure and disrupt fish passage. To mitigate this impact, inspection and maintenance of rail infrastructure would occur in accordance with ARTC's standard operating procedures. The spread of exotic aquatic weeds, such as the recorded Spiny Rush (J. acutus), is potentially accelerated by constant passing of trains and maintenance vehicles. This would be mitigated through the implementation of standard weed-management protocols for the operational rail corridor and other ARTC facilities.

ARTC is committed to minimising the impacts to biodiversity and opportunities to minimise these impacts would be investigated through further design development.

10.2 Approach

A summary of the approach to the assessments is in this section, including the legislation, guidelines and policies driving the approach and the methodology used to undertake the assessments. A more detailed description of the approach and methodology is in Technical Paper 1 and Technical Paper 2.

10.2.1 Legislative and policy context to the assessments

The terrestrial and aquatic biodiversity assessments were undertaken in accordance with the Secretary's Environmental Assessment Requirements (SEARs) and with reference to the requirements of relevant legislation, policies and assessment guidelines including:

- the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act), the *Biodiversity Conservation Act 2016* (NSW) (BC Act), Biodiversity Conservation Regulation 2017 (NSW), the *Fisheries Management Act* 1994 (NSW) (FM Act), *Biosecurity Act 2015* (NSW) (the Biosecurity Act), the *Water Management Act* 2000 (NSW) and the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act)
- Biodiversity Assessment Method 2020 Operational Manual Stage 1 (DPIE, 2020b)
- Biodiversity Assessment Method Operational Manual Stage 2 (DPIE, 2019b)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC, 2004)
- NSW Guide to Surveying Threatened Plants (OEH, 2016a)
- Survey guidelines for Australia's threatened frogs (DEWHA, 2010)
- Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013)
- Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the Environment Protection and Biodiversity Conservation Act, 1999 (DSEWPC, 2011)
- Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge, 2003)
- *EPBC Act Condition-setting Policy* (Department of Agriculture, Water and Environment (DAWE), 2020)
- Significant impact guidelines 1.1—Matters of National Environmental Significance (DAWE, 2013a) (Significant Impact Guidelines 1.1)
- Approved conservation advice, listing advice, recovery plans and information sheets for threatened biodiversity (DAWE, 2021b)
- Risk assessment guidelines for groundwater dependent ecosystems (Serov et al., 2012)
- Aquatic Ecology in Environmental Impact Assessment—EIA Guideline (Department of Planning, 2003)
- Guideline for controlled activities on waterfront land—riparian corridors (DPI, 2018a)
- *NSW Fisheries threatened species list* (DPI, undated) and distribution maps (Department of Planning, undated)
- Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology, 2021)
- Draft referral guideline for 14 birds listed as migratory species under the EPBC Act (DE, 2015) (Draft referral guideline).

A detailed description of the legislative and policy context for the assessments is in Chapter 2 of both Technical Paper 1 and Technical Paper 2.

10.2.2 Secretary's Environmental Assessment Requirements

The SEARs relevant to biodiversity, together with a reference to where they are addressed in the EIS, are in Appendix A.

10.2.3 Commonwealth requirements

The proposal is subject to approval as a controlled action under the EPBC Act. Under the NSW Government–Australian Government bilateral assessment provisions, assessment of relevant EPBC Act matters is being undertaken through an accredited assessment carried out pursuant to the EP&A Act and the BC Act. As such, details of the assessment requirements under the EPBC Act applying to biodiversity are attached to the SEARS and are in Appendix A.

10.2.4 Methodology

10.2.4.1 Study area

The study area for assessment for terrestrial and aquatic biodiversity includes the proposal site and adjoining areas. The assessment includes direct or indirect impacts as a result of works undertaken in the proposal site as shown in Figure 10.1.

10.2.4.2 Key tasks—biodiversity development assessment report

Application of the Biodiversity Assessment Method, survey limitations and offsetting calculation approach

The Biodiversity Assessment Method (BAM) sets out how biodiversity values will be assessed, prescribes requirements to avoid and minimise impacts, establishes rules for calculating the number and class of credits required for unavoidable impacts, and determines the trading rules that will apply. The BAM calculator specifies the type and extent of surveys required for a biodiversity assessment and then processes survey data to calculate the number and type of biodiversity credits that are required to offset the impacts of a development.

The BAM calculator calculates the 'ecosystem credits' required based on the plant community types (PCTs) present, their condition and the area that would be impacted. Detailed surveys to assess vegetation integrity are required for each PCT and vegetation zone. The BAM identifies the minimum number of vegetation integrity plots that must be surveyed in each vegetation zone, depending on the area of the zone.

The BAM calculator generates a list of threatened fauna species listed under the BC Act that are predicted to use the subject site based on the bioregional context for the assessment and the PCTs, patch size, vegetation cover and habitat resources present (ecosystem species and credit species). Targeted surveys are not required under the BAM for these species, but they contribute to calculation of ecosystem credits required. Some of these species may also be listed under the EPBC Act and targeted surveys may be required to meet the requirements of that Act.

Threatened species listed under the BC Act that cannot reliably be predicted to occur on a site based on PCT, distribution and habitat criteria are identified as 'candidate species credit species'. The credit calculator references geographic, vegetation and habitat data for the subject site to generate a list of the species credit entities likely to occur and requiring targeted survey.

All threatened flora species in NSW are species credit species and require offsetting if found in the subject site (or are considered likely to occur based on habitat values present). Credits for flora species are either calculated based on area of habitat or count of individuals. Some threatened fauna species are also species credit species. Credits for fauna may be calculated based on the total area of habitat present, an area of important habitat, or based on a buffer area around breeding sites.

Targeted surveys in appropriate seasons and conditions are required to confirm or discount the presence of candidate credit species at a site to meet the requirements of the BC Act and EPBC Act. If present (or likely to occur), species credits must be calculated as part of any offset requirements under the BC Act.

Surveys were conducted for the assessment in suitable habitat, where practicable, with regards to access and seasonal constraints.

The proposal site includes some areas that have not been surveyed due to restrictions to private property access or late design amendments. Within these areas, state vegetation mapping and/or inferring ground verified mapping has been applied in accordance with BAM. These areas will be subject to future detailed survey when access becomes available, and where possible, additional survey results will be presented at the submissions reporting phase via an addendum to the Biodiversity Development Assessment Report (BDAR). This includes targeted surveys for the Key's Matchstick Grasshopper.

10.2.4.3 Key tasks—terrestrial biodiversity

Database searches were undertaken to identify threatened flora and fauna species, populations, ecological communities, Commonwealth-listed migratory species and critical habitat recorded previously or predicted to occur in the locality. Detailed search areas for various databases are in section 1.5 of Technical Paper 1. The assessment of terrestrial biodiversity involved the following key tasks:

- background research using database searches to identify:
  - the likely distribution of native vegetation and threatened ecological communities
  - the presence of threatened flora and fauna listed under the BC Act, FM Act and/or the EPBC Act with the potential to be affected by the proposal
  - whether additional surveys, mapping and reporting is required
- terrestrial biodiversity field surveys (see following)
- review of spatial data for the assessment of landscape features in accordance with the BAM

- assessing the potential impacts of the proposal on native vegetation and habitats, threatened species, key threatening processes and matters of national environmental significance
- identifying mitigation and management measures to address the impacts identified, including calculating the amount of biodiversity offsets that would be required
- preparing a BDAR to describe the results of the assessment in accordance with section 6.12 of the BC Act, clause 6.8 of the Biodiversity Conservation Regulation 2017 and the BAM as detailed in Chapter 2 of Technical Paper 1.

Field surveys

- Terrestrial biodiversity surveys, involving a range of survey techniques were undertaken to map native and non-native vegetation and identify whether threatened flora and fauna species or communities listed under the BC Act and/or EPBC Act were present.
- The surveys were undertaken between 2 and 5 October, 19 and 23 November, 3 and 7 December 2018, 13 and 15 May 2019, 8 and 12 July and 2 and 4 September 2019, between 29 September and 1 October 2020, 31 January 2021, and 25 and 28 October 2021, and included:
- terrestrial flora surveys to map native and non-native vegetation and identify whether threatened flora species are present as well as vegetation integrity plots, random meanders and parallel field traverses
- terrestrial fauna surveys to identify whether threatened fauna species are present as well as habitat searches, general daytime surveys, Anabat recordings, spotlighting, call playback and remote cameras.

Weather conditions leading up and during the survey period were dry, with the region experiencing an abnormally low amount of rainfall and drought conditions. Species diversity and exotic annual weed cover was likely to be low due to drought and seasonality. Due to drought conditions and the lack of rainfall, the majority of drainage lines had little to no water at the time of survey. Where possible, additional survey results will be presented at the submissions reporting phase that will capture post-drought conditions.

The biodiversity assessment was undertaken by accredited assessors, in accordance with the BAM. A detailed description of the assessment methodology for terrestrial biodiversity is in Chapter 3 of Technical Paper 1.

10.2.4.4 Key tasks—aquatic biodiversity

The assessment of aquatic biodiversity involved the following key tasks:

- background research, including database searches of threatened species distribution maps and key fish habitat mapping to inform the scope of field surveys and assist in the description of the ecological context of the proposal site
- review and assessment of protected and sensitive land included the proposal site, plus a general buffer of 500 metres (m)
- preliminary stream order mapping in accordance with the Strahler ordering system, and habitat mapping based on review of aerial imagery and topographic mapping
- aquatic biodiversity field surveys (see following)
- assessment of fish habitat in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013)
- assessing the potential impacts of the proposal on aquatic biodiversity and identifying mitigation and management measures to address the impacts identified.

Field surveys

Field surveys were undertaken between the 3 and 6 December 2018 and between 16 and 18 December 2020, to identify aquatic habitat features, indications of stream condition, and to assess the potential for threatened aquatic species to be present. As most watercourses at the survey sites were dry at the time of the field assessments (noting 2020 was an above average year for rainfall), seven sites were sampled overall. In terms of sampling technique:

- bait traps were used for five sites (including in three watercourses a farm dam and a spring on an unnamed tributary)
- a seine net was used on a farm dam
- two fyke nets were used on Bland Creek.

A detailed description of the assessment methodology and survey techniques for aquatic biodiversity is in section 3 and section 4.6 respectively of Technical Paper 2.

10.2.4.5 Key tasks—protected and sensitive lands

The assessment of protected and sensitive lands (as detailed in Item 2 of the SEARs) involved the following key tasks:

- background research, including desktop and aerial mapping surveys
- review of relevant guidelines on protected and sensitive lands.

10.2.5 Risks identified

The environmental risk assessment for the proposal (refer to Appendix G) included consideration of potential biodiversity risks. Biodiversity risks with an overall assessed rating of medium or above as identified by the environmental risk assessment (pre-mitigated) included:

During construction:

- clearing of native vegetation resulting in loss of fauna habitat, habitat fragmentation and loss of connectivity
- direct impacts on listed threatened flora species and endangered terrestrial ecological populations and communities
- impacts on potential habitat for listed threatened fauna species, including loss of hollow-bearing tree bearing habitats and clearing of scattered trees
- injury and mortality of native fauna from vehicle strikes
- potential impacts on aquatic biodiversity and threatened species, including as a result of removal of riparian vegetation and fish passage blockages during construction of watercourse crossings
- water quality impacts and changes to flow regimes, including through the removal of farm dams, affect aquatic ecosystems
- potential impacts on protected and sensitive lands.

During operation:

- injury and mortality of native fauna from train strikes
- impacts on connectivity (and associated impacts on population viability and genetics) for terrestrial fauna, as a result of the presence of the new rail corridor.

The biodiversity assessments considered the potential risks identified by the environmental risk assessment, in addition to the potential risks and impacts identified by the scoping report, the SEARS and relevant guidelines and policies (refer to section 10.2.1).

10.2.6 How potential impacts have been avoided or minimised

The option development and assessment process for the proposal is summarised in Chapter 6: Alternatives and proposal options. The shortlist of route options was subject to a detailed assessment and the proposed alignment was refined based on evaluation of key considerations, including environmental impacts.

Potential environmental impacts, including biodiversity, were included in the list of selection criteria used for the analysis of options. This included areas of lower biodiversity value, such as areas disturbed from agricultural land use.

As a result of the route selection process, the potential for biodiversity impacts has been avoided and/or minimised by:

- minimising impacts to high biodiversity values (i.e. areas with highest vegetation integrity score, threatened ecological communities, Class 3 scattered trees and areas of potential habitat for threatened fauna). For example, the avoidance of impacts to of Inland Grey Box Woodland threatened ecological community along Ironbong Road and both Inland Grey Box Woodland and Box Gum Woodland threatened ecological communities along Dudauman Road to significantly reduce the overall impact to endangered ecological communities
- avoiding areas that provide connectivity where possible—at Ulandra Creek the proposal was relocated to an area of lower biodiversity value to avoid significant riparian vegetation and retain significant east–west connectivity.

Further detail on the efforts taken to avoid and minimise impacts on biodiversity values through the planning and design phase of the proposal is included in section 9.1 of Technical Paper 1.

In relation to the protection of flow regimes for aquatic ecosystems, the design process considered the suitability of the proposed bridge designs and compliance with fish-friendly crossing designs. The proposed bridge crossings are above the minimum watercourse crossing requirement for their respective watercourse class. The proposed culverts also meet Department of Primary Industries (DPI) design requirements as they are on 1st or 2nd order streams, defined as 'Class 4 unlikely key fish habitats' on which fish friendly watercourse crossing designs are potentially unwarranted (Fairfull and Witheridge, 2003).

10.3 Existing environment

This section describes the study area of the biodiversity assessments and the particular ecological characteristics of the proposal site.

10.3.1 Landscape features

Key landscape features are defined by the BAM. These features contribute to the overall biodiversity value of the proposal site and are used to inform appropriateness of offsets, where these are required. The key landscape features how these relate to the proposal site, are presented in Table 10.1.

TABLE 10.1 LANDSCAPE FEATURES

Landscape feature	Proposal site
Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and subregion	The proposal site is located within the NSW South Western Slopes and Inland Slopes IBRA subregion.
NSW landscape regions (Mitchell landscapes)	The proposal site is primarily located within the Frampton Hills landscape, other landscapes include: ▸ Bimbi Plains ▸ Murrumbidgee–Tarcutta Channels and Floodplains; and ▸ Springdale Hills.
Local Government Area (LGA)	The proposal site is located within the Junee Shire Council (southern section) and the Cootamundra–Gundagai Regional Council (northern section).
Rivers and streams	In additional to unnamed watercourses and drainage lines, the proposal intersects a number of named watercourses: ▸ Billabong Creek, a 6th order stream ▸ Ulandra Creek, a 5th order stream ▸ Run Boundary Creek, a 3rd order stream ▸ Isobel Creek, a 3rd order stream ▸ Powder Horn Creek, a 4th order stream ▸ Dudauman Creek, a 3rd order stream.
Important and local wetlands	Important and local wetlands in the region include the Bethungra Dam Reserve, which occurs approximately 8 km to the east (upstream) of the proposal site. Four international wetlands of importance (Ramsar) are located in excess of 400 km from the proposal site.
Connectivity features	Overall, the landscape has been heavily fragmented due to agricultural practices. The existing connectivity within the proposal site includes watercourses comprising of Billabong Creek, Ulandra Creek, Ironbong Creek, Run Boundary Creek and road reserves of Old Sydney Road, Ironbong Road and Dirnaseer Road. These connectivity features link with the largest intact patch of remnant vegetation occurring to the east of the proposal site in association with the nearby Bethungra and Ulandra Mountain range. Watercourses and associated riparian vegetation with the rivers and streams mentioned above predominantly run from east to west and provide the remaining link to movement between Bethungra and Ulandra Mountain range to the east and areas to the west. Linear habitat elements such as roadside vegetation and plantings along fencelines also provide connectivity between patches of vegetation in paddocks and scattered trees. This network of vegetation increases the permeability of the landscape.
Areas of geological significance and soil hazard features	The proposal site does not contain any areas of geological significance or soil hazard feature in relation to biodiversity.
Areas of outstanding biodiversity value	No declared areas of outstanding biodiversity value occur in or near the proposal site.

10.3.2 Terrestrial flora

10.3.2.1 Vegetation types

A total of eight native vegetation types, and one non-native vegetation type were recorded within the proposal site. Category 1 land (within the meaning of Part 5A of the *Local Land Services Act 2013*) is exempt from assessment under section 6.8 (3) of the BC Act. Category 1 land totals approximately 405 hectares within the proposal site (refer to section 3.2.2 of Technical Paper 1).

Native vegetation

The majority of native vegetation within the proposal site has been previously cleared for agriculture and other land uses, resulting in large scale fragmentation and degradation of biodiversity values in the area; however, there are patches of remnant vegetation of varying size and condition.

Native vegetation types described as PCTs within the proposal site are summarised in Table 10.2 and are mapped under vegetation zones as shown on Figure 10.1. A vegetation zone means an area of native vegetation on the subject land that is the same PCT and has a similar broad condition state.

TABLE 10.2 PLANT COMMUNITY TYPES WITHIN THE PROPOSAL SITE

Plant community type (PCT)	Condition range	Conservation status	Extent within the proposal site (ha)
PCT 5 River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion	Poor to moderate	Not listed under the BC Act or EPBC Act.	6.8
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	Low (Derived Native Grassland) to good	Parts form the BC Act listed Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (endangered). Parts form the EPBC Act listed Grey Box (*E. microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia (endangered).	27.1
PCT 80 Western Grey Box - White Cypress Pine tall woodland on loam soil on alluvial plains of NSW South Western Slopes Bioregion and Riverina Bioregion	Poor to moderate	Parts form the BC Act listed Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (endangered). Parts form the EPBC Act listed Grey Box (*E. microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia (endangered).	6.10
PCT 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	Low (Derived Native Grassland) to moderate	Parts form the BC Act listed White Box Yellow Box Blakely's Red Gum Woodland (endangered). Parts form the EPBC Act listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically (critically endangered).	10.30
PCT 276 Yellow Box grassy tall woodland on alluvium or parna loams and clays on flats in NSW South Western Slopes Bioregion	Poor to moderate	Parts form the BC Act listed White Box Yellow Box Blakely's Red Gum Woodland (endangered). Parts form the EPBC Act listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (critically endangered).	2.60
PCT 277 Blakely's Red Gum - Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	Low (Derived Native Grassland) to moderate	Parts form the BC Act listed White Box Yellow Box Blakely's Red Gum Woodland (endangered). Parts form the EPBC Act listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically (critically endangered).	17.90

Plant community type (PCT)	Condition range	Conservation status	Extent within the proposal site (ha)
PCT 309 Black Cypress Pine - Red Stringybark - red gum - box low open forest on siliceous rocky outcrops in the NSW South Western Slopes Bioregion	Moderate	Not listed under the BC Act or EPBC Act.	1.70
PCT 347 White Box - Blakely's Red Gum shrub/grass woodland on metamorphic hillslopes in the mid-southern part of the upper slopes sub-region of the NSW South Western Slopes Bioregion	Poor to Moderate	Parts form the BC Act listed White Box Yellow Box Blakely's Red Gum Woodland (endangered). Parts form the EPBC Act listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically (critically endangered).	0.43
		Total native vegetation	**72.93**

10.3.2.2 Miscellaneous ecosystems

Vegetation identified within the proposal site that was not able to be assigned to a recognised PCT was assigned to a miscellaneous ecosystem (non-native vegetation zone) referred to as exotic species/native landscape plantings (refer to Figure 10.1). This vegetation was predominately recorded has highly disturbed exotic grasslands with limited native vegetation and in some areas planted native vegetation. Dominant species identified in these areas included[1] *Alternanthera pungens** (Khaki Weed), *Avena fatua** (Wild Oat), *Bromus spp.*, *Trifolium spp.*, *Paspalum dilatatum** (Paspalum) and *Cucumis myriocarpus subsp. leptodermis** (Paddy melon). Where planted native vegetation occurred, dominant species consisted of *Eucalyptus sideroxylon, Eucalyptus melliodora, Melia azedarach, Eucalyptus camaldulensis* and *Acacia* spp. Further information on areas of planted native vegetation within the proposal site is provided in section 5.3 of Technical Paper 1.

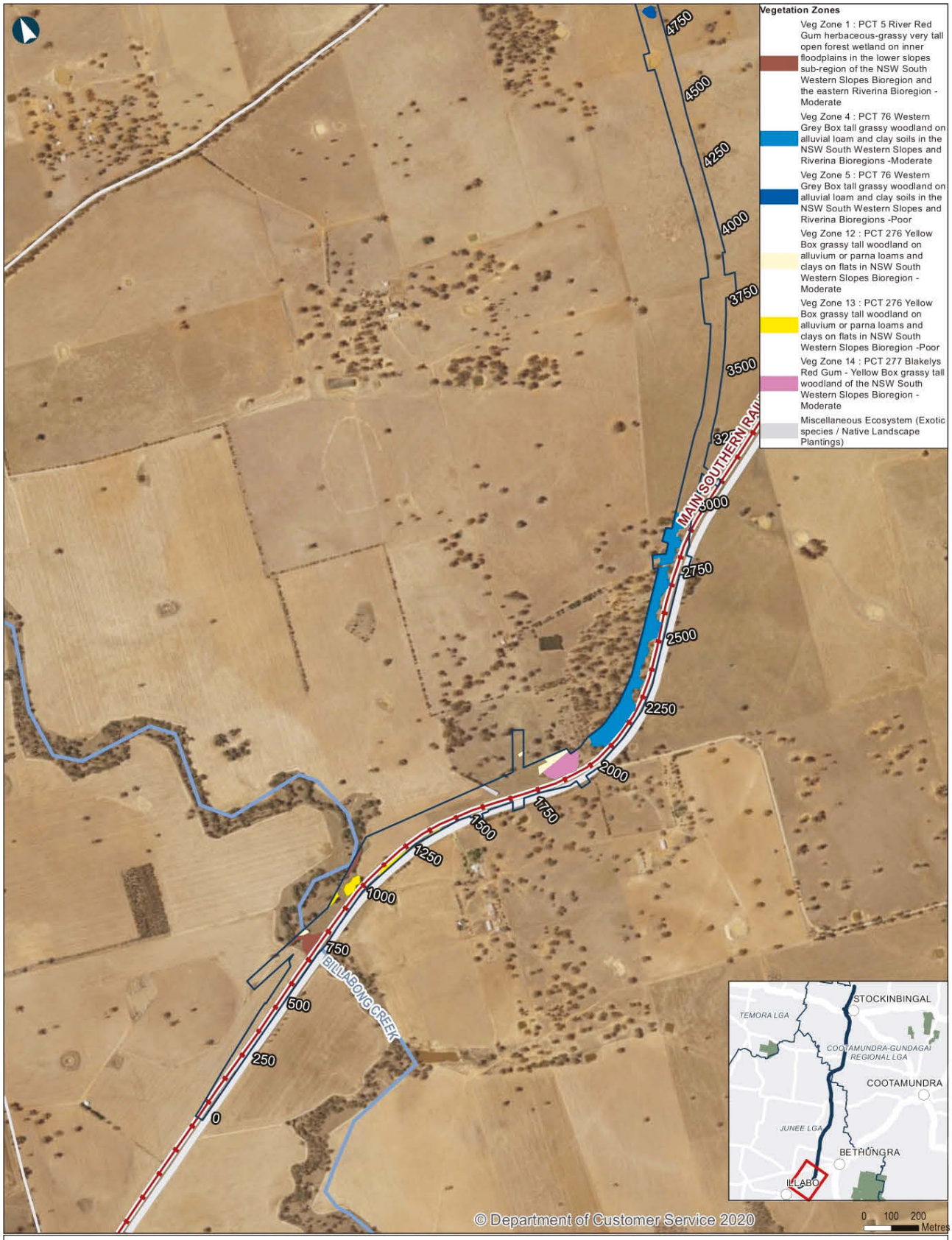
10.3.2.3 Threatened ecological communities

Six PCTs conform to two threatened ecological communities (TECs) listed under both the BC Act and the EPBC Act. These are shown in Table 10.3 with the corresponding PCT identifier.

TABLE 10.3 SUMMARY OF THREATENED ECOLOGICAL COMMUNITIES RECORDED IN THE PROPOSAL SITE IN SURVEYS

Plant Community Type (PCT) in proposal site	BC Act status	EPBC Act status
PCT 76	Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (endangered)	Grey Box (*E. microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia (endangered)
PCT 80		
PCT 266	White Box Yellow Box Blakely's Red Gum Woodland (endangered)	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (critically endangered)
PCT 276		
PCT 277		
PCT 347		

[1] The names of introduced species are denoted with an asterisk (*).



Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

- Sub-arterial road
- Arterial road
- Major Watercourse
- Existing Rail

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 1 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

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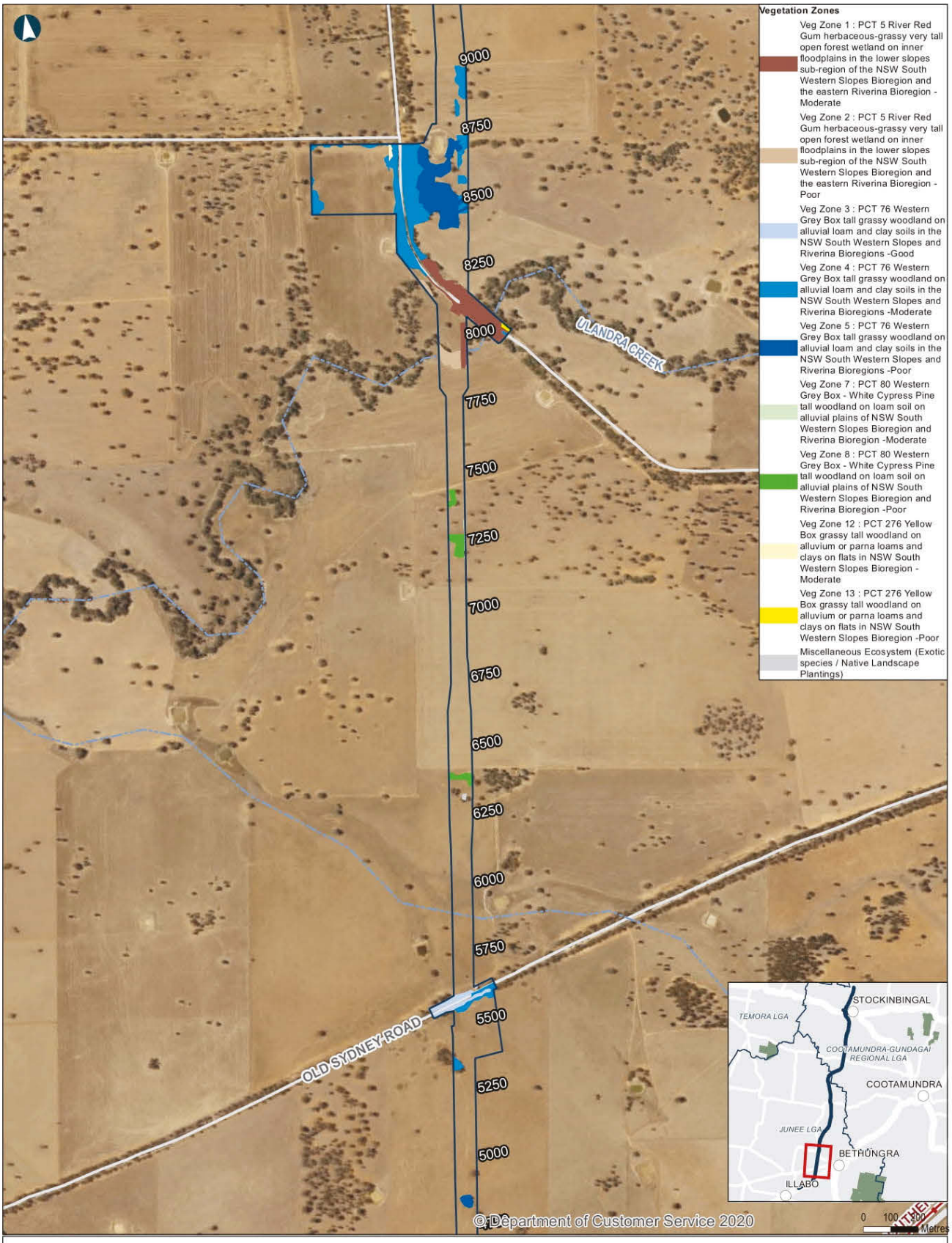

Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

- Sub-arterial road
- Arterial road
- Minor Watercourse
- Existing Rail

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 2 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

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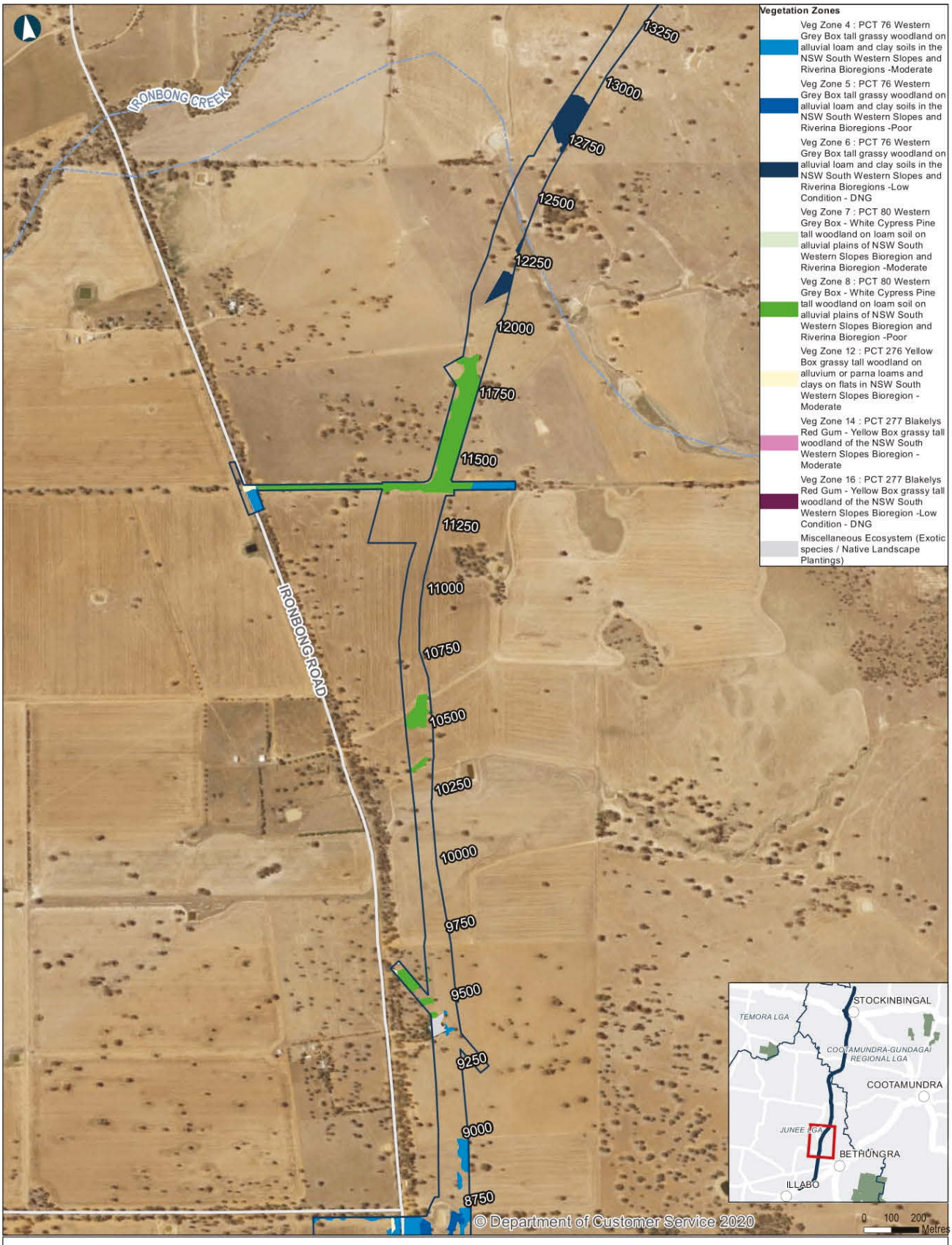

Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

- Sub-arterial road
- Arterial road
- Minor Watercourse

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 3 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

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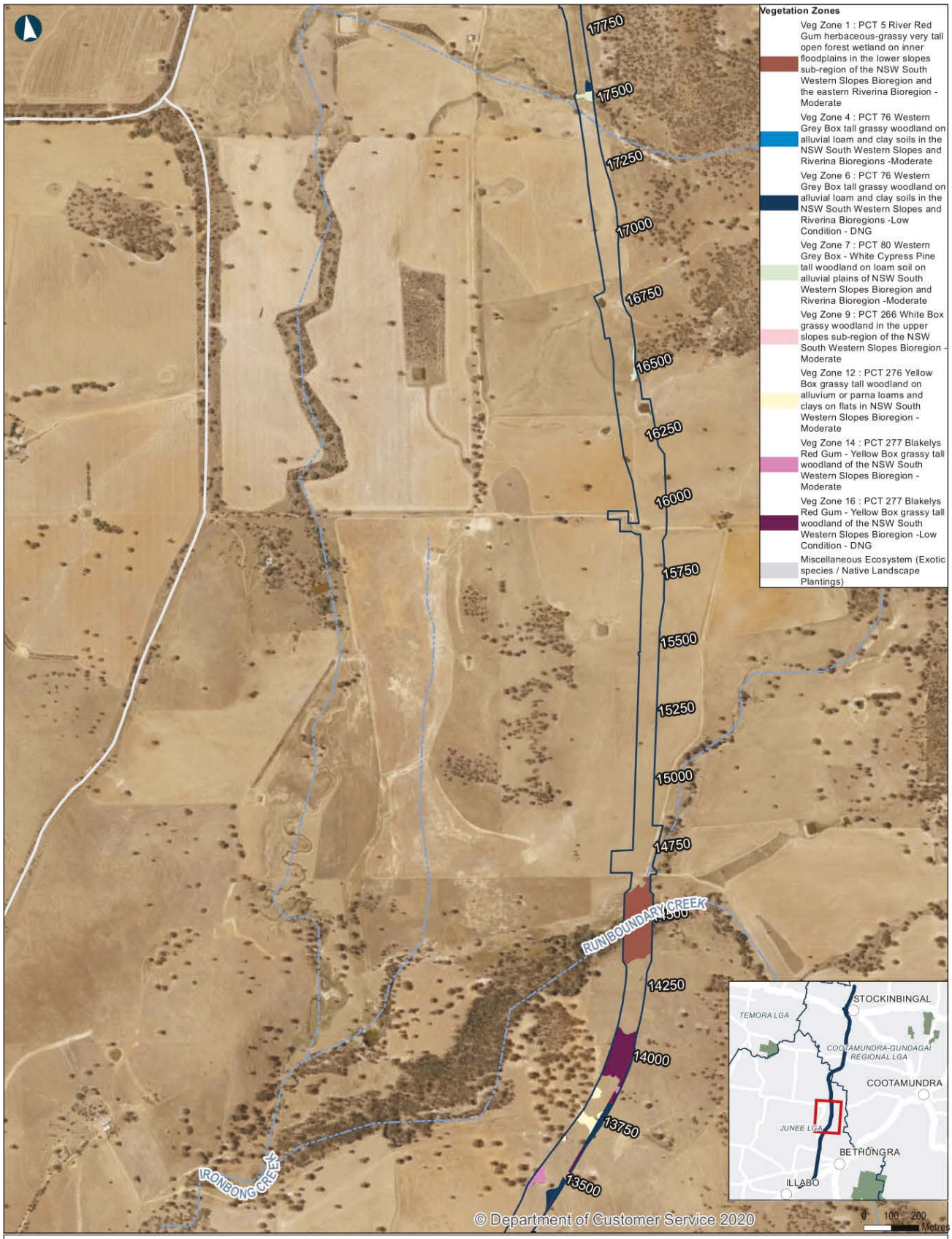

Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

- Sub-arterial road
- Arterial road
- Minor Watercourse

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 4 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

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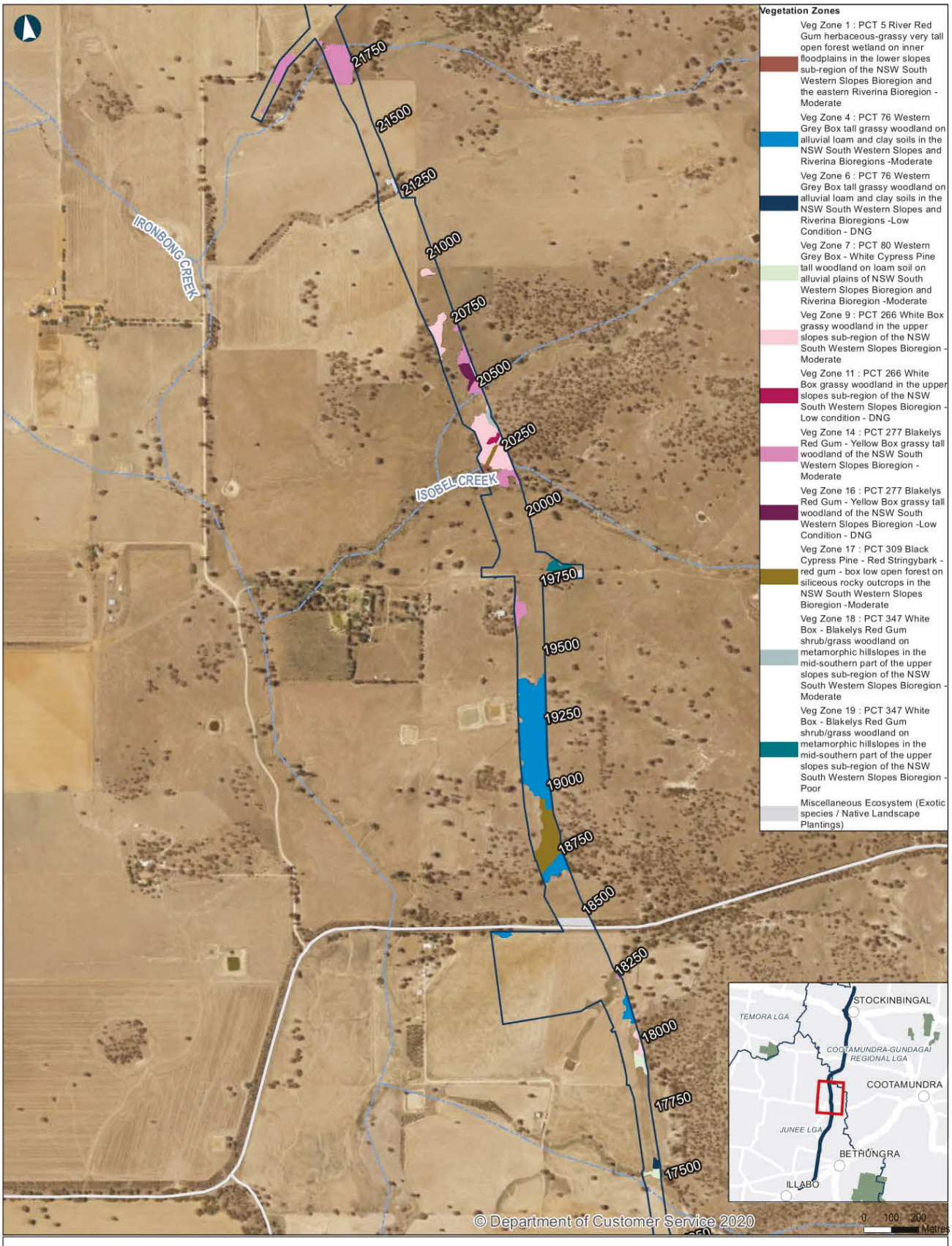


Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

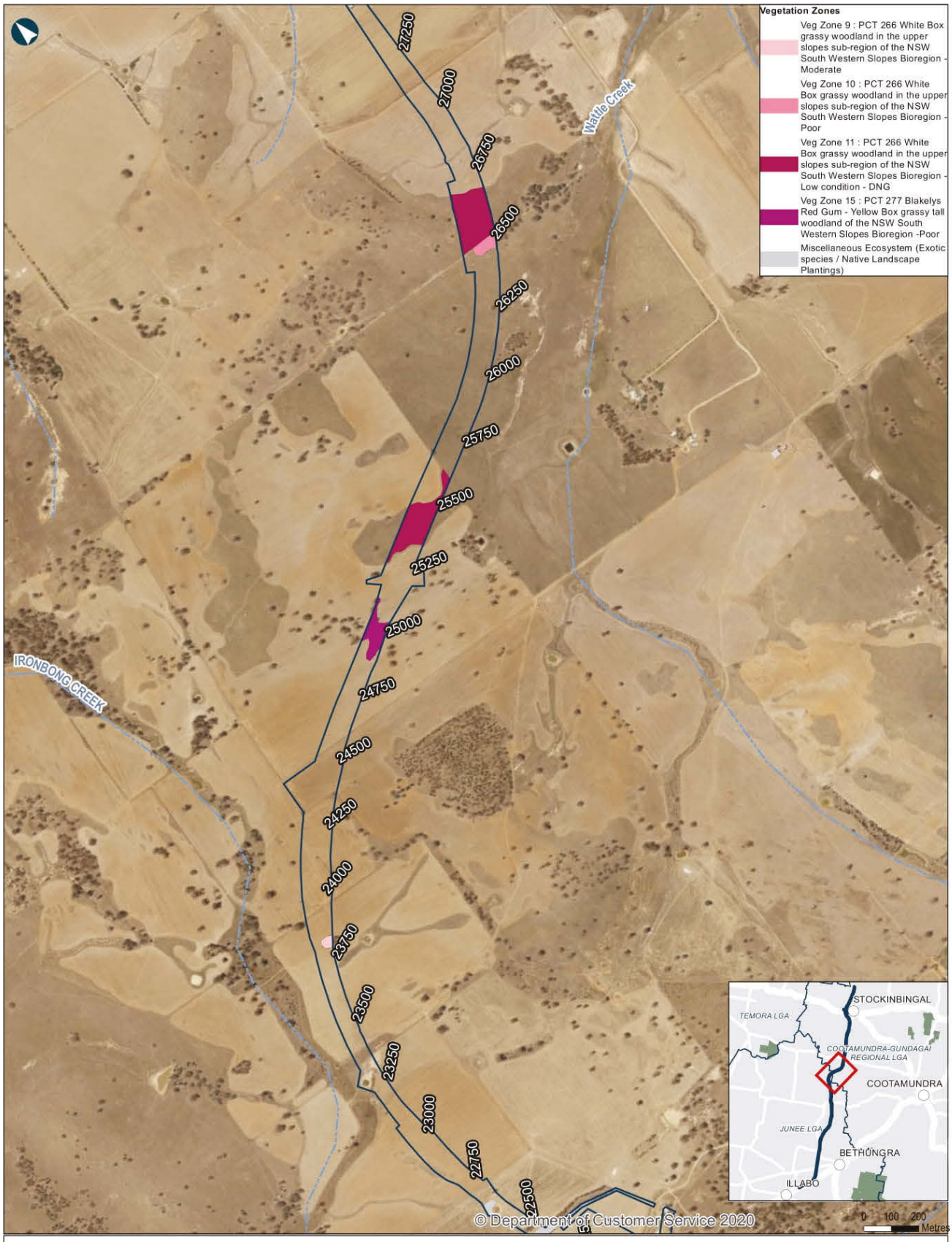
- Sub-arterial road
- Arterial road
- Minor Watercourse

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 5 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

220_0115_EIS_10_1_VegComm_r1v1.mxd



Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

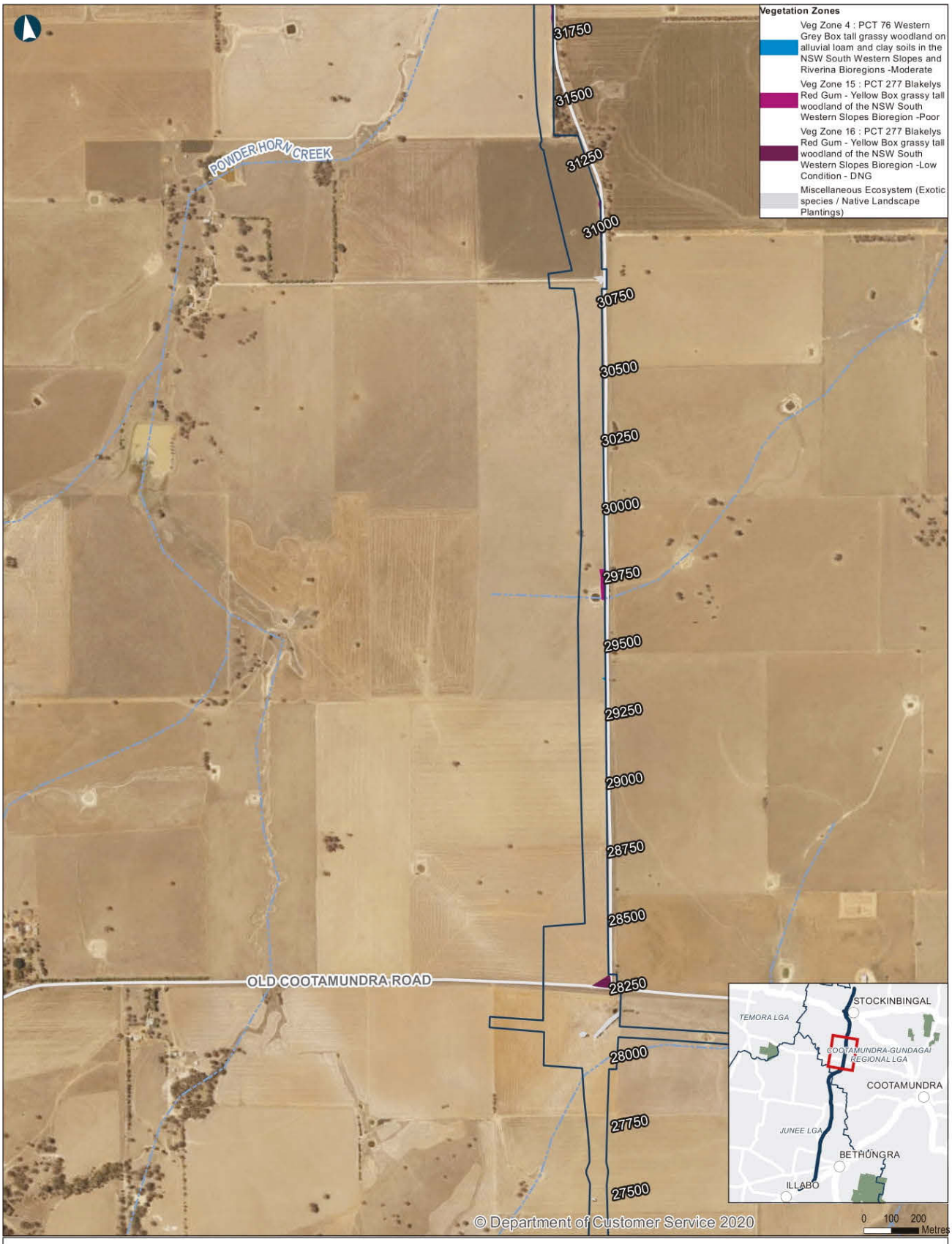
- Sub-arterial road
- Arterial road
- Minor Watercourse

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 6 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

220_0115_EIS_10_1_VegComm_r1v1.mxd



Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

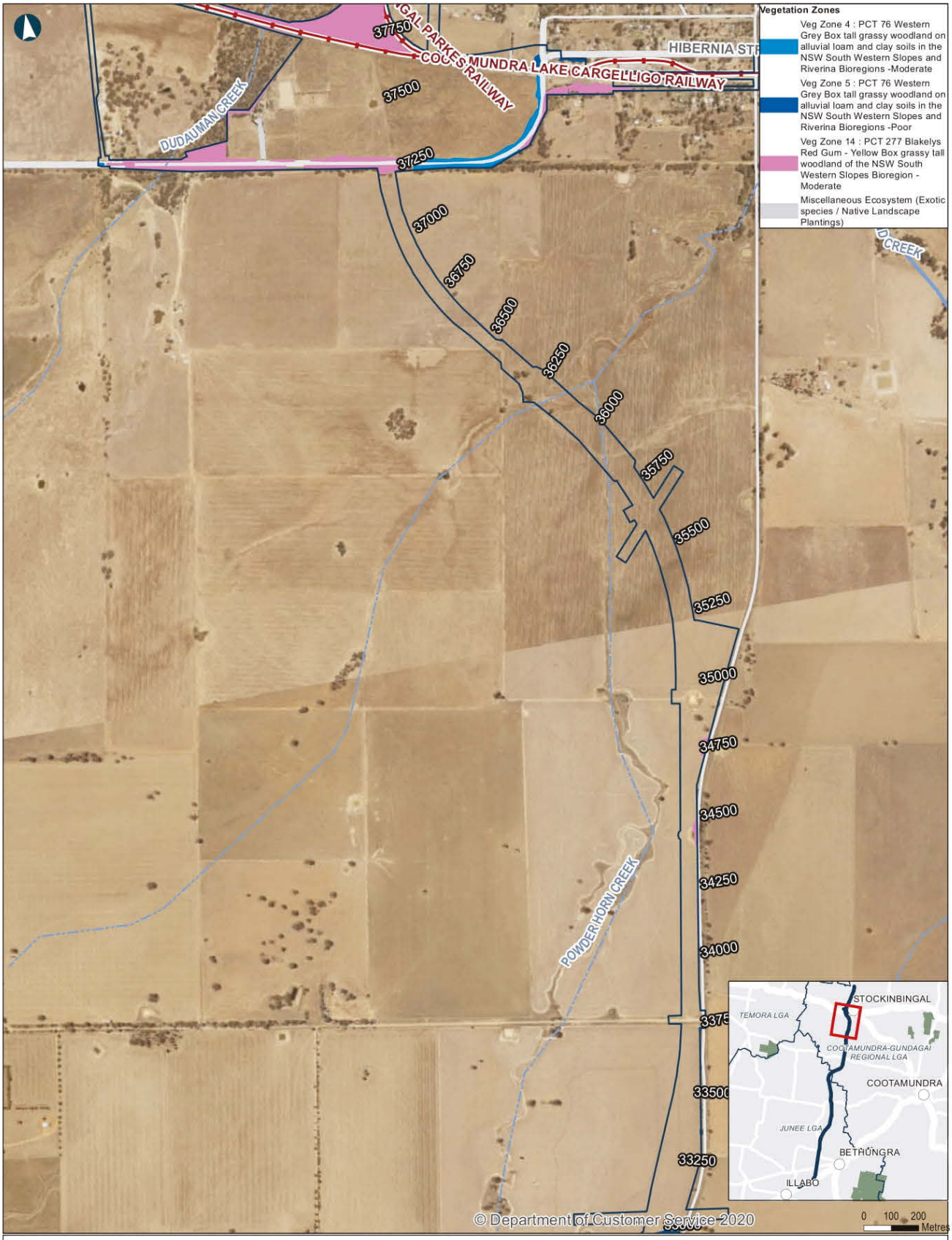
- Sub-arterial road
- Arterial road
- Minor Watercourse

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 7 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

220_0115_EIS_10_1_VegComm_r1v1.mxd



Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

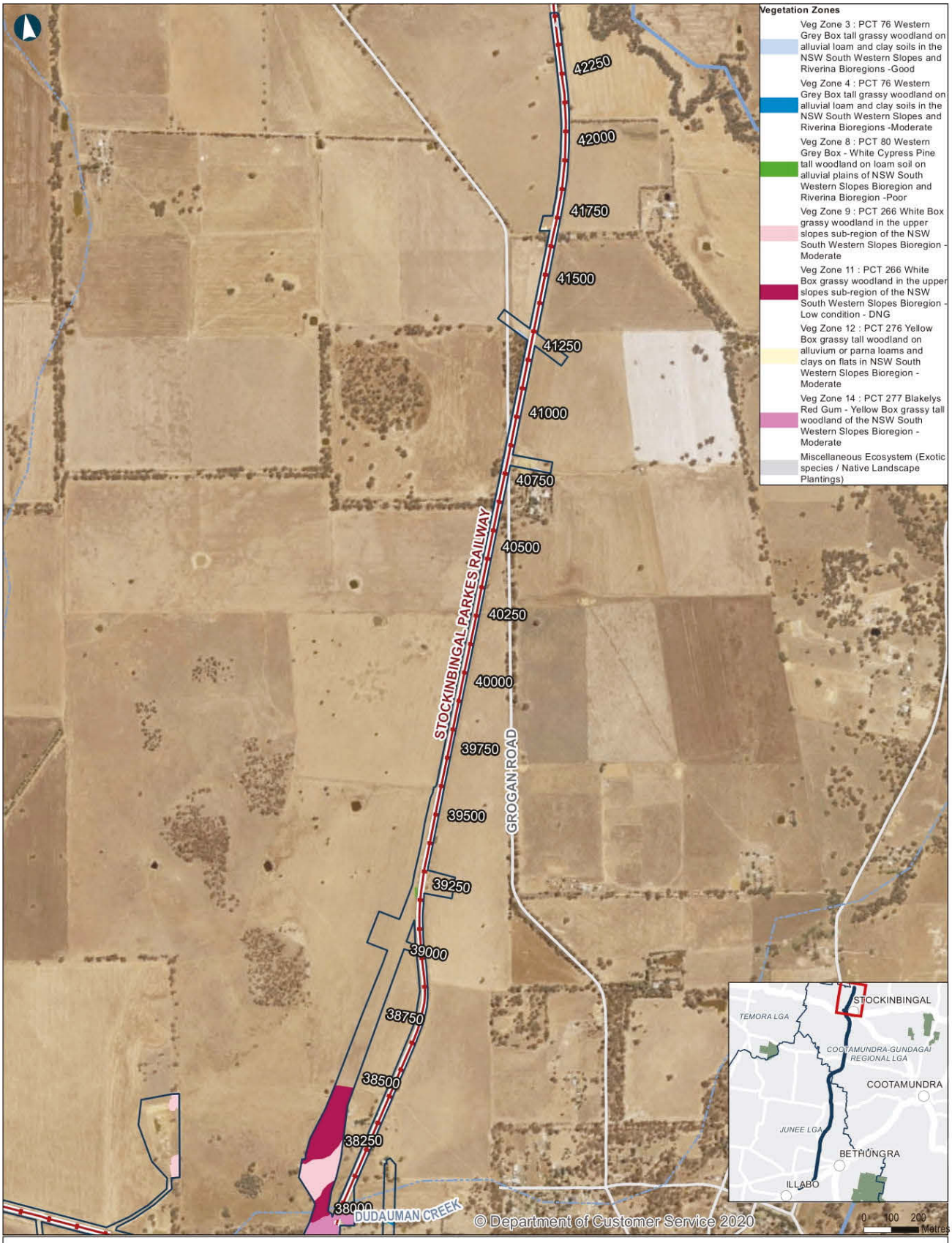
- Sub-arterial road
- Arterial road
- Major Watercourse
- Minor Watercourse
- Existing Rail

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 8 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

220_0115_EIS_10_1_VegComm_r1v1.mxd



Key features of proposal

- Proposal site
- 40950 Chainage (distance in metres from southern limit of the proposal)

Existing features

- Sub-arterial road
- Arterial road
- Major Watercourse
- Minor Watercourse
- Existing Rail

10.1 Vegetation communities within the proposal site

Coordinate System: GDA 1994 MGA Zone 55
Date: 11/17/2021 Paper size: A4 Scale: 1:20,000
MAP 9 of 9

Illabo to Stockinbingal Data Sources: LPI, IRDJV, ARTC

220_0115_EIS_10_1_VegComm_r1v1.mxd

10.3.2.4 Flora species

Threatened flora database search

Database searches identified 21 threatened plant species listed under the BC Act as being known to occur or likely to occur within the proposal site. Of these species, 16 species were considered to have a moderate or higher likelihood of occurring. Out of the identified 44 threatened plant species, 10 are also listed under the EPBC Act. A summary of threatened flora likelihood of occurrence is outlined in Table 10.4. These species are considered candidate species and were the subject of targeted surveys.

The threatened flora likelihood of occurrence table is in full in Appendix C of Technical Paper 1.

TABLE 10.4 THREATENED FLORA WITH POTENTIAL HABITAT

Scientific name	Common name	BC Act[1]	EPBC Act[1]
Acacia ausfeldii	Ausfeld's Wattle	V	–
Ammobium craspedioides	Yass Daisy	V	V
Austrostipa wakoolica	A spear-grass	E	E
Caladenia arenaria	Sand-hill Spider Orchid	E	E
Caladenia concolor	Crimson Spider Orchid	E	V
Cullen parvum	Small Scurf-pea	E	–
Diuris tricolor	Pine Donkey Orchid	V	–
Euphrasia arguta	Eyebrights	CE	CE
Indigofera efoliata	Leafless Indigo	E	E
Prasophyllum petilum	Tarengo Leek Orchid	E	E
Pultenaea humilis	Dwarf Bush-pea	V	–
Senecio garlandii	Woolly Ragwort	V	–
Swainsona murrayana	Slender Darling Pea	V	V
Swainsona recta	Small Purple Pea	E	–
Swainsona sericea	Silky Swainson-pea	V	V
Tylophora linearis	Tylophora linearis	V	E

(1) listed as V = Vulnerable, E = Endangered, CE = Critically Endangered; All are species credit species subject to targeted surveys.

Flora survey results

A total of 166 flora species were recorded within the proposal site, of which 109 were native (66%) and 57 (34%) were exotic. Species recorded were predominantly from Poaceae, Fabaceae and Asteracea families. Complete BAM plot data is in Appendix G of Technical Report 1.

Targeted surveys did not record any threatened flora species within the proposal site.

10.3.2.5 Weeds

A high number of introduced flora species were recorded within the proposal site during the field surveys, of these species seven were listed as High Threat weeds under the BC Act. In addition, one recorded species, *Lycium ferocissimum** (African Boxthorn), is listed under Priority Weeds for the Riverina region under the Biosecurity Act and listed as a Weed of National Significance (Australian Weeds Committee, 2021).

Assessment of biosecurity is in Chapter 18: Land use and property.

10.3.3 Terrestrial fauna

10.3.3.1 Terrestrial fauna habitats

While patches of moderate to good quality habitat were identified, including the presence of habitat features such as tree canopy, hollow-bearing trees, woody debris, intact shrub layer and rock outcrops, many of these patches have limited connectivity to the surrounding area due to the presence of cleared agricultural land, with extensive disturbance of native understorey.

As such, much of the habitat within the proposal site is considered suitable for highly mobile species, such as birds and some mammal species. However, the connectivity between good patches of habitat was often limited due to roads and agricultural land. Overall, the proposal site provided moderate quality habitat for terrestrial fauna, and large areas of low-quality habitat. Two terrestrial habitat types were identified within the proposal site, which are discussed in the following sections.

Open woodland

Open woodland habitat was identified in a variety of conditions, with the majority in moderate condition. Areas where livestock grazing and other agricultural practices were reduced or limited provided the best habitat for fauna, as microhabitats (i.e. fallen timber and shrubs) often were retained. Canopy species such as *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus microcarpa* (Western Grey Box), provide foraging resource for nectivorous birds and arboreal mammals, as well as roosting opportunities within hollows.

The mid- to low-storey vegetation in these areas generally formed a moderate cover of native vegetation, which consisted of the dominant species *Maireana microphylla* (Small-leaved Bluebush), *Salsola australis* and *Sclerolaena muricata* (Black Rolypoly), providing foraging habitat for woodland birds.

Microhabitats (leaf litter, fallen timber and rocky outcrops) provide opportunity to support ground dwelling fauna, including reptiles and small mammals.

Cleared grassland and agricultural land

This habitat was predominantly cleared, and provided scattered canopy trees, including mature *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus microcarpa* (Western Grey Box), providing foraging habitat for nectivorous and seed-eating fauna, as well as nesting opportunities for bird species and roosting for microchiropteran bats.

The mid- to low-storey vegetation within these areas was often highly disturbed, providing only marginal habitat for highly mobile species. However, where scattered trees are at a sufficient density, they may provide habitat for species such as the squirrel glider.

10.3.3.2 Fauna species

Threatened fauna database search

Database searches identified 59 threatened fauna species listed under the BC Act as being known to occur or predicted to occur within locality of the proposal site. Of these species, 20 species were recorded or considered to have a moderate or higher likelihood of occurring. Out of the identified 59 threatened fauna species, 10 are also listed under the EPBC Act. These species are considered candidate species and were the subject of targeted surveys.

The threatened fauna likelihood of occurrence table is in Appendix D of Technical Paper 1.

Fauna survey results

A total of 106 fauna species were recorded during the field surveys, which included 5 amphibians, 88 birds, 11 mammals and 2 reptiles (refer to Appendix H of Technical Paper 1). Of the 106 fauna species recorded, 8 are threatened species and 1 is migratory (see following sections).

Threatened fauna species

Eight threatened fauna species listed as vulnerable under the BC Act were recorded within the proposal site during field surveys (see Table 10.5). Of these, the Superb Parrot was also listed as vulnerable under the EPBC Act.

TABLE 10.5 THREATENED SPECIES RECORDED IN THE PROPOSAL SITE DURING SURVEYS

Scientific name	Common name	BC Act[1]	EPBC Act[1]	Credit type
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	–	Ecosystem credit species
Epthianura albifrons	White-fronted Chat	V	–	Ecosystem credit species
Falco subniger	Black Falcon	V	–	Ecosystem credit species
Petroica phoenicea	Flame Robin	V	–	Ecosystem credit species
Polytelis swainsonii	Superb Parrot	V	V	Species credit species (breeding)/Ecosystem credit species
Pomatostomus temporalis	Grey-crowned Babbler (eastern subspecies)	V	–	Ecosystem credit species
Petaurus norfolcensis	Squirrel Glider	V	–	Species credit species
Stagonopleura guttata	Diamond Firetail	V	–	Ecosystem credit species

(1) listed as V = Vulnerable

In addition to recorded species, one additional species credit species (*Myotis macropus*) was assumed present despite not being recorded during targeted surveys due to the presence of potential habitat, and another additional species credit species (*Keyacris scurra*), has not yet been subject to targeted surveys but has conservatively been assumed to be present based on presence of potential habitat (Table 10.6). 41 ecosystem credit species were predicted to occur and have been assessed under BAM as ecosystem credit species (Appendix J of Technical paper 1). In identifying an ecosystem credit species list for further assessment, two additional ecosystem credit species were recorded within the study area and have been included for assessment.

TABLE 10.6 THREATENED FAUNA SPECIES CREDIT SPECIES ASSUMED TO OCCUR

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Credit type
Myotis macropus	Southern Myotis	V	-	Species credit species
Keyacris scurra	Key's Matchstick Grasshopper	E	-	Species credit species

(1) Listed under the BC Act: CE = Critically Endangered, E1= Endangered, E2= Endangered Population, V= Vulnerable

(2) Listed under the EPBC Act CE = Critically Endangered, E = Endangered, V = Vulnerable

Migratory species listed under the EPBC Act

Based on field investigations and desktop review (see section 10.2.4), 11 migratory fauna species were identified to potentially occur. Based on field investigations and habitat assessments two migratory species have a moderate to high likelihood to occur within the aerial space above the proposal site. These are:

- *Apus pacificus* (Fork-tailed Swift) (listings Migratory, Marine)
- *Hirundapus caudacutus* (White-throated Needletail) (listings Vulnerable, Marine).

Neither species breed in Australia and they are unlikely to be directly dependent on terrestrial habitats.

During site investigations, no listed Migratory species were recorded within the proposal site.

10.3.4 Aquatic biodiversity

10.3.4.1 General description of aquatic habitat

A detailed description of watercourses within the proposal site is provided in Chapter 12: Hydrology and flooding.

The proposal site crosses six named watercourses—Billabong Creek, Ulandra Creek, Run Boundary Creek, Isobel Creek, Powder Horn Creek and Dudauman Creek—and numerous other crossings over small shallow watercourses and tributaries. All of the watercourses within the proposal site are highly ephemeral, flowing only after rainfall and quickly receding. The watercourses have been modified by agricultural land practices with minimal native vegetation retained along the banks of the watercourses. Figure 10.1 shows the watercourses within the proposal site.

Aquatic habitat within the proposal site includes ephemeral watercourses and farm dams. There are 14 farm dams present within the proposal site. The farm dams may contain protected native species, such as turtles and eels, for example the *Anguilla reinhardtii* (Longfin Eel). The edges of drainage lines and dams with aquatic vegetation would provide refuge habitat for amphibian species such as *Crinia parinsignifera* (Beeping Froglet) and *Limnodynastes tasmaniensis* (Spotted Grass Frog). A small amount of in-stream structural complexity (i.e. fallen timber/snags) was identified and would provide habitat for invertebrates and amphibians. Limited foraging habitat for wetland bird species (i.e. *Ardea pacifica* (White-necked Herons)) may also be provided; however, due to the size and minimal structural habitat these provide only marginal foraging habitat and are unlikely to be important foraging areas for these species within the locality.

Further discussion is in Chapter 4 of Technical Paper 2.

10.3.4.2 Key fish habitat

Key fish habitat within the proposal site (presented in order from south to north) is summarised in Table 10.7, with further information in Table 4.4 of Technical Paper 2.

TABLE 10.7 KEY FISH HABITAT

Watercourse	Strahler stream order	Habitat sensitivity type	Classification of watercourse for fish passage
Billabong Creek	6th order	Type 3—minimal	Class 3—minimal
Ulandra Creek	5th order	Type 3—minimal	Class 3—minimal
Run Boundary Creek	3rd order	Type 3—minimal	Class 3—minimal
Isobel Creek	3rd order	Type 2—moderate	Class 2— moderate

Watercourse	Strahler stream order	Habitat sensitivity type	Classification of watercourse for fish passage
Powder Horn Creek	3rd order	Type 3—minimal	Class 4—unlikely
Dudauman Creek (two crossings)	3rd order	Type 3—minimal	Class 3—minimal

(1) Ironbong Creek is outside of the proposal site

10.3.4.3 Threatened aquatic species

Database searches (BioNet website for the Atlas of NSW Wildlife (OEH, 2018), DPI threatened species lists, Primefacts and threatened species distribution maps, Atlas of living Australia and PMST results) identified a number of threatened species, endangered populations, threatened aquatic ecological communities and aquatic matters of national environmental significance listed under the FM Act, BC Act and/or EPBC Act. Six threatened species and one endangered population were determined as target species as they have been recorded or predicted to occur in watercourses within the proposal site:

- *Galaxias rostratus* (Flathead Galaxias)
- *Notopala hanleyi* (Hanley's River Snail)
- Maccullochella peelii (Murray Cod)
- *Euastacus armatus* (Murray Crayfish)
- *Mogurnda adspersa* (Southern Purple Spotted Gudgeon)
- Maccullochella macquariensis (Trout Cod)
- *Ambassis agassizii* (Western population of Olive Perchlet).

Following site survey and a likelihood of occurrence assessment, none of these species are considered likely to occur within watercourses in the proposal site due to the ephemeral nature of the watercourses and a lack of preferred habitat.

Important habitat features for these species that were absent from the watercourses that cross the proposal site include:

- Murray Cod and Trout Cod are all large-bodied species that are found in perennial, open water bodies which are not present within the proposal site.
- Flathead Galaxias, Southern Purple Spotted Gudgeon and the western population of Olive Perchlet all prefer slow flowing waterbodies with aquatic vegetation which is absent from watercourses that cross the proposal site.
- Hanley's River Snail and Murray Crayfish prefer flowing, well oxygenated waters that are not present within the proposal site.

10.3.4.4 Threatened ecological communities

The proposal site is located within the mapped distribution of two endangered aquatic ecological communities listed under the FM Act:

- Lowland Lachlan River aquatic ecological community
- Lowland Murray River aquatic ecological community.

Dudauman Creek is a tributary of Bland Creek and, as such, is part of the Lowland Lachlan River aquatic ecological community.

Billabong Creek and its tributaries (Ulandra Creek, Ironbong Creek, Run Boundary Creek and Isobel Creek) are part of the Lowland Murray River aquatic ecological community.

10.3.5 Groundwater dependent ecosystems

Ecosystems have been identified within a 2 km buffer from the proposal site that rely on the subsurface presence of groundwater and are known as groundwater dependent ecosystems (GDEs) (refer to Chapter 14: Groundwater). Within these ecosystems, the following high potential GDEs have been identified:

- three high potential aquatic (river) GDEs were identified intersecting the proposal site: Billabong Creek, Ulandra Creek and Dudauman Creek
- four high potential terrestrial (vegetation) GDEs were identified: Blakely's Red Gum, Yellow Box, Western Grey Box and White Cypress Pine.

Refer to Chapter 14: Groundwater for detailed information and mapping of GDEs.

10.3.6 Wetlands of national and international importance

Bethungra Dam Reserve, a wetland of national importance, occurs approximately 8 km to the east of the proposal site, upstream, from the proposal site and is wetland habitat created by the damming of Wandalybringle Creek.

Four international wetlands of importance (Ramsar) were identified in desktop searches:

- Banrock Station wetland complex
- Hattah-Kulkyne Lakes
- Riverland
- The Coorong and Lakes Alexandrina and Albert wetland.

These wetlands are located over 400 kilometres from the proposal site.

10.3.7 Protected and sensitive lands

A summary of protected and sensitive lands relevant to biodiversity follows.

10.3.7.1 Protected areas

Protected areas are set aside for conservation and managed by the NSW National Parks and Wildlife Service (NPWS). The protected area network in NSW includes a range of habitats and ecosystems, a diversity of plant and animal species, significant geological features and landforms, as well as Aboriginal cultural heritage sites, heritage buildings and historic sites. The categories of protected area and their relevance to the proposal site is listed and summarised in Table 10.8.

TABLE 10.8 PROTECTED AREAS

Category	Proposal site
Aboriginal areas Aboriginal cultural heritage on public land for cultural use. An area may have educational, ceremonial or other cultural significance to local Aboriginal people, or could have been used for its natural resources. A number of community conservation areas have also been reserved as Aboriginal areas.	There are no identified Aboriginal areas within the proposal site.
Community conservation areas (CCAs) CCAs are multiple-use protected areas categorised by the National Parks and Wildlife Service that protect the environment but also allow for the sustainable use of the natural resources. These include: ▸ CCA Zone 1—national parks ▸ CCA Zone 2—Aboriginal areas ▸ CCA Zone 3—state conservation areas.	There are no identified CCAs within the proposal site.
Flora reserves Protected areas of state forest that remain open for recreation. They are also important for the conservation and protection of Aboriginal cultural heritage.	There are no identified flora reserves within the study area.
Historic sites Management of historic cultural heritage sites and objects to protect and promote cultural heritage values. Historic sites are incorporated in plans of management and have conservation management plans to make sure they are well managed and maintained.	There are no identified historic sites identified in the proposal site. For discussion on Heritage, refer to Chapter 15: Cultural heritage.
Karst conservation reserves Include cave areas of national and international importance. Karst landforms include caves and their contents, gorges, and other features that reflect the complex relationship between climate, soil, ground and surface water, and biology. These areas in NSW are among the oldest and most complex in the world. Karst conservation reserves include Abercrombie, Borenore, Jenolan and Wombeyan.	There are no Karst conservation reserves within or near the proposal site. The closest site is the Abercrombie Karst conservation reserves and located approximately 152 km north-east of Stockinbingal.
National parks Areas of public land that play an important role in conservation. They protect a wide variety of native plants and animals and their habitats, as well as our historic and cultural heritage. National parks represent a wide variety of environments and provides places where people can share cultural and recreational activities.	There are no National Parks within the proposal site. The closest national park, Jindalee National Park, is located approximately 13 km east of the proposal at its nearest point at Stockinbingal.
Nationally and internationally significant areas Identified as World Heritage-listed areas, national heritage-listed areas, the International Union for the Conservation of Nature Green List of Protected and Conserved Areas and the internationally significant Ramsar wetlands.	There are no nationally and internationally significant areas identified within the proposal site.

Category	Proposal site
Nature reserves Areas of land with significant conservation values because they are in a mostly untouched natural condition with high biodiversity. Their primary purpose is to protect and conserve their outstanding, unique or representative ecosystems and Australian native plants and animals.	Ulandra Nature Reserve is located approximately 12 km from the proposal site on the southern end near Illabo. The reserve was created in June 1981 and covers an area of 3,931 hectares (ha).
Regional parks Natural or modified areas reserved for conservation. They provide opportunities for sustainable public recreation and offer open spaces for cultural and activities (including dog walking in some parks) that may not be permitted in national parks, state conservation areas or nature reserves.	There are no regional parks identified within the proposal site.
State conservation areas Lands reserved to protect areas of significant natural and cultural value as well as provide opportunities for recreation and research.	There are no state conservation areas identified within the proposal site. The closest is Combaning State Conservation Area, approximately 12 km west of the proposal site.
Wild rivers Freshwater or estuarine rivers that are in near-pristine condition in terms of animal and plant life and water flow, and are free of the unnatural rates of siltation or bank erosion that affect many of Australia's watercourses. Wild rivers in NSW are only declared within national parks and other reserves.	There are no wild rivers identified within the site or area of this proposal site.
Wilderness Large areas that remain essentially unchanged by modern human activity. Almost all declared wilderness is within national parks and nature reserves and are actively managed for fire, pests and weeds as are other parts of the reserve system. Wilderness areas provide a range of ecological, cultural and human benefits to society. They support large populations of plants and animals which can adapt and evolve over time. They contain many significant Aboriginal sites and places. Wilderness landscapes are a reminder of the Australian environment before European colonisation.	There are no wilderness areas identified within the site or area of this proposal site.
World Heritage areas Places or sites that have been added to the UNESCO World Heritage List due to their outstanding universal value and exceptional example of the world's natural and cultural heritage. The NSW national park system protects and manages four World Heritage areas: the Gondwana Rainforests of Australia, the Greater Blue Mountains, Willandra Lakes Region, and parts of the serial Australian Convict Sites World Heritage Area.	There are no World Heritage areas identified within the site or area of this proposal site.

10.3.7.2 Sensitive lands

Lands identified as sensitive lands and any occurring within the proposal site are described in Table 10.9.

TABLE 10.9 SENSITIVE LANDS

Category	Proposal site
Key fish habitats Aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of the threatened aquatic species. Defined to include all marine and estuarine habitats up to highest astronomical tide level (that reached by 'king' tides) and most permanent and semi-permanent freshwater habitats including rivers, watercourses, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank.	There are various types and class of key fish habitats identified in watercourses that cross the proposal site. Within the proposal site, five watercourses are mapped by DPI as key fish habitat, although none are permanently flowing (perennial) and are all ephemeral and are defined as moderately sensitive to minimally sensitive key fish habitat. Refer to section 10.8.2 for details of potential impacts to key fish habitat.
Waterfront land Defined in the *Water Management Act 2000* as the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river.	A total of 4.94 ha of riparian corridor, which is defined as sensitive waterfront land, occurs within the proposal site (refer to section 10.8.3)
Critical habitat Whole or part of the habitat that includes species, populations and ecological communities listed as critically endangered, endangered, vulnerable or for species extinct or extinct in the wild, or in the case of threatened ecological communities collapsed under the BC Act.	No land or waters identified as critical habitat/areas of outstanding biodiversity value under the BC Act, FM Act or EPBC Act are located in the proposal site.

Category	Proposal site
Offset lands Offset lands include BioBank sites that are enabled through 'biodiversity credits' generated by landowners and developers who are committed to enhancing and protecting biodiversity values on their land through a BioBanking agreement. Other land could also include private conservation lands and any other lands identified as offsets not defined and identified as a BioBank site.	Searches of the public registers under the former *Threatened Species Conservation Act 1995 (NSW)* and the BC Act were completed on 30 July 2021. Public biobanking registers do not identify any biobank sites within the Junee and Cootamundra–Gundagai LGAs, which associated with the proposal site. In relation to the Biodiversity Conservation Trust Register, there are a number of private conservation agreements in the Murray–Riverina region, including three in the Junee LGA, and three in the Cootamundra–Gundagai LGA. Public register data does not identify the precise location of these private conservation agreements and other offset lands.
Riparian corridors Land that is formed as a transition zone between the land and the river or watercourse or aquatic environment. They provide a range of important environmental functions such as: ▸ providing bed and bank stability and reducing bank and channel erosion ▸ protecting water quality by trapping sediment, nutrients and other contaminants ▸ providing diversity of habitat for terrestrial, riparian and aquatic plants (flora) and animals (fauna) ▸ providing connectivity between wildlife habitats ▸ conveying flood flows and controlling the direction of flood flows ▸ providing an interface or buffer between developments and watercourses ▸ providing passive recreational uses.	A total of 4.94 ha of riparian corridor occurs within the proposal site based on the *Guidelines for controlled activities on waterfront land—Riparian corridors* (NSW DPI, 2012a)—see section 10.8.3 and section 5.1 of Technical Paper 2.

10.4 Impact assessment—construction

Potential impacts on biodiversity during construction include:

- direct impacts as a result of vegetation clearing and disturbance in the proposal site
- indirect impacts on flora and fauna located outside the proposal site as a result of activities within the site.

A summary of the results of the impact assessment is in the following sections.

10.4.1 Native vegetation

10.4.1.1 Loss of native vegetation

Vegetation would need to be cleared to construct and locate the new rail corridor and permanent operational infrastructure.

Construction of the proposal would result in the loss of 72.93 ha of native vegetation, comprised of 62.83 hectares of woodland habitat and 10.1 hectares of native grassland habitat.

Land clearance is listed as a key threatening process under the BC Act and EPBC Act. Discussion of relevant key threatening processes related to direct impacts on vegetation, including loss of hollow-bearing trees, is in section 10.6.

The PCTs that would be directly affected are shown in Table 10.10.

TABLE 10.10 DIRECT IMPACTS TO NATIVE VEGETATION

Plant Community Type (PCT)	Extent within the proposal site (ha)
PCT 5 River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion	6.80
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	27.10

Plant Community Type (PCT)	Extent within the proposal site (ha)
PCT 80 Western Grey Box – White Cypress Pine tall woodland on loam soil on alluvial plains of NSW South Western Slopes Bioregion and Riverina Bioregion	6.10
PCT 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	10.30
PCT 276 Yellow Box grassy tall woodland on alluvium or parna loams and clays on flats in NSW South Western Slopes Bioregion	2.60
PCT 277 Blakely's Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	17.90
PCT 309 Black Cypress Pine – Red Stringybark – Red gum – box low open forest on siliceous rocky outcrops in the NSW South Western Slopes Bioregion	1.70
PCT 347 White Box – Blakely's Red Gum shrub/grass woodland on metamorphic hillslopes in the mid-southern part of the upper slopes sub-region of the NSW South Western Slopes Bioregion	0.43
Total area impacted by the proposal	**72.93**

10.4.1.2 Threatened ecological communities—Biodiversity Conservation Act

The total direct impact on BC Act listed TECs is 43.43 ha. The TECs affected are:

- Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions
- White Box Yellow Box Blakely's Red Gum Woodland.

A summary of direct impacts on each TEC and associated PCT is summarised in Table 10.11.

TABLE 10.11 DIRECT IMPACT ON TECS LISTED UNDER THE BC ACT

Threatened ecological community	Status[1]	Associated PCT within the construction footprint	Condition	Extent with proposal site (ha)
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions	E	PCT 76—Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	Good	1.1
			Moderate	18.7
			Poor	Does not meet listing
			Low	2.3
		PCT 80 Western Grey Box—White Cypress Pine tall woodland on loam soil on alluvial plains of NSW South Western Slopes Bioregion and Riverina Bioregion	Moderate	1.4
			Poor	Does not meet listing
Total area of Inland Grey Box Woodland				**23.5**
White Box Yellow Box Blakely's Red Gum Woodland	E	PCT 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	Moderate	4.50
			Poor	Does not meet listing
			Low	Does not meet listing
		PCT 276—Yellow Box grassy tall woodland on alluvium or parna loams and clays on flats in NSW South Western Slopes Bioregion	Moderate	2.0
			Poor	Does not meet listing
		PCT 277 Blakely's Red Gum—Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	Moderate	13.3
			Poor	Does not meet listing
			Low	Does not meet listing
		PCT 347 White Box—Blakely's Red Gum shrub/grass woodland on metamorphic hillslopes in the mid-southern part of the upper slopes sub-region of the NSW South Western Slopes Bioregion	Moderate	0.13
			Poor	Does not meet listing
Total area of White Box Yellow Box Blakely's Red Gum Woodland				**19.93**
Total area of all TECs listed under the BC Act				**43.43**

(1) E = Endangered as listed under the BC Act

A discussion on whether the proposal is likely to result in serious and irreversible impacts on these communities is in section 10.7.2.

To mitigate the potential impacts on biodiversity, biodiversity offsets would be provided in accordance with the Biodiversity Offset Scheme, as described in section 10.9.6.

10.4.1.3 Threatened ecological communities—Environmental Protection and Biodiversity Conservation Act

The total direct impact on EPBC Act listed TECs is 43.43 ha. The TECs affected are:

- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia
- White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

A summary of direct impacts on each TEC, and associated PCT is summarised in Table 10.12.

TABLE 10.12 DIRECT IMPACT ON TECS LISTED UNDER THE EPBC ACT

Threatened ecological community	Status[1]	Associated PCT within the construction footprint	Condition	Extent with proposal site (ha)
Grey Box (*E. microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia	E	PCT 76—Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	Good	1.1
			Moderate	18.70
			Low—derived native grassland	2.30
		PCT 80 Western Grey Box—White Cypress Pine tall woodland on loam soil on alluvial plains of NSW South Western Slopes Bioregion and Riverina Bioregion	Moderate	1.4
Total				**23.50**
White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	PCT 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	Moderate	4.50
		PCT 276—Yellow Box grassy tall woodland on alluvium or parna loams and clays on flats in NSW South Western Slopes Bioregion	Moderate	2.00
		PCT 277 Blakely's Red Gum—Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	Moderate	13.3
		PCT 347 White Box—Blakely's Red Gum shrub/grass woodland on metamorphic hillslopes in the mid-southern part of the upper slopes sub-region of the NSW South Western Slopes Bioregion	Moderate	0.13
Total				**19.93**
Total area of all TECs listed under the EPBC Act:				**43.43**

(1) E = Endangered, CE = Critically Endangered as listed under the EPBC Act

To understand the significance of this impact on each TEC, assessments of significance were conducted in accordance with the Significant Impact Guidelines 1.1 (DAWE, 2013a). The findings of these assessments of significance are summarised in the following sections and in full in Appendix F of Technical Paper 1.

Assessment of significance—Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of south-eastern Australia

The assessment of significance found that the proposal is likely to have a significant impact on Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of south-eastern Australia for the following reasons:

- the proposal would clear 23.5ha of the community, equivalent to approximately 0.003% of the remaining extent of the community
- the proposal will fragment eight patches of the community and is likely to exacerbate fragmentation at a regional scale that is likely to be significant to the community given its already fragmented state.

Assessment of significance–White Box–Yellow Box – Blakely's Red Gum grassy woodland and Derived Native Grasslands

The assessment of significance found that the proposal is likely to have a significant impact on White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grasslands for the following reasons:

- the proposal would clear 19.93 ha of the community in moderate to good condition
- the proposal will create fragmentation in large patches and roadside remnants of Box-Gum Woodlands and increase fragmentation between smaller patches
- given the currently highly fragmented and degraded state of this ecological community, all areas of Box-Gum Grassy Woodland that meet the minimum condition criteria should be considered critical to the survival of this ecological community. As such all occurrences of EPBC-listed Box-Gum Grassy Woodland within the proposal site are considered habitat critical to the survival of this community.

10.4.2 Terrestrial flora

Targeted surveys did not record any threatened flora species listed under the BC Act or EPBC Act, and candidate species (refer to section 10.3.2.4) were not considered to be affected by the proposal. This is based on the candidate threatened flora species assessments in section 6.2.1 (BC Act) and section 8.1.2 (EPBC Act) of Technical Paper 1.

10.4.3 Terrestrial fauna

10.4.3.1 Fauna habitat and connectivity

The proposal would exacerbate fragmentation in areas where vegetation would be removed. Due to the importance of connectivity, dispersal opportunities and habitat quality for species at a local scale, this impact has the potential to be negative to the dispersal of relatively sedentary species such as mammals, frogs, reptiles and small woodland birds.

The proposal would result in habitat loss from the removal of native vegetation (see section 10.4.1.1). It is estimated that 42 hollow-bearing trees would be removed as part of construction. This includes large remnant red gums in riparian areas, trees in forested areas and scattered trees in agricultural land.

In terms of scattered trees, a total of 58 scattered trees would be removed, comprised of:

- 50 Class 3 scattered trees comprising:
  - 42 scattered trees with hollows
  - 8 scattered trees with no hollows
- 8 Class 2 scattered trees with no hollows.

Hollow-bearing trees provide potential roosting sites for many fauna species that rely on hollows for shelter and breeding habitat. Due to the long timeframe it takes for hollows to form in eucalypts (usually greater than 150 years), the loss of these hollows represents a long-term reduction in habitat resources for fauna. The loss of such a large number of hollow-bearing trees would impact local populations of threatened fauna reliant on these habitat features, such as the Superb Parrot, Squirrel Glider, Corben's long-eared Bat, and other microbat species. There are ecosystem credit obligations associated with the removal of scattered trees for the proposal as provided outlined in section 10.9.6.1.

The proposal is unlikely to affect the movement patterns of species such as the Superb Parrot, Corben's Long-eared Bat, Regent Honeyeater and Swift Parrot. While habitat would be removed along the alignment, alternate foraging (and/or breeding) habitat would remain in adjacent areas.

Loss in connectivity and/or increase in habitat fragmentation as a result of the proposal may impact the movement of the Squirrel Glider, which is limited by gliding distances between areas of habitat. Habitat for the Squirrel Glider becomes fragmented once tree spacing becomes beyond their gliding capacity, an average glide length of 30–40 m. General locations for fauna connectivity have been identified and advice on design of fauna crossing structures provided to the design team which takes into consideration the height of remaining trees, height of double stacked trains (up to 6.5 m), gap between trees and the gliding angle of Squirrel Gliders.

The predicted level of fragmentation from the proposal is not expected to be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches.

The existing functional connectivity for many species would remain in the proposal site and be alleviated with connectivity structures and mitigation measures at the mentioned watercourses and road reserves as provided in section 10.9.4.

10.4.3.2 Injury and mortality

The injury and mortality of fauna has the potential occur during construction of the proposal. Injury and mortality may occur prior to construction when vegetation and habitat is being cleared, and during construction when machinery and plant is moved to, from and on site.

During clearing, less mobile fauna species and other small terrestrial fauna are at greater risk as these may be sheltering in vegetation with the proposal site during clearing activities and unable to move out of the area.

All roads have potential to result in the mortality of native animals. The risk is higher where roads:

- traverse areas of substantial animal habitat
- are located near natural or artificial water bodies
- contain food sources (e.g. mown grass verges, nectar-producing shrubs) that attract animals to the road's edge
- have high speed limits
- provide poor visibility of wildlife (e.g. due to bends, crests and poor lighting).

A range of fauna species are at risk of vehicle strike during construction. Fauna at risk of injury and mortality include the Squirrel Glider and other terrestrial fauna, as well as birds, bats and other gliders.

10.4.3.3 Species listed under the Biodiversity Conservation Act

A species credit obligation is required to offset the loss of threatened fauna candidate species listed under the BC Act, comprised of 30.88 ha of habitat for the Key's Matchstick Grasshopper, 60.33 ha of habitat for the Superb Parrot and Squirrel Glider, and 8.25 ha of habitat for the Southern Myotis (see section 10.9.6.1).

10.4.3.4 Species listed under the Environmental Protection and Biodiversity Conservation Act

The proposal would impact known or potential habitat for six threatened fauna candidate species listed under the EPBC Act: Superb Parrot, Swift Parrot, Regent Honeyeater, Grey-headed Flying Fox, Corben's Long-eared Bat and White-throated Needletail.

The loss of potential habitat areas for this threatened fauna within the proposal site is as follows:

- up to 72.93 ha of potential foraging habitat, of which 60.33 ha is potential breeding habitat, for the Superb Parrot
- about 60.33 ha of potential foraging habitat for the Swift Parrot
- about 30.23 ha of potential foraging habitat for the Regent Honeyeater
- about 54.6 ha of potential foraging habitat for the Grey-headed Flying Fox
- up to 11 ha of potential foraging habitat for the Corben's Long-eared Bat
- up to 60.3 ha of potential foraging habitat for White-throated Needletail.

Assessments of significance for impacts to habitat for these EPBC-listed species are included in Appendix F of Technical Paper 1. The assessments concluded the proposal was not likely to have a significant impact on these species due to:

- the highly modified, fragmented and disturbed nature of the proposal site, which would not become further fragmented from construction of the proposal for these highly mobile species
- the availability of habitat within the survey area is unlikely to constitute important habitat, due to the marginal quality of the resources
- the extent of potential habitat to be removed is a small component of available habitat locally with an abundance of similar quality habitat and that of much higher quality in the greater locality
- important populations, using the definition in the *Significant Impact Guidelines 1.1* (DAWE, 2013a) and Draft referral guideline (DE, 2015) are not present within the proposal site as the area is not considered to contain 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.

In accordance with the *EPBC Act Condition-setting Policy* (DAWE, 2020), biodiversity offsets are required to compensate for significant residual effects on matters of national environmental significance. Further information is in section 10.2.1.

10.4.3.5 Migratory species

The Fork-tailed Swift (*Apus pacificus*) and White-throated Needletail (*Hirundapus caudacutus*) were considered to have a moderate likelihood of utilising habitat within the proposal site. Whilst these species may occur, the habitats within the proposal site are unlikely to constitute 'important habitat' as defined under the EPBC Act and in accordance with the Significant Impact Guidelines 1.1 (DAWE, 2013a) and the Draft referral guideline (DE, 2015).

The habitat present is unlikely to support significant proportions of the population of any migratory species nor are the habitats critical to any life stage of these species. They are likely to use higher quality habitat within the greater locality where more extensive areas of native vegetation occur. Because of this and their mobile nature, these species are not considered to be significantly affected by the proposal.

10.4.4 Aquatic biodiversity

Construction has the potential to impact on watercourses and water quality in the study area (refer to Chapter 12: Hydrology and flooding and Chapter 13: Water quality). Associated potential impacts from construction of the proposal on aquatic biodiversity may include the following direct impacts:

- removal of riparian corridor vegetation
- removal of instream vegetation and large woody debris
- temporary obstruction of fish passage
- impacts on water quality
- loss of aquatic habitat within farm dams within the proposal site
- an increase in the rate of spread of exotic macrophyte species.

The proposal would directly impact 4.94 ha of riparian corridor (on sensitive waterfront land) located within the proposal site through vegetation clearing for construction (see section 10.8.3).

Large woody debris and macrophytes within the stream provides shelter, feeding and spawning habitat for many native birds, fish and invertebrates. Instream or aquatic vegetation is also effective at water purification by further removing nutrients. Removal of large woody debris (snags) is a Key Threatening Process under the FM Act (see section 10.6).

Fish passage along our watercourses is critical to the survival of Australian native fish and maintaining fish passage in key fish habitat is a requirement of DPI policy and guidelines (Fairfull and Witheridge, 2003) (refer to section 5.1.3 of Technical Paper 2). Potential impacts to fish passage during construction include earthworks or placement of structures (including temporary culverts) that block watercourses and installed erosion and sediment control measures. The risk of impact to aquatic biodiversity because of temporary crossings at Isobel Creek and Powder Horn Creek is considered low as these watercourses are ephemeral and were defined as moderately and minimally sensitive key fish habitat (see section 10.3.4.2).

As per section 10.3.4.1, the majority of watercourses that cross the proposal site are ephemeral. The impact of high turbidity following sediment disturbance during construction can affect macrophytes and aquatic fauna (refer to section 5.1.4 in Technical Paper 2). Potential pollution impacts on the aquatic environment are mainly associated with management of stockpiles, construction compounds and refuelling methods. Potential water quality impacts would be addressed by implementing standard mitigation measures designed to minimise erosion and sedimentation, and potential water quality impacts (refer to Chapter 12: Hydrology and flooding and Chapter 13: Water quality).

There are 14 farm dams located within the proposal site as shown in Figure 10.1 and 10 dams have been identified for decommissioning. The dams may contain potential habitat for protected native species such as turtles and eels. The dams being decommissioned would likely require dewatering and as such, will result in a loss of aquatic habitat for non-threatened aquatic species. The dewatering process also has the potential to impact water quality in receiving waters, through the input of mobilised sediments.

The exotic *Juncus acutus* (Spiny Rush) was recorded at several sites during aquatic field surveys. This species is highly adaptable, and its distribution is not restricted to areas of permanent or semi-permanent water. The spread of exotic aquatic weeds such as *Juncus acutus* (Spiny Rush) is potentially accelerated by construction activities and machinery moving across the proposal site. Spiny rush is regarded as a serious environmental weed in NSW as infestations can obstruct water flow, out-compete native aquatic species and can reduce the productivity of pastures.

The proposal site is located within the mapped distribution of two aquatic TECs (see section 10.3.4.4). Assessments of significance of the potential impact on these were undertaken and are included in section 5.3 of Technical Paper 2. The assessments concluded that the proposal is unlikely to have an adverse impact on these TECs.

No nationally listed threatened aquatic species, endangered populations, TECs or aquatic migratory species listed under the EPBC Act are expected to occur in the watercourses within the study area and therefore no impacts are predicted. Accordingly, an assessment of the impact of the proposal on matters of national environmental significance is not required.

10.4.5 Indirect impacts unable to be avoided

Potential indirect impacts from construction of the proposal may include:

- reduced viability of adjacent habitat due to edge effects—where new edges are created, and vulnerable to degradation through the establishment and spread of weeds and other impacts
- transport of weeds and pathogens—introduction pests and pathogens to areas of native vegetation not previously exposed due to construction related impacts
- reduced viability of adjacent habitat due to noise, dust, light spill and contamination pollution has the potential to disturb fauna and may disrupt foraging, reproductive, or movement behaviours
- connectivity and habitat fragmentation—removal of native vegetation and splitting of habitat patches can result in habitat fragmentation dividing once continuous habitats into separate smaller 'fragments' (see section 10.4.3)
- changes to geomorphology of watercourses—temporary changes in watercourse flows and velocities downstream of waterbodies and watercourses within the proposal site may occur as a result of construction activities (such as earthworks, relocation of utilities and removal of vegetation)
- reduced water quality—due to changes in hydrology, the potential increase in turbidity downstream of construction areas, potential impact to watercourses from leaks and spills and disturbance of potentially contaminated soil.

The nature, extent, duration and consequence of these indirect impacts are detailed in section 10.2 of Technical Paper 1.

10.5 Impact assessment—operation

10.5.1 Terrestrial biodiversity

Operation has the potential to result in the following impacts on terrestrial biodiversity:

- injury and mortality of fauna attempting to cross the rail line and roads
- impacts on connectivity (and associated impacts on population viability and genetics), particularly for terrestrial fauna
- additional noise, vibration and light impacts as a result of train operations
- mobilisation of dust
- potential for spills from refuelling
- potential for bushfire from sparks
- spread of weeds and pests.

No additional direct impacts to native vegetation would occur during operation of the proposal; however, vegetation clearing for construction could introduce edge effects and weed invasion into additional areas of native vegetation and habitat.

While greatly reduced in intensity to that caused during construction, operation of the proposal would result in impacts such as increased noise, vibration and light. However, other than train movements there are no significant sources of emissions during operation of the proposal. The impacts from noise, vibration and light emissions from train movements is not anticipated to result in significant impacts to fauna.

The presence of road and rail infrastructure and associated movement of trains and vehicles would result in risk of vehicle strike to fauna species such as the Squirrel Glider. The species is highly mobile and glides between areas of habitat. However, the proposal is likely to result in increased risk of train strike to this species due to the length of the trains and 6.3 m height of double-stacked containers. Minimising injury and mortality will be delivered in the concept and detailed design processes of the roads and rail infrastructure including fauna crossings and landscaping plans.

Operation of the proposal is considered unlikely to result in a significant increase in connectivity and movement from fragmentation than what already exists, as it occurs within a predominantly fragmented landscape with limited large patches of remnant vegetation. Existing connectivity is limited to watercourses and road reserves. These connectivity features link with the largest intact patch of remnant vegetation occurring to the east of the proposal site. The proposal includes bridges and culverts where it intersects these areas, which would continue to provide opportunity for the safe movement of fauna and maintain key areas of connectivity.

Severe fragmentation and increases in mortality may reduce gene flow and gene pool and lead to inbreeding depression in remnant populations of Squirrel Glider with greater risk of loss due to mortality and catastrophes (such as wildfires). For long-term viability of populations fragments must be functionally linked to large remnants. Habitat for the Squirrel Glider becomes fragmented once tree spacing becomes beyond their gliding capacity.

Squirrel Gliders primarily move through their home range by gliding from tree to tree with an average glide length of 30–40 m and a maximum glide length of approximately 70 m (van der Ree et al. 2003). General locations for fauna connectivity have been identified and advice on design of fauna crossing structures provided to the design team which takes into consideration the height of remaining trees, gap between trees, the gliding angle of Squirrel Gliders and the vertical clearance of 6.5 m for double-stacked trains. The provision of crossing structures will decrease the likelihood of fragmentation impacts; however, the Squirrel Glider will be impacted by the proposal and therefore offsets will be required for this species (refer to section 10.9.6.1).

Other potential indirect impacts from operation of the proposal could include potential discharge of pollutants; however, this would be appropriately managed during operation of the proposal to prevent potential impacts to biodiversity, discussed further in Chapter 13: Water quality.

10.5.2 Aquatic biodiversity

During the operational phase of the proposal, the proposed railway line and upgrades would be complete and cleared areas would be landscaped and stabilised as required. Areas with high risk of soil erodibility would be stabilised and therefore there would be little or no risk of soil erosion and subsequent transport of sediment into nearby watercourses.

Operation has the potential to result in the following impacts on aquatic biodiversity:

- obstruction of fish passage
- impacts on water quality
- an increase in the rate of spread of exotic macrophyte species.

During operation of the project, it will be important to maintain fish passage through rail infrastructure within intersected watercourses to avoid potential impacts on Australian fish. The proposal includes bridge and culvert specifications to meet the design requirements of *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries* (Fairfull, and Witheridge, 2003). For Class 3—minimal key fish habitat, the minimum recommended crossing type is a culvert or ford (in that order of preference). For Class 2—moderate key fish habitat, the recommended crossing type is a bridge, arch structure, culvert (high-flow design) or ford (in that order of preference). Potential impacts associated with culverts or bridges being blocked by debris during flooding remain during operation and without maintenance may obstruct fish passage.

For the operational phase, the risks include potential downstream impacts on water quality from mobilisation of stormwater runoff from new impervious surfaces, as well as from possible leaks or spills from maintenance vehicles on the permanent access tracks or from cargo in train carriages. Maintenance works required during the life of the proposal could also result in dispersion of sediment, pollutants and pesticides from weed control and minor vegetation clearing.

The spread of exotic aquatic weeds such the recorded *Spiny Rush* (*J. acutus*) is potentially accelerated by constant passing of trains and maintenance vehicles.

10.6 Key threatening processes

Key Threatening Processes are listed under the BC Act, EPBC Act or FM Act, summarises as they relate to the proposal in Table 10.13.

TABLE 10.13 KEY THREATENING PROCESSES AND RELEVANCE TO THE PROPOSAL

Key threatening process	Listing reference	Relevance to proposal
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	BC Act	A total of six watercourses were identified within the proposal site and potential impacts to natural flow regimes are discussed in section 10.2.6 and detailed in section 5.2.2 of Technical Paper 2.
Anthropogenic climate change/loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	BC Act and EPBC Act	The construction of the proposal would contribute towards anthropogenic climate change through the emission of greenhouse gases and clearing of native vegetation. However, this would potentially be in part offset by benefits created in the removal of trucks from the road and in the efficiency of transportation from the operation of the proposal.
Bushrock removal	BC Act	Bushrock would be removed during the construction phase of the proposal.
Clearing of native vegetation/land clearance	BC Act and EPBC Act	The proposal would involve the clearing all strata layers of 72.93 ha of native vegetation. Offsets for vegetation clearing will be secured to ensure no net loss.

Key threatening process	Listing reference	Relevance to proposal
Infection by Psittacine Circoviral (beak and feather) Disease (PCD) affecting endangered psittacine species and populations	BC Act and EPBC Act	PCD affects parrots and associated species (psittacines birds), and is often fatal. Threatened species considered to have a high potential for being adversely impacted by PCD recorded within the proposal is the Swift Parrot. The construction of the proposal is not considered likely to further increase risk of this key threatening process in the locality.
Infection of native plants by *Phytophthora cinnamomi*	BC Act and EPBC Act	Without implementation of mitigation measures, construction of the proposal may have the potential to increase the risk of introducing or spreading this pathogen and exotic weeds as it would require the movement of soil, water and plant material. Mitigation measures would be implemented as part of the CEMP to reduce this risk.
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	EPBC Act	
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	BC Act	
Invasion and establishment of exotic vines and scramblers	BC Act	
Invasion of native plant communities by exotic perennial grasses	BC Act	
Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif.)	BC Act	
Reduced viability of adjacent habitat due to edge effects	BC Act	
Novel biota and their impact on biodiversity	EPBC Act	
Predation by feral cats and fox	BC Act	It is unlikely that the proposal would further exacerbate the impact predator species populations than what currently exists within the locality.
Loss of hollow-bearing trees	BC Act	The proposal would result in the loss of hollow-bearing trees. A register of hollow-bearing tree loss would be recorded during the construction phase of the proposal. The biodiversity offsets for hollow-bearing trees related to scattered trees are detailed in section 10.9.6.
Removal of dead wood and dead trees	BC Act	Dead wood and dead trees (stags) within the impact area would be removed during the construction phase of the proposal.
Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams	FM Act	Potential impacts of these structures include increased flow velocities and the blockage to fish passage. These impacts are discussed in sections 10.4.4 and 10.5.2 and are detailed in section 5.1.3 and 5.2.1 of Technical Paper 2.
Degradation of native riparian vegetation along NSW watercourses	FM Act	The proposal would result in the loss of 4.94 ha of native riparian vegetation resulting in impacts such as increased risk of erosion as described in section 10.8.3. This vegetation is important for maintaining or improving the shape, stability (or geomorphic form) and ecological functions of a watercourse (DPI, 2012a).
Removal of large woody debris from NSW rivers and streams	FM Act	A total of six streams would be impacted and may require removal of large woody debris.

10.7 Additional impacts that require consideration

10.7.1 Prescribed biodiversity impacts on threatened entities

Prescribed biodiversity impacts are identified in clause 6.1 of the Biodiversity Conservation Regulation 2017 and relate to those impacts that may be difficult to quantify, replace or offset, making avoiding and minimising these impacts critical to satisfy the requirements of Section 7 of the BAM (avoiding or minimising impact on biodiversity values).

A summary of prescribed biodiversity impacts of relevance to the proposal is provided in Table 10.14. A full discussion of prescribed biodiversity impacts is provided in Chapter 7 of Technical Paper 1.

TABLE 10.14 SUMMARY OF PRESCRIBED BIODIVERSITY IMPACTS

Prescribed biodiversity impact	Relevance to current proposal
Impacts of development on the habitat of threatened species or ecological communities associated with rocks	While rock outcrops occur within and adjacent to the proposal site, no direct impacts of the proposal are anticipated to occur to fauna species that occur in association with rocky habitats. Indirect impacts would be mitigated and unlikely to lead to significant impact to associated species.
Impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation	One non-native vegetation community occurs within the proposal site. However, it is unlikely the removal of non-native vegetation patches would have a significant impact on any native threatened fauna. Trees and shrubs associated with non-native vegetation offers foraging, nesting and sheltering habitat to locally occurring threatened birds however removal of non-native vegetation will result in negligible direct and indirect impacts on these threatened species.
Impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range Impacts of the development on movement of threatened species that maintains their life cycle	Overall the habitat present within the landscape has been heavily fragmented due to agricultural practices (i.e. cropping and livestock use). Existing connectivity is limited to watercourses and road reserves. The proposal is likely to result in a reduction in vegetation patch sizes resulting in minor increases in localised fragmentation of the regional wildlife patches along the mentioned watercourses and road reserves. The loss of habitat and native vegetation may partially affect the movement patterns of several terrestrial fauna species, including the Squirrel Glider and other mammals, frogs, and reptiles; however, it is unlikely to significantly affect the movement or life cycle of species that already occurs within the proposal site.
Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities	Impacts to water quality, water bodies and hydrological processes would predominantly impact aquatic biodiversity and are discussed further in Chapter 13: Water quality. Unmanaged construction activities in proximity to watercourses or waterbodies could increase levels of sediments and other contaminants in receiving waters. No threatened entity was identified to be dependent on waterbodies for part of their life cycle. Mitigation measures (see section 10.9.4) would be implemented to reduce the impact to these areas due to the proposal.
Impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC	This impact has the potential to occur in both construction and operation phases. During construction the increase in construction vehicle movements and increase in road use means potential vehicle strike to native fauna is likely to occur. While it is not possible to eliminate the risk of roadkill, it is possible to minimise this through roads and access routes, and the implementation of road signs and speed limits during construction (see mitigation measures in section 10.9.4). During operation, potential train strike to native fauna is likely to occur due to the increase in train movements and train height. While it is not possible to eliminate the risk of train strike, minimising vehicle strike during operation will be delivered in the concept and detailed design processes of the rail infrastructure including fauna crossings and landscaping plans (refer to mitigation measures in section 10.9.4).

10.7.2 Serious and irreversible impacts

Under the BC Act, assessment of serious and irreversible impact (SAII), is required in accordance with the assessment criteria set out in the BAM.

One TEC identified within the proposal site, comprising White Box Yellow Box Blakely's Red Gum Woodland, is identified as a candidate SAII entity in Appendix 3 of *Guidance to assist a decision-maker to determine a serious and irreversible impact* (DPIE, 2019a). Assessment of SAII for this TEC is provided in section 12.1.1 of Technical Paper 1. It was concluded that the proposal would not result in SAII.

No threatened flora or fauna SAII entities will be affected by the proposal.

10.7.3 Groundwater dependent ecosystems

There are a number of GDEs located within a 2 km buffer of the proposal site as described in section 10.3.5.

The primary risks on groundwater and subsequently on GDEs resulting from the construction and operation of the proposal were identified in Technical Paper 6: Groundwater, including:

- groundwater take (dewatering)
- changes to groundwater flow paths or groundwater discharge impacting surface water and groundwater quality.

The impact of the proposal on the underlying groundwater sources and the ecosystems that rely on it was assessed to be a negligible-to-low risk to the groundwater environment during both construction and operation. This is principally due to the proposals' cut depths not anticipated to intersect the regional groundwater table for the Lachlan alluvial or Fracture rock groundwater sources. In addition, groundwater is currently not a preferred option to be used to support water supply for construction. The potential groundwater impacts were assessed against the minimal impact considerations of the NSW Aquifer Interference Policy, with the predicted impacts anticipated to be less than level 1 impact considerations. Any residual risk to the groundwater environment would be reduced by the implementation of appropriate groundwater mitigation and management measures.

Further information on the assessment of impacts to GDEs is provided in Chapter 14: Groundwater.

10.7.4 Wetlands of national and international importance

Bethungra Dam Reserve (of national importance) is unlikely to be impacted by the proposal due to its location 8 km upstream from the proposal site, and the nature of the proposal.

The four closest international wetlands of importance (Ramsar) occur greater than 400 km from the proposal site and would not be affected by the proposal.

10.8 Impacts on protected and sensitive lands

10.8.1 Protected areas

The proposal would not impact any conservation reserves, national parks or state forests. Crown land occurs in the study area in the form of road reserves and other reserves (refer to Chapter 18: Land use and property).

10.8.2 Key fish habitat

Key fish habitats are located within the proposal site as identified in Table 10.7. Of the five identified, none of these are permanently flowing (perennial), are all ephemeral and are defined as moderately sensitive to minimally sensitive key fish habitat. Impacts to key fish habitat in ephemeral watercourses are as follows:

- Permanent built structures within key fish habitat areas in ephemeral streams are expected to be negligible as all water crossing structures proposed are bridges, and depending on the size of the bridge, instream pylons may or may not be required. Where required, the proposal design and location, construction methodology and mitigation strategy has aimed to minimise disturbance of habitat features as far as practicable.
- Some permanent clearance of riparian vegetation may be required on the banks of ephemeral watercourses however will be managed through the rehabilitation strategy for the proposal. Riparian vegetation would also be re-established where practicable within the riparian zone which is not required for operation.
- Removal of large woody debris would be temporary and would be reinstated upstream or downstream of the area of impact.
- No indirect impacts to aquatic habitat due to sedimentation or changes in water quality is expected as all water crossing structures across ephemeral watercourses would be built when the streambed is dry, and erosion and sediment controls would be established prior to any construction activities.

As the fish habitat in watercourses that cross the proposal site does not include highly sensitive key fish habitat, and consists mainly of minimally sensitive key fish habitat, the proposal is unlikely to permanently impact or disrupt areas of key fish habitat and therefore no aquatic biodiversity offsets would be required under the FM Act.

10.8.3 Waterfront land

Construction impacts on riparian corridor would include clearing approximately 4.94 ha of riparian corridor vegetation (i.e. waterfront land as defined under the *Water Management Act 2000*). This vegetation is important for maintaining or improving the shape, stability (or geomorphic form) and ecological functions of a watercourse (DPI, 2012a). The riparian corridor generally reduces the risk of erosion by reinforcing and increasing cohesion of the soil, and by providing a protective surface matting. Further details of its role are provided in section 5.1.1 of Technical Paper 2.

The construction of the proposal would involve works on the bed and bank of watercourses and all land in the construction footprint which is within 40 metres of the riverbanks (the riparian corridor).

Activities that are expected to impact waterfront land include:

- riparian vegetation clearing (approximately 4.94 ha)
- instream works
- earthworks, including cuttings and embankments and movement/use of vehicles across exposed soil
- construction compounds and associated activities.

Table 10.15 identifies the proposal would include clearing approximately 4.94 ha of riparian corridor. This represents 8.6% of the total vegetation within the proposal site that requires clearing. The area of impact to riparian vegetation is greatest for PCT 5 and PCT 277, while the impact to remaining PCTs is less than a hectare. Where possible, the construction footprint would be minimised to reduce clearing in the riparian corridor and practices would be implemented to minimise disturbance of the banks. Bank stabilisation would also be undertaken after installation of water crossing structures as part of the reinstatement plan. These impacts are regarded as minor importance to the long-term survival of the ecological aquatic communities in the locality.

TABLE 10.15 AREA OF CLEARANCE OF RIPARIAN VEGETATION TYPE IN THE PROPOSAL SITE

Vegetation type	Area of impact (ha)
Miscellaneous ecosystem (planted vegetation)	0.10
Miscellaneous ecosystem (exotic species)	0.04
PCT 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	0.31
PCT 276 Yellow Box grassy tall woodland on alluvium or parna loams and clays on flats in NSW South Western Slopes Bioregion	0.04
PCT 277 Blakelys Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	1.51
PCT 309 Black Cypress Pine – Red Stringybark – red gum – box low open forest on siliceous rocky outcrops in the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion	0.05
PCT 5 River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion	2.33
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	0.27
PCT 796 Derived grassland of the NSW South Western Slopes	0.18
PCT 80 Western Grey Box – White Cypress Pine tall woodland on Loam soil on alluvial plains of NSW South Western Slopes Bioregion and Riverina Bioregion	0.11
Total	**4.94**

10.8.4 Critical habitat

As no critical habitats have been identified in the study area, no critical habitats are expected to be impacted by the proposal.

10.8.5 Biobank sites, private conservation lands and other offset lands

The proposal would not affect any biobank sites. The potential impact on any private conservation agreements as identified in section 10.3.7.2 or other offset lands within the proposal site would be commented on and advised by the Biodiversity Conservation Trust.

10.9 Mitigation and management

10.9.1 Approach to mitigation and management

The overall approach to managing impacts on biodiversity is, in order of importance, to:

- avoid impacts through the planning and design process (refer to section 10.2.6)
- minimise impacts through the planning and design process (refer to section 10.2.6)
- mitigate impacts using a range of mitigation measures
- offset any residual impact that could not be avoided or mitigated as required by relevant legislation.

ARTC is committed to minimising the environmental impact of the proposal and is investigating opportunities through further design development to reduce actual impact areas where practicable. The area that would be directly impacted by construction activities would depend on factors such as presence of significant vegetation, constructability, construction management and safety considerations, landform, slopes and anticipated sub-soil structures. Direct impacts would be reduced as far as practicable. The exact amount of clearance (within the proposal site) would be refined during further design development.

10.9.1.1 Approach to managing the key potential impacts identified

The key potential issues identified by the biodiversity assessment are:

- removal of native vegetation, including hollow-bearing trees and scattered trees
- substantial direct impacts on BC Act-listed fauna species and fauna habitat
- significant impacts on threatened fauna listed under the EPBC Act
- impacts on fish habitat
- impacts on fauna connectivity and train strike during operation.

Vegetation clearing

- Measures are provided in section 10.9.4 to mitigate impacts that cannot be avoided. The potential for impacts during construction would be managed in accordance with a proposal-specific biodiversity management plan, which would be implemented as part of the CEMP. The plan would detail processes, relevant requirements and responsibilities to minimise biodiversity impacts during construction. Further information is provided in the outline CEMP outline in Appendix E.
- The proposal would not result in any serious or irreversible impacts on any species or ecological community.

Impacts on fauna

- As part of the biodiversity management plan, protocols would be included for the removal of habitat features and rescue and relocation of fauna from areas of disturbance. Pre-clearing surveys targeting threatened species are recommended to determine additional site-specific management measures required during construction.

Fauna connectivity

- The proposal includes structures that would promote fauna connectivity measures. These tend to be drainage structures that would also be used by fauna, such as bridges and culverts. The appropriate location and design of other structures to enhance connectivity (such as dedicated culverts, glider poles and barrier poles) would be identified during detailed design. These measures would be defined by the proposed fauna connectivity strategy, which would also outline appropriate monitoring and reporting requirements. Measures to enhance connectivity would also assist in minimising the potential for train-strike impacts. Monitoring of fauna connectivity structures and relevant threatened species would assist in confirming the value of the proposed structures in terms of minimising the potential impacts of habitat fragmentation. Monitoring would also potentially allow for improvements to be identified for this proposal and other rail proposals in Australia (as appropriate).

Impacts on fish habitat

- Potential water quality impacts would be addressed by implementing standard mitigation measures designed to minimise impacts on watercourses, erosion and sedimentation, and contamination impacts (refer to Chapter 12: Hydrology and flooding, Chapter 13: Water quality and Chapter 20: Soils and contamination).
- Watercourse crossings would be designed and constructed in accordance with relevant policies and guidelines, including *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull and Witheridge (2003).

10.9.1.2 Approach to managing other potential impacts

Other measures to further minimise impacts on biodiversity are provided in section 10.9.4.

10.9.2 Expected effectiveness

The mitigation measures specified in Table 10.16 are anticipated to reduce the likelihood and/or consequence of the identified risks. All the proposed mitigation measures are considered to have a high likelihood of success as they are known to be effective (refer to Table 11.1 of Technical Paper 1). Developing a biodiversity management plan to identify the process for clearing and rehabilitation, protect sensitive areas, manage weeds, and manage unexpected finds, is expected to be the most effective measure to minimise the potential impacts as far as reasonably practicable.

10.9.3 Interactions between mitigation measures

Mitigation measures to minimise potential impacts to biodiversity would also be implemented as part of those identified for Chapter 12: Hydrology and flooding, Chapter 13: Water quality, Chapter 16: Noise and vibration, Chapter 24: Air quality, and Chapter 20: Soils and contamination. The rehabilitation strategy (mitigation measure BD-8 as outlined in Table 10.16) would also assist in mitigating identified land use, landscape and visual impacts.

10.9.4 Recommended mitigation measures

The measures outlined in Table 10.16 would be implemented to mitigate the potential biodiversity impacts.

TABLE 10.16 BIODIVERSITY MITIGATION MEASURES

Ref	Impact	Mitigation measures	Timing
BD-1	Impacts on fish passage	Watercourse crossing structures, both temporary and permanent in nature, would meet Inland Rail design standards and be designed in accordance with *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull and Witheridge, 2003) and *Policy and Guidelines for fish habitat conservation and management* (DPI, 2013a) as far as practicable.	Detailed design/ pre-construction
BD-2	Fauna connectivity	A fauna connectivity strategy would be prepared to guide detailed design. It would include investigation and design of: ▸ locations for fauna crossing structures, particularly for Squirrel Glider, including consideration of height of remaining trees, height of double-stacked trains (up to 6.5 m), gap between trees and the gliding angle of Squirrel Gliders ▸ the provision of localised fencing to direct fauna to crossing structures in accordance with relevant guidelines ▸ fauna furniture to be included in the design of bridges and culverts where appropriate to encourage crossings by native fauna. The connectivity strategy would include monitoring and reporting requirements in relation to the operational performance of the final measures.	Detailed design/ pre-construction
BD-3	Managing the potential for biodiversity impacts during construction	Pre-clearing surveys would be undertaken prior to construction by a suitably qualified ecologist in accordance with the biodiversity management plan. Specific surveys would include: ▸ surveys for roosting microbats and birds in structures, including telegraph poles and buildings that are proposed to be removed ▸ searches for nest trees ▸ identification of hollow-bearing trees and logs requiring fauna management during removal ▸ aquatic fauna salvage in watercourses or residual pools within 50 m of the construction footprint, and in areas that would be enclosed by silt curtains (e.g. piling locations).	Detailed design/ pre-construction

Ref	Impact	Mitigation measures	Timing
BD-4	Managing the potential for biodiversity impacts during construction	Clearing extents/site boundary/limit of works would be consistent with project extents defined in a condition of approval.	Detailed design/ pre-construction
BD-5	Managing the potential for biodiversity impacts during construction	The clearing extents/site boundary/limit of works would be clearly defined with flagging or marking tape, signage or other suitable means to delineate no go areas. This delineation and marking process would align with the project flagging/marking tape process and specifications.	Detailed design/ pre-construction
BD-6	Managing the potential for biodiversity (aquatic) impacts during construction	Direct impacts on in-stream vegetation and native vegetation on the banks of watercourses would be avoided as far as practicable by establishing appropriate setback distances.	Detailed design/ pre-construction
BD-7	Managing the potential for biodiversity impacts during construction	A biodiversity management plan would be prepared prior to construction and implemented as part of the CEMP. The plan would include measures to manage biodiversity and minimise the potential for impacts during construction. The plan would be prepared in accordance with relevant legislation, guidelines and standards. The plan would include, but not be limited to: ▸ locations and requirements for pre-clearing surveys, including terrestrial and aquatic habitats ▸ establishing protocols for the staged clearing of vegetation and safe tree felling and log removal to reduce the risk of fauna mortality ▸ measures to avoid and minimise clearing of hollow-bearing trees and scattered trees where practicable ▸ measures relating to the provision and management of nest boxes, including reuse of hollows and monitoring protocols ▸ animal handling protocols, including relocation and emergency care ▸ an unexpected finds protocol ▸ measures to manage biosecurity risks in accordance with the Biosecurity Act ▸ measures to reduce the risk of terrestrial and aquatic fauna mortality/injury ▸ measures relating to the stripping, stockpiling and management of topsoil where it contains seedbank or weed material.	Construction
BD-8	Rehabilitation of vegetation and habitats subject to temporary disturbance	A rehabilitation strategy would be prepared to guide rehabilitation planning, implementation, monitoring and maintenance of disturbed areas once construction is complete. The strategy would include clear objectives for rehabilitation of native vegetation in temporary disturbances areas and in riparian areas.	Construction
BD-9	Managing the potential for biodiversity (aquatic) impacts during construction	Scheduling of construction activities to minimise time of works in or adjacent to drainage lines and waterfront land (watercourse bed and land within 40 metres of the highest bank of the watercourse (DPI, 2012), particularly during periods of flow	Construction
BD-10	Managing the potential for biodiversity (aquatic) impacts during construction	Where it is not practicable to work in the dry, a sediment or silt curtain attached to the same sides of the bank and around the works area would be installed for erosion and sediment control and to maintain fish passage.	Construction

Ref	Impact	Mitigation measures	Timing
BD-11	Weed management	Weed management protocols for the operational rail corridor and other ARTC facilities would be in accordance with the requirements of the Biosecurity Act and incorporated into the operational environmental management framework. These protocols would 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 Matters of National Environmental Significance, or the BC Act -listed receptors, habitat or land uses sensitive to spray-drift from the application of pesticides and herbicides ▸ erosion and sediment control risks associated with broad-scale weed removal or treatment.	Operation
BD-12	Fauna connectivity	The operational performance of fauna connectivity measures (including impacts on fauna as a result of train operations) would be monitored in accordance with the fauna connectivity strategy. This would include recording of wildlife collisions with trains, and monitoring of use of crossing structures by target species (including the Squirrel Glider) and feral predators. The need for additional measures or modifications to existing measures would be identified to respond to any issues identified.	Operation
BD-13	Aquatic ecology	Culverts that provide for the flow of watercourses would be inspected and maintained in accordance with ARTC's standard operating procedures to address any issues that may contribute to the blockage of fish passage.	Operation

10.9.5 Managing residual impacts

Residual impacts are impacts of the proposal that may remain after implementation of:

- Design and construction planning measures to avoid and minimise impacts (see section 10.2.6 and Chapter 8: Proposal description—construction)
- specific measures to mitigate and manage identified potential impacts (see section 10.9.4).

The key potential biodiversity issues and impacts originally identified by the environmental risk assessment (refer to Appendix G) are listed in Table 10.17. The (pre-mitigation) risks associated with these impacts, which were identified by the environmental risk assessment, are outlined. Further information on the approach to the environmental risk assessment, including descriptions of criteria and risk ratings, is in Appendix G.

The potential issues and impacts identified by the environmental risk assessment were considered as part of the terrestrial and aquatic biodiversity assessment, summarised in sections 10.4 and 10.5. The mitigation and management measures listed in Table 10.16 that would be applied to manage these impacts are also identified. The significance of potential residual impacts (after application of these mitigation measures) is rated using the same approach as the original environmental risk assessment. The approach to managing significant residual impacts (considered to be those rated medium or above) is also described.

TABLE 10.17 RESIDUAL IMPACT ASSESSMENT—BIODIVERSITY

Phase	Potential impacts	Pre-mitigated risk			Mitigation measures (refer to Table 10.16)	Residual risk			How residual impacts would be managed
		Likelihood	Consequence	Risk rating		Likelihood	Consequence	Risk rating	
Construction	▸ Clearing of native vegetation resulting in loss of fauna habitat, habitat fragmentation and loss of connectivity.	Almost certain	Moderate	High	BD-2 to BD-5, BD-7	Likely	Moderate	High	A fauna connectivity strategy would be prepared to guide detailed design and would include crossing structures, particularly at major watercourses. A biodiversity management plan would be implemented and would include measures to manage biodiversity and minimise the potential for impacts during construction. Implementation of these measures would minimise the potential for residual impacts.
	▸ Direct impacts on listed threatened flora species and endangered terrestrial ecological populations and communities.	Almost certain	Moderate	High	BD-2 to BD-5, BD-7 and BD-8	Likely	Moderate	High	The biodiversity management plan would include measures to manage impacts on threatened flora species and endangered ecological communities. Implementation of these measures would minimise the potential for residual impacts.
	▸ Impacts on potential habitat for listed threatened fauna species.	Almost certain	Moderate	High	BD-2 to BD-5, BD-7 to BD-8	Likely	Moderate	High	The fauna connectivity strategy would include fauna crossing structures for threatened fauna species, particularly the Squirrel Glider. The biodiversity management plan would include measures to manage impacts on threatened fauna species. Implementation of these measures would minimise the potential for residual impacts.
	▸ Native fauna mortality from vehicle strikes.	Almost certain	Moderate	High	BD-2 to BD-5, BD-7 and BD-8	Likely	Minor	Medium	The biodiversity management plan includes protocols for animal handling protocols, including relocation and emergency care.

Phase	Potential impacts	Pre-mitigated risk			Mitigation measures (refer to Table 10.16)	Residual risk			How residual impacts would be managed
		Likelihood	Consequence	Risk rating		Likelihood	Consequence	Risk rating	
	▸ Potential impacts on aquatic biodiversity and threatened species, including as a result of removal of riparian vegetation and fish passage blockages during construction of watercourse crossings.	Likely	Moderate	High	BD-1, BD-6, BD-9, BD-10	Unlikely	Minor	Low	n/a
	▸ Water quality impacts and changes to flow regimes, including through the removal of farm dams, affect aquatic ecosystems.	Possible	Moderate	Medium	BD-1	Unlikely	Minor	Low	n/a
	▸ Potential impacts on protected and sensitive lands.	Possible	Moderate	Medium	BD-1, BD-6, BD-9, BD-10	Unlikely	Minor	Low	n/a
Operation	▸ Injury and mortality of native fauna from train strikes.	Possible	Moderate	Medium	BD-12	Possible	Minor	Low	n/a
	▸ Impacts on connectivity (and associated impacts on population viability and genetics) for terrestrial fauna, as a result of the presence of the new rail corridor.	Likely	Moderate	High	BD-12	Possible	Moderate	Medium	The operational performance of fauna connectivity measures (including impacts on fauna as a result of train operations) would be monitored in accordance with the fauna connectivity strategy.

10.9.6 Biodiversity offset approach

Biodiversity offsets are required to compensate for the unavoidable loss of ecological values as a result of the proposal, as outlined in Section 12.2 of Technical Paper 1.

Biodiversity offsets are required for impacts to native vegetation, threatened species and their habitats and impacts associated with scattered tree clearing.

Biodiversity offsets for the proposal would ensure that the credit obligations are met under the BC Act. The Act establishes a framework to avoid, minimise and offset impacts on biodiversity from development through the Biodiversity Offsets Scheme (BOS). The BAM was established by the former Office of Environment and Heritage (OEH) as a standard method to implement the aims of the BOS and to address the loss of biodiversity and threatened species. The scheme creates a market framework for the conservation of biodiversity values and the offsetting of development impacts. It also provides the mechanisms to offset impacts of development, clearing or biodiversity certification such that there is no loss of biodiversity values.

The following approach would follow as part of the identification of biodiversity offsets:

- demonstrate reasonable measures to avoid and minimise the direct and indirect impacts on native vegetation and habitat
- summarise and identify prescribed biodiversity impacts as part of the BAM detailed in Table 10.7 of Technical Paper 1
- identify offsets required to compensate for the residual biodiversity impacts using the BAM calculator including significantly affected MNES listed under the EPBC Act
- biodiversity offsets will be finalised prior to project construction impacts
- offsets will primarily consist of land-based offsets that are strategically located within the impact and adjacent sub-regions to the Inland Rail corridor. Priority will be given to sites that maximise the co-location of ecosystem and species offset requirements across multiple NSW projects, and contain large enough areas to meet the predicted NSW requirements. Further information on the proposed offset strategy provided in Section 13.6 of Technical Paper 1.

A summary of the biodiversity offsets for the proposal is in section 10.9.6.1, with further information in Chapter 13 of Technical Paper 1.

10.9.6.1 Biodiversity Conservation Act offsets for affected biodiversity values

Ecosystem credits

The required ecosystem credits for impacts to native vegetation from the proposal are summarised in Table 10.18.

TABLE 10.18 ECOSYSTEM CREDITS REQUIRED TO OFFSET PROPOSAL IMPACTS

Plant community type	Threatened ecological community[1]	Area affected (ha)	Ecosystem credit
PCT 5 River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion	Not listed	6.8	188
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions	27.1	747
PCT 80 Western Grey Box – White Cypress Pine tall woodland on loam soil on alluvial plains of NSW South Western Slopes Bioregion and Riverina Bioregion		6.1	117
PCT 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	White Box Yellow Box Blakely's Red Gum Woodland	10.3	199
PCT 276 Yellow Box grassy tall woodland on alluvium or parna loams and clays on flats in NSW South Western Slopes Bioregion		2.6	97
PCT 277 Blakely's Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion		17.9	684
PCT 309 Black Cypress Pine – Red Stringybark – red gum – box low open forest on siliceous rocky outcrops in the NSW South Western Slopes Bioregion	Not listed	1.70	33

Plant community type	Threatened ecological community[1]	Area affected (ha)	Ecosystem credit
PCT 347 White Box – Blakely's Red Gum shrub/grass woodland on metamorphic hillslopes in the mid-southern part of the upper slopes sub-region of the NSW South Western Slopes Bioregion	White Box Yellow Box Blakely's Red Gum Woodland	0.43	10
Total		**72.93**	**2,079**

(1) Threatened ecological community: 1 = Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions. 2 = White Box Yellow Box Blakely's Red Gum Woodland

Species credits

Species credits are required for three species recorded or assumed to be present based on habitat within the proposal site. Species credits required to offset impacts from the proposal are summarised in Table 10.19.

TABLE 10.19 SPECIES CREDITS REQUIRED TO OFFSET PROPOSAL IMPACTS

Species	Area impacted (ha)	Required species credits
Keyacris scurra (Key's Matchstick Grasshopper)	30.88	792
Myotis macropus (Southern Myotis)	8.25	291
Petaurus norfolcensis (Squirrel Glider)	60.33	1,896
Polytelis swainsonii (Superb Parrot)	60.33	1,896

Ecosystem credits for scattered tree clearing

The required ecosystem credit obligation for scattered tree clearing is summarised in Table 10.20.

TABLE 10.20 ECOSYSTEM CREDITS FOR SCATTERED TREE CLEARING REQUIRED TO OFFSET PROPOSAL IMPACTS

Plant community type	Threatened ecological community	Number of trees	Required ecosystem credits
PCT 5 River Red Gum herbaceous—grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion	Not listed	1	1
PCT 76 Western Grey Box tall grassy woodland on alluvial loam and clay soils in the NSW South Western Slopes and Riverina Bioregions	Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions	33	32
PCT 80 Western Grey Box – White Cypress Pine tall woodland on loam soil on alluvial plains of NSW South Western Slopes Bioregion and Riverina Bioregion	Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions	6	5
PCT 266 White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	White Box Yellow Box Blakely's Red Gum Woodland	3	3
PCT 276 Yellow Box grassy tall woodland on alluvium or parna loams and clays on flats in NSW South Western Slopes Bioregion	White Box Yellow Box Blakely's Red Gum Woodland	10	8
PCT 277 Blakely's Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	White Box Yellow Box Blakely's Red Gum Woodland	5	4
Total		**58**	**53**