CHAPTER 11

Flora and Fauna

CALVERT TO KAGARU ENVIRONMENTAL IMPACT STATEMENT

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

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11.1 Scope of chapter

This chapter provides a summary of matters of national environmental significance (MNES), matters of state environmental significance (MSES), matters of local environmental significance (MLES), vegetation communities and habitats as well as weed and pest presence. MLES include those matters that are not an MNES or MSES but are important at a local scale. These include 'least concern' regional ecosystems when not a defined distance from a waterway or wetland, least concern flora and fauna species, locally defined movement corridors (i.e. Biodiversity Planning Assessments (BPA)) and locally defined Koala habitat.

Potential impacts to sensitive environmental attributes (i.e. prescribed environmental matters as defined in the Environmental Offsets Regulation 2014) (referred to in this chapter as 'sensitive environmental receptors') resulting from the construction, commissioning and reinstatement, and operation (where relevant) of the Project are also identified, with a suite of proposed mitigation measures to minimise environmental impacts resulting from the Project.

For the purpose of this chapter, the assessment of potential impacts was focused on the disturbance footprint and ecology study area presented in Figure 11.1 and described in Section 11.4.1. An assessment of the potential impacts of the Project prior to, as well as following, the implementation of mitigation measures is provided, together with the significance of the anticipated impacts to each sensitive environmental receptor for the pre- and post-mitigation scenarios. Assessment of sensitive environmental receptors against the relevant government significant impact assessment criteria to identify potential offset obligations is provided.

11.2 Terms of Reference

The Terms of Reference (ToR) describe the matters the proponent must address in the Environmental Impact Statement (EIS) for the Project. The matters relating to flora and fauna are contained in ToR 11.96 to 11.108.

A stand-alone document pertaining to MNES is provided as Appendix K: Matters of National Environmental Significance Technical Report in consideration of Sections 11.1 to 11.35 and Section 11.92 to 11.104 of the ToR. Specific sections of the ToR and the relevant Chapter/Document sections are provided in Table 11.1.

TABLE 11.1: TERMS OF REFERENCE COMPLIANCE TABLE—FLORA AND FAUNA

Terms of Reference requirement		Where addressed
Information requirements		
Matters of national environmental significance—background and context		
11.1	This section should provide a stand-alone description and detailed assessment of the impacts of the project on the controlling provision for the project under the EPBC Act inclusive of any avoidance, mitigation and offset measures.	
11.2	The Commonwealth Minister for the Environment and Energy (the Commonwealth Minister) has determined that the project (EPBC 2017/7944) is likely to impact upon listed threatened species and communities (sections 18 and 18A of the EPBC Act).	
11.3	The EIS must be prepared in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland relating to environmental assessment. This will enable the EIS to meet the impact assessment requirements under both Commonwealth and Queensland legislation.	
11.4	The statutory obligations for conduct of the EIS process under the bilateral agreement are set out in Part 13 of the State Development and Public Works Organisation Regulation 2010.	
11.5	Once the draft EIS has been prepared to the satisfaction of the Coordinator-General and MNES addressed to the satisfaction of the Australian Government Department of the Environment and Energy, the draft EIS will be made available for public comment.	
11.6	The proponent may be required by the Coordinator-General or the Department of the Environment and Energy to provide additional material to address matters raised in submissions on the EIS	
11.7	At the conclusion of the environmental assessment process, the Coordinator- General will provide a copy of the report evaluating the environmental impacts of the project to the Commonwealth Minister.	
11.8	After receiving the evaluation report and sufficient information about the relevant impacts of the action, the Commonwealth Minister for the Environment and Energy has 30 business days to consider whether the impacts of the proposal are acceptable, or not, and to decide whether or not to approve each controlling provision.	

Terms of Reference requirement		Where addressed
11.9	The Commonwealth Minister's decision under Part 9 of the EPBC Act is separate to the approval decisions made by Queensland state agencies and other agencies with jurisdiction on state matters.	
Information Requirements		
11.10	Consideration must be given to any relevant policy statements available from **environment.gov.au**, including: a) Matters of National Environmental Significance: Significant impact guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy and b) any approved conservation advice, recovery plans and threat abatement plans (as relevant) for listed threatened species and ecological communities.	Sections 11.3 Appendix K: Matters of National Environmental Significance Technical Report, Sections 2.1, 3.4.4, 5.3.3, 5.3.4 and 5.3.5, and 5.4
11.11	The EIS must: a) assess all the relevant impacts that the action has, will have or is likely to have, including on receiving environments of the project b) provide enough information about the action and its relevant impacts to allow the Commonwealth Minister to make an informed decision on whether or not to approve the action c) address the matters set out in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Cwlth) (EPBC Regulations).	Sections 11.7 and 11.9 Appendix K: Matters of National Environmental Significance Technical Report, Sections 1.8, 5.1, 5.2, 5.3.2–5.3.5, 9 and Appendix B
11.12	The MNES section of the EIS should bring together assessments of impacts from other chapters and produce a stand-alone assessment in a format suited for assessment under the EPBC Act.	Appendix K: Matters of National Environmental Significance Technical Report
11.13	The project should initially be assessed in its own right followed by an assessment of the cumulative impacts related to existing major projects and/or development that is progressing through a publicly available planning and approval process. Cumulative impacts not solely related to the project development should also be described.	Section 11.7 and 11.12 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Section 6 Appendix K: Matters of National Environmental Significance Technical Report, Section 7 Chapter 22: Cumulative Impacts, Section 22.5.4
11.14	Predictions of the extent of threat (risk), impact and the benefits of any mitigation measures proposed, should be based on sound science and quantified where possible. All sources of information relied upon should be referenced.	Sections 11.7, 11.8 and 11.9 Appendix K: Matters of National Environmental Significance Technical Report, Sections 5.2, 5.3, 9 and Appendix B
11.15	An estimate of the reliability of any predictions should be provided.	Appendix K: Matters of National Environmental Significance Technical Report, Appendix A
11.16	Any positive impacts of the Project should be identified and evaluated.	Appendix K: Matters of National Environmental Significance Technical Report, Section 1.10 Chapter 2: Project Rationale, Sections 2.3, 2.4 and 2.5 Chapter 16: Social
11.17	The extent of any new field work, modelling or testing should be commensurate with risk and should be such that when used in conjunction with existing information, provides sufficient confidence in predictions that well-informed decisions can be made.	Sections 11.4.4 and 11.4.5 Appendix K: Matters of National Environmental Significance Technical Report, Sections 3.2, 3.3 and 3.4

Terms of Reference requirement		Where addressed
11.18	In accordance with Schedule 4 of the EPBC Regulations, feasible project alternatives must be discussed, including: a) if relevant, the alternative of taking no action b) a comparative description of the impacts of each alternative on the triggered MNES protected by the controlling provision c) sufficient detail to make clear why any alternative or option is preferred to another.	Appendix K: Matters of National Environmental Significance Technical Report, Section 1.7 Chapter 2: Project Rationale, Sections 2.6 and 2.7
11.19	Short, medium and long-term advantages and disadvantages of the alternatives or options must be discussed.	Appendix K: Matters of National Environmental Significance Technical Report, Section 1.7 Chapter 2: Project Rationale, Sections 2.6 and 2.7
11.20	The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: a) the person proposing to take the action b) for an action for which a person has applied for a permit, the person making the application. If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must also be included.	Chapter 1: Introduction, Section 1.2 Appendix K: Matters of National Environmental Significance Technical Report, Section 1.3 Appendix F: Corporate Policies
11.21	The economic and social impacts of the action, both positive and negative, must be summarised. Matters of interest should include: a) consideration at the local, regional and national levels b) any public consultation activities undertaken, and their outcomes c) any consultation with indigenous stakeholders d) identification of affected parties and communities that may be affected and a description of the views of those parties and communities e) project economic costs and benefits of the project and project alternatives, including the basis for their estimation through cost/benefit analysis or similar studies; and f) employment and other opportunities expected to be generated by the project in each of the construction and operational phases.	Appendix K: Matters of National Environmental Significance Technical Report, Sections 1.10 and 1.11 Chapter 2: Project Rationale, Sections 2.3, 2.4 and 2.5 Chapter 5: Stakeholder Engagement, Sections 5.4, 5.5 and 5.6 Chapter 16: Social, Sections 16.5, 16.7, 16.8 and 16.9 Chapter 17: Economics
11.22	The EIS must provide background to the action and describe in detail all components of the action for example (but not limited to), the construction, operation and (if relevant) decommissioning components of the action. This must include the location of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Section 11.7.1 Appendix K: Matters of National Environmental Significance Technical Report, Sections 1.8 and 1.9 Chapter 6: Project Description and Figure 6.4
11.23	The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.	Sections 11.7 and 11.9 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Section 5.1.1 Appendix K: Matters of National Environmental Significance Technical Report, Sections 1.8, 1.9 and 5.1.1 Chapter 6: Project Description

Terms of Reference requirement		Where addressed
11.24	The EIS must also provide details on the current state of groundwater and surface water in the region as well as any use of these resources.	Section 11.5.1 Chapter 13: Surface Water and Hydrology, Section 13.5 Chapter 14: Groundwater, Section 14.5 Appendix K: Matters of National Environmental Significance Technical Report, Section 4.2 Appendix M: Surface Water Quality Technical Report, Section 5 Appendix O: Groundwater Technical Report, Sections 4, 5, 6 and 7
Listed threatened species and communities		
11.25	The EIS must describe the listed threatened species and ecological communities identified below (including EPBC Act status, distribution, life history and habitat).	Appendix K: Matters of National Environmental Significance Technical Report, Sections 4.3.1, 4.3.2, 4.4.1– 4.4.4 and Appendix B
11.26	The EIS must consider and assess the impacts to the listed threatened species and ecological communities identified in section 11.29 and 11.31 (including EPBC Act status, distribution, life history and habitat and any others that are found to be or may potentially be present in areas that may be impacted by the project. Impacts from each component of the project of relevance to each listed threatened species or ecological community should be identified. Impacts may result from: a) a decrease in the size of a population or a long-term adverse effect on an ecological community b) reduction in the area of occupancy of the species or extent of occurrence of the ecological community c) fragmentation of an existing population or ecological community d) disturbance or destruction of habitat critical to the survival of the species or ecological community e) disruption of the breeding cycle of a population f) modification, destruction, removal, isolation or reduction of the availability or quality of habitat to the extent that the species is likely to decline g) modification or destruction of abiotic (non-living) factors (such as water, nutrients or soil) necessary for the ecological community's survival h) the introduction of invasive species that are harmful to the species or i) ecological community becoming established j) interference with the recovery of the species or ecological community.	Sections 11.7.2, 11.9 and 11.10 Appendix K: Matters of National Environmental Significance Technical Report, Sections 5.1, 5.2 and 5.3
11.27	The EIS should describe any mitigation measures proposed to reduce the impact on the listed threatened species and ecological communities and proposed mitigation measures. Supporting evidence should be provided to demonstrate the appropriateness of mitigation measures proposed. Where the likely success of mitigation measures cannot be supported by evidence, identify contingencies in the event the mitigation is not successful.	Section 11.8 Appendix K: Matters of National Environmental Significance Technical Report, Sections 5.2–5.4
11.28	The EIS should describe any offsets proposed to compensate for residual impacts.	Section 11.11 Appendix K: Matters of National Environmental Significance Technical Report, Section 5.4

Terms of Reference requirement		Where addressed
List of potential listed threatened species and their status		
11.29	The EIS must address impacts on, but not limited to, the following listed threatened species for the proposed action: ▸ Regent Honeyeater (*Anthochaera phrygia*) – critically endangered; ▸ Australasian Bittern (*Botaurus poiciloptilus*) – endangered; ▸ Curlew Sandpiper (*Calidris ferruginea*) – critically endangered; ▸ Coxen's Fig-Parrot (*Cyclopsitta diophthalma coxeni*) – endangered; ▸ Eastern Bristlebird (*Dasyornis brachypterus*) – endangered; ▸ Red Goshawk (*Erythrotriorchis radiatus*) – vulnerable; ▸ Squatter Pigeon (southern subspecies) (*Geophaps scripta scripta*) – vulnerable; ▸ Painted Honeyeater (*Grantiella picta*) – vulnerable; ▸ Swift Parrot (*Lathamus discolor*) – critically endangered, marine; ▸ Eastern curlew, Far Eastern Curlew (*Numenius madagascariensis*) – critically endangered, marine, migratory; ▸ Black-throated Finch (southern) (*Poephila cincta cincta*) – endangered; ▸ Australian Painted Snipe (*Rostratula australis*) – endangered, marine; ▸ Black-breasted Button-quail (*Turnix melanogaster*) – vulnerable; ▸ Mary River Cod (*Maccullochella mariensis*) – endangered; ▸ Pink Underwing Moth (*Phyllodes imperialis smithersi*) – endangered; ▸ Large-eared Pied Bat (*Chalinolobus dwyeri*) – vulnerable; ▸ Northern Quoll (*Dasyurus hallucatus*) – endangered; ▸ Spot-tailed Quoll (SE mainland population) (*Dasyurus maculatus*) – endangered; ▸ Greater Glider (*Petauroides Volans*) – vulnerable; ▸ Brush-tailed Rock-wallaby (*Petrogale penicillata*) – vulnerable; ▸ Koala (*Phascolarctos cinereus*) (combined population of Queensland, New South Wales and the Australian Capital Territory) – vulnerable; ▸ Long-nosed Potoroo (SE mainland) (*Potorous tridactylus tridactylus*) – vulnerable; ▸ New Holland Mouse (*Pseudomys novaehollandiae*) – vulnerable; ▸ Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable; ▸ Five-clawed Worm-skink, Long-legged Worm-skink (*Anomalopus mackayi*) – vulnerable; ▸ Marlborough blue (*Cycas ophiolitica*)– endangered; ▸ Hairy-joint Grass (*Arthraxon hispidus*) – vulnerable; ▸ A shrub (*Bertya ernestiana*) – vulnerable; ▸ Three-leaved Bosistoa, Yellow Satinheart (*Bosistoa transversa*) – vulnerable; ▸ Miniature Moss-orchid, Hoop Pine Orchid (*Bulbophyllum globuliforme*) – vulnerable; ▸ Boonah Tuckeroo (*Cupaniopsis tomentella*) – vulnerable; ▸ Bluegrass (*Dichanthium setosum*) – vulnerable; ▸ Wandering Pepper-cress (*Lepidium peregrinum*) – endangered; ▸ Macadamia nut, Queensland Nut Tree, (*Macadamia integrifolia*) – vulnerable; ▸ Rough-shelled Bush Nut, Rough-leaved Queensland Nut (*Macadamia tetraphylla*) – vulnerable; ▸ Cooneana Olive (*Notelaea ipsviciensis*) – critically endangered; ▸ Lloyd's Olive (*Notelaea lloydii*) – vulnerable; ▸ Lesser Swamp-orchid (*Phaius australis*) – endangered;	Sections 11.7.2, 11.9, 11.10 and 11.12 Appendix K: Matters of National Environmental Significance Technical Report, Sections 4.3, 4.4, 5.1, 5.3.2, 5.3.4 and 5.3.5

Terms of Reference requirement		Where addressed
11.29 (cont'd)	▸ Mt Berryman Phebalium (*Phebalium distans*) – critically endangered; ▸ Shiny-leaved Condoo, Black Plum, Wild Apple (*Planchonella eerwah*) – endangered; ▸ Austral Cornflower, Native Thistle (*Rhaponticum australe*) – vulnerable; ▸ Quassia (*Samadera bidwillii*) – vulnerable; ▸ Brush sophora (*Sophora fraseri*) – vulnerable; ▸ Austral Toadflax, Toadflax (*Thesium australe*) – vulnerable ▸ Adorned Delma, Collared Delma (*Delma torquata*) – vulnerable; ▸ Dunmall's Snake (*Furina dunmalli*) – vulnerable; ▸ Three-toed Snake-tooth Skink (*Saiphos reticulatus*) – vulnerable;	
11.30	The EIS must address how the impacts to each of the listed species is not inconsistent with relevant recovery plans, threat abatement plans and conservation advices.	Section 11.10 Appendix K: Matters of National Environmental Significance Technical Report, Section 5.3 and Appendix B
List of potential listed threatened communities		
11.31	The EIS must address impacts on the following listed threatened ecological communities for the proposed action: a) Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland – critically endangered; b) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Bon-Gum Grassy Woodland and Derived Grassland)– critically endangered; c) Lowland Rainforest of Subtropical Australia – critically endangered; d) Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered.	Sections 11.9 and 11.10 Appendix K: Matters of National Environmental Significance Technical Report, Sections 4.3.1.2, 4.4.1.3, 5.1, 5.3.2 and 5.3.3
11.32	The EIS must address how the impacts to each of the listed communities is not inconsistent with relevant recovery plans, threat abatement plans and conservation advices.	Section 11.10 Appendix K: Matters of National Environmental Significance Technical Report, Sections 5.3.3 and Appendix B
Offsets		
11.33	The EIS must describe any significant adverse residual impacts of the action for each relevant matter protected by the EPBC Act, after all proposed avoidance and mitigation measures are considered.	Section 11.10 Appendix K: Matters of National Environmental Significance Technical Report, Sections 5.3.3, 5.3.4, 5.3.5 and 5.4
11.34	The EIS must propose offsets for all residual impacts to matters protected by the EPBC Act consistent with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy.	Section 11.11 Appendix K: Matters of National Environmental Significance Technical Report, Section 5.4
Conclusion		
11.35	The EIS must include an overall conclusion for the action describing the acceptability of the impact of undertaking the action in the manner proposed on the protected matters, in the context of: a) the requirements of the EPBC Act; b) the principles of ecologically sustainable development and the precautionary principle; and c) the proposed avoidance, mitigation measures, and if relevant, offsets d) measures proposed to address any residual impacts.	Sections 11.3, 11.4.8, 11.8 and 11.11 Appendix K: Matters of National Environmental Significance Technical Report, Section 8

Terms of Reference requirement		Where addressed
Flora and fauna		
Existing environment		
11.96	Identify and describe matters of State environmental significance (MSES), State and regionally significant biodiversity and natural environmental values of the terrestrial and aquatic ecology, including their seasonal variations, likely to be impacted by the project which have not been addressed in the section on MNES	Section 11.5 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Section 4
11.97	Describe the likely impacts on the biodiversity and natural environmental values of affected areas arising from the construction and operation of the project. The assessment should include, but not be limited to, the following key elements:	Refer sub-sections below
	a) MSES, matters of local environmental significance, and designated State and regional biodiversity values and conservation corridors of conservation significance. Reference should be made to the Biodiversity Planning Assessment and BioCondition assessment tools where appropriate (refer Appendix 1).	Sections 11.5 and 11.7 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1 and 5.3
	b) terrestrial and aquatic ecosystems (including groundwater-dependent ecosystems) and their interaction and areas surrounding watercourses and wetlands	Sections 11.5 and 11.7 Chapter 13: Surface Water and Hydrology, Sections 13.5 and 13.6 Chapter 14: Groundwater, Section 14.5.7 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1 and 5.3
	c) biological diversity including listed flora and fauna species and regional ecosystems, connectivity and essential habitat	Sections 11.5 and 11.7 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1 and 5.3
	d) the existing integrity of ecological processes, including habitats of threatened, near-threatened or special least-concern species	Sections 11.5 and 11.7 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1 and 5.3
	e) the integrity of landscapes and places, including wilderness and similar natural places	Sections 11.5 and 11.7 Chapter 10: Landscape and Visual Amenity, Section 10.6 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1 and 5.3
	f) actions of the project that require an authority under the NC Act and Water Act (for example, riverine protection permits) and/or could be assessable development for the purposes of the VMA, Fisheries Act and PA	Chapter 3: Project Approvals, Sections 3.4.14, 3.4.19, 3.4.21, 3.4.33, 3.4.35, and Table 3.4
	g) any exposure to contaminants or the bio-accumulation of contaminants	Sections 11.7.2.11 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1.2.11
	h) impacts on native fauna due to proximity to the site and site impacts (e.g. lighting, noise, waste and fencing)	Sections 11.5, 11.7.2.9, 11.7.2.10 and 11.7.2.13 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1 and 5.3
	i) impacts to movement of native fauna due to barrier effect of linear infrastructure	Sections 11.5 and 11.7.2.8 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1 and 5.3
	j) impacts on vegetation category areas identified on the regulated vegetation management maps under Queensland's vegetation management framework	Sections 11.5 and 11.7 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1 and 5.3

Terms of Reference requirement		Where addressed
Mitigation measures		
11.98	Describe any proposed measures to avoid, minimise or mitigate potential impacts on natural values, and enhance these values. Assess how the nominated quantitative indicators and standards may be achieved for nature conservation management. In particular, address measures to protect or preserve any threatened or near-threatened species.	Sections 11.8 and 11.9 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.2.1, 5.2.2, 5.2.3 and 5.3
11.99	Assess the need for buffer zones and the retention, rehabilitation, planting or construction of movement corridors across the railway and propose measures that would avoid the need for waterway barriers or propose measures to mitigate the impacts of their construction and operation.	Sections 11.8 and 11.9 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 4.5.5, 5.2.1, 5.2.2, 5.2.3 and 5.3
11.100	Describe how the achievement of the objectives would be monitored and audited, and how corrective actions would be managed	Sections 11.8 and 11.9 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.2.1, 5.2.2, 5.2.3 and 5.3
11.101	Where a significant residual impact will occur on a prescribed environmental matter as outlined in the Environmental Offsets Regulation 2014, the offset proposal(s) must be consistent with the requirements of Queensland's EO Act and the latest version of the Queensland Environmental Offsets Policy (refer Appendix 1).	Sections 11.10 and 11.11 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.3 and 5.4
11.102	Assess the need and suitability and provide objective commitments to the provision of fauna passage between habitat fragmented by the rail corridor, of suitable design and location for affected species and their habitat.	Section 11.8 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 2, 4.4.18, 5.2.1, 5.2.2 and 5.2.3
11.103	Demonstrate that actions of the project avoid and minimise impacts of clearing of vegetation regulated through the VMA/PA and how any clearing maintains connectivity of the remaining mapped category B area in the landscape. Provide details on the exemptions/assessment pathway for any clearing of vegetation regulated through the VMA/PA	Section 11.8 Chapter 3: Project Approvals, Sections 3.4.21 and 3.4.33 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 2, 4.4.18, 5.2.1, 5.2.2 and 5.2.3
Biosecurity		
Existing environment		
11.104	Provide information on the current distribution of animal pests and weeds on the preferred alignment.	Sections 11.5.2.4 and 11.5.3.2 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 4.4.4, 4.5.1.3 and 4.5.2.3
11.105	Surveys of animal pests and weeds should be undertaken in those areas identified during the desktop assessment as containing listed flora, fauna or ecological communities of national or state environmental significance (MNES or MSES defined by the EPBC and NC Acts respectively	Sections 11.5.2.4 and 11.5.3.2 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 4.4.1, 4.5.1.3 and 4.5.2.3
Impact assessment		
11.106	Describe the impact the project's construction and operation will have on the spread of pest animals and weed species along the preferred alignment and into adjoining properties	Sections 11.7.2.4 and 11.9 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Section 5.1.2.4

Terms of Reference requirement		Where addressed
Mitigation measures		
11.107	Propose detailed measures to control and limit the spread of pests and weeds on the preferred alignment and adjacent areas and any relevant local government area Biosecurity Plans. This includes restricted matters listed in the Biosecurity Act and Biosecurity Regulation 2016 and designated pests under the Public Health Act 2005	Section 11.8 Appendix J: Terrestrial and Aquatic Ecology Technical Report, Sections 5.2.2, 5.2.3 and 5.3
11.108	All proposed measures must be in accordance with any relevant biosecurity surveillance or prevention program authorised under the Biosecurity Act and any requirements of the VMA/PA. Mitigation measures may be developed in consultation with relevant agencies and local government (e.g. baiting programs).	

11.3 Legislation, policies, standards and guidelines

The legislation, policies and guidelines relevant to the Project with respect to terrestrial and aquatic ecological values are presented in Table 11.2.

TABLE 11.2: LEGISLATION, POLICIES AND GUIDELINES RELEVANT TO THE ECOLOGICAL ASPECTS OF THE PROJECT

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Commonwealth			
Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)	Australia and its Territories. Specifically, projects that involve or have the potential to impact nationally and internationally important flora, fauna, ecological communities and heritage places—defined under the EPBC Act as MNES	The EPBC Act is the Australian Government's central piece of environmental legislation and provides the legal basis for the management and protection of nationally and internationally important flora, fauna, ecological communities and heritage places. Under Section 45 of the EPBC Act, the Australian Government and the Queensland (QLD) Government have a bilateral agreement relating to environmental assessment. This agreement allows the Australian Government Minister for the Environment and Department of Agriculture, Water and Environment (DAWE) to rely on specified environmental impact assessment processes of QLD in assessing actions under the EPBC Act.	ARTC submitted an EPBC Act referral to the then Department of the Environment and Energy (DotEE) (now Department of Agriculture, Water and the Environment (DAWE) in May 2017 (EPBC 2017/7944). The Minster for the Environment determined that the Project is a 'controlled action' on 21 June 2017 requiring the preparation of an EIS. The controlling provisions for the controlled action are: ▸ Listed threatened species and communities. The EPBC Act controlled action will be assessed under the bilateral agreement with the QLD Government. As required by the ToR, this EIS addresses the relevant sections of Schedule 4 of the EPBC Regulations 2000.
EPBC Act Environmental Offsets Policy (2012) (EPBC Act Offsets Policy)	Areas subject to the EPBC Act	The EPBC Act Offset Policy was developed to support the management and protection of MNES under the EPBC Act and outlines the Australian Government's approach to the use of environmental offsets for impacts to MNES (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), 2012). Eight principles for the use of environmental offset under the EPBC Act have been developed by DAWE. These principles are used to assess any proposed environmental offset for MNES to ensure consistency, transparency and equity under the Act. The Australian Government's position is that environmental offsets must: ▸ Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action ▸ Be built around direct offsets but may include other compensatory measures ▸ Be in proportion to the level of statutory protection that applies to the protected matter ▸ Be of a size and scale proportionate to the residual impacts on the protected matter ▸ Effectively account for and manage the risks of the offset not succeeding	The Project will implement a range of mitigation measures to avoid and minimise significant residual impacts on the MNES. Offsets provided for under the policy include direct offsets, and other compensatory methods (or indirect offsets). It is likely that a combination of methods will be applicable to the Project, based on the extent of the significant residual impacts on MNES. The Project will comply with the EPBC Act Offsets Policy for any significant adverse residual impacts to MNES. ARTC's Environmental Offset Delivery Strategy—Qld is contained in Appendix K: Matters of National Environmental Significance Technical Report and Appendix J: Terrestrial and Aquatic Ecology Technical Report. This strategy informs the development of offsets delivery components including a Detailed Environmental Offset Delivery Plan and Offset Area Management Plans to be developed and implemented by ARTC prior to construction starting.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
EPBC Act Environmental Offsets Policy (2012) (EPBC Act Offsets Policy) (continued)	Areas subject to the EPBC Act (continued)	▸ Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of State or territory offsets that may be suitable as offsets under the Act for the same action) ▸ Be efficient, effective, timely, transparent, scientifically robust and reasonable ▸ Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced (DSEWPaC, 2012). The Australian Government defines offsets as measures that compensate for the residual adverse impacts of an action on the environment (DSEWPaC, 2012).	
Matters of National Environmental Significance: *Significant impact guidelines 1.1—Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment (DotE), 2013)	MNES	The purpose of the guideline is to assist any person who proposes to take an action to decide whether or not they should submit a referral to the DAWE for a decision by the Australian Government Minister for Environment (the Minister) on whether assessment and approval is required under the EPBC Act. These guidelines outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required. Important terms and phrases are explained.	Assessment of MNES against the guidelines will facilitate the determination of a significant residual impact to MNES.
EPBC Act: *Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)*, (DotE, 2014)	MNES	The purpose of the guideline is to assist any person who proposes to take an action to decide whether or not they should submit a referral to the DAWE for a decision by the Australian Government Environment Minister (the minister) on whether assessment and approval is required under the EPBC Act in relation to the Koala. These guidelines outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required.	Assessment of MNES against the guidelines will facilitate the determination of a significant residual impact to Koala.
Draft Referral guidelines for 14 birds listed as migratory species under the EPBC Act (DotE, 2015a)	MNES	The purpose of the guidelines are to assist any person who proposes to take an action to decide whether or not they should submit a referral to the DAWE for a decision by the Australian Government Environment Minister (the minister) on whether assessment and approval is required under the EPBC Act in relation to the 14 migratory birds. These guidelines outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required.	Assessment of MNES (non-threatened migratory species) against the guidelines will facilitate the determination of a significant residual impact to migratory birds relevant to this guideline.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Draft guideline to nationally protected species significantly impacted by paddock tree removal (DoEE, 2020)	MNES	National environmental law applies to the removal of paddock trees when a 'significant impact' on a nationally protected ecosystem or species is likely to occur. Nationally protected ecosystems include Ramsar wetlands and ecological communities listed in the critically endangered, endangered or vulnerable categories under the EPBC Act. In very rare circumstances, these ecosystems may be significantly impacted by paddock tree removal. Only a very small subset of nationally protected species may be significantly impacted by removing paddock trees. In some cases, undertaking mitigation activities may mean that the removal of paddock trees is lawful and does not require referral under national environmental law. The purpose of the guideline is to assist any person who proposes to clear paddock trees to decide whether or not the action may impact threatened species listed under the EPBC Act and if submission of a referral to DAWE for a decision by the Australian Minister for the Environment on whether assessment and approval is required under the EPBC Act. The guideline outlines species-specific actions to assist in deciding whether or not referral may be required.	Assessment of MNES against the guideline will facilitate the determination of a significant residual impact to applicable threatened species (such as Koala). The species-specific approval requirements noted in the draft guideline are identified here with their relevance to the Project: ▸ Regent Honeyeater (*Anthochaera phrygia*): *Removing Ironbark paddock trees within known breeding areas or frequented visitation sites.* The nearest breeding site is over 100 km south-west of the Project. The species occurs sporadically in the greater Brisbane region (at best) and does not 'frequent' the Project area or surrounds. The approval requirements within the guideline are not relevant to this species regarding the Project. ▸ Painted Honeyeater (*Grantiella picta*): *Removing old growth eucalyptus paddock trees containing mistletoe within known breeding areas.* The species is not known to breed to the east of the Great Dividing Range and only sporadically occurs in the greater Brisbane region. The approval requirements within the Guideline are not relevant to this species regarding the Project. ▸ Coxen's Fig Parrot (*Cyclopsitta diophthalma coxeni*): *Any removal of old growth fig paddock trees in areas of known visitation by this species*. There are no records of the species within 20 km of the Project. There are no records in the region from the year 2000 onwards. As such, there are no areas of known visitation associated with the Project. The approval requirements within the guideline are not relevant to this species in relation to the Project. ▸ Swift Parrot (*Lathamus discolor): Removing Tasmanian Blue Gum and Black Gum paddock trees in known breeding areas. These parrots only breed in Tasmania*. The Project is located in South East Queensland. The approval requirements within the guideline are not relevant to this species in relation to the Project. ▸ Koala (*Phascolarctos cinereus*): *Removing paddock trees where they are habitat critical to the species' survival or provide the only movement opportunity/refuge to or between areas of habitat critical to the species survival.* There is potential habitat within the Project disturbance footprint and surrounds, which is analogous to this description.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Species recovery plans	MNES	Recovery plans for listed threatened species and ecological communities have been made or adopted under the EPBC Act. These plans remain in force until, and unless, the species is removed from the threatened list. A recovery plan is a document stating the research and management actions necessary to stop the decline, support the recovery, and enhance the chance of long-term survival in the wild, of a protected community, animal or plant species.	Species recovery plans for the following MNES relevant to this Project have been adopted by DAWE and have been considered as part of this assessment: ▸ Macadamia Nut (*Macadamia integrifolia*) ▸ Rough-shelled Bush Nut (*Macadamia tetraphylla*) ▸ Brush-tailed Rock-wallaby (*Petrogale penicillata*) ▸ Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) ▸ Large-eared Pied Bat (*Chalinolobus dwyeri*) ▸ Black-breasted Button-quail (*Turnix melanogaster*) ▸ Coxen's Fig-parrot (*Cyclopsitta diophthalma coxeni*) ▸ Eastern Bristlebird (*Dasyornis brachypterus*) ▸ Red Goshawk (*Erythrotriorchis radiatus*) ▸ Regent Honeyeater (*Anthochaera phrygia*) ▸ Swift Parrot (*Lathamus discolor*) ▸ Mary River Cod (*Maccullochella mariensis*) Draft recovery plans exist for the following species: ▸ Australasian Bittern (*Botaurus poiciloptilus*) ▸ Australian Painted Snipe (*Rostratula australis*) ▸ Australian Lungfish (*Neoceratodus forsteri*) ▸ Grey-headed Flying-fox (*Pteropus poliocephalus*) Species recovery plans adopted by DAWE are accessible at: **environment.gov.au/cgi-bin/sprat/public/publicshowallrps.pl**
Threat abatement plans	MNES	Threat abatement plans provide for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on native species and ecological communities. Implementing the plan should assist the long-term survival in the wild of affected native species or ecological communities	Threat abatement plans relevant to MNES associated with the Project include: ▸ Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* ▸ Threat abatement plan for biological effects, including lethal toxic ingestion, caused by cane toads (*Rhinella marina*) ▸ Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) ▸ Threat abatement plan for competition and land degradation by rabbits ▸ Threat abatement plan for predation by feral cats ▸ Threat abatement plan for predation by the European red fox ▸ Threat abatement plan for competition and land degradation by unmanaged goats ▸ Threat abatement plan to reduce the impacts of tramp ants on biodiversity in Australia and its territories. Threat abatement plans approved by DAWE are accessible at: **environment.gov.au/biodiversity/threatened/threat-abatement-plans/approved**

Legislation/policy	Legislative jurisdiction	Intent	Applicability
State			
Agricultural Chemicals Distribution Control Act 1966 (Qld) (ACDC Act)	Queensland	The ACDC Act and Agricultural Chemicals Distribution Control Regulation 1988 aim to control the distribution of agricultural chemicals from aircraft and from ground equipment. A herbicide, a category of agricultural chemical, is defined as any material used or intended to be used for destroying, or preventing the spread of weeds. Herbicides are registered by the Australian Pesticides and Veterinary Medicines Authority (APVMA). The misuse of herbicides has the potential to harm agriculture or livestock, the environment, trade, or human health, and the ACDC Act and Regulation are in place to ensure that commercial operators and their businesses distribute herbicides responsibly.	Large areas of the ecology study area have significant weed growth, particularly non-native grasses, which have been introduced as part of historic agricultural land use of the area. In addition, Project activities have the potential to increase the proliferation of weeds and pests. There is the requirement to appropriately manage weeds and pests as part of Project works. Any use of pesticides or herbicides to manage pests and weeds will need to be performed in accordance with the ACDC Act. Ground distribution of pesticides and herbicides may require both the operator of the equipment and the company or business employing or directing the operators to be licensed in accordance with the ACDC Act. For the purposes of the CEMP, the APVMA will regulate the lawful application of pesticides and herbicides for targeted pest and weed management activities.
Biosecurity Act 2014 (Qld) (Biosecurity Act)	Queensland	The Biosecurity Act seeks to provide a framework for an effective biosecurity system for QLD that helps to manage and minimise State biosecurity risks, as well as facilitate the response to biosecurity issues and events in a timely and effective way, so as to align with national and international obligations. The Act introduces the general biosecurity obligation on all persons to take all reasonable and practical measures to prevent or minimise biosecurity risks. Under the Biosecurity Act, red imported fire ants (*Solenopsis invicta*) are a Category 1 'restricted matter' and must be reported if found and all reasonable steps taken to minimise the risk of them spreading. The Act establishes a Fire Ant Biosecurity Zone. Restrictions on the movement of carriers of fire ants within and out of the zone will be prescribed and will include 'risk items' such as soil or anything that has soil attached and material that is a product or by-product of quarrying or mining. Movement of carriers by anyone of land within the zone will be prohibited unless the person has a Biosecurity Instrument Permit or under a prescribed exemption (which includes implementing risk-mitigation activities).	The Project will potentially involve interaction with restricted matters and prohibited matters (potentially including pests, diseases or contaminants) and will therefore require compliance with the Biosecurity Act. The Biosecurity Management Plan will ensure that the potential spread of invasive species as a result of Project activities are minimised and managed appropriately. The Biosecurity Management Plan will consider operational impacts associated with movement of stock and produce on trains as a vector for spread of pest animals, plants and pathogens. The Project will traverse areas contained within Fire Ant Biosecurity Zones 1 and 2; therefore, there will be restrictions around the movement of materials that could spread the red imported fire ants. The Biosecurity Management Plan will also consider red imported fire ants.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Environmental Offsets Act 2014 (Qld) (Offsets Act)	Queensland	The Offsets Act and associated Environmental Offsets Regulation 2014 (Qld) seeks to *'counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets'*. Introduced on 1 July 2014, the Act is administered by DES, and establishes a new framework to regulate the delivery of offsets in QLD, integrating the previous multiple sets of policies in a manner that provides an outcome-based approach and reduces duplication. Under the Offsets Act, an environmental offset is defined as 'an activity undertaken to counterbalance a significant residual impact of a prescribed activity on a prescribed environmental matter'. The Act defines the type of activities for which offsets may be imposed (i.e. 'prescribed activities') where these activities are determined to result in a 'significant residual impact'. To achieve the purpose of the Offsets Act, the *Queensland Environmental Offsets Policy* (Version 1.9, December 2020) (DES, 2020f) has been developed to provide further guidance on the requirements for the assessment of 'significant residual impacts', and accepted methods for the delivery of offsets, where required.	The Project will be required to deliver environmental offsets consistent with the Offsets Act. Environmental offsets for significant residual impacts to a prescribed matter may be delivered through a proponent-driven offset (e.g. land-based offset), a financial offset calculated in accordance with the Financial Settlement Offset Calculation Methodology, or a combination of proponent driven and financial offsets. ARTC's Environmental Offset Delivery Strategy—Qld is contained in Appendix K: Matters of National Environmental Significance Technical Report and Appendix J: Terrestrial and Aquatic Ecology Technical Report. This strategy informs the development of offset delivery components including a Detailed Environmental Offset Delivery Plan and Offset Area Management Plans.
Environmental Protection Act 1994 (Qld) (EP Act)	Queensland	The EP Act is the key legislative framework for environmental management and protection in Queensland. It regulates activities that will, or have the potential to, release contaminants into the environment that may cause environmental harm. These activities are defined as Environmentally Relevant Activities (ERAs). ERAs include both prescribed ERAs and resource activities. The EP Act regulates the application of Environmental Authorities (EAs) for ERAs and employs a number of mechanisms to achieve its objectives relating to biodiversity, including the Environmental Protection Regulation 2019 (Qld) (EP Regulation). The EP Regulation identifies prescribed ERAs that require an approval and provides the mechanism for levels of protection for Environmentally Sensitive Areas, which are defined in Schedule 12 of the EP Regulation. The EP Act also regulates wetlands in wetland management areas under the subordinate Environmental Protection Policy (EPPs) including the Environmental Protection (Water and Wetland Biodiversity) Policy 2019. The EPP (Water and Wetland Biodiversity) establishes a process for identifying environmental values to be protected and states standards for water quality in support of those values.	The identification of any prescribed ERAs that will require an EA has been identified in Chapter 3: Project Approvals. Confirmation of these ERAs will be undertaken as part of the post-EIS approvals process. The EP Act also lists obligations and duties to prevent environmental harm, nuisances and contamination. ARTC will comply with the general environmental duty through the implementation of the environmental management plans for the construction and operation of the Project.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Fisheries Act 1994 (Qld) (Fisheries Act)	Queensland	The Fisheries Act provides for the management, use, development and protection of fish habitats and resources, together with the management of aquaculture activities. Administered by the Department of Agriculture and Fisheries (DAF), the Fisheries Act applies to: ▸ Works in a declared Fish Habitat Area (FHA) ▸ Waterway barrier works resulting in the construction of instream structures inhibiting the free movement of fish along waterways ▸ Waterway barrier works. Under the provisions of the Fisheries Act and the Planning Act, a Development Permit for Operational Works involving waterway barrier works is required for works that pose a barrier to fish passage (including permanent, partial and temporary barriers) within a waterway that is mapped by DAF on the spatial data layer 'Queensland waterways for waterway barrier works' unless: ▸ The works have a low impact to fisheries productivity and comply with DAF's requirements for 'works which are not waterway barrier works' which include (subject to specific design and construction requirements): ▸ New single or multi-span bridges ▸ Maintenance of existing bridge structures not subject to an existing permit ▸ Bank revetment ▸ Road resurfacing at waterway crossings ▸ Stormwater outlet construction. Works that occur within these waterways will be defined as waterway barrier works, unless the works comply with the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF, 2018).	The Project traverses mapped waterways for waterway barrier works and therefore will likely trigger the requirement to obtain a Development Permit for Operational Works that is constructing or raising waterway barrier works, unless an exemption applies, or where works can be shown to comply with the accepted development requirements. The Project does not require: ▸ The removal, destruction or damage of marine plants ▸ Works involving aquaculture ▸ Work that is completely or partly within a declared FHA.
Nature Conservation Act 1992 (Qld) (NC Act)	Queensland	The NC Act provides for the conservation of nature through protection of all native plants, birds, reptiles, mammals and amphibians in QLD (along with a limited range of invertebrates and freshwater fish). The NC Act is based on principles aimed at conserving biological diversity, ecologically sustainable use of wildlife, ecologically sustainable development and international criteria developed by the International Union for the Conservation of Nature for establishing and managing protected areas.	The following permits and management plans may be required for the Project: ▸ Wildlife Movement Permits (Sections 88 and 97 of the NC Act) for wildlife protected under the NC Act, and those found in certain areas covered by conservation plans created and implemented under the NC Act ▸ Clearing Permit (Protected Plants) (Section 89 of the NC Act) for the clearing of vegetation contained within high risk areas identified on the Department of Environment and Science (DES) flora survey trigger map, or where protected plants have been identified in a Project survey within a proposed clearing area

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Nature Conservation Act 1992 (Qld) (NC Act) (continued)	Queensland (continued)	The NC Act has 14 subordinate regulatory instruments in the form of regulations, conservation plans and notices. Of particular relevance to the Project are three instruments that regulate disturbance to flora, fauna and habitat, including: ▸ Nature Conservation (Animals) Regulation 2020, which prohibits the taking or destruction pf protect animals, without authorisation, and lists all fauna species considered to be extinct in the wild, endangered, vulnerable, near threatened, least concern and special least concern wildlife (refer Chapter 25: Glossary and Abbreviations for definitions of these terms). Also listed is international wildlife and prohibited wildlife. ▸ Nature Conservation (Plants) Regulation 2020, which prohibits the taking or destruction, without authorisation, of protected plants and lists all flora species that are considered to be extinct in the wild, endangered, vulnerable, near threatened, least concern and special least concern wildlife (refer Chapter 25: Glossary and Abbreviations for definitions of these terms). Also listed is international wildlife and prohibited wildlife. ▸ *Nature Conservation (Protected Plants) Conservation Plan 2000*, which provides protection for protected flora species. Currently, all species of native Australian flora are listed as protected plants, including those species that are considered of least concern The NC Act also includes provisions for protected areas such as national parks, nature refuges, and World Heritage management areas.	▸ Rehabilitation Permit (spotter catcher endorsement) (Part 14 of the Nature Conservation (Animals) Regulation 2020). ▸ Damage Mitigation Permit (removal and relocation) (Part 10 of the Nature Conservation (Animals) Regulation 2020). ▸ A species management plan must be submitted to the DES for approval for tampering with some animal breeding places (Section 335 of the Nature Conservation (Animals) Regulation 2020).
Planning Act 2016 (Qld) (Planning Act)	Queensland	The purpose of the Planning Act is to provide an efficient, effective, transparent, integrated, coordinated and accountable system of land use planning, development assessment and dispute resolution to facilitate the achievement of ecological sustainability. Together with a development assessment system, Chapter 1 of the Planning Act establishes a hierarchy of planning instruments which comprises: ▸ State planning policies (including temporary policies) ▸ Regional plans ▸ Planning schemes ▸ Temporary local planning instruments ▸ Planning scheme policies.	The Project may trigger the requirement to obtain approval for aspects of development that are assessable under Schedule 10 of the Planning Regulation 2017, which may influence ecological aspects (and integrated through other legislation as part of the Development Assessment Rules process) following completion of the EIS process.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Public Health Act 2005 (Public Health Act)	Queensland	The objective of the Public Health Act is to is to protect and promote the health of the QLD public by: ▸ Preventing, controlling and reducing risks to public health ▸ Providing for the identification of, and response to, notifiable conditions ▸ Imposing obligations on persons and particular healthcare facilities involved in the provision of declared health services to minimise infection risks ▸ Inquiring into serious public health matters ▸ Responding to public health emergencies ▸ Providing for compliance with this Act to be monitored and enforced.	The Project will traverse areas that potentially contain designated pests as defined under the Public Health Act e.g. Fire Ant Biosecurity Zones). Measures to control and minimise the spread of these pests as required.
Vegetation Management Act 1999 (Qld) (VM Act)	Queensland, specifically activities that are regulated through the Planning Act	The VM Act regulates the conservation and management of vegetation communities and clearing of vegetation identified as 'regulated vegetation' identified as Category A, B, C and R. The VM Act provides a framework for identification, description, and mapping of remnant Regional Ecosystems (REs) certified by DES as endangered, of concern or least concern (refer Chapter 25: Glossary and Abbreviations for definitions of these terms). It also provides a framework for the identification, description and mapping of High Value Regrowth (HVR) vegetation as endangered, of concern or least concern.	The clearing of vegetation regulated under the VM Act (e.g. Category B and C regulated vegetation) will occur as a result of the Project. Clearing of any relevant remnant or regulated regrowth vegetation will constitute operational works under Schedule 10 of the Planning Regulation that will require development approval, unless an exemption applies. Under Schedule 21, Part 1, Item 14 of the Planning Regulation, the following clearing work is exempt clearing work for which a development permit is not required: *(14) Clearing vegetation for the construction or maintenance of infrastructure stated in Schedule 5, if-* *(a) the clearing is on a designated premises; or* *(b) the infrastructure is government supported transport infrastructure.* The Project is considered to be government supported infrastructure as per requirements of the Planning Regulation. Vegetation clearing for the Project is considered to be eligible for exemption under Schedule 21 of the Planning Regulation given the Project is for transport infrastructure (rail transport infrastructure) that is government supported transport infrastructure (for a public use and funded partly by the Australian Government).

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Water Act 2000 (Qld) (Water Act)	Queensland	The Water Act provides for the sustainable management of non-tidal waters and other resources, together with the establishment and operation of water authorities, and for other purposes. The QLD Government (2018b) maintains Watercourse Identification Mapping (WIM), which identifies defined watercourses under the Water Act, as well as drainage features (not regulated under the Water Act). Through the Planning Act, certain water related development under the Water Act is assessable. In addition to the approvals triggered under the Planning Act, the Water Act regulates the undertaking of works that involve the excavating or placing fill in a watercourse, lake or spring.	The Project involves works within defined mapped watercourses and the provisions of the Water Act may apply. Other unmapped waterways will be required to be verified during the detailed design phase to determine their status under the Water Act. The Project involves the removal of vegetation, excavation or placing fill in a waterway, lake or spring. ARTC is an approved entity for the purposes of the riverine protection permit exemption requirements. Where works are proposed within a watercourse, these activities will be in accordance with the riverine protection permit exemption requirements. A riverine protection permit will be required in instances where the exemption requirements cannot be achieved. ARTC or the construction contractor will obtain a water entitlement, water licences and/or development permits for watercourse diversion for the Project to enable the take of water for use during construction. Where works are proposed within a watercourse, these activities will be in accordance with the riverine protection permit exemption requirements. A riverine protection permit will be required in instances where the exemption requirements cannot be achieved.
Back on Track species prioritisation framework	Queensland	The Back on Track species prioritisation framework is an initiative of the DES, based on the method of Marsh et al., (2007) that ranks species (regardless of their NC Act or EPBC Act classification) as critical, high, medium, or low priority for the State and for the Natural Resource Management (NRM) region. There is also a data deficient category according to three sets of criteria: probability of extinction, consequences of extinction and potential for successful recovery. Although it is not statutory, the Back on Track priority species provides a framework for biodiversity assessment and species prioritisation when determining ecological values.	Priority Back on Track species have been identified for each of the 14 NRM regions across Queensland. The Project is located in the SEQ NRM region. A total of 105 priority Back on Track species (56 flora species and 49 fauna species) are known to occur within the SEQ NRM region through the prioritisation framework (DERM, 2010c).
Biodiversity Planning Assessments (BPAs)	Queensland	BPAs for each of QLD's bioregions have been prepared based on the methodology outlined in the Biodiversity Assessment and Mapping Methodology (BAMM) (DEHP, 2014c). The BPAs draw on the DES certified RE mapping, database information, and expert panel reports, and incorporate information about threatened ecosystems and/or species, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, as well as buffers to wetlands or other types of important areas for ecological processes.	The Project is located within the SEQ BPA area (QLD Government, 2019a). The following reports outline the BPAs conducted within the ecology study area: ▸ Biodiversity Planning Assessment for the southeast Queensland Bioregion: Fauna Expert Panel Report (Version 4.1) (DEHP, 2016a) ▸ Biodiversity Planning Assessment for the southeast Queensland Bioregion: Flora Expert Panel Report (Version 4.1) (DEHP, 2016b)

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Biodiversity Planning Assessments (BPAs) (continued)	Queensland (continued)	The BPA assigns areas to one of three biodiversity significance levels, including: 1. State significance—areas assessed as being significant for biodiversity at the bioregional or State scales 2. Regional significance—areas assessed as being significant for biodiversity at the sub-bioregional scale 3. Local significance and or other values—local values that are of significance at the local government scale. All remnant vegetation will qualify into one of the above three categories. Although it is not legislated, the BPA provides a framework for biodiversity assessment when determining environmental values. ▸ In addition to terrestrial BPAs, aquatic BPAs use and assess the conservation and ecological value of wetland systems based on a series of national and international criteria, including naturalness (aquatic and catchment), diversity and richness, threatened species/ecosystems, priority species/ecosystem, special features, connectivity and representativeness to provide aquatic conservation assessments for SEQ (DEHP, 2015).	▸ Biodiversity Planning Assessment for the southeast Queensland Bioregion: Landscape Expert Panel Report (Version 4.1) (DEHP, 2016c) The ecology study area is located within the Bremer and Logan Aquatic Conservation Assessment catchments (as part of the wider SEQ catchment) and outlined within the following report: Aquatic Conservation Assessment using AquaBAMM for the riverine and non-riverine wetland of South East QLD (DEHP, 2015).
Nature Conservation (Koala) Conservation Plan 2017 (Koala Plan)	Queensland	The Koala Plan requires any clearing in certain areas to be undertaken sequentially, and in the presence of a suitably qualified Koala spotter. The Koala Plan also prescribes three mapped Koala districts (A, B and C) and includes requirements relating to the release of rehabilitation, sick or injured Koalas.	The Project will require clearing within District A as identified in the Koala Plan. Clearing works in Koala habitat within District A require 'sequential clearing' and the presence of Koala spotters.
Queensland Environmental Offsets Policy (Qld) (QEOP)	Queensland	The QEOP (DES, 2020f) aims to provide a framework for environmental offsets in QLD, including principles and guidelines for using environmental offsets and guidance on when offsets should be used. The QEOP outlines seven principles that direct the way offsets must be used to contribute to environmentally sustainable development (ESD) as follows: ▸ Offsets will not replace or undermine existing environmental standards or regulatory requirements, or be used to allow development in areas otherwise prohibited through legislation or policy ▸ Impacts must first be avoided, then minimised, before considering the use of offsets for any remaining impact ▸ Offsets must achieve a conservation outcome that achieves an equivalent environmental outcome ▸ Offsets must provide environmental values as similar as possible to those being lost	The Project will deliver environmental offsets consistent with the QEOP. ARTC's Environmental Offset Delivery Strategy—Qld is contained in Appendix K: Matters of National Environmental Significance Technical Report and Appendix J: Terrestrial and Aquatic Ecology Technical Report. This strategy informs the development of offset delivery components including a Detailed Environmental Offset Delivery Plan and Offset Area Management Plans.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Queensland Environmental Offsets Policy (Qld) (QEOP) (continued)	Queensland (continued)	▸ Offset provision must minimise the time-lag between the impact and delivery of the offset ▸ Offsets must provide additional protection to environmental values at risk, or additional management actions to improve environmental values ▸ Where legal security is required, offsets must be legally secured for the duration of the impact on the prescribed environmental matter.	
Queensland Environmental Offsets Policy Significant Residual Impact Guideline (*Nature Conservation Act 1992 Environmental Protection Act 1994* and *Marine Parks Act 2004*) (DEHP, 2014a)	Queensland	The purpose of this guideline is to assist in deciding whether or not a prescribed activity will or is likely to have a significant residual impact on a MSES. This guideline applies to any activity prescribed in the Environmental Offsets Regulation 2014 that requires an approval in relation to MSES, under any of the following: ▸ NC Act ▸ *Marine Parks Act 2004* ▸ EP Act.	The Project involves disturbance to features protected under the EP Act and NC Act and, as such, assessment against the MSES guidelines is required to determine if a significant residual impact on an MSES occurs.
South East Queensland Regional Plan 2017	Queensland. Specifically, activities that are regulated through the Planning Act.	Regional plans are State planning instruments made under the Planning Act. Regional plans seek to provide strategic direction to achieve regional outcomes that align with the State interests in planning and development.	The Project is located within the South East QLD (SEQ) Regional Planning area. The regional plan, known as *ShapingSEQ*, provides the regional framework for collaboration with the regions' 12 local governments for the management of growth, planning directions, economic competitiveness and high-quality living. The *ShapingSEQ* plan identifies the need to plan strategically for the protection and enhancement of biodiversity values, Koala habitat and landscape function and processes. Inland Rail has been identified in this plan.
State Planning Policy 2017 (SPP)	Queensland	The SPP is a key component of the QLD land use planning system which articulates the QLD Government's 17 State interests in land use planning and development. The SPP is a statutory instrument and requires that the State interests be integrated into local government planning schemes. Some State interests in the SPP include assessment benchmarks that apply to certain types of development where a local government planning scheme does not appropriately integrate the relevant State interest. A number of the State interests set out in the SPP apply to the Project and to the Project impact areas.	The SPP is applicable to the Project across various aspects, including terrestrial and aquatic ecology, which is represented by the *State interest guideline—biodiversity* (DSDMIP, 2017). The biodiversity State interest requires development to be located in areas to avoid significant impacts to MNES, avoid and minimise impacts to MSES and MLES, maintaining or enhancing ecological processes and connectivity by avoiding fragmentation, and conserve and enhance Koala habitat extent and condition.

11.4 Methodology

11.4.1 Ecology study area

The ecology study area adopts the EIS investigation corridor, being an approximate 2 km-wide study area, 1 km either side of the proposed rail alignment. It includes the disturbance footprint, which encompasses all areas where works are proposed, including both permanent and temporary works, and land within a 1 km radius either side of the proposed rail alignment. The study area is slightly wider around Chainage (Ch) 38 to Ch 45 to accommodate for the options analysis that was undertaken for the Teviot Range crossing. It should be noted that for the estimation of direct impacts, the disturbance footprint does not include the surface area associated with the rail tunnel (where the alignment intersects a portion of the Teviot Range) as no surface disturbance is predicted. Refer Figure 11.1.

11.4.2 Sensitive environmental receptors

A receptor is a feature, area or structure that may be affected by direct or indirect changes to the environment. Impact assessments reported within this chapter specifically focus on sensitive environmental receptors, which were identified by reviewing existing literature and previous studies relevant to the ecology study area and refined through field investigations and modelling where applicable. Sensitive environmental receptors include:

- Protected areas (e.g. national parks, nature refuges, coordinated conservation areas, conservation parks and resource reserves)
- EPBC Act listed Threatened Ecological Communities (TECs)
- EPBC Act listed threatened species and their associated habitat
- EPBC Act listed migratory species and their associated habitat
- NC Act listed threatened and near-threatened species and their associated habitat
- NC Act listed least concern and special least concern (SLC) species and their associated habitat
- REs, high-value regrowth and wildlife habitat
- Priority Back on Track flora and fauna species
- Significant wetlands (i.e. international, national and State)
- State significant ecological constraints (i.e. Biodiversity Planning Assessment).

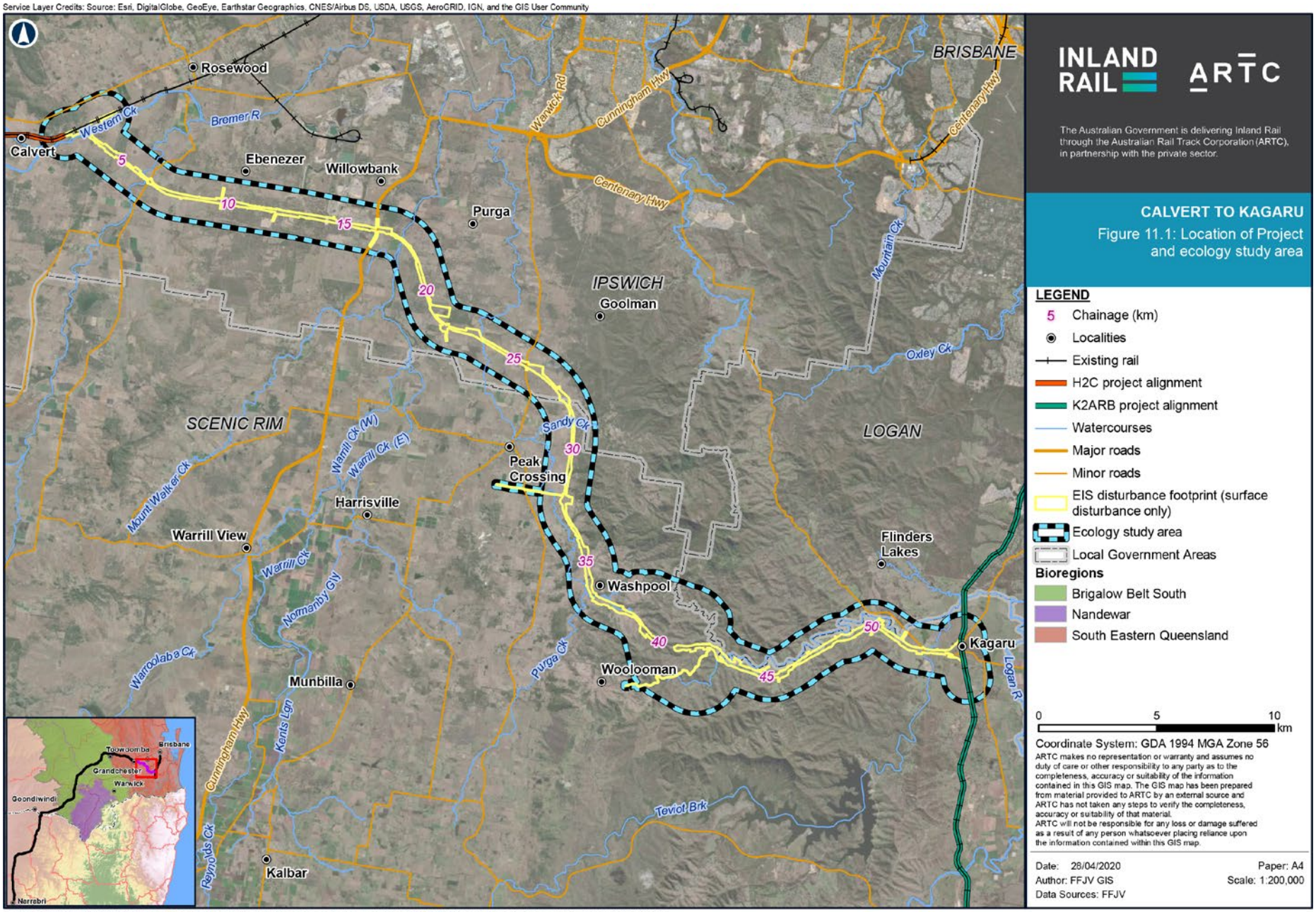
In instances where conservation-significant species (i.e. species listed as threatened, near-threatened, migratory and SLC) did not have potential habitat within the ecology study area, these species were not subject to impact assessment. They were not considered to be sensitive environmental receptors for the purpose of the impact assessment process as the risk of impacts to these sensitive environmental receptors is considered low.

Further detail related to the identification of sensitive environmental receptors is provided within Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report.

11.4.3 Review of existing literature and previous studies

11.4.3.1 Overview

In addition to a review of publicly available databases, an analysis of existing ecological field data associated with the ecology study area was undertaken. A total of 16 ecological assessment reports were identified (refer Table 11.3), which presented ecological values of the ecology study area (i.e. located within the broader study area), including species diversity, abundance and seasonal distribution (refer Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report). In addition to the reports identified in Table 11.3, site-specific database queries as identified in Table 11.4 were undertaken to produce the predictive habitat mapping related to threatened flora and fauna (refer Section 11.4.4).


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Rosewood
Calvert
Ebenezer
Willowbank
Purga
BRISBANE
IPSWICH
Goolman
SCENIC RIM
LOGAN
Peak Crossing
Harrisville
Warrill View
Flinders Lakes
Washpool
Kagaru
Woolooman
Munbilla
Kalbar
Western Ck
Bremer R
Warrill Ck (W)
Warrill Ck (E)
Sandy Ck
Mount Walker Ck
Warrill Ck
Normanby Gly
Warroolaba Ck
Purga Ck
Reynolds Ck
Kents Lgn
Teviot Brk
Oxley Ck
Logan R
Mountain Ck
Warwick Rd
Cunningham Hwy
Centenary Hwy
5
10
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20
25
30
35
40
45
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Toowoomba
Brisbane
Grandchester
Warwick
Goondiwindi
Nobby
Norrebri
INLAND RAIL
ARTC
The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.
CALVERT TO KAGARU
Figure 11.1: Location of Project and ecology study area
LEGEND
5 Chainage (km)
Localities
Existing rail
H2C project alignment
K2ARB project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Bioregions
Brigalow Belt South
Nandewar
South Eastern Queensland
0 5 10 km
Coordinate System: GDA 1994 MGA Zone 56
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Paper: A4
Author: FFJV GIS
Scale: 1:200,000
Data Sources: FFJV
Map by: MEF/GN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.1_Regional_V4.mxd Date: 9/04/2020 10:21

TABLE 11.3: PROJECT RELATED ASSESSMENTS AND REPORTS

Document title	Reference	Summary of significant findings related to sensitive environmental receptors
Southern Freight Rail Corridor Study (March 2010)	AECOM (2010a and 2010b)	▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC ▸ Observations of Koala (*Phascolarctos cinereus*), anecdotally known to occur throughout the study area from community consultation feedback. Also identified at Paynes Road in September 2009 ▸ Observation of Brush-tailed Rock Wallaby (*Petrogale penicillata*), observed opportunistically on Mount Flinders ▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) during field investigations ▸ Identification of patch of Brigalow (*Acacia harpophylla*) TEC within current ecology study area, although outside the disturbance footprint (i.e. identified on Lot 118 Plan CH312530, Calvert) ▸ Detection of the Powerful Owl (*Ninox strenua*) during nocturnal call-playback ▸ Analysis and confirmation of remnant vegetation as listed under the VM Act within the study area.
Calvert to Kagaru Flora and Fauna Technical Report	Jacobs–GHD (2016b)	▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East QLD TEC, which extends into the periphery of the proposed rail corridor ▸ Confirmed the presence of Brigalow (*Acacia harpophylla*) TEC within current ecology study area though outside disturbance footprint (i.e. identified on Lot 118 Plan CH312530, Calvert) ▸ Observations of Koala (*Phascolarctos cinereus*), with direct observations and Koala scats in both in-tact and fragmented landscapes ▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) during field investigations ▸ Observations of feeding signs (i.e. orts) of Glossy-black Cockatoos (*Calyptorhynchus lathami*) during field investigations.
Woolooman Tunnel Geotechnical Access–Ecological Assessment Report	GHD (2017a)	▸ Evidence of Koala (*Phascolarctos cinereus*) presence (scats) recorded.
Australian Rail Track Corporation/Transport—Land/southwest of Ipswich/Queensland/Inland Rail Calvert to Kagaru Project (EPBC Referral number 2017/7944)	ARTC (2017a)	▸ Provides initial details on how the Project is likely to impact MNES and MSES. This includes, identification of potential impacts to threatened species, remnant vegetation and migratory species.
Initial Advice Statement: Inland Rail—Calvert to Kagaru (10 May 2017)	ARTC (2017b)	▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East QLD TEC, particularly around the Purga nature reserve ▸ Observations of Koala (*Phascolarctos cinereus*), nine distinct locations along the alignment ▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) during field investigations ▸ Observations of feeding signs (i.e. orts) of Glossy-black Cockatoos (*Calyptorhynchus lathami*) during field investigations.

Document title	Reference	Summary of significant findings related to sensitive environmental receptors
Inland Rail–Gowrie to Kagaru Geotechnical investigations. MNES assessment report, 23 July 2018	EMM (2018a)	▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC particularly around Ebenezer ▸ Evidence of Koala (*Phascolarctos cinereus*) presence (scats and scratches) throughout locations along alignment ▸ Observation of Swift parrot (*Lathamus discolor*) along alignment south of Rosewood ▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*), particularly around Ebenezer and Willowbank.
Inland Rail—Gowrie to Kagaru Geotechnical investigations. Protected plant survey reports (2018 and 2019) Preclearance survey reports (2018 and 2019)	EMM (2018b–e; 2019a–c)	▸ No observations of MSES flora species. ▸ No MNES observed.
Inland Rail—Calvert to Kagaru Geotechnical investigations. Protected plants flora survey reports (8 May 2019, 20 June 2019) Preclearance survey report (11 June 2019)	Eco Logical Australia (ELA) (2019a–c)	▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC east of Paynes Road (June 2019) ▸ Evidence of Koala (*Phascolarctos cinereus*) presence (scats and scratches) throughout locations along alignment.

11.4.3.2 Data source review

Prior to field investigations, a desktop analysis of publicly available datasets was undertaken to identify sensitive environmental receptors potentially occurring within the ecology study area. Details of the relevant database sources, search dates, search area parameters and type of information considered for the desktop study are summarised in Table 11.4.

TABLE 11.4: DATABASE AND DOCUMENT REVIEW SUMMARY

Database/data source name	Database search date	Database search areas	Data type
Atlas of Living Australia (Atlas of Living Australia, 2020)	29/03/2020	Disturbance footprint with 50 km buffer applied	Ongoing inspection of records of flora and fauna, including threatened species listed under the EPBC Act and/or NC Act and those identified as MLES. The Atlas database includes confirmed records from all Australian museums including the Queensland Museum.
Flying Fox Monitoring Program (Queensland Government, 2020a)	24/03/2020	Ecology study area	Show the general location of flying-fox roosts in QLD recorded by DES/DAWE and include continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Flying-fox roost monitoring and locations (DES, 2020c)	06/02/2020	Disturbance footprint with 15 km buffer applied	Show the general location of flying-fox roosts in QLD recorded by the DES and includes camp survey data for continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Birdata database (Birds Australia, 2019)	29/03/2019	Ecology study area	Records of avian fauna, including threatened and migratory species listed under the EPBC Act and/or NC Act.
Biodiversity Planning Assessment (BPA) mapping (Queensland Government, 2019a)	06/02/2020	Ecology study area	State, regional (MSES) and local (MLES) significant biodiversity matters mapping. This mapping has been used to indicate the location of bioregional corridors (i.e. in the State, regional and local context). This mapping has also been used in the predictive modelling to identify core habitat areas (refer Section 11.5.4).
Back on Track species prioritisation framework (DEHP, 2010)	06/02/2020	SEQ NRM	The Back on Track species are categorised as Critical, High, Medium, or Low priority for the State and for each NRM region in QLD. There is also a data deficient category according to three sets of criteria: probability of extinction, consequences of extinction and potential for successful recovery. Data is presented as a list of species (refer Section 11.5.2 (flora) and Section 11.5.3 (fauna).
EPBC Act Protected Matters Search Tool (DAWE, 2020a)	06/02/2020	Ecology study area	Provides a 'predictive' account of MNES identified within a specific area. Includes MNES such as World Heritage properties, national heritage places or wetlands of international importance and threatened/migratory species.
Groundwater Dependent Ecosystems Atlas (BoM, 2020)	06/02/2020	Ecology study area	Provides information related to three types of groundwater-dependent ecosystems (GDEs): aquatic, terrestrial and subterranean.
Wildlife Habitat Map, version (Queensland Government, 2019d)	06/02/2020	Ecology study area	Modelled habitat under the VM Act for a conservation-significant species listed under the EPBC Act and/or the NC Act.
Regulated Vegetation Management Map (version 11) (Queensland Government, 2020c)	06/02/2020	Ecology study area	Mapping of REs and High Value Regrowth that provide habitat for conservation significant species under the EPBC Act and/or NC Act and may be considered a TEC under EPBC Act.
Register of critical habitat (DAWE, 2020b)	06/02/2020	Australian extent	Critical habitat listed under the EPBC Act.
Map of Referable Wetlands (Department of Environment and Science, 2020e)	06/02/2020	Regional extent	Includes State significant, referable wetlands, important wetlands in the Great Barrier Reef catchments and wetland REs.

Database/data source name	Database search date	Database search areas	Data type
WildNet database (Queensland Government, 2019b) incorporating WildNet and Herbrecs datasets	06/02/2020	Ecology study area	Records of flora and fauna, including conservation significant species listed under the EPBC Act and/or NC Act and MLES.
Queensland Waterways for Waterway Barrier Works (Queensland Government, 2020b)	06/02/2020	Ecology study area	Waterways where proposed waterway barrier works require assessment and approval under the *Fisheries Act 1994*.
Watercourse Identification Mapping (Queensland Government, 2018b)	06/02/2020	Ecology study area	Known extent of watercourses and drainage features that are managed under the Water Act.
Wetland Info database (DES, 2020a)	06/02/2020	Ecology study area	Provides interactive maps, species records, case studies and legislation associated with QLD wetlands. Also provides access to QLD AquaBAMM assessments.
Fish Habitat Areas (Queensland Government, 2020d)	06/02/2020	Ecology study area	Boundaries of gazetted, declared fish habitat areas (FHAs).
Queensland Springs Database (Queensland Government, 2018d)	06/02/2020	Regional extent	The dataset provides a comprehensive catalogue of permanently saturated springs that have fixed locations and any associated surface expression GDEs.
Matters of State Environmental Significance (Queensland Government, 2019c)	06/02/2020	Ecology study area	Location of MSES including: ▸ Protected areas ▸ Marine parks ▸ Management A and Management B declared FHAs ▸ Threatened and special least concern wildlife listed under the NC Act ▸ Regulated vegetation under the VM Act (version 11) ▸ Wetlands in a wetland protection area or wetlands of high ecological significance ▸ Wetlands and watercourses in high ecological value waters as defined in the Environmental Protection (Water) Policy 2019, Schedule 2 ▸ Legally secured offset areas.

11.4.4 Predictive habitat modelling

Following a review of government databases and existing ecological field data/investigations, predictive habitat modelling was developed for conservation significant flora and fauna species and communities that had been identified as possibly occurring within the ecology study area. Where available, assumptions used to develop the models were derived from species recovery plans, Commonwealth-approved conservation advice, and relevant scientific studies. The predictive habitat modelling was used to identify and map areas that were considered to have potential to provide habitat for conservation significant species and applies the precautionary principle (i.e. where doubt exists, habitat is included rather than excluded in addition to the inclusion of some areas of habitat that are not considered essential to the survival of the species) so as not to underestimate potential habitat for threatened species.

The predictive habitat modelling for each species used a range of existing, publicly available GIS datasets, which were used simultaneously to create a specific habitat layer for each of the species and communities identified as potentially occurring within the ecology study area.

The habitat categories applied to MNES species were:

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

For species listed only under the provisions of the NC Act (i.e. MSES species), habitat categories consisted of:

- General habitat
- Essential habitat
- Core habitat.

These habitat categories align with significant impact assessment criteria as stipulated under the EPBC Act and the NC Act and are defined in Sections 11.4.4.1 to 11.4.4.6. Further information related to the specific assumptions used to model habitat for each individual species is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report.

11.4.4.1 Potential habitat (MNES)

Potential habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as *important habitat* or *habitat critical to the survival of the species* (i.e. records of the species are considered anomalies as general microhabitat features are not considered to be present from a desktop perspective). Potential habitat also includes habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen-backed records and where this does not completely address the relevant criteria to be mapped as *habitat critical to the survival of the species.* Potential habitat may include areas of suboptimal habitat for species. Impacts to potential habitat are not considered to contribute to significant impact to an MNES because the loss of these areas is not deemed to be significant in accordance with the Commonwealth-significant impact criteria. However, impact to potential habitat has been considered in relation to movement of species and the potential to contribute towards fragmentation and barrier effects, rather than the loss of habitat per se.

11.4.4.2 General habitat (MSES)

General habitat consisted of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat (i.e. records of the species are considered anomalies, as general microhabitat features are not considered to be present from a desktop perspective). General habitat also includes habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. General habitat may include areas of suboptimal habitat for a species.

11.4.4.3 Important habitat (MNES)

In line with DAWE's guidelines, areas of important habitat are regarded as a surrogate for important populations of Brigalow Belt reptiles. Relevant to the current investigations, the following species are classified as Brigalow Belt reptiles and, where relevant, important habitat for these species has been mapped as defined in *Section 5 of the Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC, 2011a):

- Dunmall's Snake (Furina dunmalli)
- Collared Delma (Delma torquata)
- Five-clawed Worm-skink (*Anomalopus mackayi*).

In addition to the species identified above, the important habitat has been used to capture 'Priority habitat areas' for the Swift Parrot (*Lathamus discolor*) as identified in the *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Birds Australia, 2011). Impacts to important habitat are considered to contribute towards significant residual impacts to an MNES.

11.4.4.4 Essential habitat (MSES)

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

11.4.4.5 Core habitat (MSES)

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

11.4.4.6 Habitat critical to the survival of the species (MNES)

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

11.4.5 Field methodology

11.4.5.1 Terrestrial ecology

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

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

Opportunistic site investigations associated with pre-clearance work for geotechnical investigations were used to supplement the desktop-based datasets and validate predictive, species-specific mapping. Surveys undertaken at opportunistic survey locations were in accordance with the methodology prescribed in *Flora Survey Guidelines—Protected Plants* (DES, 2016b). Field-based surveys associated with the Project EIS approximated an area of 299 ha (i.e. 82 ha associated with targeted surveys and 217 ha associated with opportunistic investigations). This represents approximately 2.4 per cent of the ecology study area and approximately 30.6 per cent of the disturbance footprint.

Field-based surveys associated with the Project EIS complemented historic and concurrent investigations undertaken by AECOM, Jacobs–GHD, EMM, FFJV and ELA (refer Table 11.5 and Figure 11.3). Note that there is overlap in the location of surveys undertaken for programs presented in Table 11.5 and those undertaken as part of targeted investigations associated with the Project EIS. Data derived from surveys presented in Table 11.5 were incorporated into the current EIS documentation, where applicable.

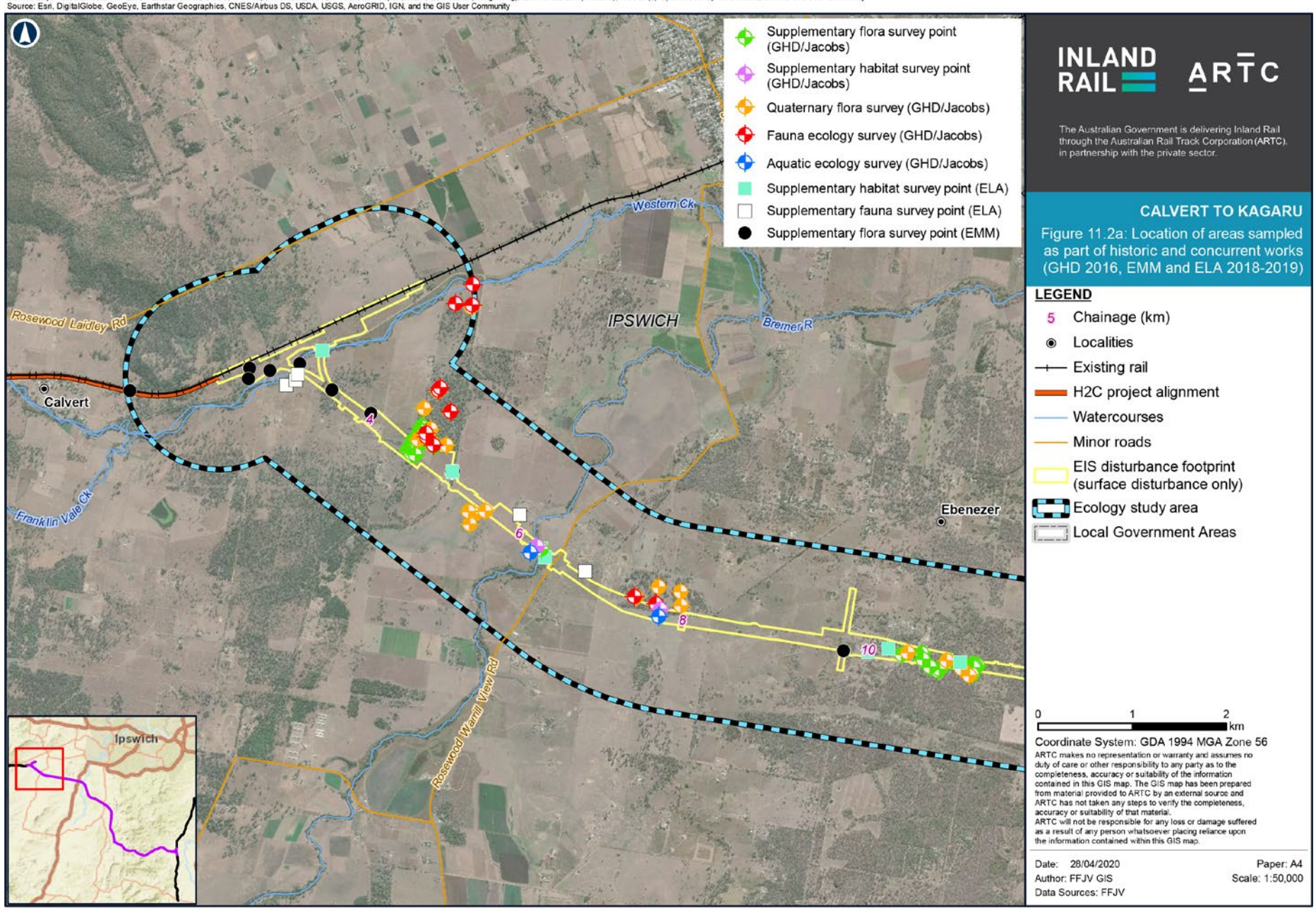
Project EIS field investigations (undertaken by FFJV) were undertaken over a nine-consecutive day period during spring, between 11 September 2017 and 19 September 2017 (refer Figure 11.4).

Following the initial sampling associated with the EIS studies (2017), the Project's alignment through the Teviot Range was revised, and moved north. Additional ecological surveys to support geotechnical investigations (i.e. March 2017 to September 2018) were undertaken along the amended alignment (including the section in the Teviot Range associated with the tunnel). However, given no surface disturbance is proposed for areas associated with the tunnel, survey within this section of the alignment has not been as intense as in other areas identified for direct disturbance.

TABLE 11.5: TIMING OF FIELD INVESTIGATIONS ASSOCIATED WITH THE PROJECT AND USED TO SUPPLEMENT THE RESULTS OF THE CURRENT STUDY

Study/investigation	Consultant/ year	Timing of investigations	Season	Methodologies and notes
Southern Freight Rail Corridor Study (March 2010)	AECOM (2010a and 2010b)	March–April (2008)	Autumn (2008)	▸ Verification of REs and vegetation communities within corridor ▸ Targeted surveys for threatened flora and fauna species ▸ Incidental aquatic surveys ▸ 26 sites targeted within the corridor
Calvert to Kagaru Flora and Fauna Technical Report	Jacobs–GHD (2016b)	9–16 May (2016)	Autumn (2016)	▸ Verification of vegetation communities—60 flora sites ▸ Targeted surveys for threatened flora and fauna species ▸ Rapid habitat assessments ▸ Nocturnal searches/spotlighting ▸ Active searches for Koala ▸ Electrofishing
Woolooman Tunnel Geotechnical Access–Ecological Assessment Report and Protected Plants Assessment Report	GHD (2017a,b)	13–17 February (2017)	Summer (2017)	▸ Survey of alternative tunnel options in Teviot Range for Project (including areas outside the ecology study area) ▸ Protected plant surveys (systematic transect searches and plot-based population surveys) ▸ Searches for fauna breeding places ▸ Threatened fauna habitat surveys ▸ Targeted surveys for threatened fauna species ▸ Active searches for Koala ▸ Nocturnal searches/spotlighting
Protected plant surveys associated with geotechnical investigations to support EPBC Referral 2018-8263	EMM (2018b, 2018c)	16 May 2018 and 28 June 2018	Autumn, Winter (2018)	▸ Protected plant surveys within/adjacent to alignment (meander surveys—minimum 30 minutes) at 70 sites
Pre-clearing surveys associated with geotechnical investigations to support EPBC Referral 2018-8263 and inform the Gowrie to Kagaru Geotechnical Investigations Environmental Management Plan	EMM (2018d, 2018e)	4–14 September 2018 26–28 November 2018	Spring (2018)	▸ Threatened fauna habitat assessments within/adjacent to alignment ▸ Searches for fauna breeding places ▸ Vegetation community and TEC confirmation ▸ Fauna observations ▸ Carried out at 25 sites throughout corridor
Protected Plant surveys associated with geotechnical investigations – identified as opportunistic surveys throughout this technical report	FFJV (2017–2018)	March 2017–September 2018	Autumn, Winter, Spring, (2017–2018)	▸ Protected plant surveys within/adjacent to alignment (meander surveys—minimum 30 minutes) and habitat surveys carried out at 69 sites ▸ Confirmation of vegetation communities
Protected plant surveys associated with geotechnical investigations	ELA (2019a, 2019b)	December 2018 – April 2019	Summer 2018/2019	▸ Protected plant surveys (meander surveys—minimum 30 minutes) at 42 sites throughout alignment

Study/investigation	Consultant/ year	Timing of investigations	Season	Methodologies and notes
Pre-clearing surveys associated with geotechnical investigations for C2K alignment	ELA (-2019c)	December 2018 – April 2019	Summer/ Autumn (2018/2019)	▸ Threatened fauna habitat surveys ▸ Habitat assessment ▸ Searches for fauna breeding places ▸ Fauna observations ▸ Confirmation of vegetation communities and TEC ▸ Carried out at 296 sites within corridor
Protected plant surveys associated with geotechnical investigations for Gowrie to Kagaru alignment	EMM (2019a, 2019b)	13–24 May 2019 3 June - 16 July 2019	Autumn/ Winter (2019)	▸ Threatened fauna habitat assessments ▸ Searches for fauna breeding places ▸ Confirmation of vegetation communities ▸ Fauna observations ▸ Carried out at 15 sites within corridor
Pre-clearing surveys associated with geotechnical investigations for Gowrie to Kagaru alignment	EMM (2019c)	14–29 May 2019	Autumn (2019)	▸ Threatened fauna habitat assessments within/adjacent to alignment ▸ Searches for fauna breeding places ▸ Confirmation of vegetation communities ▸ Fauna observations ▸ Carried out at 14 sites within corridor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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Supplementary flora survey point (GHD/Jacobs)
Supplementary habitat survey point (GHD/Jacobs)
Quaternary flora survey (GHD/Jacobs)
Fauna ecology survey (GHD/Jacobs)
Aquatic ecology survey (GHD/Jacobs)
Supplementary habitat survey point (ELA)
Supplementary fauna survey point (ELA)
Supplementary flora survey point (EMM)
Western Ck
Rosewood Laidley Rd
IPSWICH
Bremer R
Calvert
Franklin Vale Ck
Ebenezer
Rosewood Warrill View Rd
Ipswich
4
6
8
10
INLAND RAIL
ARTC
The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.
CALVERT TO KAGARU
Figure 11.2a: Location of areas sampled as part of historic and concurrent works (GHD 2016, EMM and ELA 2018-2019)
LEGEND
5 Chainage (km)
Localities
Existing rail
H2C project alignment
Watercourses
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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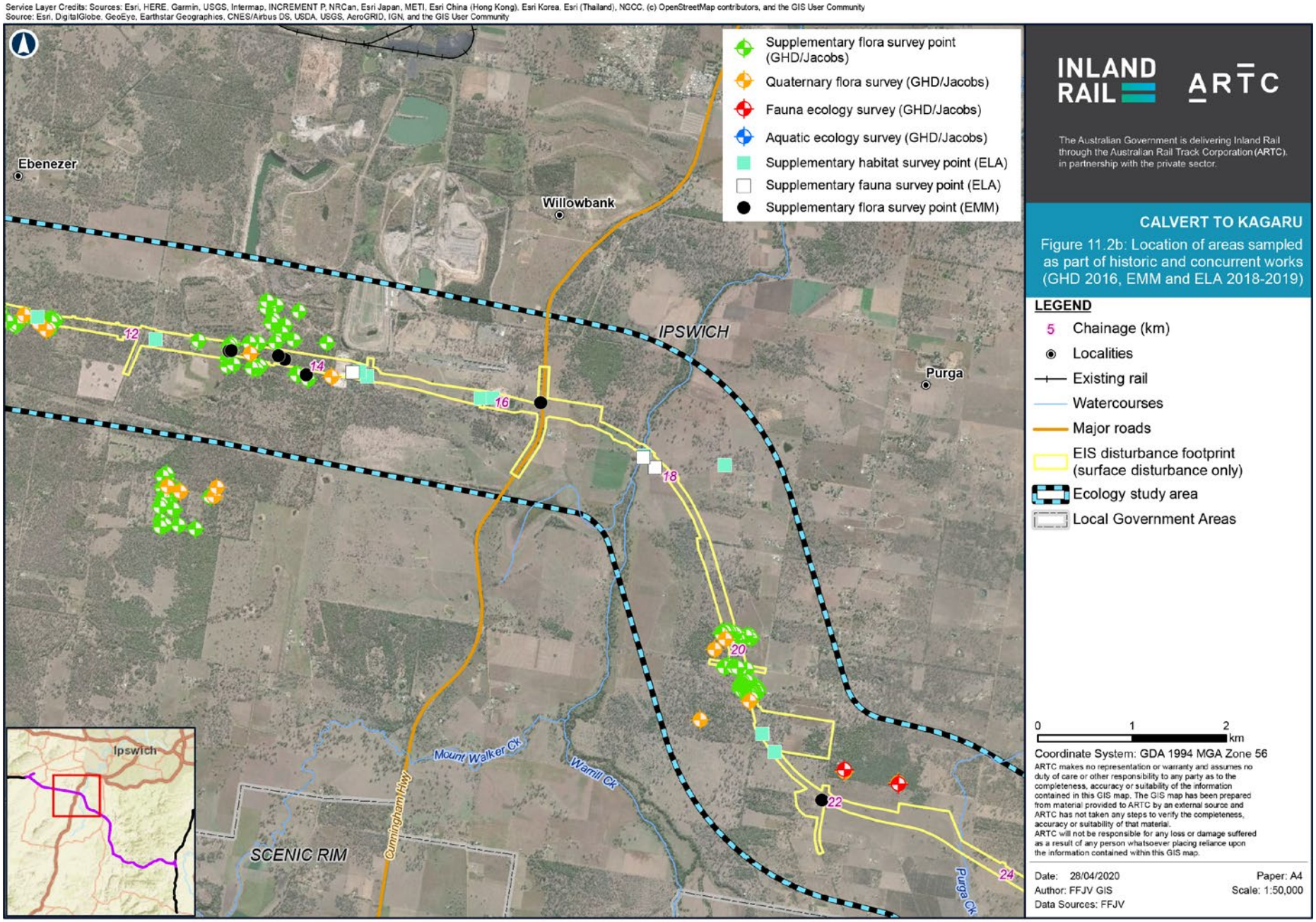
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Supplementary flora survey point (GHD/Jacobs)
Quaternary flora survey (GHD/Jacobs)
Fauna ecology survey (GHD/Jacobs)
Aquatic ecology survey (GHD/Jacobs)
Supplementary habitat survey point (ELA)
Supplementary fauna survey point (ELA)
Supplementary flora survey point (EMM)
Ebenezer
Willowbank
IPSWICH
Purga
SCENIC RIM
Mount Walker Ck
Warrill Ck
Cunningham Hwy
Purga Ck
12
14
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24
Ipswich
INLAND RAIL
ARTC
The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.
CALVERT TO KAGARU
Figure 11.2b: Location of areas sampled as part of historic and concurrent works (GHD 2016, EMM and ELA 2018-2019)
LEGEND
5 Chainage (km)
Localities
Existing rail
Watercourses
Major roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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Paper: A4
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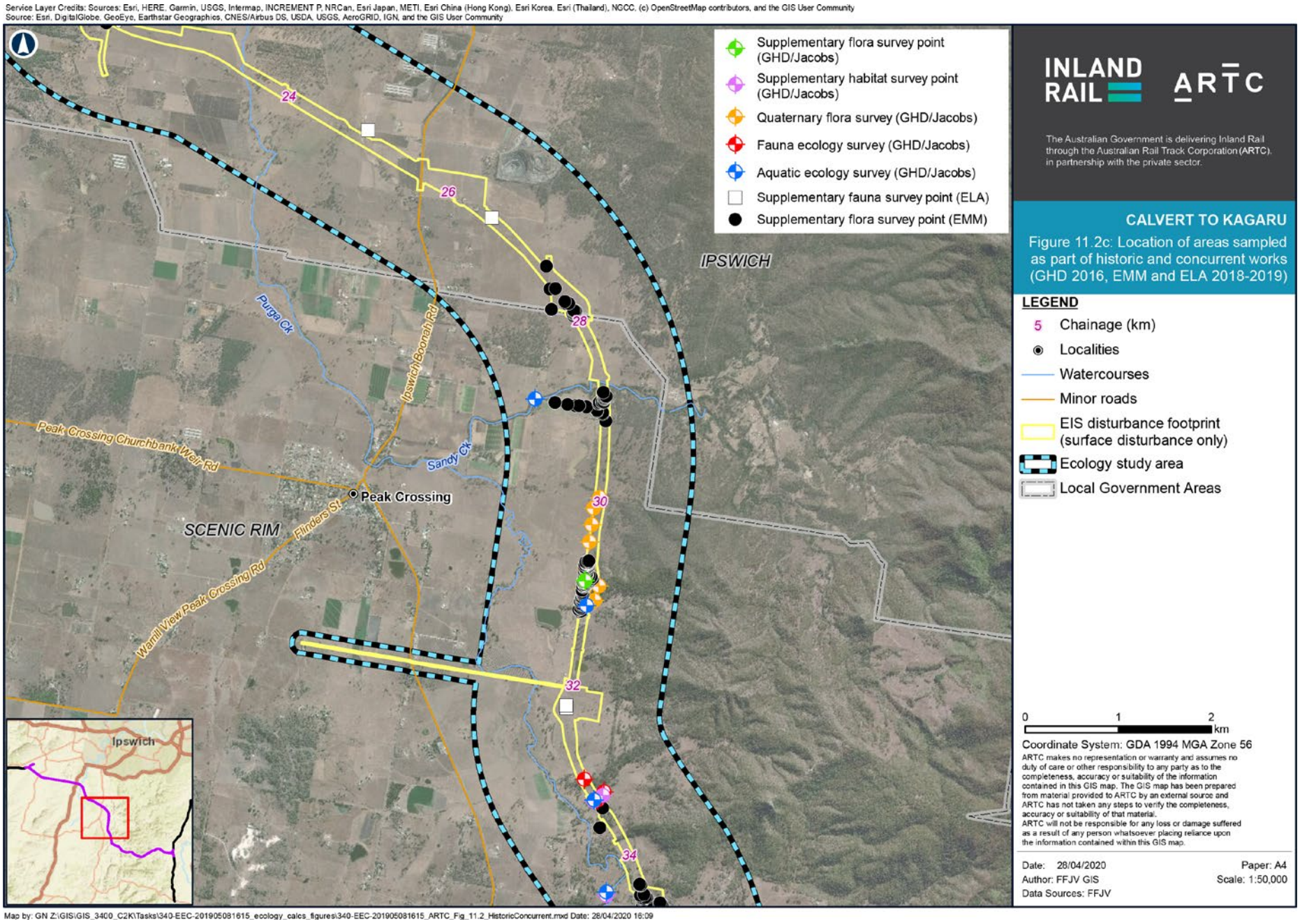
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Supplementary flora survey point (GHD/Jacobs)
Supplementary habitat survey point (GHD/Jacobs)
Quaternary flora survey (GHD/Jacobs)
Fauna ecology survey (GHD/Jacobs)
Aquatic ecology survey (GHD/Jacobs)
Supplementary fauna survey point (ELA)
Supplementary flora survey point (EMM)
IPSWICH
SCENIC RIM
Peak Crossing
Purga Ck
Ipswich Boonah Rd
Sandy Ck
Peak Crossing Churchbank Weir Rd
Flinders St
Warrill View Peak Crossing Rd
24
26
28
30
32
34
Ipswich
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CALVERT TO KAGARU
Figure 11.2c: Location of areas sampled as part of historic and concurrent works (GHD 2016, EMM and ELA 2018-2019)
LEGEND
5 Chainage (km)
Localities
Watercourses
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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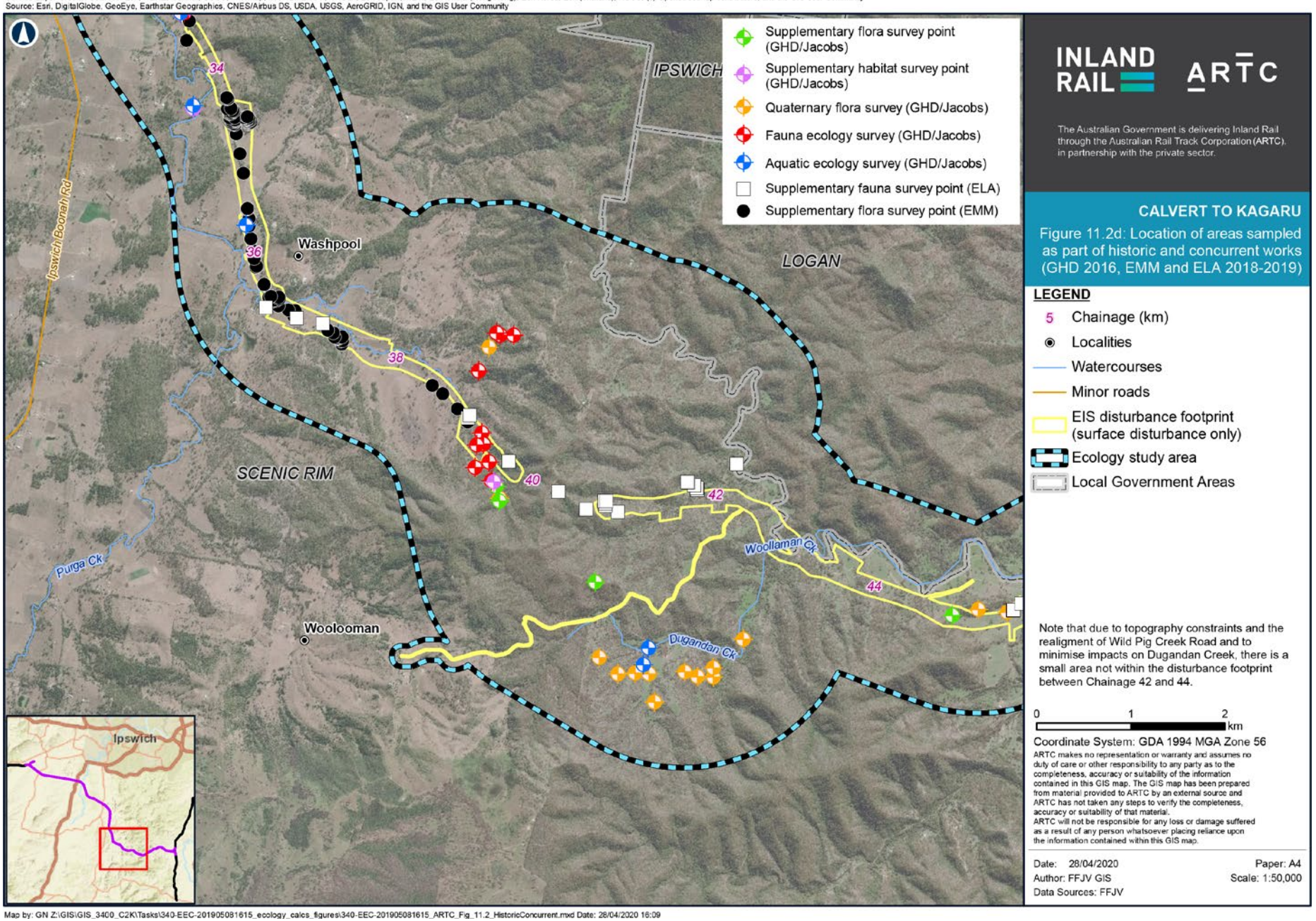
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Supplementary flora survey point (GHD/Jacobs)
Supplementary habitat survey point (GHD/Jacobs)
Quaternary flora survey (GHD/Jacobs)
Fauna ecology survey (GHD/Jacobs)
Aquatic ecology survey (GHD/Jacobs)
Supplementary fauna survey point (ELA)
Supplementary flora survey point (EMM)
IPSWICH
LOGAN
SCENIC RIM
Washpool
Wooloman
Ipswich Boonah Rd
Purga Ck
Woollaman Ck
Dugandan Ck
34
36
38
40
42
44
Ipswich
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Figure 11.2d: Location of areas sampled as part of historic and concurrent works (GHD 2016, EMM and ELA 2018-2019)
LEGEND
5 Chainage (km)
Localities
Watercourses
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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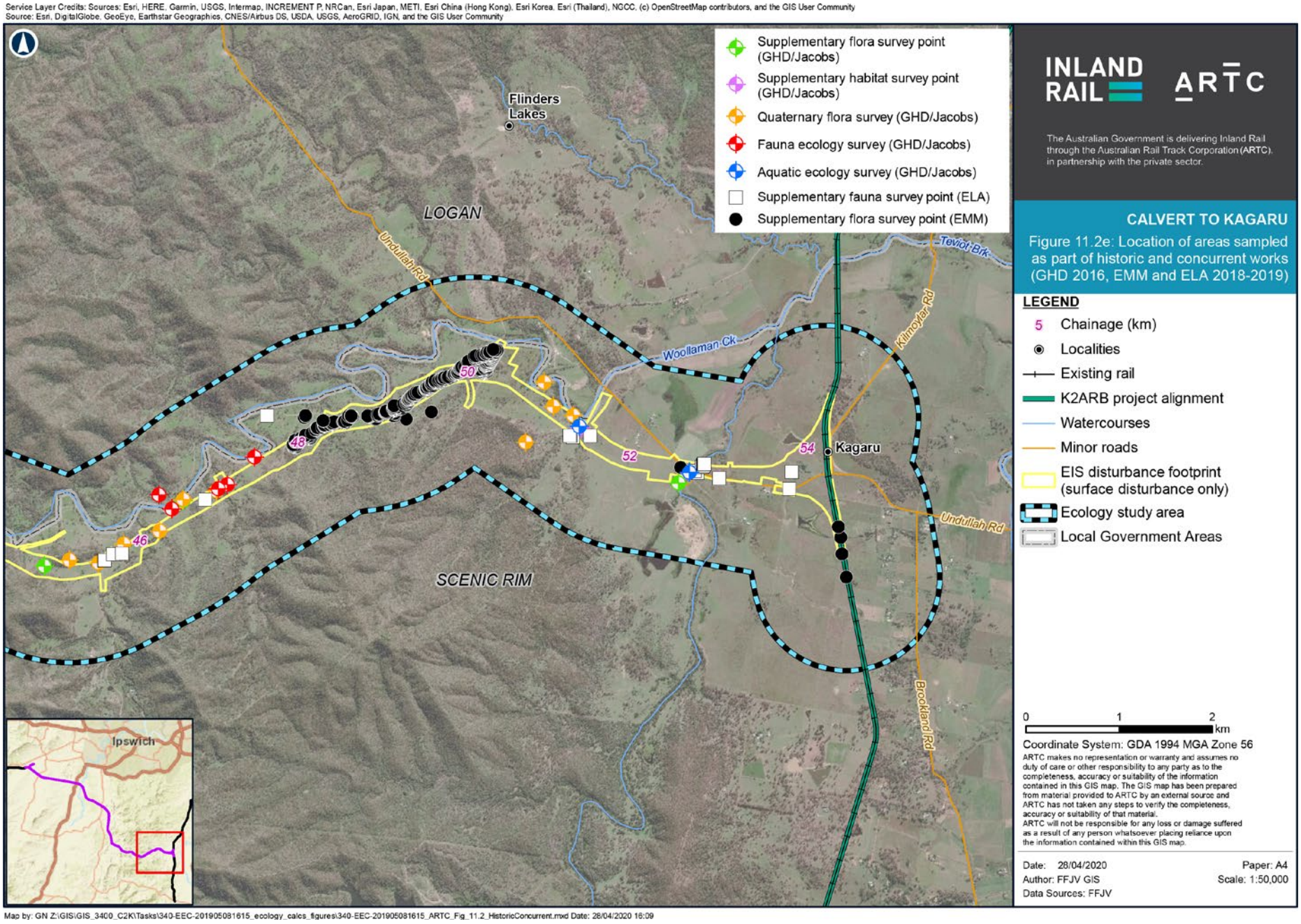
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Supplementary flora survey point (GHD/Jacobs)
Supplementary habitat survey point (GHD/Jacobs)
Quaternary flora survey (GHD/Jacobs)
Fauna ecology survey (GHD/Jacobs)
Aquatic ecology survey (GHD/Jacobs)
Supplementary fauna survey point (ELA)
Supplementary flora survey point (EMM)
Flinders Lakes
LOGAN
SCENIC RIM
Kagaru
Undullah Rd
Woollaman Ck
Teviot Brk
Kilmoylar Rd
Brockland Rd
46
48
50
52
54
Ipswich
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Figure 11.2e: Location of areas sampled as part of historic and concurrent works (GHD 2016, EMM and ELA 2018-2019)
LEGEND
5 Chainage (km)
Localities
Existing rail
K2ARB project alignment
Watercourses
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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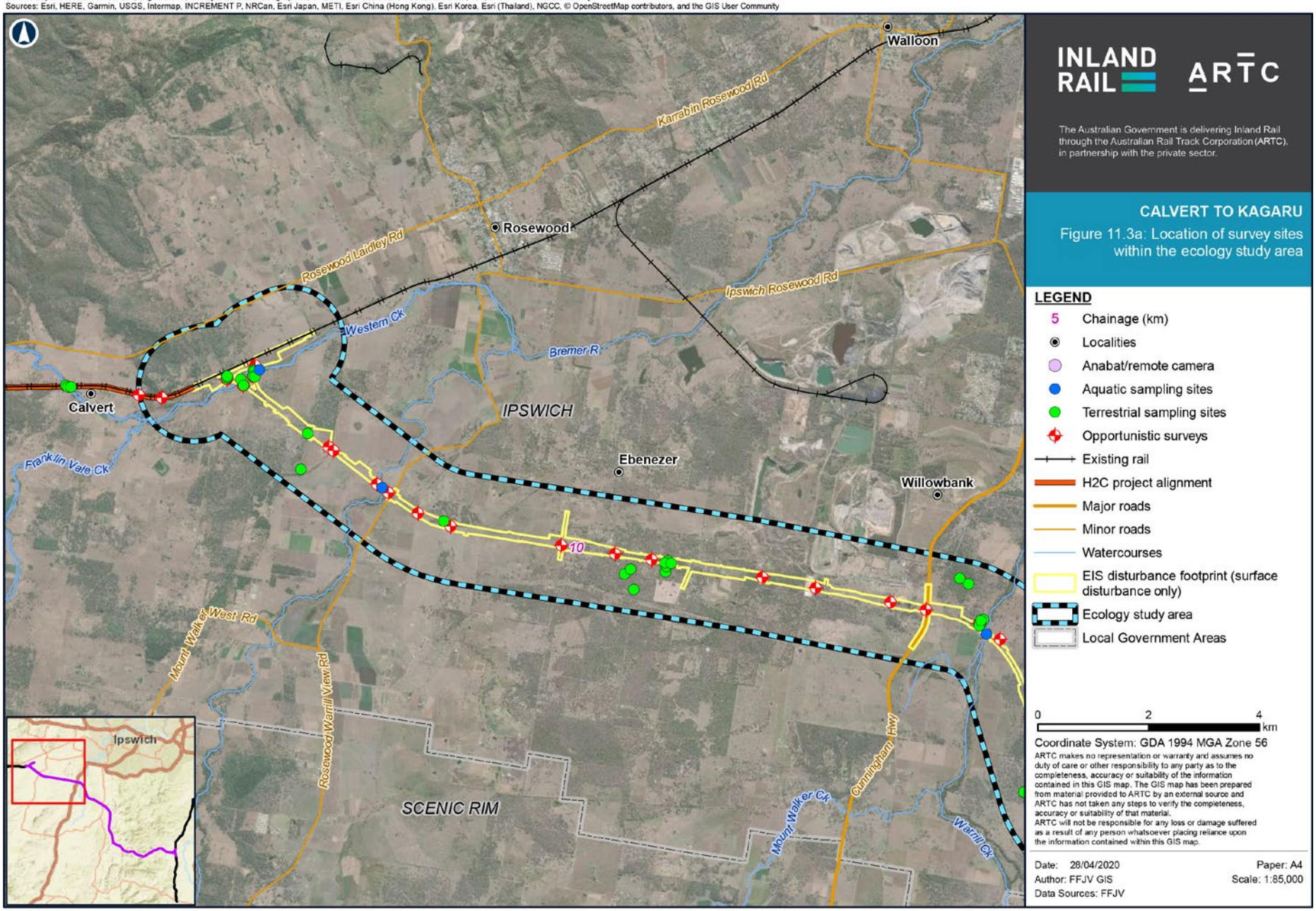
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Walloon
Karrabin Rosewood Rd
Rosewood
Rosewood Laidley Rd
Western Ck
Ipswich Rosewood Rd
Bremer R
IPSWICH
Calvert
Franklin Vale Ck
Ebenezer
Willowbank
10
Mount Walker West Rd
Rosewood Warrill View Rd
SCENIC RIM
Mount Walker Ck
Cunningham Hwy
Warrill Ck
Ipswich
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Figure 11.3a: Location of survey sites within the ecology study area
LEGEND
5 Chainage (km)
Localities
Anabat/remote camera
Aquatic sampling sites
Terrestrial sampling sites
Opportunistic surveys
Existing rail
H2C project alignment
Major roads
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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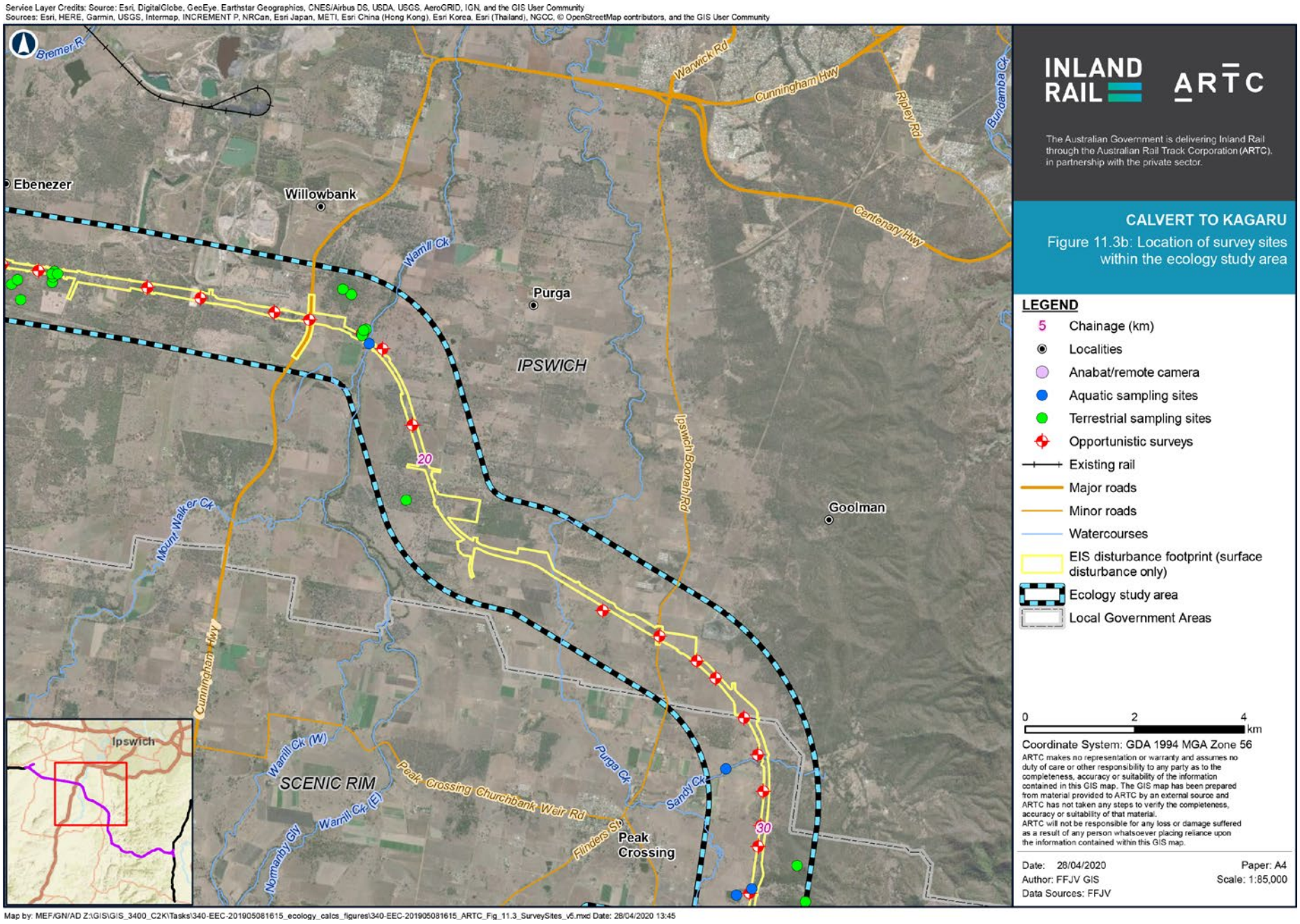
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Bremer R
Ebenezer
Willowbank
Warrill Ck
Purga
IPSWICH
Warwick Rd
Cunningham Hwy
Ripley Rd
Burdamba Ck
Centenary Hwy
Ipswich Boonah Rd
Goolman
20
Mount Walker Ck
Cunningham Hwy
Warrill Ck (W)
SCENIC RIM
Peak Crossing Churchbank Weir Rd
Purga Ck
Sandy Ck
Warrill Ck (E)
Normanby Gly
Flinders St
Peak Crossing
30
Ipswich
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Figure 11.3b: Location of survey sites within the ecology study area
LEGEND
5 Chainage (km)
Localities
Anabat/remote camera
Aquatic sampling sites
Terrestrial sampling sites
Opportunistic surveys
Existing rail
Major roads
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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Author: FFJV GIS
Data Sources: FFJV
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Scale: 1:85,000
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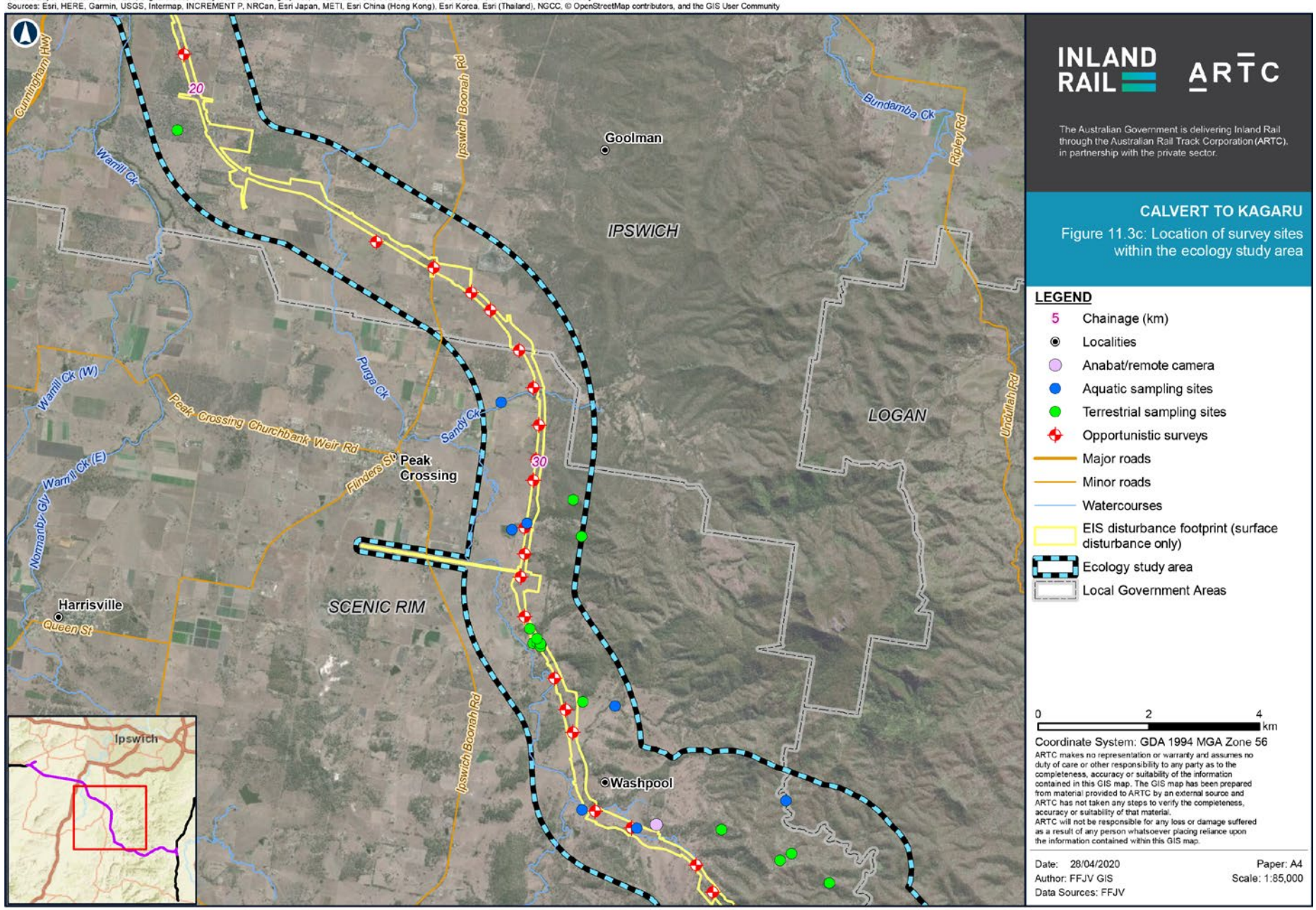
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Cunningham Hwy
Warrill Ck
Ipswich Boonah Rd
Goolman
Burndamba Ck
Ripley Rd
IPSWICH
Warrill Ck (W)
Purga Ck
Peak Crossing Churchbank Weir Rd
Sandy Ck
Undullah Rd
LOGAN
Flinders St
Peak Crossing
Warrill Ck (E)
Normanby Gly
Harrisville
Queen St
SCENIC RIM
Washpool
Ipswich
20
30
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Figure 11.3c: Location of survey sites within the ecology study area
LEGEND
5 Chainage (km)
Localities
Anabat/remote camera
Aquatic sampling sites
Terrestrial sampling sites
Opportunistic surveys
Major roads
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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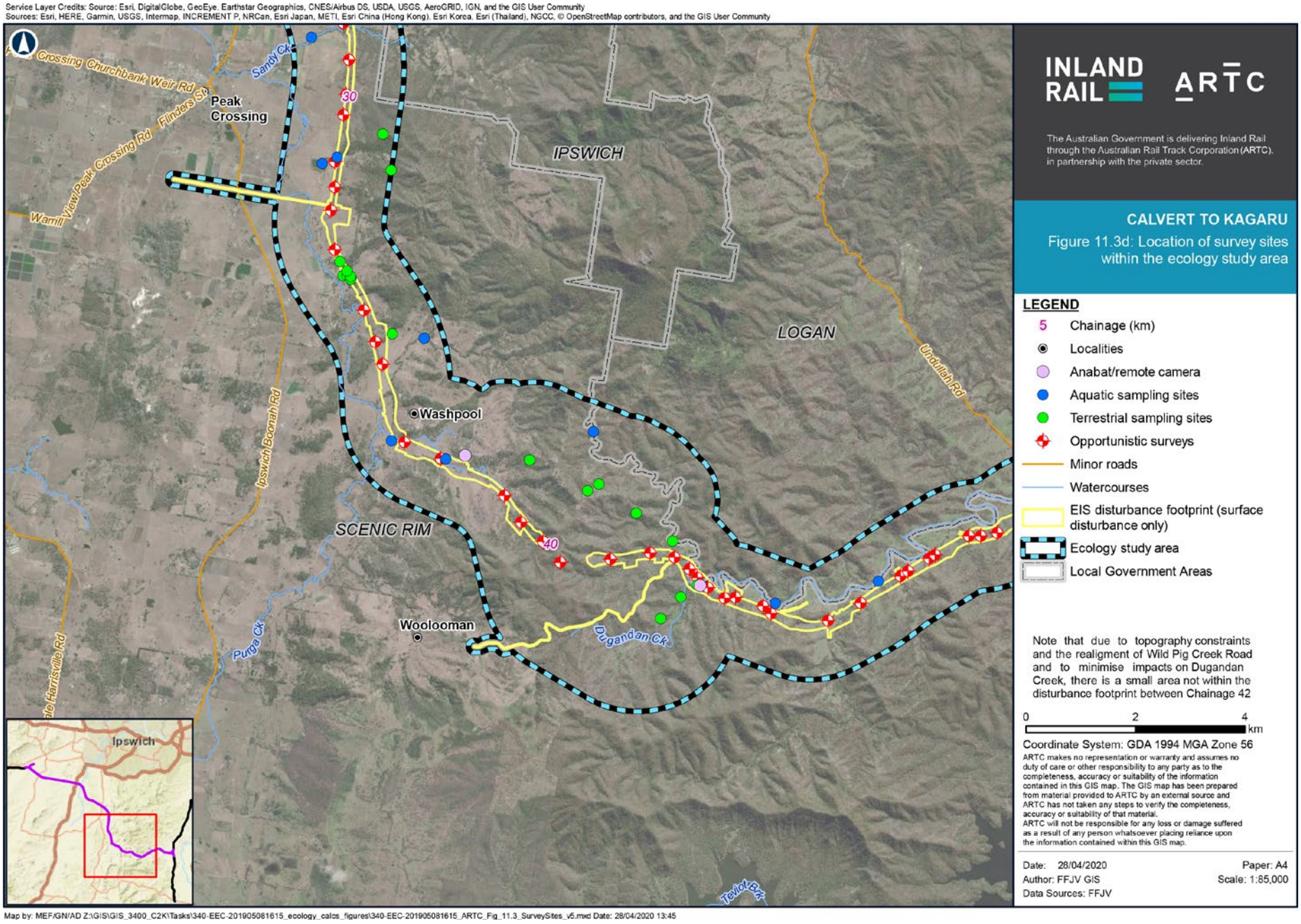
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Peak Crossing
Sandy Ck
Crossing Churchbank Weir Rd
Flinders St
Warrill View Peak Crossing Rd
IPSWICH
LOGAN
SCENIC RIM
Washpool
Ipswich Boonah Rd
Undullah Rd
Woolooman
Purga Ck
Dugandan Ck
Ipswich
30
40
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Figure 11.3d: Location of survey sites within the ecology study area
LEGEND
5 Chainage (km)
Localities
Anabat/remote camera
Aquatic sampling sites
Terrestrial sampling sites
Opportunistic surveys
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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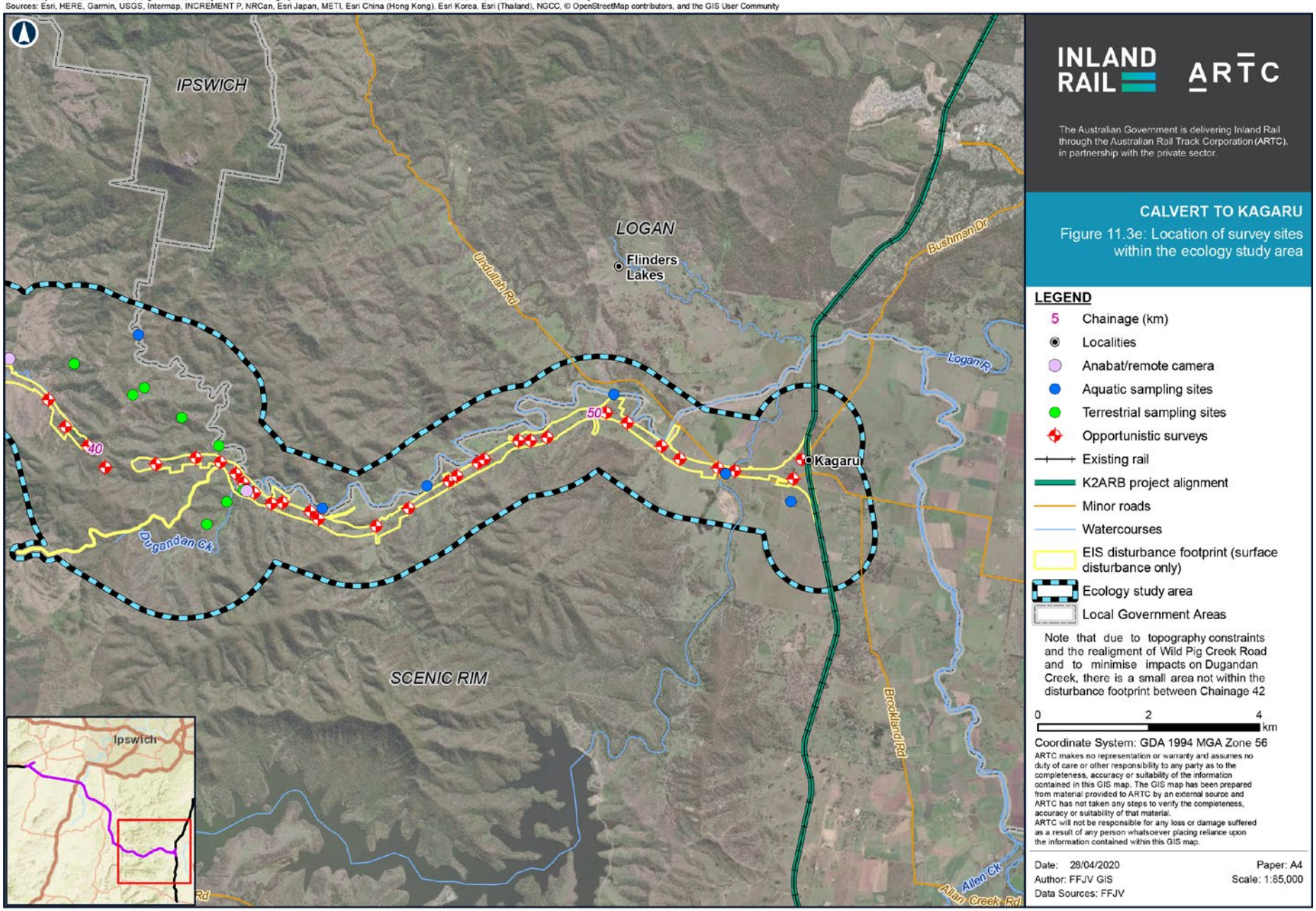
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IPSWICH
LOGAN
Flinders Lakes
Undullah Rd
Bushman Dr
Logan R
50
40
Kagaru
Dugandan Ck
SCENIC RIM
Brockland Rd
Allen Ck
Allan Creek Rd
Ipswich
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Figure 11.3e: Location of survey sites within the ecology study area
LEGEND
5 Chainage (km)
Localities
Anabat/remote camera
Aquatic sampling sites
Terrestrial sampling sites
Opportunistic surveys
Existing rail
K2ARB project alignment
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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A representative sampling approach was employed as part of the EIS field sampling methodology. Sampling sites were selected, which were specifically identified as containing features of interest. Specifically, the following features were used to target areas:

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

At each location, a census of all flora, fauna, vegetation communities and habitat features (e.g. presences of hollows, leaf litter, surface rocks, soil banks, water and wetlands, and the availability of foraging resources such as flowers and fruit) was undertaken. Surveys were undertaken with due consideration of the following:

- Australian Government-published guidelines for threatened species, where applicable (environment.gov.au/epbc/policy-statements)
- *Methodology for survey and mapping of REs and vegetation communities in Queensland* (Neldner et al., 2012)
- *Terrestrial vertebrate fauna guidelines for Queensland* (Eyre et al., 2018)
- *Flora Survey Guidelines—Protected Plants*, NC Act (DES, 2016b).

Areas sampled as part of the field reconnaissance are presented in Figure 11.4. Where field analysis identified sensitive environmental receptors or deviations from the predictive habitat modelling, this information was used to refine the relevant species-specific model to increase the accuracy and precision of the data for use in subsequent impact assessment analysis.

Further details related to the field assessment methodologies is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report.

11.4.5.2 Aquatic ecology

A total of 16 sites were selected for aquatic habitat assessments based on wetland and watercourse mapping and land access. The aquatic ecology field assessment described the environmental values of targeted drainage systems within the ecology study area. The AUSRIVAS Physical Assessment Protocol was used in the field assessment of the drainage systems (Parsons, et al., 2002). The physical habitat assessment was based on the AUSRIVAS bioassessment method, which provides a protocol for the assessment of stream physical and geomorphological condition (DNRM, 2001).

As the aquatic ecology field assessment was used to determine potential habitat viability, the assessment was conducted on intersecting defined watercourses along the Project alignment. The results were used to refine the aquatic receptors present within the ecology study area.

The AUSRIVAS Physical Assessment Protocol is a standardised rapid method for the collection of geomorphological, physical habitat and riparian data.

The key geomorphological, physical habitat and riparian data that was collected at each assessment site from 25 September 2017 to 29 September 2017, included:

- Valley characteristics, including valley shape and channel slope
- Land use, including catchment land use and local land use
- Physical morphology and bedform of the watercourse, including channel shape and extent and type of bars (i.e. an elevated region of sediment (such as sand or gravel) that has been deposited by the flow)
- Cross-sectional dimensions of the watercourse, including bank-full channel width and depth, bank width and height and baseflow stream width and depth
- Substrate characteristics, including bed compaction, sediment angularity, bed stability rating, sediment matrix and substrate composition
- Floodplain characteristics, including floodplain width and features
- Bank characteristics, including bank shape and slope, bank material, bedrock outcrops, factors affecting bank stability and artificial bank protection measures
- In-stream vegetation and organic matter, including extent of large woody debris, macrophyte cover and species composition

- Physical condition indicators and habitat assessment
- Riparian vegetation characteristics, including shading of channel, extent of trailing bank vegetation, species compositions, riparian zone width and extent of disturbance
- Water quality visual observations, including turbidity, water and sediment oils, water and sediment odours, algae and moss cover.

Qualitative water quality observations were supported by collection of water samples for quantitative assessments as part of the Project surface water quality investigations (refer Chapter 13: Surface Water and Hydrology, Appendix M: Surface Water Quality Technical Report and Appendix J: Terrestrial and Aquatic Ecology Technical Report).

The habitat value of each aquatic ecology assessment site was assessed to describe the aquatic fauna assemblages that were considered likely to use the area. Recordings of incidental fauna species observed during the aquatic field survey were taken at each aquatic ecology assessment site. A sample of aquatic fauna species present at the time the aquatic sampling was undertaken using baited traps and dip netting, specifically targeting vertebrate species such as fish and turtles, as appropriate. Aquatic flora species were also identified at the time of sampling. Adequate habitat assessment and field data was collected to inform a likelihood of occurrence assessment for threatened aquatic species within the ecology study area.

During the aquatic ecology field investigations, data was collected with respect to any aquatic invasive species and other disturbances present within or affecting the aquatic environments.

Further details related to the field assessment methodologies is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report.

11.4.5.3 Survey effort

In addition to the targeted EIS study survey locations identified in Figure 11.3 and initial flora studies carried out by GHD–Jacobs in 2016 (60 sites within the ecology study area), 69 opportunistic surveys associated with geotechnical investigations were undertaken by FFJV personnel, specifically targeting areas within the disturbance footprint. The location of opportunistic surveys is shown in Figure 11.3. A total area of approximately 299 ha was assessed (i.e. 82 ha associated with targeted surveys and 217 ha associated with opportunistic investigations). This represents approximately 2.4 per cent of the ecology study area and approximately 30.6 per cent of the disturbance footprint.

Protected plant surveys conducted during 2018 and 2019 (refer Table 11.3) by EMM (2018b, 2018c, 2019a, 2019b) and ELA (2019a, 2019b) include surveys at 196 sites within and adjacent to the disturbance footprint. It is estimated that 149 linear kilometres of protected plant meander/pre-clearance surveys to have being undertaken. The methods used are considered to provide an acceptable level of survey effort to sufficiently inform an assessment against the both Commonwealth and State-based guidelines for threatened flora species.

11.4.6 Impact assessment methodology

The terrestrial and aquatic impact assessment of the Project uses a significance-based impact assessment framework to identify and assess Project-related impacts in relation to sensitive environmental receptors. Several stages were involved in the assessment of Project impacts to sensitive environmental receptors, which included identifying sensitive environmental receptors, defining their 'sensitivity' rating, identifying potential impacts resulting from the Project and identification of the magnitude of impacts to the sensitive environmental receptor (i.e. extent of area impact).

For the purpose of impact assessment, terrestrial and aquatic ecology sensitive environmental receptors were assessed both quantitatively and qualitatively. A significant impact depends on the sensitivity of a sensitive environmental receptor, the quality of the environment that is impacted, and the magnitude of the potential impacts. Determination of the sensitivity or vulnerability of the sensitive environmental receptor and the magnitude of the potential impacts facilitate the assessment of the significance of potential ecological impacts.

The use of predictive habitat models facilitated the quantification of potential impacts to which initial mitigation measures were then applied. Reassessment of Project-related impacts accounting for the implementation of Project mitigation measures then identified instances where potentially significant impacts, such as a result of the Project to sensitive environmental receptors, may occur.

Where potentially significant impacts following Project mitigation measures were identified, these sensitive environmental receptors were then subject to significant impact assessment using the relevant significant impact guidelines to inform potential offset requirements.

For MNES, the significant impact criteria is outlined in the *Matters of National Environmental Significance Significant impact guidelines 1.1* (*Environment Protection and Biodiversity Conservation Act 1999*) (DotE, 2013); *EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)* (DotE, 2014), and the *Draft referral guidelines for 14 birds listed as migratory species under the EPBC Act* (DotE, 2015a).

For MSES, the significant impact criteria are outlined in the *Queensland Environmental Offsets Policy Significant Residual Impact Guidelines* (DEHP, 2014a).

Further details related to the impact assessment are provided in Appendix J: Terrestrial and Aquatic Technical Ecology Report and Appendix K: Matters of National Environmental Significance Technical Report.

11.4.7 Stakeholder engagement

Flora, fauna and habitat matters have been raised regularly by stakeholders and the community in discussions, meetings and correspondence with the Project team. These include:

- Habitat for Koalas (*Phascolarctos cinereus*)
- Impacts to the Regent Honeyeater (*Anthochaera phrygia*)
- Retention of Swamp Tea-tree (*Melaleuca irbyana*)
- Habitat connectivity across the corridor.

The Project team also held a workshop on how to provide species record information or data collected by community members to the QLD Government so it can be recorded and recognised in the Wildlife Online database. This data was subsequently used as part of the EIS investigations. The feedback provided by stakeholders and the community to the Project team has continuously reinforced the importance of ecological values to the community and driven the Project team to seek opportunities to avoid, minimise and manage impacts to species and their habitats wherever feasible in this stage of Project development.

11.4.8 Precautionary principle

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

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

Ecological assessments have responded to this requirement in the following ways:

- The assessment of potential impacts is based on best practice, using the best available information. The assessment has involved key stakeholders and the relevant government agencies.
- The impact assessment considered the maximum potential area of disturbance.
- The Project alignment was first investigated in 2005. Since then, the Project alignment has been the subject of numerous desktop and field investigations, as well as wide-reaching stakeholder consultation. Knowledge gained over this period will ensure that the Project is designed, constructed and operated in a way that minimises potential impacts.
- Lack of full scientific certainty has not been used as a reason for postponing measures to prevent environmental damage. For example, threatened species that could potentially occur but were not observed within the ecology study area during field surveys are still assumed present (rather than absent). Measures to avoid and/or mitigate impacts on threatened species are proposed, on the basis that these threatened species could be present within the ecology study area.
- The detailed design will aim to further minimise impacts and site and species-specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable and the significant residual impacts are offset.
- During development of the Project, the alignment has been refined to:
  - Avoid sensitive vegetation, areas with known threatened flora and fauna communities, and key habitat areas
  - Avoid known items/areas of cultural heritage significance
  - Minimise flooding impacts
  - Minimise impacts on existing agricultural land and infrastructure, while also considering potential future land uses.

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

The Project contributions to the conversation of biological diversity and ecological integrity include:

- A crossing structure hierarchy was adopted during design development. Preference was given to bridges over culverts as, on the whole, bridges result in less severe impacts to fauna passage.

Close attention was paid to the DAF *Accepted development requirements for operational work that is constructing or raising waterway barrier works* when designing bridges and culverts across mapped QLD Waterways for waterway barriers works (QLD Government, 2020b).

- A Reinstatement and Rehabilitation Plan will be developed to guide the approach to rehabilitating disturbed areas. Rehabilitation will occur progressively throughout the construction phase.
- Other plans that will be developed to minimise potential impacts on biodiversity during the construction phase include: Erosion and Sediment Control Plans, Biosecurity Management Plan, Flora and Fauna Sub-plan and Soil Management Plan to the CEMP.

Where impacts cannot be avoided (e.g. clearing of remnant vegetation or habitat for a threatened species), mitigation and management measures will be implemented. Where required, biodiversity offsets will be secured. An Environmental Offset Delivery Strategy—Qld for the Project has been prepared in consultation with the QLD and Australian Governments and is included in Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report.

11.5 Description of existing conditions

11.5.1 Regional and local context

Moving from west to east, the landscapes within the Calvert area (western study area) are characterised by very high levels of anthropogenic disturbance and present a highly fragmented environment dominated primarily by pasture grasses, isolated trees and areas of woody regrowth. While much of the area is subject to grazing and other agricultural practices, waterways (e.g. Western Creek and the Bremer River) typically retain some degree of floristic structural complexity and have the potential to act as local fauna movement conduits and refuge habitats for a diversity for species.

Areas around Ebenezer (east of Calvert) are typically characterised as a highly fragmented and anthropogenically impacted (i.e. subject to land clearing for agricultural purposes) landscape. However, areas of woody regrowth vegetation (i.e. Category C regulated vegetation) are more abundant compared to the western portion of the alignment, particularly those areas to the south of the Project. As in the west, non-native pasture improvement species (e.g. grasses) dominate much of the landscape. Areas containing remnant vegetation (i.e. Category B regulated vegetation) are present within this area; however, these vegetation communities largely exist as isolated islands within a fragmented landscape.

Despite this fragmented landscape, the areas associated with Ebenezer have been identified as an ecological corridor of regional significance under the BPA. The area is also modelled by DES as core habitat for *Melaleuca irbyana*, with patches of vegetation around Ebenezer and Purga analogous to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC.

The areas south of Purga towards Peak Crossing and Washpool are largely rural landscapes dominated by pasture species. However, within these areas, woody regrowth and remnant vegetation in the form of intact ecosystems are increasingly common to the east of the ecology study area, particularly around Peak Crossing and Washpool. These areas coincide with the Project's parallel alignment with the Teviot Range. Most of this remnant vegetation is located outside of the ecology study area and situated in areas of sloping topography, which are generally not conducive to agricultural activities.

Throughout the Woolooman area (in the east of the ecology study area) and the Teviot Range, the terrain is rugged and there is minimal development, although historic land clearing practices have resulted in large areas of woody regrowth vegetation that has not yet reached remnant status (in relation to canopy height and cover). While there is some remnant vegetation contained within the ecology study area, most remnant communities are located to the north and south of the Project. The existing nature of the topography and vegetation within the Teviot Range, enhances its ability to function as a fauna movement conduit, facilitating wildlife movement in a north–south direction.

The Teviot Range has been identified as a terrestrial ecological corridor of State significance under the BPA. In addition, this area functions as flora and fauna refuge habitat and is known to support conservation-significant species such as Lloyd's Olive (*Notelaea lloydii*), Koala (*Phascolarctos cinereus*), Glossy-black Cockatoo (*Calyptorhynchus lathami*) and the Powerful Owl (*Ninox strenua*).

The area of Teviot Range to the north and east of the Project alignment and the ecology study area (i.e. Flinders Peak) is centred on a cluster of intrusive volcanic plugs of Tertiary geologic age (Mounts Blaine, Catherine, Goolman, Perry, Welcome, Flinders Peak and Ivorys Rock) and is recognised by DES as an area of special biodiversity (DEHP, 2016a; DEHP, 2016b; and DEHP, 2016c). This is due to the presence of several South East QLD endemic taxa and wildlife refugia.

The eastern portion of the alignment (areas around Kagaru) is characterised by largely non-remnant vegetation communities and agricultural land. The landscape is highly fragmented, with remnant vegetation communities restricted to steep topography or drainage features.

Potential aquatic and terrestrial GDEs were identified as being present within the ecology study area. Numerous watercourses traversing the groundwater study area are designated as moderate potential aquatic GDEs from regional studies (as defined in the GDE Atlas (BoM, 2020)) including Western Creek, Bremer River, Warrill Creek, Purga Creek and Teviot Brook. The potential GDEs are described as wetlands 'supplied by alluvial aquifers with near-permanent flow'.

Low and moderate potential terrestrial GDEs (from regional studies) have been identified within the Teviot Range portion of the ecology study area. These are generally described as wetland vegetation supplied by low porosity sedimentary rock with intermittent flow. Wetland supplied by alluvial aquifers with near permanent flow (eastern flank) and riparian vegetation supplied by sedimentary rocks with saline flow (western flank) are also indicated.

11.5.2 Flora and ecological communities

A total of 23 threatened or near-threatened flora species as listed under the EPBC Act (20 species) and/or the NC Act (20 species) have been identified from databases searches associated with the ecology study area. The majority of the species protected under the NC Act are also protected under the EPBC Act.

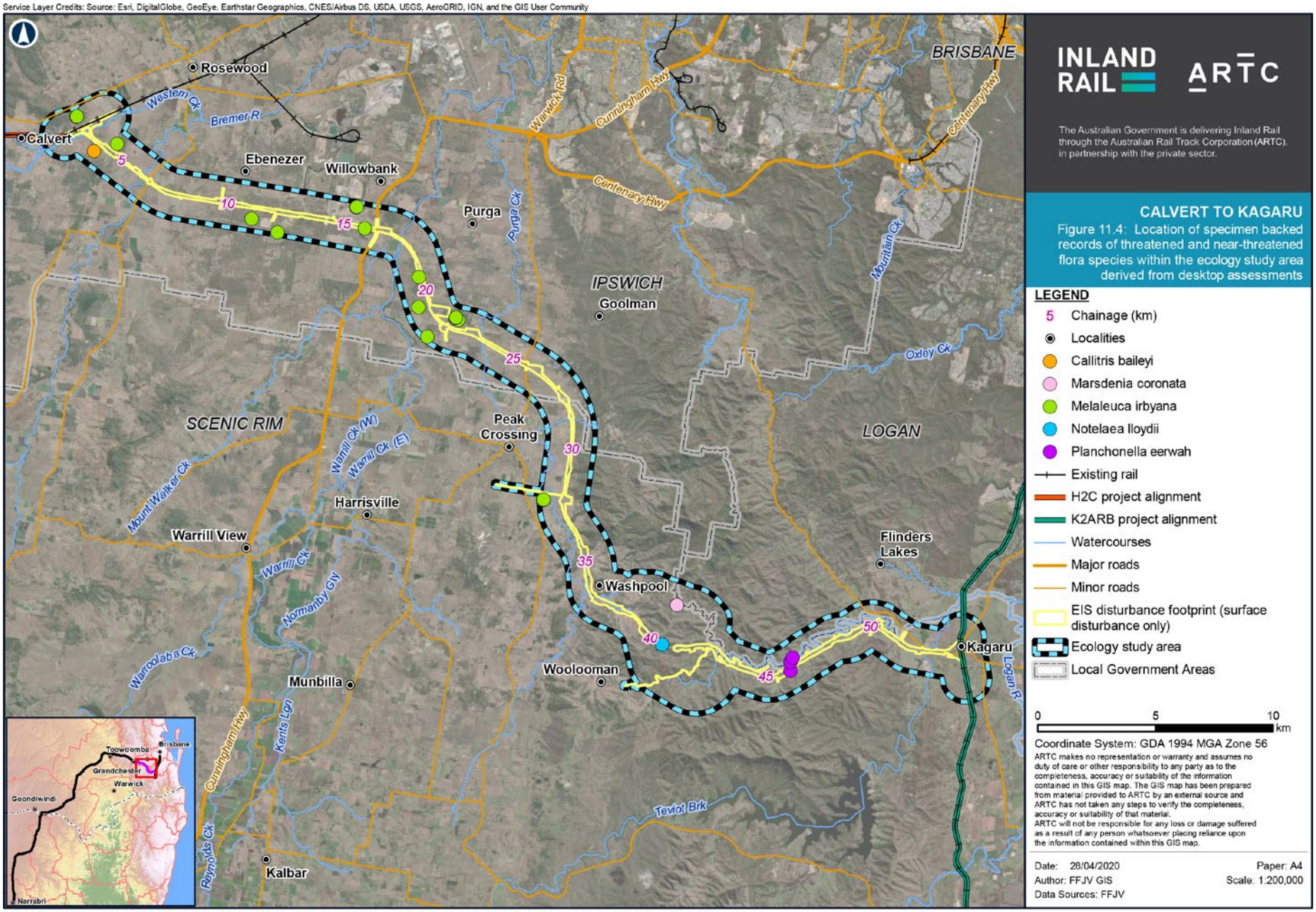
Five species listed under the provisions of the NC Act (five species) and/or the EPBC Act (two species) are considered likely to occur within the ecology study area based on specimen-backed records in Wildlife online and the Atlas of Living Australia databases and the presence of suitable habitat. The location of threatened or near-threatened flora species derived from specimen-backed records (e.g. Herbrecs and Atlas of Living Australia) within the ecology study area, is provided in Figure 11.5.

A total of 14 species listed under the provisions of the NC Act (12 species) and/or the EPBC Act (14 species) are considered as a 'possible occurrence' within the ecology study area based on the presence of suitable habitat.

A total of four species (Cooneana olive (*Notelaea ipsviciensis*), Austral cornflower (*Rhaponticum australe*) listed under the provisions of the NC Act and the EPBC Act are considered unlikely to occur within the ecology study area, based on their distributional limits.

The Austral toadflax (*Thesium australe*) is not currently known to occur within or in close proximity to the ecology study area. Nearby database records associated with this species exceed 27 years (and are largely much older) and the environment associated with these areas has undergone significant change as a result of anthropogenic processes and is no longer considered to be suitable for the persistence of this species.

A total of 252 plant species were identified within the ecology study area during Project EIS field assessments. These species included a total of 183 (72 per cent) native species and 69 (28 per cent) non-native species. A comprehensive list of flora species recorded within the ecology study area is available in Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report.


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Rosewood
Calvert
Ebenezer
Willowbank
Purga
BRISBANE
IPSWICH
Goolman
SCENIC RIM
Peak Crossing
LOGAN
Harrisville
Warrill View
Flinders Lakes
Washpool
Kagaru
Woolooman
Munbilla
Kalbar
Western Ck
Bremer R
Warwick Rd
Cunningham Hwy
Centenary Hwy
Purga Ck
Mountain Ck
Oxley Ck
Warrill Ck (W)
Warrill Ck (E)
Mount Walker Ck
Warrill Ck
Normanby Gly
Warroolaba Ck
Kents Lgn
Reynolds Ck
Logan R
Tevlot Brk
5
10
15
20
25
30
35
40
45
50
Toowoomba
Brisbane
Grandchester
Warwick
Goondiwindi
Narrabri
INLAND RAIL
ARTC
The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.
CALVERT TO KAGARU
Figure 11.4: Location of specimen backed records of threatened and near-threatened flora species within the ecology study area derived from desktop assessments
LEGEND
5 Chainage (km)
Localities
Callitris baileyi
Marsdenia coronata
Melaleuca irbyana
Notelaea lloydii
Planchonella eerwah
Existing rail
H2C project alignment
K2ARB project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 5 10 km
Coordinate System: GDA 1994 MGA Zone 56
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Date: 28/04/2020
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Author: FFJV GIS
Scale: 1:200,000
Data Sources: FFJV
Map by: MF/GN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.4_Specimen_backed_flora_v2.mxd Date: 28/04/2020 14:17

11.5.2.1 Threatened flora

Two threatened flora species, listed under the provision of the NC Act and/or the EPBC Act were identified within the ecology study area (refer Figure 11.6):

- Swamp Tea-tree (*Melaleuca irbyana*) located on the alluvial pains to the west of the Teviot Range, in the localities of Ebenezer and Purga. The species was observed as scattered individuals within the understory to eucalypt woodlands, in fragmented landscapes, and as part of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC (refer Section 11.5.2.3).
- Lloyd's Olive (*Notelaea lloydii*)—eight specimens were recorded above the proposed tunnel where the Project alignment intersects the western edge of the Teviot Range (south-east of the Washpool area).

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

- Hairy-joint grass (*Arthraxon hispidus*) (in shaded or potential wetter areas throughout)
- Miniature moss-orchid (*Bulbophyllum globuliforme*) (dry rainforest habitat in Teviot Range)
- Boonah tuckeroo (*Cupaniopsis tomentella*) (dry rainforest habitat in Teviot Range)
- An algae *(Lychnothamnus barbatus)* (Warrill Creek crossing area)
- Shiny-leaved condoo (*Planchonella eerwah*) (dry rainforest habitat in Teviot Range).

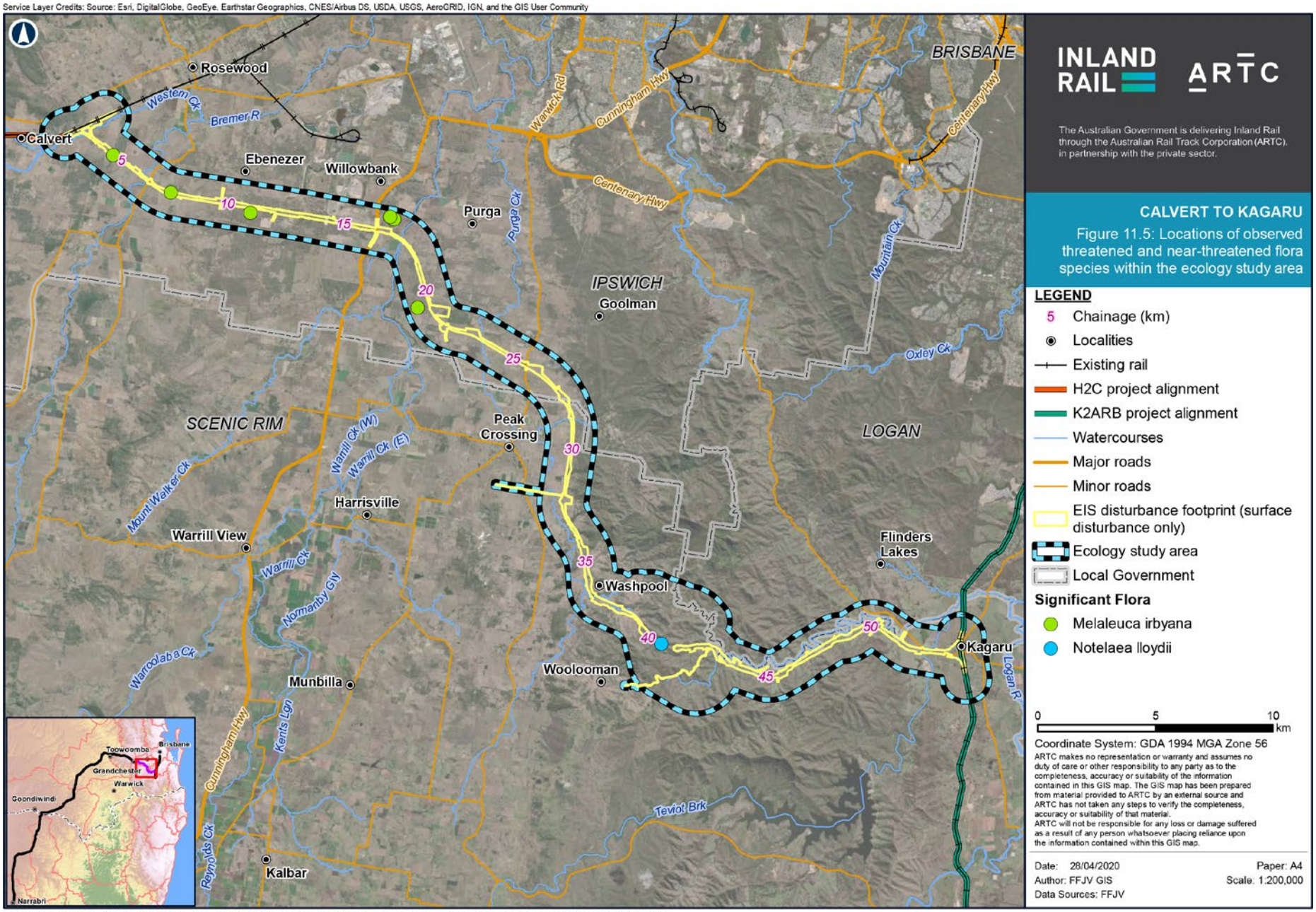
In addition, 10 special least concern flora species[1] as listed under the provisions of the NC Act were identified (refer Table 11.6). For further details related to identified flora species, refer Appendix J: Terrestrial and Aquatic Technical Ecology Report and Appendix K: Matters of National Environmental Significance Technical Report.

TABLE 11.6: THREATENED AND SPECIAL LEAST CONCERN FLORA SPECIES OBSERVED DURING PROJECT EIS INVESTIGATIONS WITHIN THE ECOLOGY STUDY AREA

Family	Species name	Common name	NC Act status	EPBC Act status
Adiantaceae	*Adiantum hispidulum*	Rough Maidenhair Fern	SLC	-
Adiantaceae	*Cheilanthes sieberi*	Rock Fern	SLC	-
Myrtaceae	*Melaleuca irbyana*	Swamp Tea-tree	E	-
Oleaceae	*Notelaea lloydii*	Lloyd's Olive	V	V
Orchidaceae	*Cymbidium canaliculatum*	Black Orchid	SLC	-
Orchidaceae	*Dockrillia linguiformis*	Tongue Orchid	SLC	-
Campanulaceae	*Lobelia purpurascens*	White Root	SLC	-
Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell	SLC	-
Malvaceae	*Brachychiton populneus*	Kurrajong	SLC	-
Menyanthaceae	*Nymphoides indica*	Water Snowflake	SLC	-
Nymphaeaceae	*Nymphaea gigantea*	Giant Waterlily	SLC	-
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Johnson's Grass Tree	SLC	-

Table notes:
- = Species not listed E = Endangered SLC = Special least concern V = Vulnerable

1. Special least concern flora species that are likely to be subject to harvesting for the purposes of commercial and/or recreational demand and the nature of their growth and reproduction.


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Rosewood
Calvert
Ebenezer
Willowbank
Purga
Goolman
IPSWICH
BRISBANE
SCENIC RIM
LOGAN
Peak Crossing
Harrisville
Warrill View
Flinders Lakes
Washpool
Kagaru
Woolooman
Munbilla
Kalbar
Western Ck
Bremer R
Warwick Rd
Cunningham Hwy
Centenary Hwy
Purga Ck
Mountain Ck
Oxley Ck
Mount Walker Ck
Warrill Ck (W)
Warrill Ck (E)
Warrill Ck
Normanby Gly
Warroolaba Ck
Kents Lgn
Reynolds Ck
Tevlot Brk
Logan R
5
10
15
20
25
30
35
40
45
50
Toowoomba
Brisbane
Grandchester
Warwick
Goondiwindi
Narrabri
INLAND RAIL
ARTC
The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.
CALVERT TO KAGARU
Figure 11.5: Locations of observed threatened and near-threatened flora species within the ecology study area
LEGEND
5 Chainage (km)
Localities
Existing rail
H2C project alignment
K2ARB project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government
Significant Flora
Melaleuca irbyana
Notelaea lloydii
0 5 10 km
Coordinate System: GDA 1994 MGA Zone 56
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Date: 28/04/2020
Paper: A4
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Scale: 1:200,000
Data Sources: FFJV
Map by: MF/AD/GN Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.5_SigFlora_V3.mxd Date: 28/04/2020 14:19

11.5.2.2 Vegetation communities

Desktop analysis indicates that the ecology study area contains Category B (remnant vegetation) and Category C (high-value regrowth) regulated vegetation as indicated on the regulated vegetation map (QLD Government, 2019c; QLD Government, 2020c). This vegetation is listed as endangered, of concern or least concern REs (16 in total). The ecology study area does not contain vegetation mapped as Category R (refer Table 11.7 and Figure 11.7). A list of the REs (Category B and Category C regulated vegetation) and their extent within the ecology study area is provided in Table 11.8. Limited ground-truthing has been used to confirm this mapping where possible. Table 11.7 summarises the extent of Category B and Category C areas of regulated vegetation that are endangered or of concern REs within the ecology study area. For further information related to regulated vegetating, refer Appendix J: Terrestrial and Aquatic Ecology Technical Report.

TABLE 11.7: EXTENT OF CATEGORY B AND CATEGORY C AREAS OF REGULATED VEGETATION THAT ARE ENDANGERED OR OF CONCERN REGIONAL ECOSYSTEMS WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Regulated vegetation category	**Ecology study area**	**Disturbance footprint**
Category B—Remnant vegetation	1,755.32	33.55
Category C—High-value regrowth	1,779.10	118.00

TABLE 11.8: DESCRIPTIONS OF REGIONAL ECOSYSTEMS (CATEGORY B AND CATEGORY C REGULATED VEGETATION) WITHIN THE ECOLOGY STUDY AREA

	Management status			Extent (ha)	
Regional ecosystems	**VM Act**	**Biodiversity**	**Description (REDD Version 11)**	**Within ecology study area**	**Disturbance footprint**
12.3.3	E	E	*Eucalyptus tereticornis* woodland. *Eucalyptus crebra* and *Eucalyptus moluccana* are sometimes present and may be relatively abundant in places, especially on edges of plains and higher level alluvium. Other species that may be present as scattered individuals or clumps include *Angophora subvelutina* or *Acacia floribunda*, *Corymbia clarksoniana*, *Corymbia intermedia*, *Corymbia tessellaris*, *Lophostemon suaveolens* and *Eucalyptus melanophloia*. Occurs on Quaternary alluvial plains, terraces and fans where rainfall is usually less than 1,000 mm/year.	83.86	2.74
12.3.3d	E	E	*Eucalyptus moluccana* woodland. Other frequently occurring species include *Eucalyptus tereticornis*, *Eucalyptus crebra*, *Eucalyptus siderophloia*, *Corymbia citriodora* subsp. *Variegata*, *Angophora leiocarpa* and *Corymbia intermedia*. Occurs on margins of Quaternary alluvial plains often adjacent to sedimentary geologies. May also occur on stranded Pleistocene river terraces. Floodplain (other than floodplain wetlands).	29.00	1.97
12.3.7	LC	OC	Narrow fringing woodland of *Eucalyptus tereticornis*, *Casuarina cunninghamiana* subsp. *cunninghamiana* +/- *Melaleuca viminalis*. Other species associated with this RE include *Melaleuca bracteata*, *Melaleuca trichostachya*, *Melaleuca linariifolia*. North of Brisbane *Waterhousea floribunda* commonly occurs and may at times dominate this RE. *Melaleuca fluviatilis* occurs in this RE in the north of the bioregion. *Lomandra hystrix* often present in stream beds. Occurs on fringing levees and banks of rivers and drainage lines of alluvial plains throughout the region.	113.54	14.72
12.3.7c	LC	OC	*Melaleuca bracteata* open forest +/- emergent *Eucalypts tereticornis*. Occurs in drainage depressions on Quaternary alluvial plains. Riverine wetland or fringing riverine wetland.	0.37	0.00

Regional ecosystems	Management status		Description (REDD Version 11)	Extent (ha)	
	VM Act	Biodiversity		Within ecology study area	Disturbance footprint
12.3.8	OC	OC	Swamps with characteristic species including *Cyperus* spp., *Schoenoplectus* spp., *Philydrum lanuginosum*, *Eleocharis* spp., *Leersia hexandra*, *Cycnogeton procerus*, *Nymphaea* spp., *Nymphoides indica*, *Persicaria* spp., *Phragmites australis*, *Typha* spp. and a wide range of sedges grasses or forbs. Emergent *Melaleuca* spp. may sometimes occur. Occurs in freshwater swamps associated with floodplains.	73.98	0.75
12.3.18	E	E	*Melaleuca irbyana* low open forest or thicket. Emergent *Eucalyptus moluccana*, *Eucalyptus crebra*, *Eucalyptus tereticornis* or *Corymbia citriodora* subsp. *Variegata* may be present. Occurs on Quaternary alluvial plains where drainage of soils is impeded. This is analogous to the EPBC Act listed Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC.	111.27	7.54
12.3.19	E	E	*Eucalyptus moluccana* and/or *Eucalyptus tereticornis* and *Eucalyptus crebra* open forest to woodland, with a sparse to mid-dense understorey of *Melaleuca irbyana*. Occurs on margins of Quaternary alluvial plains.	82.95	10.67
12.8.24	E	E	*Corymbia citriodora* subsp. *Variegata*, *Eucalyptus crebra* +/- *Eucalyptus Moluccana* open forest. Occurs on Cainozoic igneous rocks especially lower slopes of rhyolite and trachyte hills (e.g. Moogerah Peaks).	0.54	0.00
12.9-10.2	LC	NC	*Corymbia citriodora* subsp. Variegata open forest or woodland usually with Eucalyptus crebra. Other species such as Eucalyptus tereticornis, Eucalyptus moluccana, Eucalyptus acmenoides and Eucalyptus siderophloia may be present in scattered patches or in low densities. Understorey can be grassy or shrubby. Shrubby understorey of Lophostemon confertus (whipstick form) often present in northern parts of bioregion. Occurs on Cainozoic and Mesozoic sediments.	1,289.05	37.37
12.9-10.3	OC	OC	*Eucalyptus moluccana* open forest. Other canopy species include *Eucalyptus siderophloia* or *Eucalyptus crebra*, *Eucalyptus tereticornis* and *Corymbia citriodora* subsp. *Variegata*. Understorey generally sparse but can become shrubby in absence of fire. Occurs on Cainozoic and Mesozoic sediments, especially shales. Prefers lower slopes.	47.13	0.05
12.9-10.7	OC	OC	*Eucalyptus crebra* +/- *Eucalyptus tereticornis*, *Corymbia tessellaris*, *Angophora leiocarpa*, *E. melanophloia* woodland. Occurs on Cainozoic and Mesozoic sediments.	558.51	17.20
12.9-10.11	E	E	*Melaleuca irbyana* low open forest or thicket. Emergent *Eucalyptus moluccana*, *Eucalyptus crebra*, *Eucalyptus tereticornis* or *Corymbia citriodora* subsp. *Variegata* may be present. Occurs on Mesozoic sediments where drainage of soils is impeded.	151.29	11.30

Regional ecosystems	Management status		Description (REDD Version 11)	Extent (ha)	
	VM Act	Biodiversity		Within ecology study area	Disturbance footprint
12.9-10.16	OC	OC	Microphyll to notophyll vine forest +/- Araucaria cunninghamii. Characteristic species include Argyrodendron sp. (Kin W.D.Francis AQ81198), Araucaria cunninghamii, Agathis robusta, Backhousia myrtifolia, Cupaniopsis parvifolia, Dendrocnide photinophylla, Rhodosphaera rhodanthema, Flindersia australis, Flindersia. xanthoxyla, Drypetes deplanchei, Olea paniculata, Diospyros geminata, Gossia bidwillii, Excoecaria dallachyana and Vitex lignum-vitae. Archontophoenix cunninghamiana often present in gully floors. Occurs on Cainozoic and Mesozoic sediments.	71.64	4.58
12.9-10.17	LC	NC	Open forest to woodland complex generally with a variety of stringybarks, grey gums, ironbarks and in some areas spotted gum. Canopy trees include *Eucalyptus siderophloia, Eucalyptus. propinqua or Eucalyptus major, Eucalyptus acmenoides or Eucalyptus portuensis, Eucalyptus carnea* and/or *Eucalyptus microcorys* and/or *Corymbia citriodora* subsp. *Variegata*. Other species that may be present locally include *Corymbia intermedia, Corymbia. trachyphloia, Eucalyptus tereticornis, Eucalyptus biturbinata, Eucalyptus moluccana, Eucalyptus longirostrata, Eucalyptus. fibrosa* subsp. *fibrosa* and *Angophora leiocarpa. Lophostemon confertus* or *Lophostemon confertus* (Whipstick form), often present in gullies and as a sub-canopy or understorey tree. Mixed understorey of grasses, shrubs and ferns. Hills and ranges of Cainozoic and Mesozoic sediments.	10.78	0.00
12.9-10.17a	LC	NC	*Lophostemon confertus* or *Lophostemon suaveolens* dominated open forest usually with emergent *Eucalyptus* and/or *Corymbia* species. Occurs in gullies and southern slopes on Cainozoic and Mesozoic sediments.	196.76	4.89
12.9-10.27	E	E	*Corymbia citriodora* subsp. *Variegata, Eucalyptus crebra* and/or *Eucalyptus. moluccana, Eucalyptus. tereticornis* open forest with a sparse to mid-dense understorey of *Melaleuca irbyana*. Occurs on lower slopes and elevated flats with impeded drainage on Mesozoic sediments.	297.26	30.12
Non-remnant/ HVR	-	-	Not applicable.	9,324.31	828.59

Table notes:
LC = Least concern NC = No concern at present OC = Of concern E = Endangered

11.5.2.3 Threatened ecological communities (EPBC Act)

A single endangered TEC, (Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East QLD) exists within the central and western portion of the ecology study area based on State RE mapping and ground-truthing surveys carried out as part of EIS studies, by Jacobs-GHD (2016b) and surveys by EMM and ELA (2018 (various) and 2019 (various)). The extent and distribution of Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East QLD within the ecology study area is shown in Table 11.9 and Figure 11.8. Refer Appendix K: Matters of National Environmental Significance Technical Report for further details related to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC located within the ecology study area.

TABLE 11.9: THREATENED ECOLOGICAL COMMUNITIES IDENTIFIED WITHIN THE ECOLOGY STUDY AREA

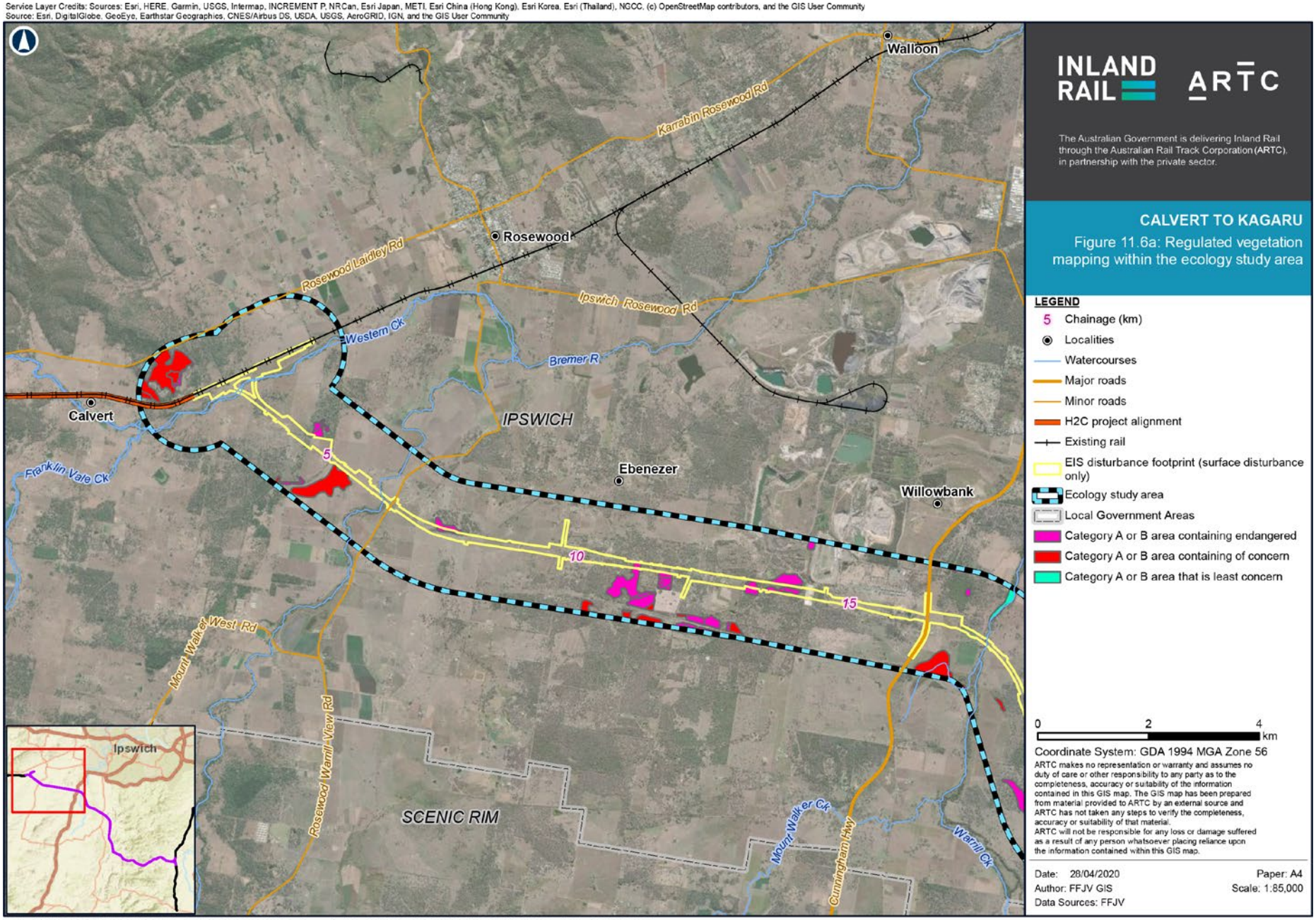
TEC name	EPBC Act status	Extent (ha)	
		Ecology study area	Disturbance footprint
Swamp Tea-tree (*Melaleuca irbyana*) forest of South East QLD (analogous to RE 12.3.18 and 12.9-10.11)	CE	261.95 (unconfirmed)	20.8 (confirmed TEC) 9.65 (regrowth TEC)

Table notes:
CE = Critically endangered

11.5.2.4 Introduced flora

In total, 69 non-native flora species were identified during the Project EIS field investigations (refer Appendix J: Terrestrial and Aquatic Technical Ecology Report).

Of the 69 non-native flora species, 27 are listed as restricted matters pursuant to the Biosecurity Act and were identified during EIS field investigations. These species were typically common and widespread throughout the ecology study area; however, they were most prevalent and in greatest densities within disturbed areas (refer Table 11.10).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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Walloon
Karrabin Rosewood Rd
Rosewood
Rosewood Laidley Rd
Ipswich Rosewood Rd
Western Ck
Bremer R
IPSWICH
Calvert
Franklin Vale Ck
5
Ebenezer
Willowbank
10
15
Mount Walker West Rd
Rosewood Warrill View Rd
SCENIC RIM
Mount Walker Ck
Cunningham Hwy
Warrill Ck
Ipswich
INLAND RAIL
ARTC
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CALVERT TO KAGARU
Figure 11.6a: Regulated vegetation mapping within the ecology study area
LEGEND
5 Chainage (km)
Localities
Watercourses
Major roads
Minor roads
H2C project alignment
Existing rail
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Category A or B area containing endangered
Category A or B area containing of concern
Category A or B area that is least concern
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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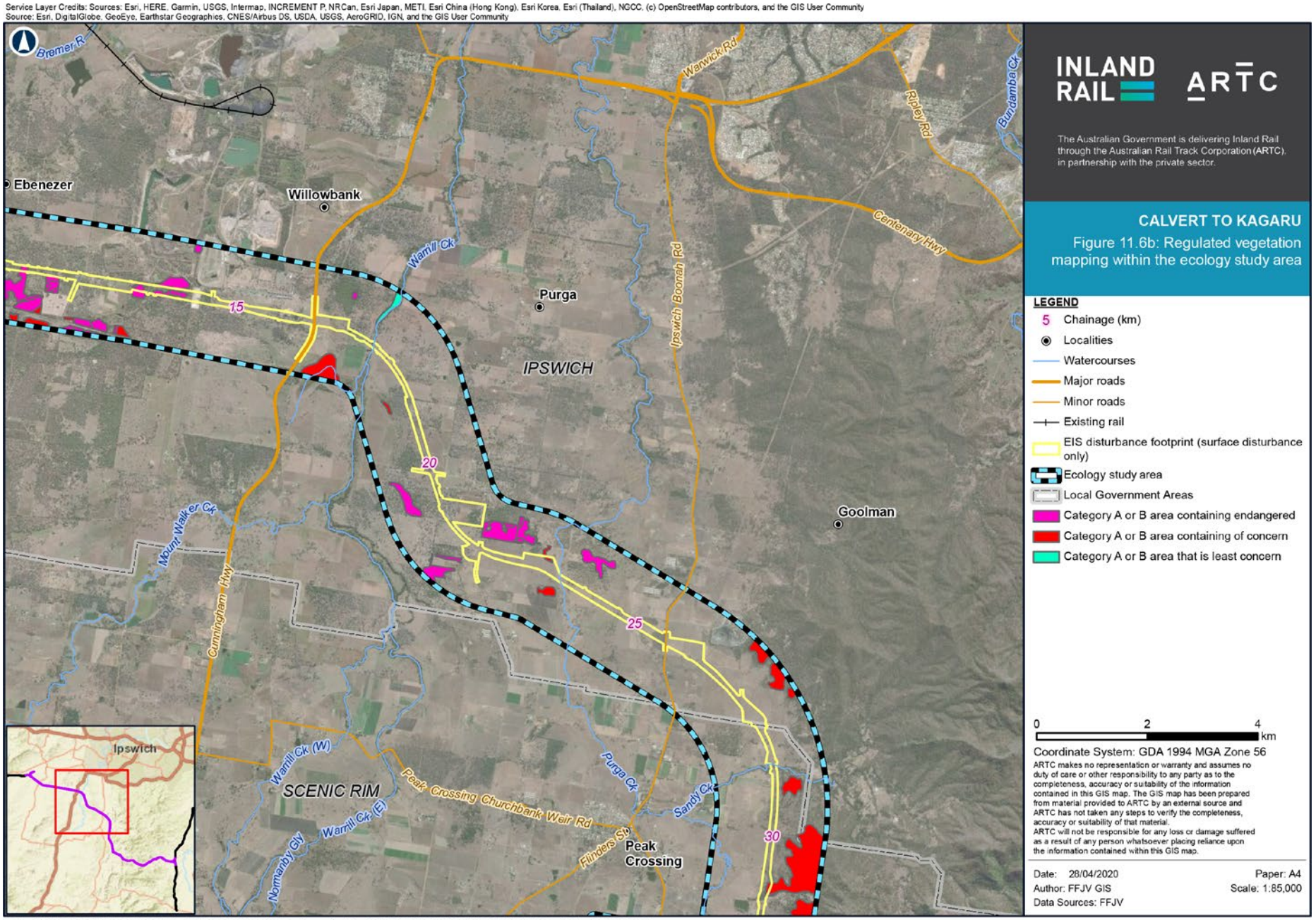
Paper: A4
Scale: 1:85,000
Map by: MEF/GN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.6_RE_v3.mxd Date: 28/04/2020 14:21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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Bremer R
Ebenezer
Willowbank
Warrill Ck
Purga
IPSWICH
Warwick Rd
Ripley Rd
Burdamba Ck
Centenary Hwy
Ipswich Boonah Rd
15
20
25
30
Goolman
Mount Walker Ck
Cunningham Hwy
Warrill Ck (W)
SCENIC RIM
Peak Crossing Churchbank Weir Rd
Purga Ck
Sandy Ck
Warrill Ck (E)
Normanby Gly
Flinders St
Peak Crossing
Ipswich
INLAND RAIL
ARTC
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CALVERT TO KAGARU
Figure 11.6b: Regulated vegetation mapping within the ecology study area
LEGEND
5 Chainage (km)
Localities
Watercourses
Major roads
Minor roads
Existing rail
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Category A or B area containing endangered
Category A or B area containing of concern
Category A or B area that is least concern
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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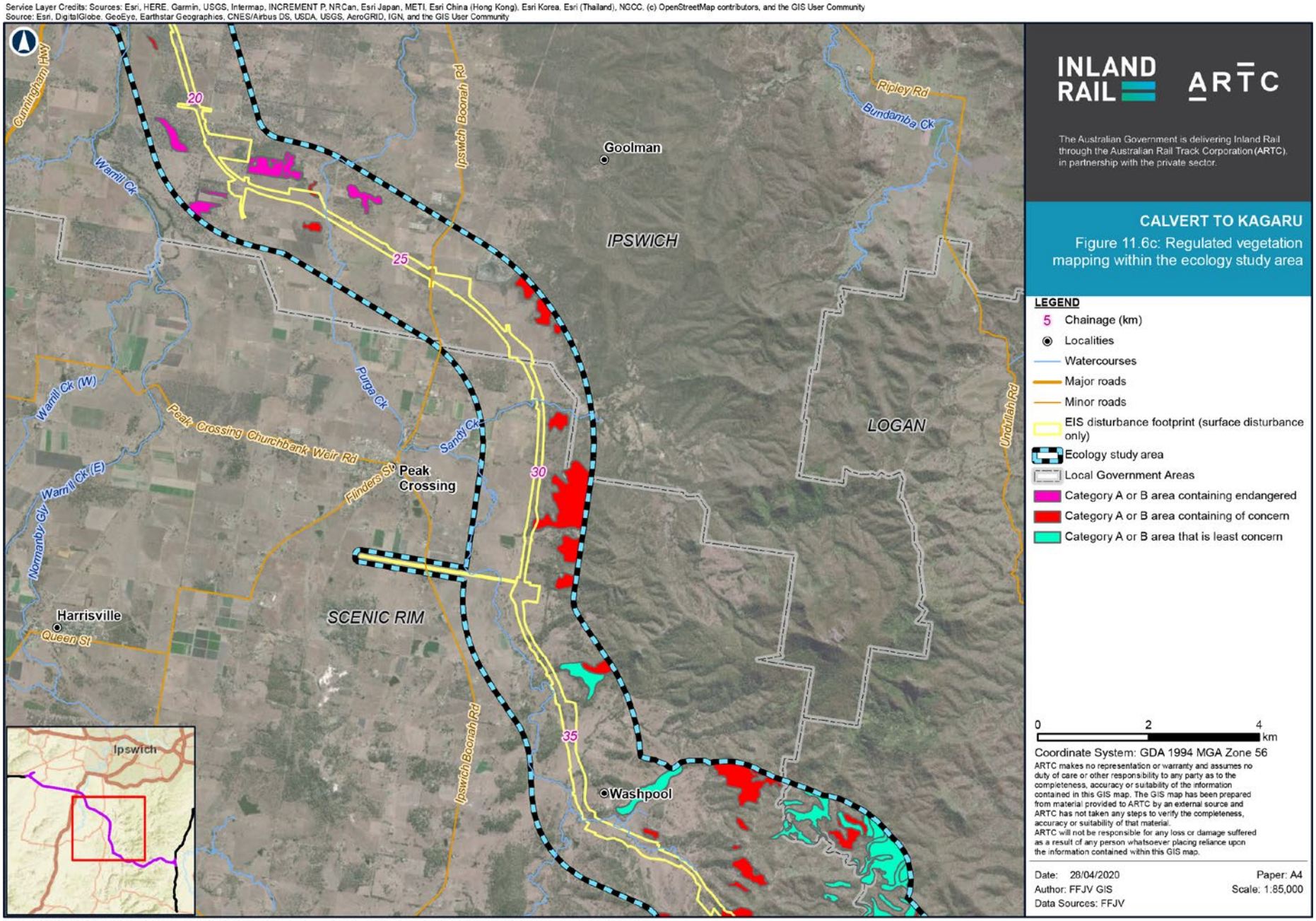
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Cunningham Hwy
Warrill Ck
Ipswich Boonah Rd
Goolman
Ripley Rd
Bundamba Ck
IPSWICH
LOGAN
Purga Ck
Sandy Ck
Undullah Rd
Warrill Ck (W)
Warrill Ck (E)
Peak Crossing Churchbank Weir Rd
Flinders St
Peak Crossing
Normanby Gly
Harrisville
Queen St
SCENIC RIM
Washpool
20
25
30
35
Ipswich
INLAND RAIL
ARTC
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CALVERT TO KAGARU
Figure 11.6c: Regulated vegetation mapping within the ecology study area
LEGEND
5 Chainage (km)
Localities
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Category A or B area containing endangered
Category A or B area containing of concern
Category A or B area that is least concern
0
2
4
km
Coordinate System: GDA 1994 MGA Zone 56
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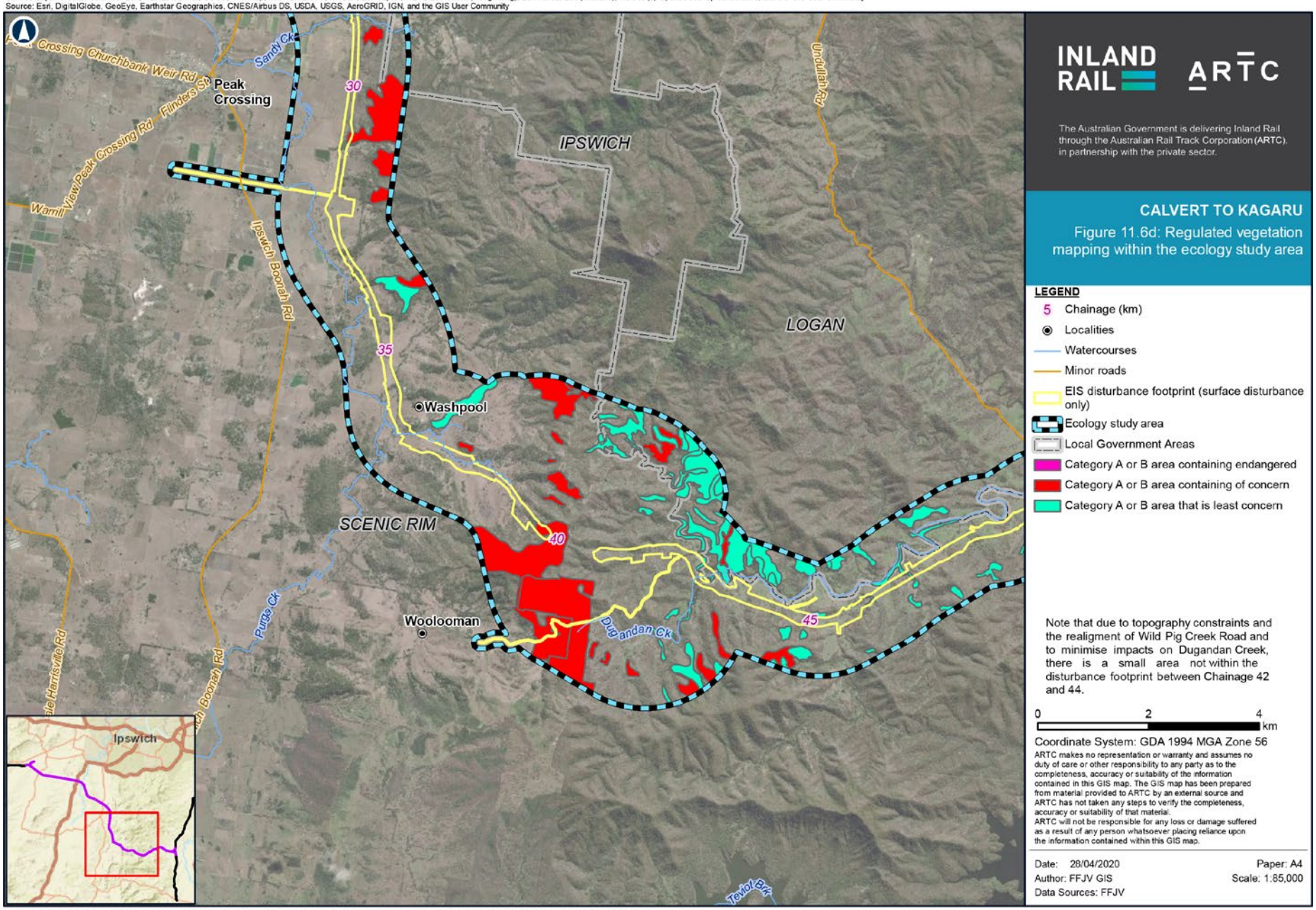
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Peak Crossing
Churchbank Weir Rd
Flinders St
Warrill View Peak Crossing Rd
Sandy Ck
Ipswich Boonah Rd
Undullah Rd
IPSWICH
LOGAN
SCENIC RIM
Washpool
Wooloman
Purga Ck
Dugandan Ck
Harrisville Rd
30
35
40
45
Ipswich
INLAND RAIL
ARTC
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CALVERT TO KAGARU
Figure 11.6d: Regulated vegetation mapping within the ecology study area
LEGEND
5 Chainage (km)
Localities
Watercourses
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Category A or B area containing endangered
Category A or B area containing of concern
Category A or B area that is least concern
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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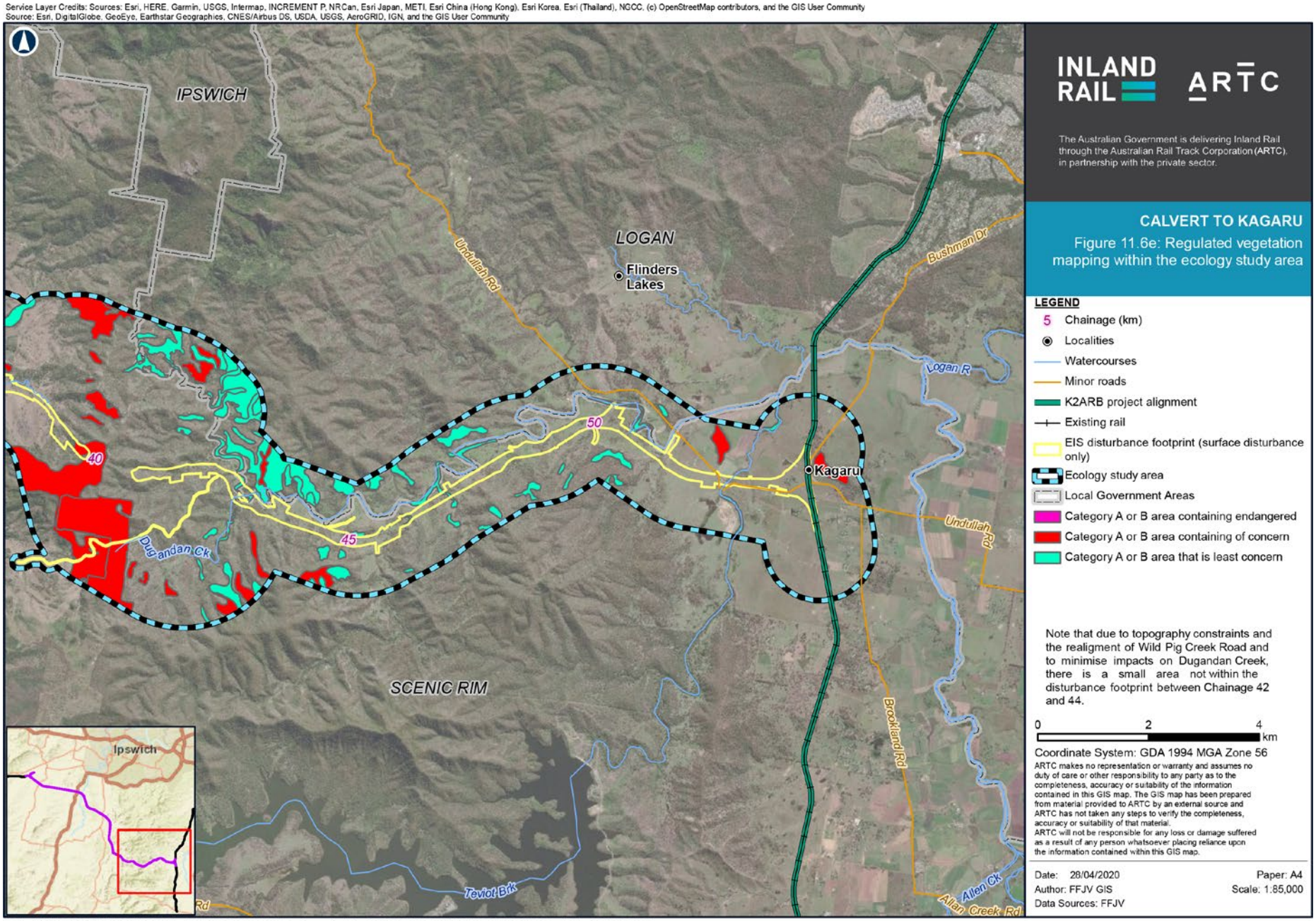
Map by: MEF/GN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.6_RE_v3.mxd Date: 28/04/2020 14:21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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
IPSWICH
LOGAN
SCENIC RIM
Flinders Lakes
Kagaru
Undullah Rd
Bushman Dr
Logan R
Undullah Rd
Brookland Rd
Allen Ck
Allan Creek Rd
Teviot Brk
Dugandan Ck
40
45
50
Ipswich
INLAND RAIL
ARTC
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Figure 11.6e: Regulated vegetation mapping within the ecology study area
LEGEND
5 Chainage (km)
Localities
Watercourses
Minor roads
K2ARB project alignment
Existing rail
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Category A or B area containing endangered
Category A or B area containing of concern
Category A or B area that is least concern
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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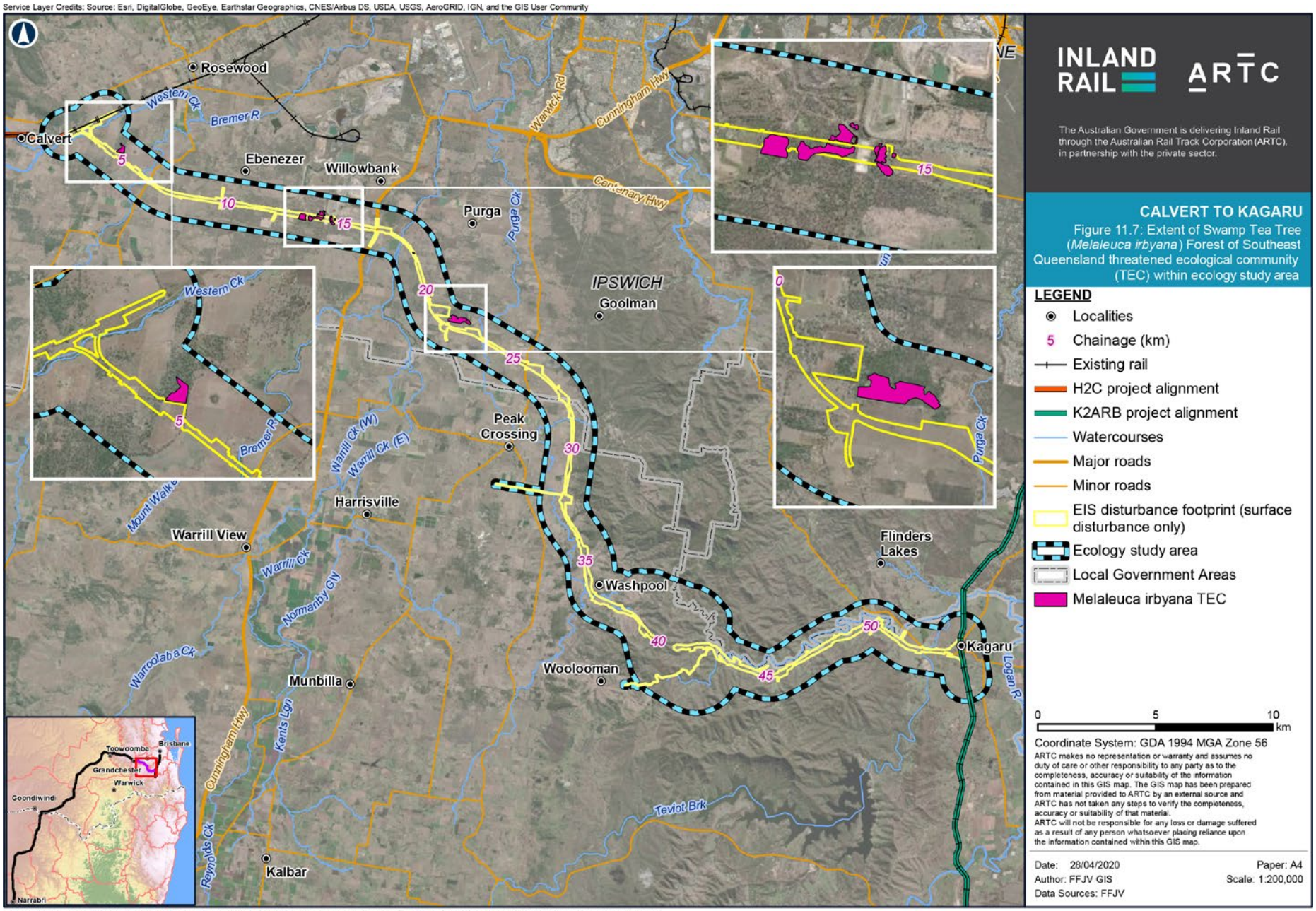
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Rosewood
Calvert
Ebenezer
Willowbank
Purga
IPSWICH
Goolman
Peak Crossing
Harrisville
Warrill View
Flinders Lakes
Washpool
Kagaru
Wooloomin
Munbilla
Kalbar
Western Ck
Bremer R
Warrill Ck (W)
Warrill Ck (E)
Warrill Ck
Purga Ck
Logan R
Teviot Brk
Mount Walker
Normanby Gly
Warcolaba Ck
Kents Lgn
Reynolds Ck
Cunningham Hwy
Centenary Hwy
Warwick Rd
5
10
15
20
25
30
35
40
45
50
Toowoomba
Brisbane
Grandchester
Warwick
Goondiwindi
Narrabri
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Figure 11.7: Extent of Swamp Tea Tree (Melaleuca irbyana) Forest of Southeast Queensland threatened ecological community (TEC) within ecology study area
LEGEND
Localities
Chainage (km)
Existing rail
H2C project alignment
K2ARB project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Melaleuca irbyana TEC
0
5
10
km
Coordinate System: GDA 1994 MGA Zone 56
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TABLE 11.10: RESTRICTED MATTERS IDENTIFIED WITHIN THE ECOLOGY STUDY AREA

Family name	Species name	Common name	Schedule 2 of the Biosecurity Act*	Weeds of national significance	Relative abundance within ecology study area	Areas containing greatest densities within ecology study area
Anacardiaceae	*Schinus terebinthifolius*	Broad-leaf pepper tree	Category 3	No	Occasional to common	Riparian forest and bushland
Aristolochiaceae	*Aristolochia elegans*	Dutchman's pipe	Category 3	No	Uncommon	Riparian forest and bushland
Asparagaceae	*Asparagus africanus*	Asparagus fern	Category 3	Yes	Common	All areas containing bushland
Asparagaceae	*Asparagus asparagoides*	Bridal creeper	Category 3	Yes	Scattered presence	All areas containing bushland
Asteraceae	*Ambrosia artemisiifolia*	Annual ragweed	Category 3	No	Uncommon	Riparian forest and bushland
Asteraceae	*Baccharis halimifolia*	Groundsel bush	Category 3	Yes	Common	Disturbed areas including grazing land
Asteraceae	*Parthenium hysterophorus*	Parthenium weed	Category 3	Yes	Uncommon	Disturbed areas including grazing land
Asteraceae	*Senecio madagascariensis*	Fireweed	Category 3	Yes	Common	Disturbed areas including grazing land
Basellaceae	*Anredera cordifolia*	Madeira vine	Category 3	Yes	Common	Riparian forest and bushland
Bignoniaceae	*Tecoma stans*	Yellow bells	Category 3	No	Uncommon	Riparian forest and bushland
Cactaceae	*Opuntia aurantiaca*	Tiger pear	Category 3	Yes	Uncommon	Disturbed areas including grazing land
Cactaceae	*Opuntia dillenii*	Prickly pear	Category 3	Yes	Uncommon	Disturbed areas including grazing land
Cactaceae	*Opuntia stricta*	Common pest pear	Category 3	Yes	Common	Disturbed areas including grazing land
Cactaceae	*Opuntia tomentosa*	Velvety tree pear	Category 3	Yes	Common	Disturbed areas including grazing land
Crassulaceae	*Bryophyllum delagoense*	Mother-of-millions	Category 3	Yes	Common, occasional to severe infestation	Disturbed areas including grazing land
Fabaceae	*Vachellia nilotica*	Prickly acacia	Category 3	Yes	Uncommon to common	Riparian forest, bushland and disturbed areas
Lauraceae	*Cinnamomum camphora*	Camphor laurel	Category 3	No	Common	Riparian forest and bushland
Oleaceae	*Ligustrum lucidum*	Broad-leaf privet	Category 3	No	Common	Riparian forest and bushland
Poaceae	*Sporobolus fertilis*	Giant Parramatta grass	Category 3	Yes	Very common	Disturbed areas including grazing land
Poaceae	*Sporobolus pyramidalis*	Giant rat's tail grass	Category 3	Yes	Common	Disturbed areas including grazing land
Pontederiaceae	*Eichhornia crassipes*	Water hyacinth	Category 3	Yes	Common	Farm dams
Salviniaceae	*Salvinia molesta*	Salvinia	Category 3	Yes	Common	Farm dams

Family name	Species name	Common name	Schedule 2 of the Biosecurity Act*	Weeds of national significance	Relative abundance within ecology study area	Areas containing greatest densities within ecology study area
Sapindaceae	*Cardiospermum grandiflorum*	Balloon vine	Category 3	No	Common	Riparian areas
Solanaceae	*Lycium ferocissimum*	African boxthorn	Category 3	Yes	Common	Disturbed areas including grazing land
Ulmaceae	*Celtis sinensis*	Chinese celtis	Category 3	No	Occasional to common	Riparian forest and bushland
Verbenaceae	*Lantana camara*	Lantana	Category 3	Yes	Very common, occasional to severe infestation	Bushland
Verbenaceae	*Lantana montevidensis*	Creeping lantana	Category 3	No	Common, occasional to severe infestation	Bushland

Table notes:

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

11.5.3 Fauna

A total of 35 threatened or near-threatened fauna species identified under the EPBC Act and/or NC Act have been identified from databases searches associated with the ecology study area. This includes 16 birds, 9 mammals, four reptiles, one amphibian, three fish species and two invertebrates.

Seven species (four species of birds and three species of mammals) listed under the provisions of the NC Act and/or the EPBC Act are considered likely to occur within the ecology study area based on specimen-backed records in Wildlife online and the Atlas of Living Australia databases and the presence of suitable habitat.

A total of 16 species (seven species of birds, five species of mammals, two species of reptiles, one species of amphibian and one species of fish) listed under the provisions of the NC Act (12 species) and/or the EPBC Act (14 species) are considered as a 'possible occurrence' within the ecology study area based on the presence of suitable habitat.

A total of 12 species (five species of birds, one species of mammal, two species of reptiles, two species of fish, two invertebrate species) listed under the provisions of the NC Act and/or the EPBC Act are considered unlikely to occur within the ecology study area based on their distributional limits.

The majority of the species protected under the NC Act are also protected under the EPBC Act.

In addition, 11 non-threatened migratory species as listed under the EPBC Act and one SLC mammal (Short-beaked Echidna (*Tachyglossus aculeatus*)) are also predicted to occur within the ecology study area. The location of specimen-backed records for threatened, near-threatened and migratory fauna species, derived from database sources (e.g. Birds Australia, WildNet and Atlas of Living Australia) that are known from the ecology study area is provided in Figure 11.8.

Project EIS field investigations identified a total of 172 fauna species, including 164 native species (95.3 per cent) and 8 non-native species (4.7 per cent), 6 of which are restricted matters. A comprehensive list of fauna species recorded within the ecology study area is available in Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report.

11.5.3.1 Threatened fauna

The threatened or near-threatened species are identified from the ecology study area consist of the following:

- Koala (*Phascolarctos cinereus*) with direct observation of individuals and identification via scats (located throughout the ecology study area)
- Swift Parrot (*Lathamus discolor*) was recorded in alluvial Queensland blue gum (*Eucalyptus tereticornis*) woodlands in the Ebenezer area adjacent to the Project disturbance footprint
- Glossy-black Cockatoo (*Calyptorhynchus lathami*) identified via the presence of unique feeding traces (i.e. orts) located on the western slopes of the Teviot Range
- Powerful Owl (*Ninox strenua*) detected via call play-back sampling.

Brush-tailed Rock-wallaby (*Petrogale penicillata*) was also identified incidentally on Flinders Peak (approximately 4 km north of the Project alignment) during investigations for the SFRC (AECOM, 2010a). However, essential habitat components (e.g. rocky outcrops, cliffs caves etc.) were not encountered during the field investigations for the EIS.

Field investigations also confirmed the presence of habitat (foraging and breeding) for the following threatened species, noting that the Teviot Range an extensive tract of habitat with varying levels of disturbance (with regard to the ecology study area) had a range of features known to support a variety of fauna species:

- Collared Delma (*Delma torquata*)—Teviot Range where microhabitats such as coarse woody debris and loose rocky outcrops occur
- Regent Honeyeater (*Anthochaera phrygia*)—box-ironbark woodlands
- Australasian Bittern (*Botaurus poiciloptilus*)—wetlands
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)—rocky habitat within the Teviot Range
- Red Goshawk (*Erythrotriorchis radiatus*)—extensive intact habitat within Teviot Range
- Painted Honeyeater (*Grantiella picta*)—eucalypt/acacia woodlands
- Swift Parrot (*Lathamus discolor*)—eucalypt woodlands
- Greater Glider (*Petauroides volans volans*)—eucalypt woodlands with large hollows present
- Koala (*Phascolarctos cinereus*)—eucalypt woodlands
- Grey-headed Flying-fox (*Pteropus poliocephalus*)—foraging habitat throughout.

In addition to these species, two non-threatened migratory species listed under the EPBC Act were observed within the ecology study area:

- Rufous Fantail (*Rhipidura rufifrons*) associated with forested areas and drainage lines on the Teviot Range
- Glossy Ibis (*Plegadis falcinellus*) associated with wetland areas.

The location of the observed threatened, near-threatened and migratory fauna species within the ecology study area is provided in Figure 11.9.

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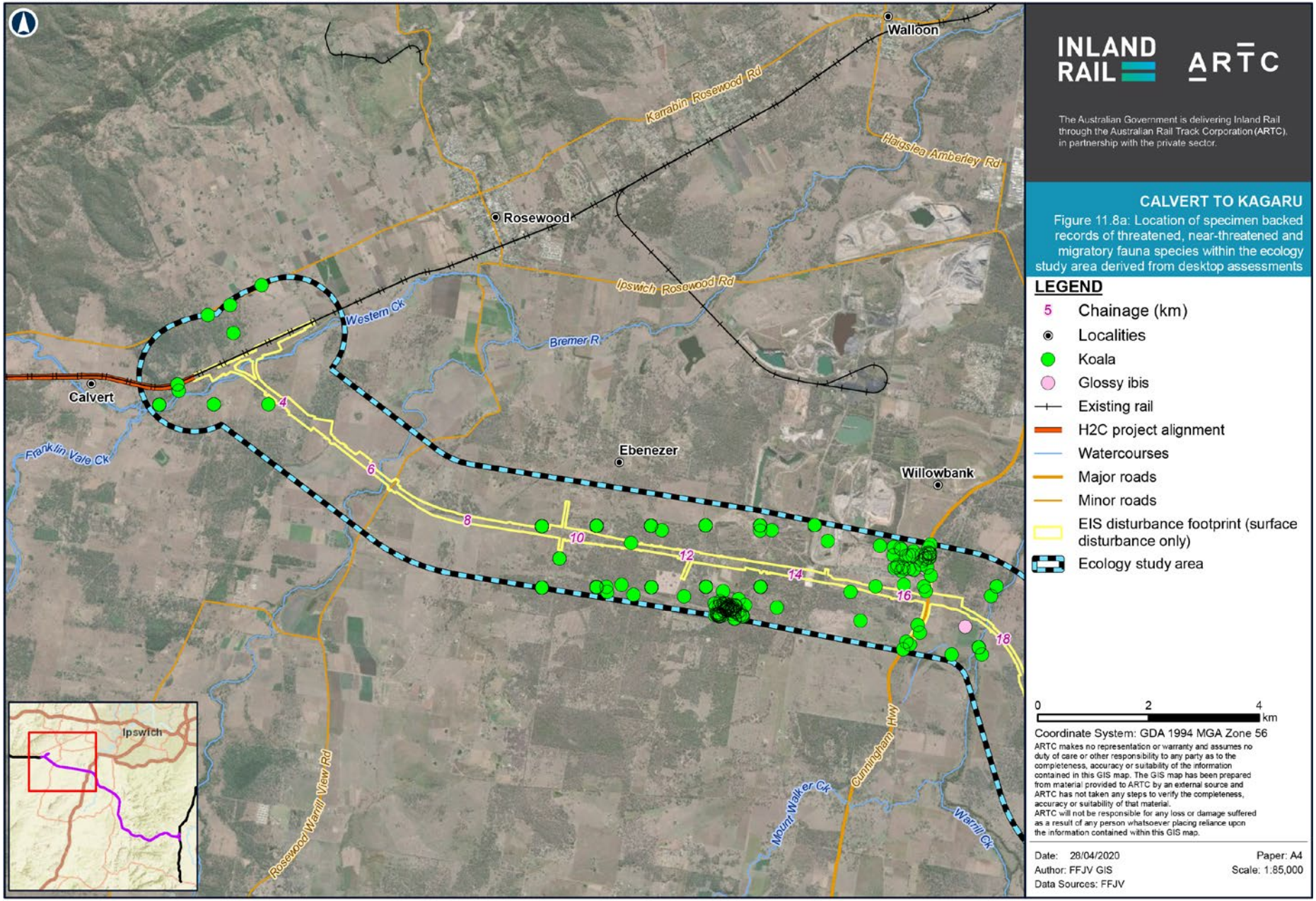

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Figure 11.8a: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments

LEGEND

- 5 Chainage (km)
- Localities
- Koala
- Glossy ibis
- Existing rail
- H2C project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- Ecology study area

0 2 4 km

Coordinate System: GDA 1994 MGA Zone 56

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Author: FFJV GIS
Data Sources: FFJV

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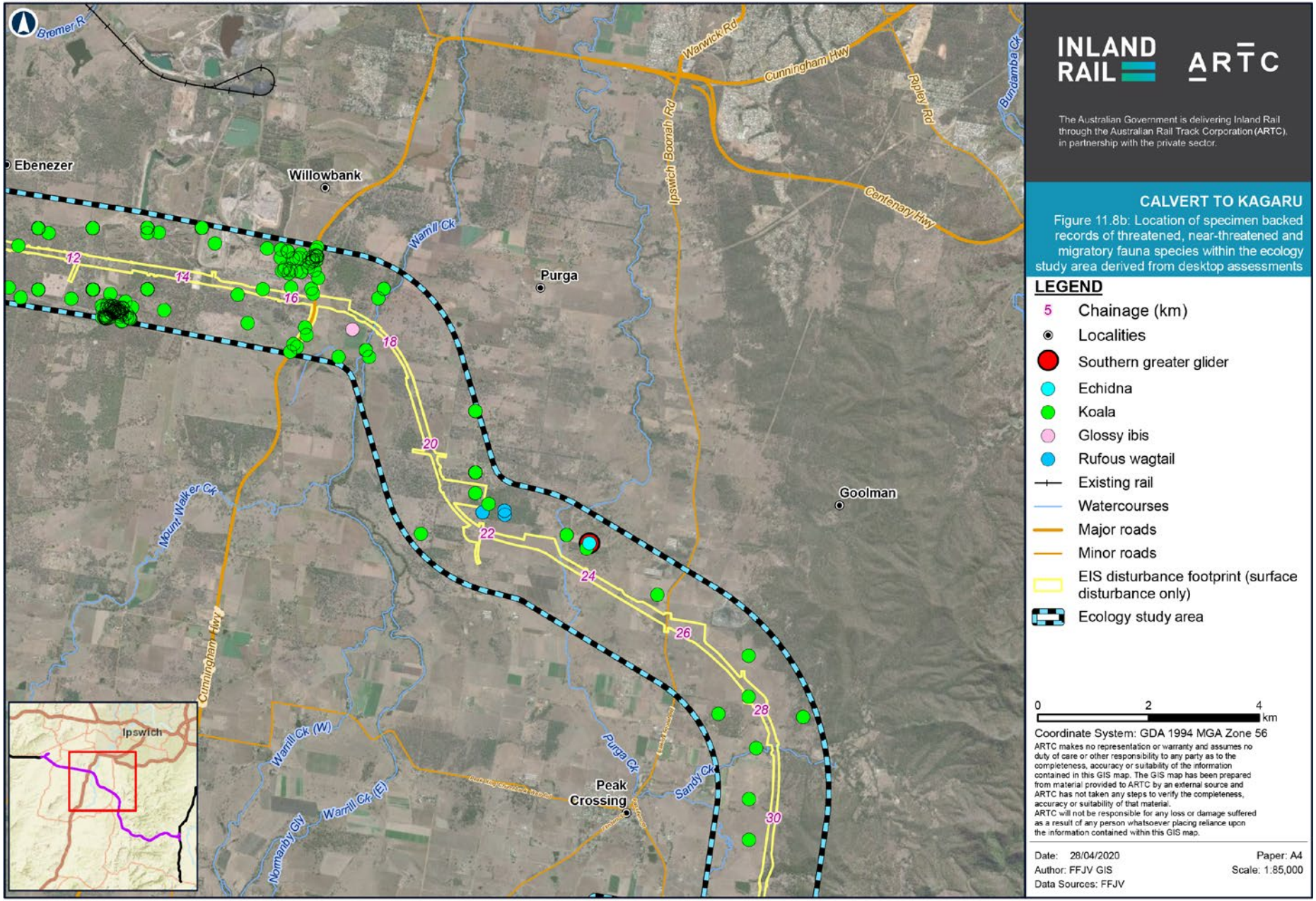
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Bremer R
Ebenezer
Willowbank
Warrill Ck
Purga
Warwick Rd
Cunningham Hwy
Ipswich Boonah Rd
Ripley Rd
Bundamba Ck
Centenary Hwy
Goolman
Mount Walker Ck
Cunningham Hwy
Warrill Ck (W)
Warrill Ck (E)
Normanby Gly
Purga Ck
Sandy Ck
Peak Crossing
Ipswich
12
14
16
18
20
22
24
26
28
30
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Figure 11.8b: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments
LEGEND
5 Chainage (km)
Localities
Southern greater glider
Echidna
Koala
Glossy ibis
Rufous wagtail
Existing rail
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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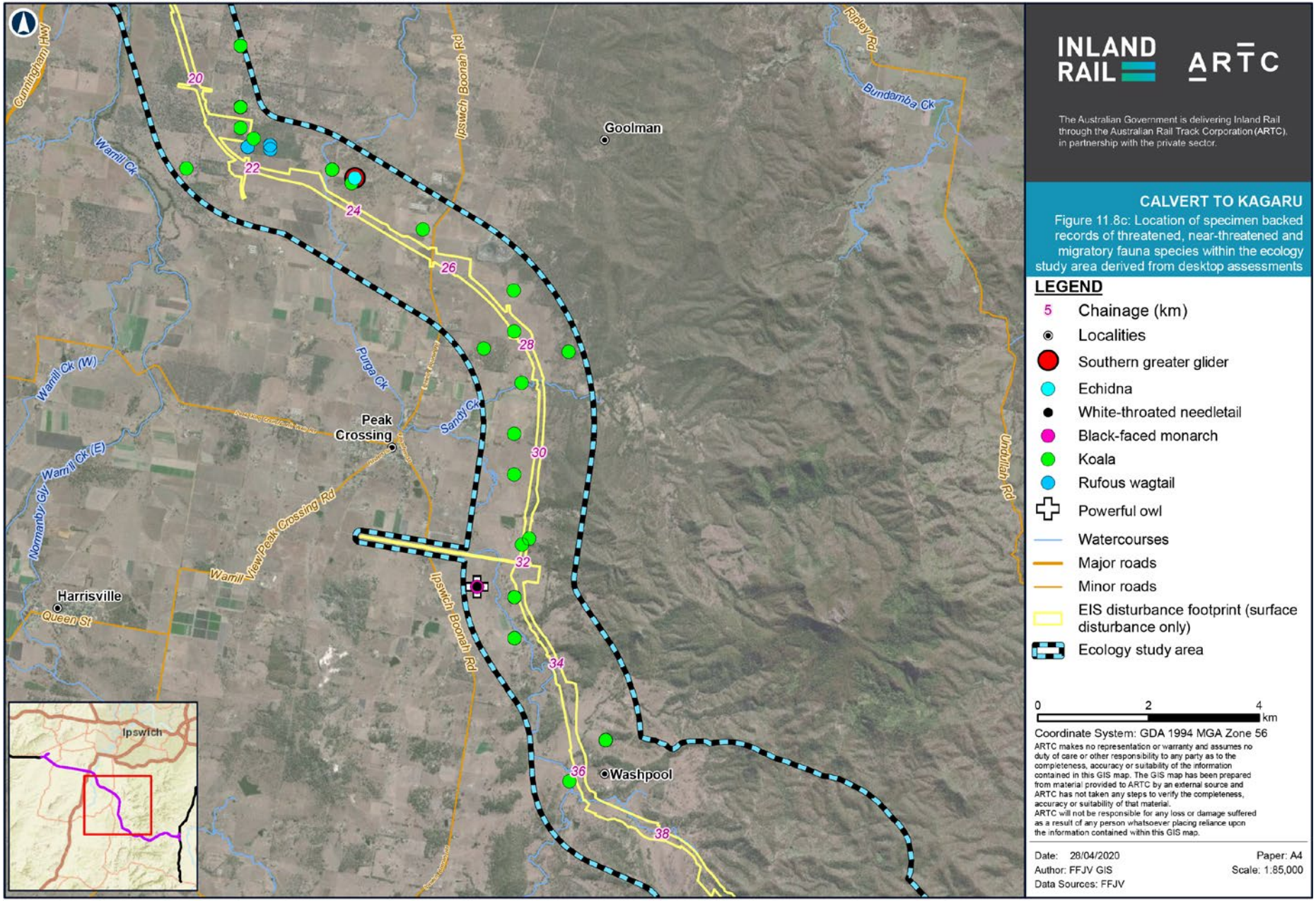
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Cunningham Hwy
Warrill Ck
Ipswich Boonah Rd
Ridley Rd
Bundamba Ck
Goolman
20
22
24
26
28
30
32
34
36
38
Purga Ck
Sandy Ck
Peak Crossing
Warrill Ck (W)
Warrill Ck (E)
Normanby Gly
Warrill View Peak Crossing Rd
Harrisville
Queen St
Ipswich Boonah Rd
Washpool
Urdwilla Rd
Ipswich
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Figure 11.8c: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments
LEGEND
5 Chainage (km)
Localities
Southern greater glider
Echidna
White-throated needletail
Black-faced monarch
Koala
Rufous wagtail
Powerful owl
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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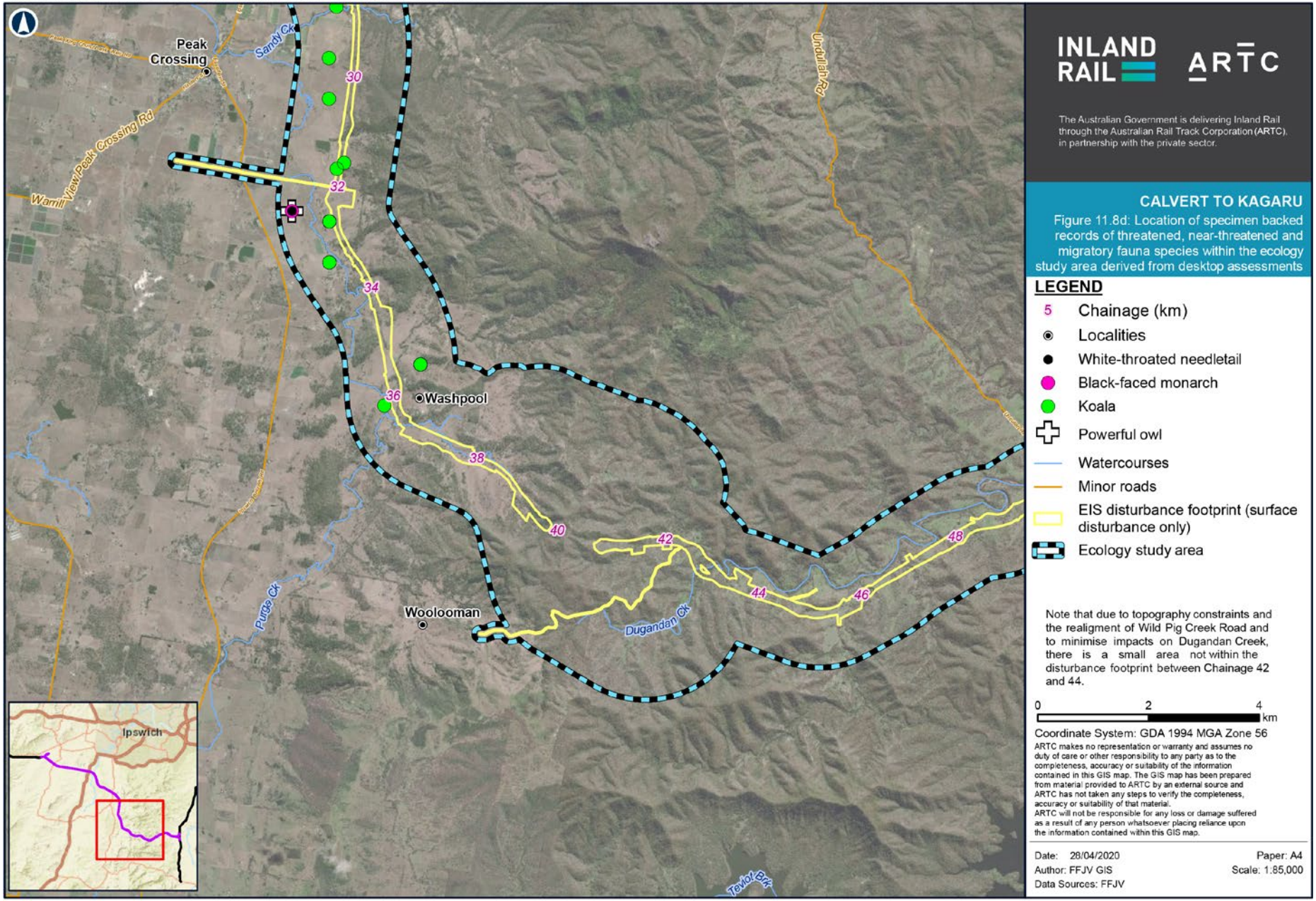
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Peak Crossing
Sandy Ck
Undullah Rd
Wamil View Peak Crossing Rd
30
32
34
36
38
40
42
44
46
48
Washpool
Woolooman
Purga Ck
Dugandan Ck
Taylor Brk
Ipswich
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Figure 11.8d: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments
LEGEND
5 Chainage (km)
Localities
White-throated needletail
Black-faced monarch
Koala
Powerful owl
Watercourses
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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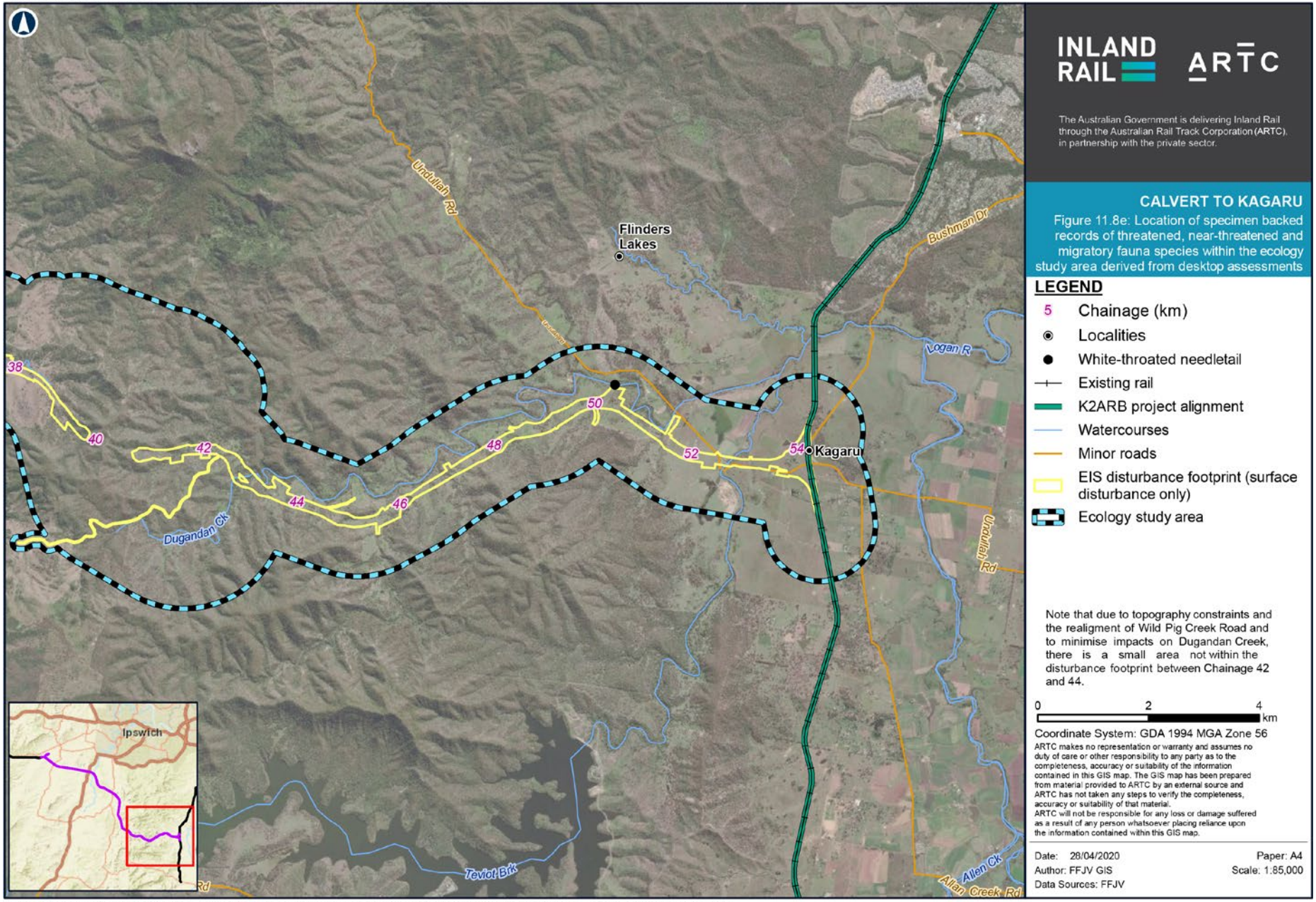

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Figure 11.8e: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments

LEGEND

- 5 Chainage (km)
- Localities
- White-throated needletail
- Existing rail
- K2ARB project alignment
- Watercourses
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- Ecology study area

Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.

0 2 4 km

Coordinate System: GDA 1994 MGA Zone 56

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Data Sources: FFJV

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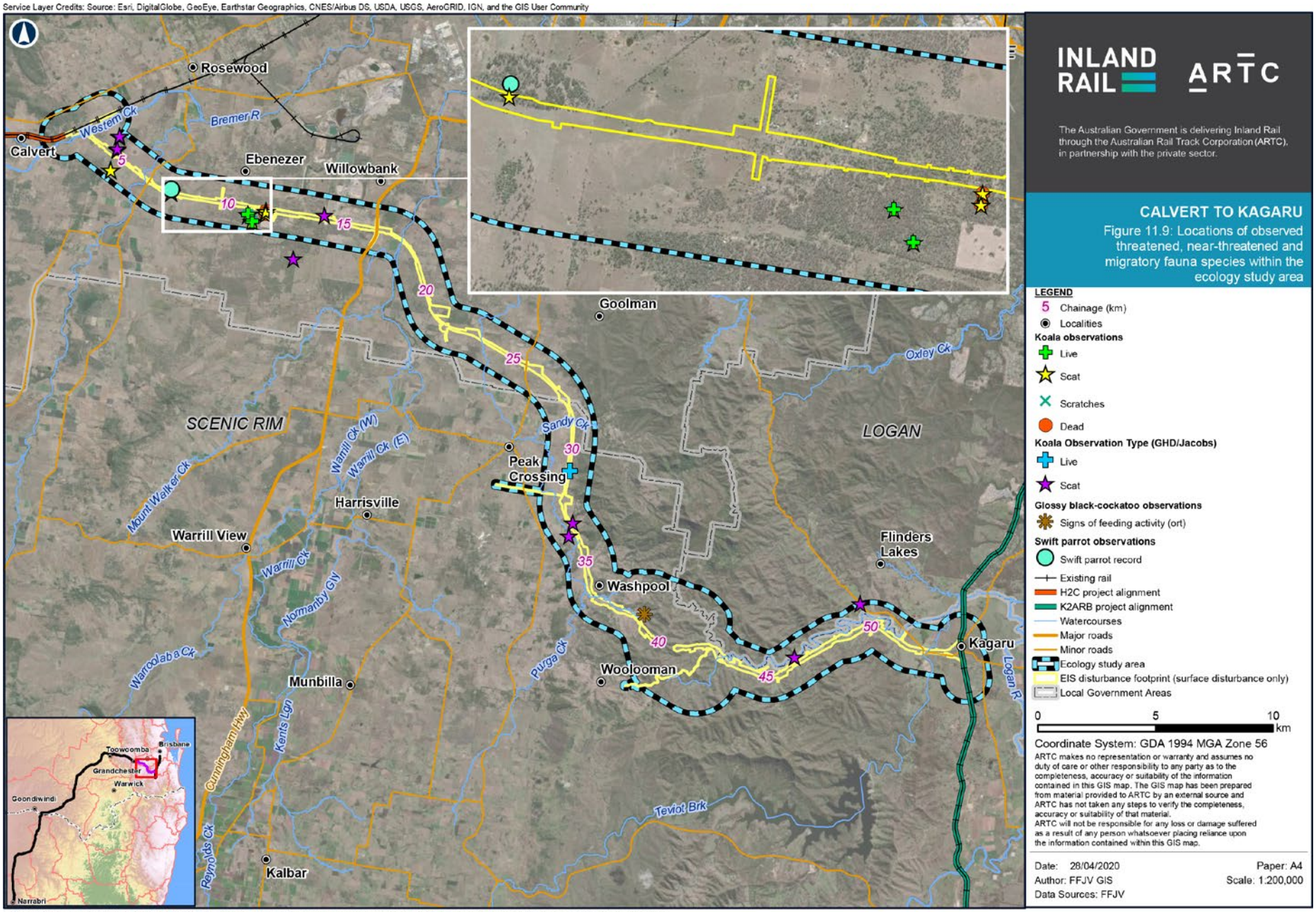
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Rosewood
Calvert
Western Ck
Bremer R
Ebenezer
Willowbank
Goolman
Oxley Ck
SCENIC RIM
LOGAN
Sandy Ck
Peak Crossing
Harrisville
Warrill View
Mount Walker Ck
Warrill Ck (W)
Warrill Ck (E)
Warrill Ck
Normanby Gly
Flinders Lakes
Washpool
Kagaru
Logan R
Woolooman
Purga Ck
Munbilla
Warroolaba Ck
Cunningham Hwy
Kents Lgn
Reynolds Ck
Kalbar
Teviot Brk
5
10
15
20
25
30
35
40
45
50
Toowoomba
Brisbane
Grandchester
Warwick
Goondiwindi
Narrabri
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Figure 11.9: Locations of observed threatened, near-threatened and migratory fauna species within the ecology study area
LEGEND
Chainage (km)
Localities
Koala observations
Live
Scat
Scratches
Dead
Koala Observation Type (GHD/Jacobs)
Live
Scat
Glossy black-cockatoo observations
Signs of feeding activity (ort)
Swift parrot observations
Swift parrot record
Existing rail
H2C project alignment
K2ARB project alignment
Watercourses
Major roads
Minor roads
Ecology study area
EIS disturbance footprint (surface disturbance only)
Local Government Areas
0
5
10
km
Coordinate System: GDA 1994 MGA Zone 56
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11.5.3.2 Introduced fauna

Eight non-native fauna species, including six declared as restricted matters (invasive animals) under the Biosecurity Act, were identified within ecology study area during Project EIS field investigations (refer Table 11.11). These species were widespread across the entire ecology study area. While not observed, it is noted that the red imported fire ant (*Solenopsis invicta*) is known from the ecology study area.

TABLE 11.11: RESTRICTED MATTER FAUNA SPECIES IDENTIFIED WITHIN THE ECOLOGY STUDY AREA

Family name	Species name	Common name	Restricted matter (Biosecurity Act)	Relative abundance within ecology study area
Bufonidae	*Rhinella marina*	Cane toad	No	Very common
Canidae	*Canis lupus familiaris*	Dog	Yes	Common
Suidae	*Sus scrofa*	Pig	Yes	Common
Canidae	*Vulpes Vulpes*	Red fox	Yes	Common
Leporidae	*Lepus europaeus*	European hare	Yes	Common
Leporidae	*Oryctolagus cuniculus*	European rabbit	Yes	Uncommon
Muridae	*Rattus rattus*	Black rat	No	Common
Poeciliidae	*Gambusia holbrooki*	Eastern mosquitofish	Yes	Very common

Table notes:
Restricted matters = includes noxious fish, weeds and pest animals. This restricted matter must not be distributed. This means it must not be given as a gift, sold, traded or released into the environment unless the distribution or disposal is authorised in a regulation or under permit.

11.5.4 Wildlife mapping, protected areas, Koala mapping and Biodiversity Planning Assessment mapping

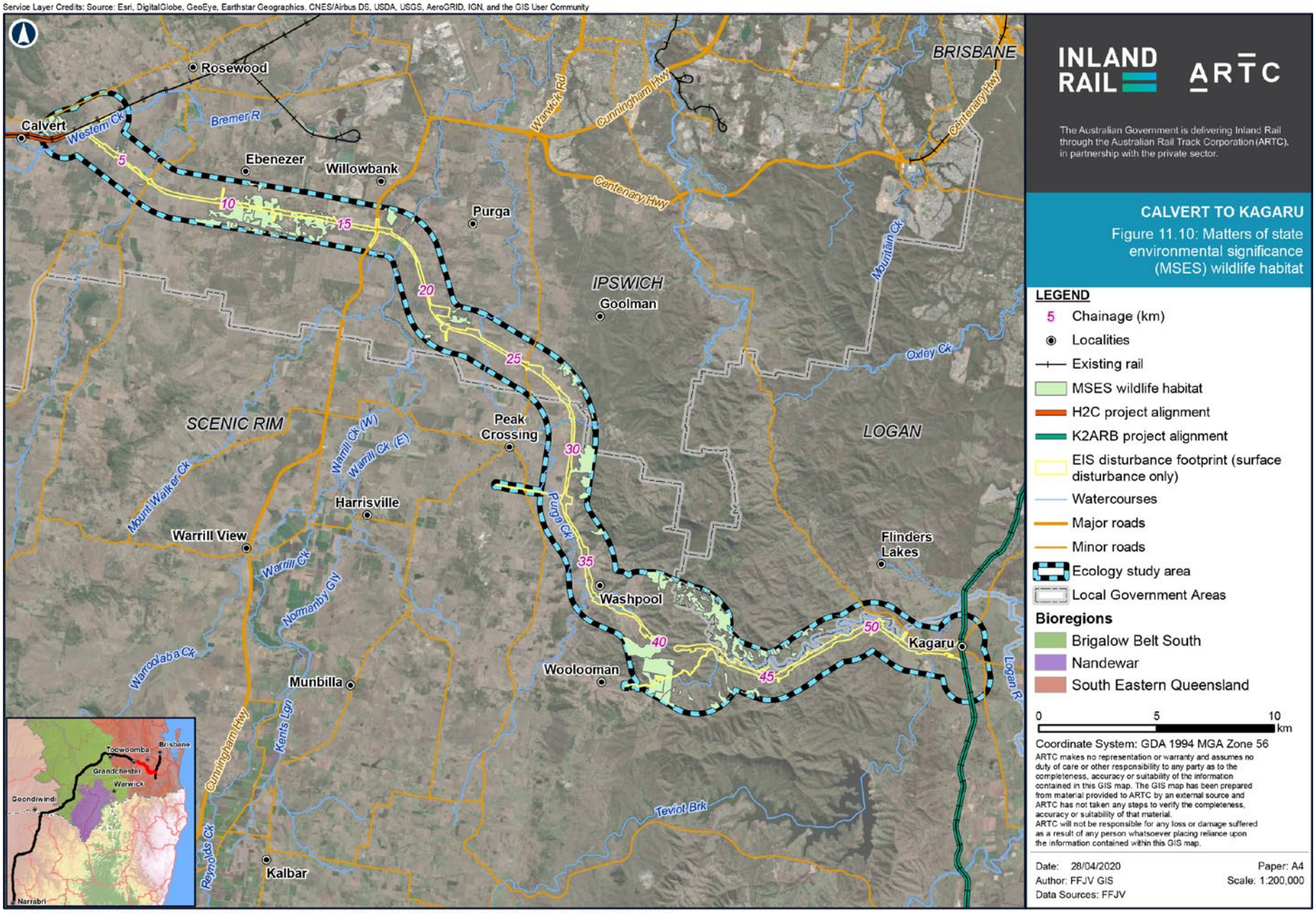
11.5.4.1 Threatened species habitat mapping

Habitat for threatened flora and fauna (including some SLC animals) as listed under the NC Act and the Nature Conservation (Animals) Regulation 2020 are defined as MSES under the QLD SPP. This habitat includes areas listed as 'essential habitat' for threatened species as mapped under the VM Act.

Mapped MSES wildlife habitat and essential habitat mapping occurring within the ecology study area and disturbance footprint is shown in Figure 11.11 and quantified in Table 11.12. Much of this habitat has been mapped for the Koala (*Phascolarctos cinereus).*

TABLE 11.12: MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE WILDLIFE HABITAT PRESENT WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Identified wildlife habitat	Ecology study area	Disturbance footprint
MSES wildlife mapping	1,381.79	88.97
Essential habitat	1,259.38	25.89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Rosewood
Calvert
Western Ck
Bremer R
Ebenezer
Willowbank
Purga
Warwick Rd
Cunningham Hwy
Centenary Hwy
BRISBANE
IPSWICH
Goolman
Mountain Ck
Oxley Ck
SCENIC RIM
LOGAN
Peak Crossing
Warrill Ck (W)
Warrill Ck (E)
Mount Walker Ck
Harrisville
Warrill View
Warrill Ck
Normanby Gly
Warroolaba Ck
Munbilla
Kents Lgn
Reynolds Ck
Kalbar
Purga Ck
Washpool
Flinders Lakes
Kagaru
Logan R
Wooloomin
Teviot Brk
5
10
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25
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35
40
45
50
Toowoomba
Brisbane
Grandchester
Warwick
Goondiwindi
Narrabri
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Figure 11.10: Matters of state environmental significance (MSES) wildlife habitat
LEGEND
5 Chainage (km)
Localities
Existing rail
MSES wildlife habitat
H2C project alignment
K2ARB project alignment
EIS disturbance footprint (surface disturbance only)
Watercourses
Major roads
Minor roads
Ecology study area
Local Government Areas
Bioregions
Brigalow Belt South
Nandewar
South Eastern Queensland
0 5 10 km
Coordinate System: GDA 1994 MGA Zone 56
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11.5.4.2 Protected areas

Three areas protected under the Nature Conservation (Protected Areas) Regulation 1994 (i.e. Koala Crossing Nature Refuge, Purga Nature Reserve (Ipswich Council Management), and Gum Tips Nature Refuge) are contained within the ecology study area. Purga Nature Reserve overlaps the disturbance footprint for 0.36 ha and is shown in Chapter 6: Project Description, Figure 6.2.

Areas protected under the *Forestry Act 1959* (i.e. Protected Forestry Areas) and voluntary declarations protected under the VM Act are not contained within the ecology study area.

Nearby nature refuges (not located within the ecology study area) include Sticky Gully Nature Refuge and Angel Place Nature Refuge, both located to the south of the ecology study area.

There are no known legally secured offset areas located within the ecology study area.

11.5.4.3 Koala habitat mapping

The ecology study area is wholly contained within Koala district A, which is defined as South East QLD under the Planning Regulation 2017.

The *Nature Conservation (Koala) Conservation Plan 2017* categorises four distinct areas: Koala Priority Areas, Koala Habitat Areas, Koala Habitat Restoration Areas, Locally Refined Koala Habitat Areas.

Koala Priority Areas are large, connected areas where a focus will be on habitat protection, habitat restoration and threat mitigation to safeguard Koala populations in South East Queensland. Koala Priority Areas constitute the second largest habitat category within the ecology study area and the second largest category in the disturbance footprint.

Koala Habitat Areas (core) represent the best quality Koala habitat, based on modelling of biophysical measures (such as climate), suitable vegetation (for both food and shelter), and Koala sighting records. This mapping also generally aligns with the essential habitat mapping for Koalas.

Koala Habitat Restoration Areas is land that could be restored and established as Koala habitat. These areas feature low threats or constraints, and high conservation opportunities. The category constitutes the second largest are within the ecology study area and constitute the largest habitat category within the disturbance footprint.

Koala Habitat Areas (locally refined) are currently protected in South East Queensland and include areas of remnant (uncleared) or high-value regrowth vegetation previously protected by local governments. A relatively small proportion of the ecology study area and disturbance footprint is mapped as Locally Refined Koala Habitat Areas.

The extent of these areas is shown in Figure 11.12 and defined in Table 11.13.

TABLE 11.13: THE EXTENT OF KOALA MAPPING WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Koala mapping category	**Ecology study area**	**Disturbance footprint**
Koala Priority Areas	3,770.56	258.48
Koala Habitat Areas	3,006.09	145.57
Koala Habitat Restoration Areas	3,636.14	295.13
Locally Refined Koala Habitat Areas	327.42	27.92

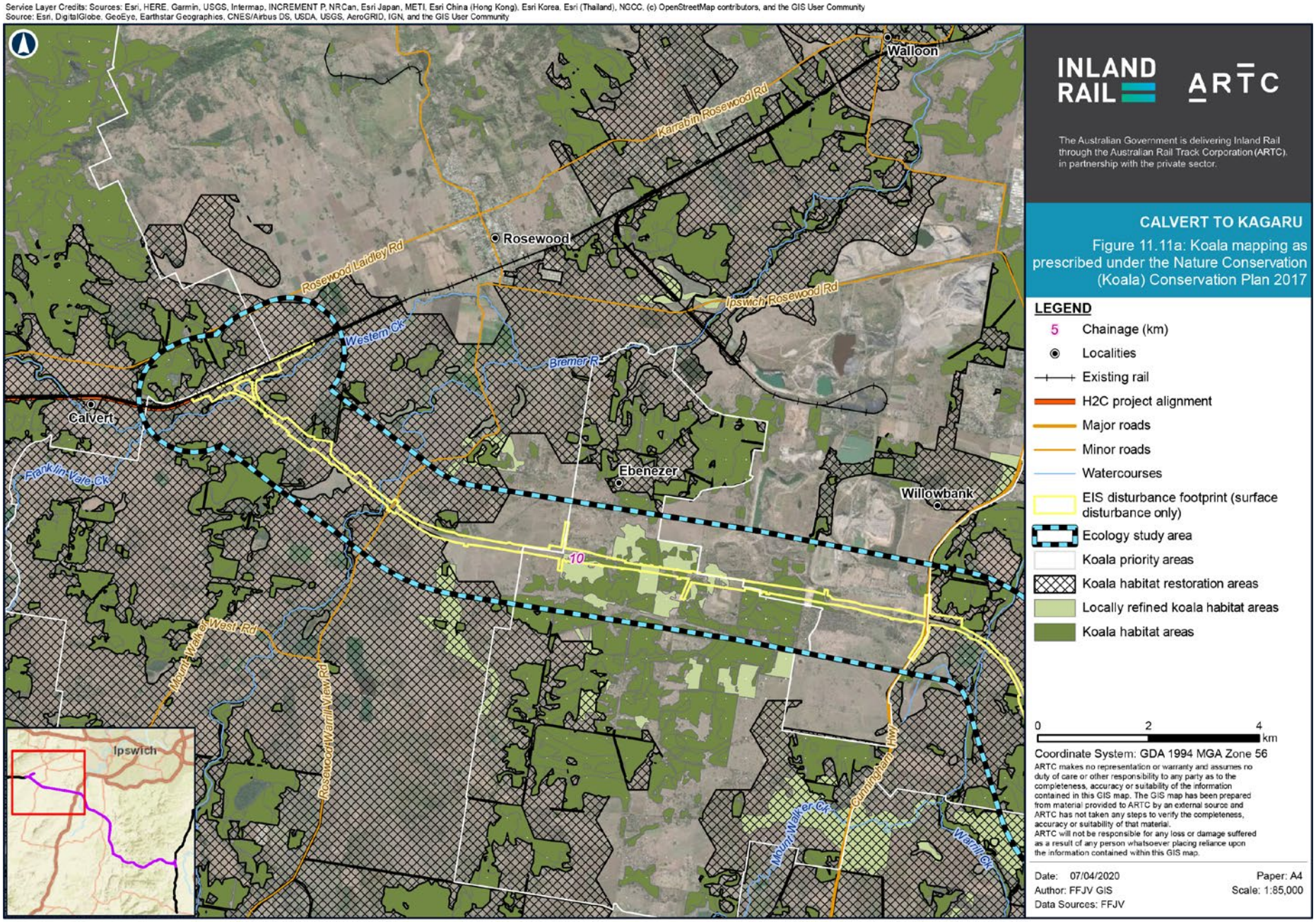
11.5.4.4 Biodiversity Planning Assessment mapping

The BPA classifies areas according to their significance based on the presence of Endangered Vulnerable and Near Threatened (EVNT) taxa. It excludes highly mobile fauna taxa. The ecology study area includes areas of State and regional habitat values for EVNT taxa. The extent of this habitat within the ecology study area is provided in Table 11.14 and shown in Figure 11.13. These areas overlap substantially with those mapped as essential habitat and MSES wildlife habitat (refer Section 11.5.4.1).

TABLE 11.14 : THE EXTENT OF BIODIVERSITY PLANNING ASSESSMENT HABITAT VALUES WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Habitat for EVNT taxa	**Ecology study area**	**Disturbance footprint**
State	1,110.92	116.92
Regional	293.23	1.35

Areas identified under the BPA as corridors qualify either because they are existing vegetated corridors important for contiguity, including regrowth, or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and 'stepping stones'.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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Walloon
Karrabin Rosewood Rd
Rosewood
Rosewood Laidley Rd
Ipswich Rosewood Rd
Western Ck
Bremer R
Calvert
Franklin Vale Ck
Ebenezer
Willowbank
10
Mount Walker West Rd
Rosewood Warrill View Rd
Ipswich
Mount Walker Ck
Cunningham Hwy
Warrill Ck
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Figure 11.11a: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017
LEGEND
5 Chainage (km)
Localities
Existing rail
H2C project alignment
Major roads
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Koala priority areas
Koala habitat restoration areas
Locally refined koala habitat areas
Koala habitat areas
0 2 4 km
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Scale: 1:85,000
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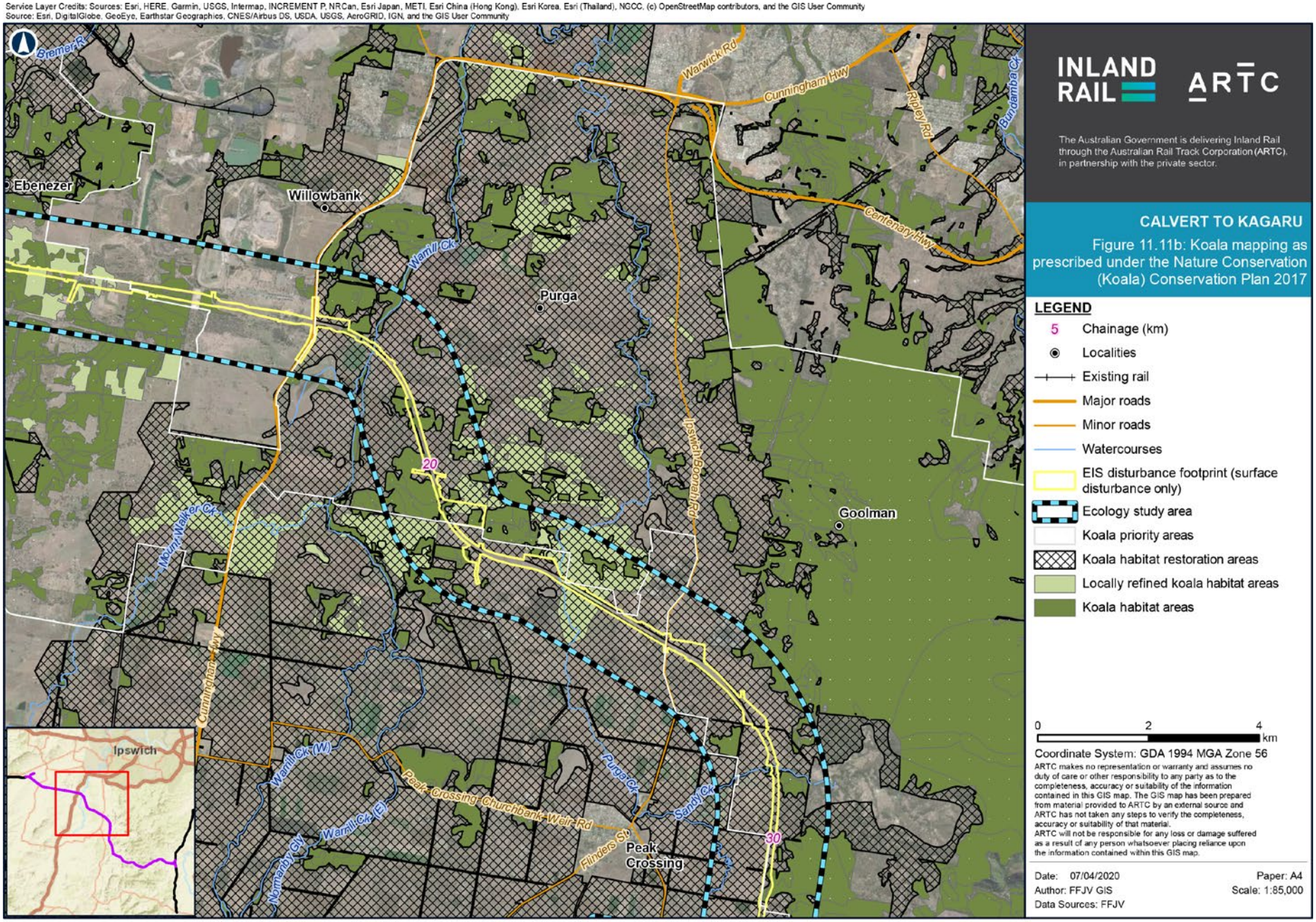
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Bremer R
Ebenezer
Willowbank
Warrill Ck
Warwick Rd
Cunningham Hwy
Ridley Rd
Burrandowa Ck
Centenary Hwy
Purga
Ipswich Boonah Rd
20
Goolman
Mount Walker Ck
Cunningham Hwy
Ipswich
Warrill Ck (W)
Warrill Ck (E)
Normanby Cl
Peak Crossing Churchbank Weir Rd
Purga Ck
Sandy Ck
Flinders St
Peak Crossing
30
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CALVERT TO KAGARU
Figure 11.11b: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017
LEGEND
5 Chainage (km)
Localities
Existing rail
Major roads
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Koala priority areas
Koala habitat restoration areas
Locally refined koala habitat areas
Koala habitat areas
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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Author: FFJV GIS
Scale: 1:85,000
Data Sources: FFJV
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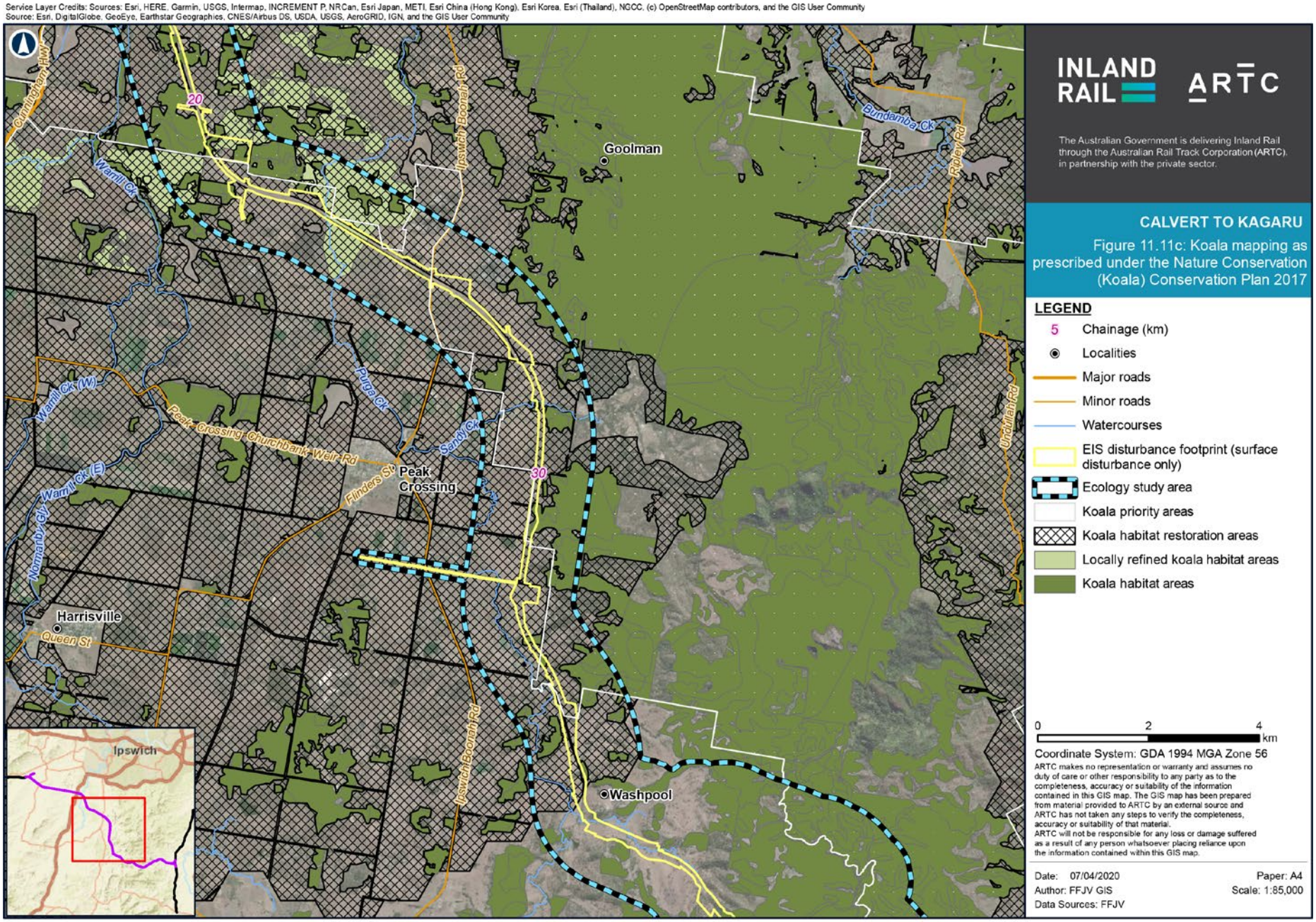
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Goolman
Peak Crossing
Harrisville
Washpool
Ipswich
Cunningham Hwy
Warrill Ck
Warrill Ck (W)
Warrill Ck (E)
Normanby Cl
Peak Crossing-Churchbank-Weir Rd
Flinders St
Queen St
Purga Ck
Sandy Ck
Ipswich-Boonah Rd
Bundamba Ck
Ridley Rd
Undullah Rd
20
30
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CALVERT TO KAGARU
Figure 11.11c: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017
LEGEND
5 Chainage (km)
Localities
Major roads
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Koala priority areas
Koala habitat restoration areas
Locally refined koala habitat areas
Koala habitat areas
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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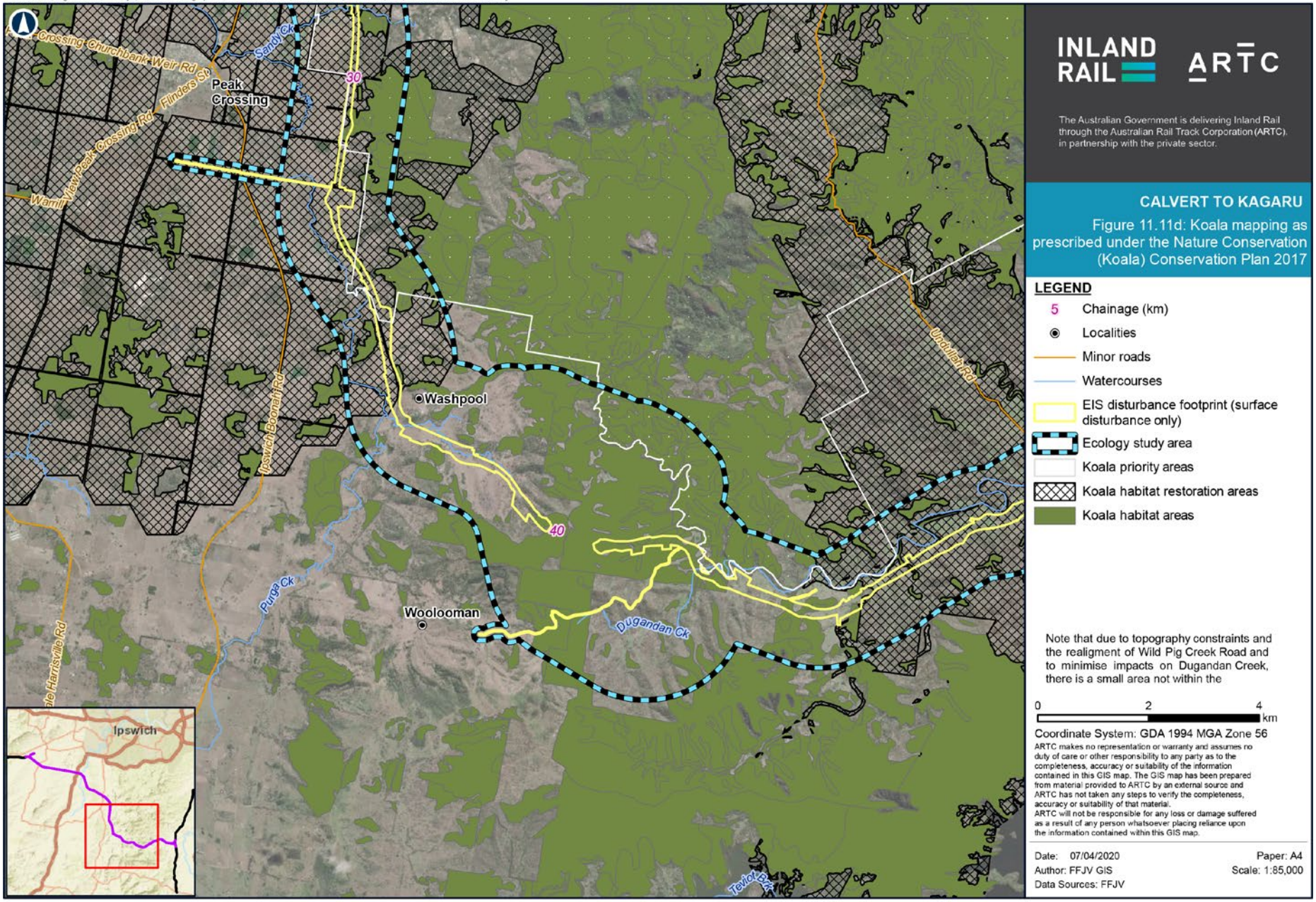
Data Sources: FFJV
Paper: A4
Scale: 1:85,000
Map by: AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905061615_ARTC_Fig_11.11_koala_map.mxd Date: 28/04/2020 14:39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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Crossing
Churchbank
Weir Rd
Flinders St
Peak Crossing
Sandy Ck
30
Warrill View
Peak Crossing Rd
Washpool
Ipswich Boonah Rd
Undullah Rd
40
Purga Ck
Wooloomin
Dugandan Ck
Harrisville Rd
Ipswich
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Figure 11.11d: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017
LEGEND
5 Chainage (km)
Localities
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Koala priority areas
Koala habitat restoration areas
Koala habitat areas
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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Data Sources: FFJV
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Scale: 1:85,000
Map by: AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.11_koala_map.mxd Date: 28/04/2020 14:39

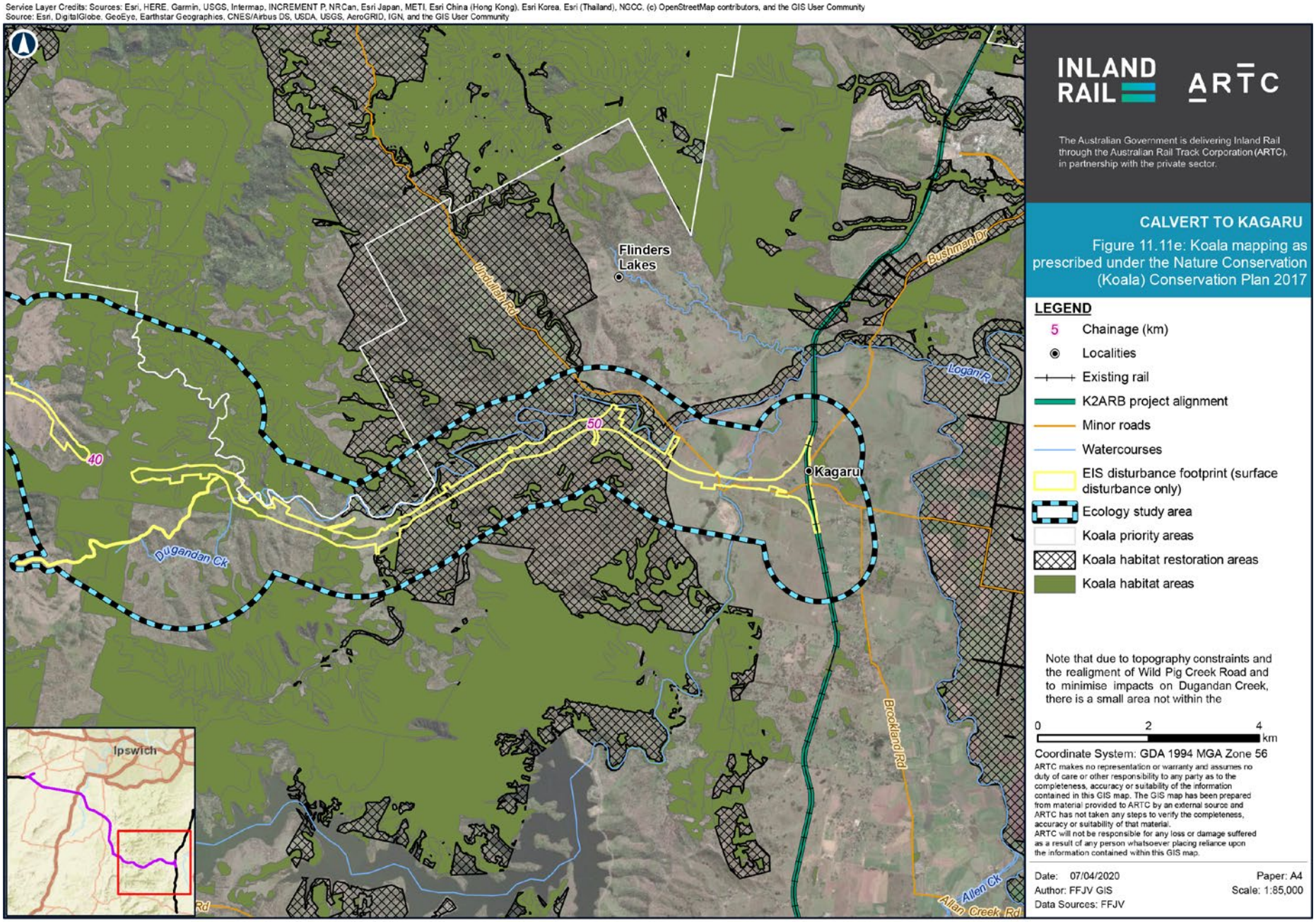
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Flinders Lakes
Undullah Rd
Bushman Dr
Logan R
Kagaru
Brocklands Rd
Allen Ck
Allan Creek Rd
Dugandan Ck
40
50
Ipswich
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Figure 11.11e: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017
LEGEND
5 Chainage (km)
Localities
Existing rail
K2ARB project alignment
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
Koala priority areas
Koala habitat restoration areas
Koala habitat areas
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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Data Sources: FFJV
Paper: A4
Scale: 1:85,000
Map by: AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905061615_ARTC_Fig_11.11_koala_map.mxd Date: 28/04/2020 14:39

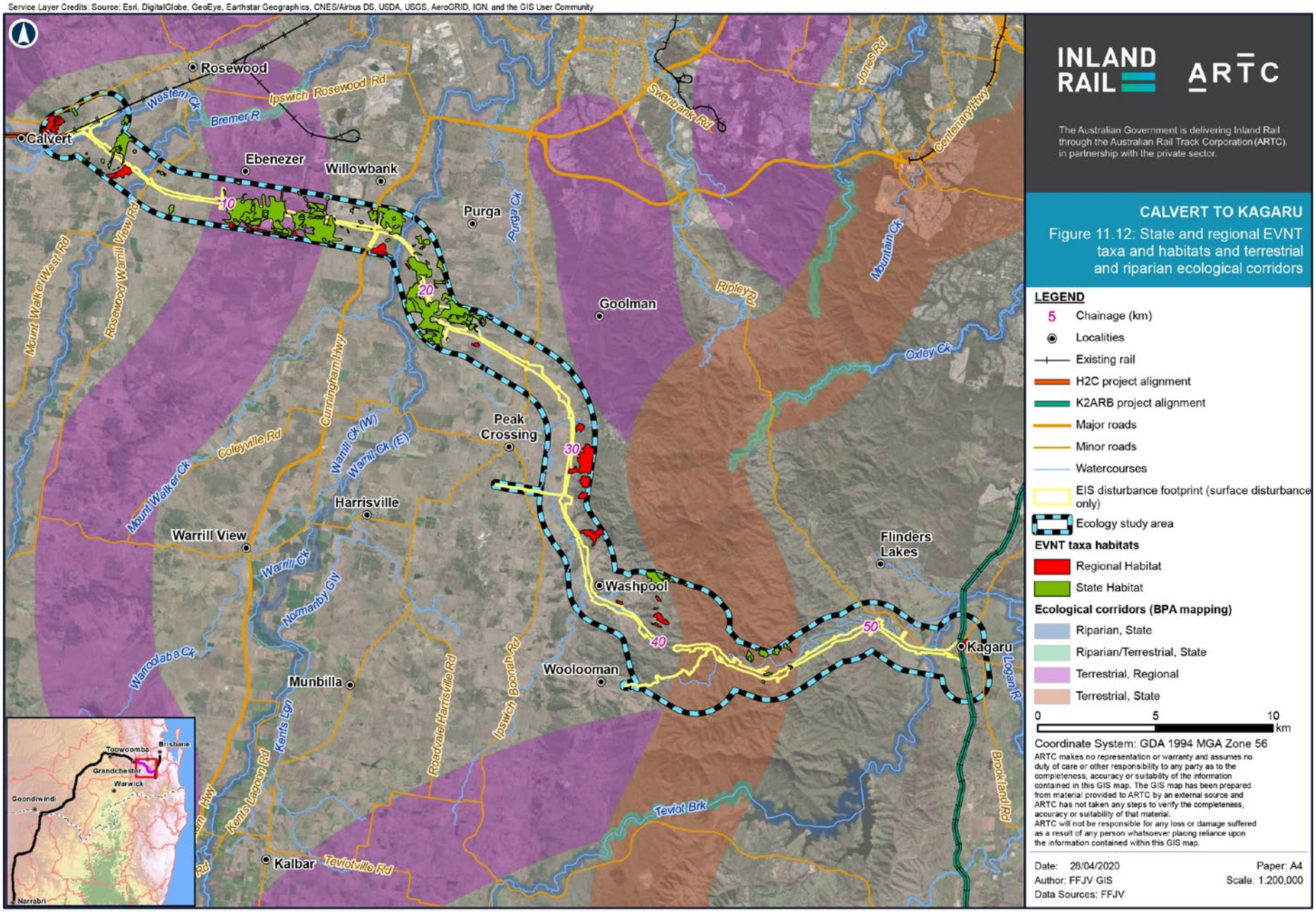
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Rosewood
Calvert
Ebenezer
Willowbank
Purga
Goolman
Peak Crossing
Harrisville
Warrill View
Washpool
Flinders Lakes
Kagaru
Munbilla
Woolooman
Kalbar
Ipswich Rosewood Rd
Western Ck
Bremer R
Purga Ck
Swanbank Rd
Jones Rd
Centenary Hwy
Mountain Ck
Ripley Rd
Oxley Ck
Mount Walker West Rd
Rosewood Warrill View Rd
Cunningham Hwy
Warrill Ck (W)
Warrill Ck (E)
Coleyville Rd
Mount Walker Ck
Warrill Ck
Normanby Gly
Warroolaba Ck
Kents Lgn
Kents Lagoon Rd
Roadvale Harrisville Rd
Ipswich Boonah Rd
Teviot Brk
Teviotville Rd
Logan R
Brooklands Rd
10
20
30
40
50
Toowoomba
Brisbane
Grandchester
Warwick
Goondiwindi
Narrabri
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Figure 11.12: State and regional EVNT taxa and habitats and terrestrial and riparian ecological corridors
LEGEND
5 Chainage (km)
Localities
Existing rail
H2C project alignment
K2ARB project alignment
Major roads
Minor roads
Watercourses
EIS disturbance footprint (surface disturbance only)
Ecology study area
EVNT taxa habitats
Regional Habitat
State Habitat
Ecological corridors (BPA mapping)
Riparian, State
Riparian/Terrestrial, State
Terrestrial, Regional
Terrestrial, State
0 5 10 km
Coordinate System: GDA 1994 MGA Zone 56
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Author: FFJV GIS
Scale: 1:200,000
Data Sources: FFJV
Map by: AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.12_EVNT_corridors.mxd Date: 28/04/2020 14:44

The ecology study area is traversed by terrestrial and riparian ecological corridors. The location of these corridors is provided in Figure 11.13 and quantified in Table 11.15.

TABLE 11.15: THE EXTENT OF BIODIVERSITY PLANNING ASSESSMENT TERRESTRIAL AND RIPARIAN ECOLOGICAL CORRIDORS WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Corridor type	**Ecology study area**	**Disturbance footprint**
Regional terrestrial corridors	1,005.86	87.86
State riparian corridors	510.72	40.86
State terrestrial corridors	1,809.17	119.80

11.5.5 Predicted habitat for conservation significant species

Predicted habitat mapping for threatened, near-threatened, migratory and SLC species indicates that potential habitat exists for 9 flora and 33 fauna species within the ecology study area (refer Table 11.16, Table 11.17 and Table 11.18). Areas of habitat for these species are provided in Table 11.16, Table 11.17 and Table 11.18 and maps provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report.

TABLE 11.16: PREDICTED HABITAT FOR THREATENED (EPBC ACT) FLORA AND FAUNA SPECIES WITHIN THE ECOLOGY STUDY AREA

				Predicted habitat within the ecology study area (ha)* (12,442.24 ha)				Predicted habitat within the disturbance footprint (ha)* (972.49 ha)			
Species name	**Common name**	**NC Act status**	**EPBC Act status**	**Total habitat**	**Potential habitat**	**Important habitat**	**Habitat critical to the survival of the species**	**Total habitat**	**Potential habitat**	**Important habitat**	**Habitat critical to the survival of the species**
Flora (threatened)											
Arthraxon hispidus	Hairy-joint Grass	V	V	67.47	67.47	0.00	0.00	4.15	4.15	0.00	0.00
Bulbophyllum globuliforme	Miniature Moss-orchid	NT	V	6.29	6.29	0.00	0.00	0.00	0.00	0.00	0.00
Cupaniopsis tomentella	Boonah Tuckeroo	V	V	6.29	6.29	0.00	0.00	0.00	0.00	0.00	0.00
Lychnothamnus barbatus	A Green Algae	V	E	113.45	113.45	0.00	0.00	6.90	6.90	0.00	0.00
Notelaea lloydii	Lloyd's Olive	V	V	1,089.16	0.00	0.00	1,089.16	26.77	0.00	0.00	26.77
Planchonella eerwah	Shiny-leaved Condoo	E	E	6.29	6.29	0.00	0.00	0.00	0.00	0.00	0.00
Fauna (threatened)											
Anthochaera phrygia	Regent Honeyeater	E	CE	924.90	924.90	0.00	0.00	11.43	11.43	0.00	0.00
Botaurus poiciloptilus	Australasian Bittern	E	E	592.72	592.72	0.00	0.00	42.43	42.43	0.00	0.00
Calidris ferruginea	Curlew Sandpiper	E	CE, M	600.53	600.53	0.00	0.00	38.15	38.15	0.00	0.00
Chalinolobus dwyeri	Large-eared Pied Bat	E	V	89.30	89.30	0.00	0.00	2.89	2.89	0.00	0.00
Dasyurus maculatus	Spotted-tailed Quoll (South-eastern mainland population)	V	E	1,927.68	1,571.09	0.00	356.59	76.36	69.44	0.00	6.92
Delma torquata	Collared Delma	V	V	898.27	0.00	898.27	0.00	9.56	0.00	9.56	0.00
Erythrotriorchis radiatus	Red Goshawk	E	V	1,968.90	305.75	0.00	1,663.15	79.05	1.80	0.00	77.25
Grantiella picta	Painted Honeyeater	V	V	311.23	311.23	0.00	0.00	30.10	30.10	0.00	0.00
Lathamus discolor	Swift Parrot	E	CE	2,966.22	2,764.98	0.00	201.24	141.18	129.44	0.00	11.74
Neoceratodus forsteri	Australian Lungfish	V	V	249.15	249.15	0.00	0.00	27.62	27.62	0.00	0.00
Petauroides volans volans	Greater Glider	V	V	1,007.67	1,007.67	0.00	0.00	16.60	16.60	0.00	0.00

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the ecology study area (ha)* (12,442.24 ha)				Predicted habitat within the disturbance footprint (ha)* (972.49 ha)			
				Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species	Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species
Petrogale penicillata	Brush-tailed Rock-wallaby	V	V	0.024	0.024	0.00	0.00	0.00	0.00	0.00	0.00
Phascolarctos cinereus	Koala combined populations of QLD, NSW and the ACT)	V	V	7,613.98	4,878.50	0.00	2,735.48	598.48	474.17	0.00	124.31
Potorous tridactylus	Long-nosed Potoroo (SE mainland)	V	V	875.63	875.63	0.00	0.00	9.56	9.56	0.00	0.00
Pseudomys novaehollandiae	New Holland Mouse	V	V	880.47	880.47	0.00	0.00	9.56	9.56	0.00	0.00
Pteropus poliocephalus	Grey-headed Flying-fox	LC	V	3,084.70	1,873.48	0.00	1,211.22	143.89	72.45	0.00	71.44
Rostratula australis	Australian Painted Snipe	E	E	600.53	52.36	0.00	548.17	38.15	3.60	0.00	34.55
Turnix melanogaster	Black-breasted Button-quail	E	V	4.19	0.00	0.00	4.19	0.00	0.00	0.00	0.00
Hirundapus caudacutus^	White-throated Needletail	V	V, M	12,445.93	9,361.23	3,084.70	0.00	972.49	828.59	143.90	0.00

Table notes:

CE = Critically endangered E = Endangered V = Vulnerable M = Migratory LC = Least concern - = Not listed

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

* = No value (i.e. 0) represent areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. For species where no habitat is present within the ecology study area, impact assessment has not occurred although their habitat requirements and ecology has been considered through the modelling process (refer Appendix K: Matters of National Environmental Significance Technical Report).

TABLE 11.17: PREDICTED HABITAT FOR EPBC ACT LISTED MIGRATORY SPECIES WITHIN THE ECOLOGY STUDY AREA

				Predicted habitat within the ecology study area (ha)* (12,442.24 ha)			Predicted habitat within the disturbance footprint (ha)* (972.49 ha)		
Species name	**Common name**	**NC Act status**	**EPBC Act status**	**Total habitat**	**Potential habitat**	**Important habitat**	**Total habitat**	**Potential habitat**	**Important habitat**
EPBC Act migratory species									
Pandion haliaetus	Osprey	SLC	M	592.72	527.68	65.04	42.43	42.43	0.00
Cuculus optatus	Oriental Cuckoo	SLC	M	162.31	157.06	5.25	7.60	7.60	0.00
Myiagra cyanoleuca	Satin Flycatcher	SLC	M	162.31	157.06	5.25	7.60	7.60	0.00
Rhipidura rufifrons	Rufous Fantail	SLC	M	162.31	157.06	5.25	7.60	7.60	0.00
Monarcha melanopsis	Black-faced Monarch	SLC	M	162.31	157.06	5.25	7.60	7.60	0.00
Symposiachrus trivirgatus	Spectacled Monarch	SLC	M	162.31	157.06	5.25	7.60	7.60	0.00
Motacilla flava	Yellow Wagtail	SLC	M	684.43	521.02	163.41	45.33	42.43	2.90
Actitis hypoleucos	Common Sandpiper	SLC	M	684.43	521.02	163.41	45.33	42.43	2.90
Calidris acuminata	Sharp-tailed Sandpiper	SLC	M	684.43	521.02	163.41	45.33	42.43	2.90
Gallinago hardwickii	Latham's Snipe	SLC	M	684.43	521.02	163.41	45.33	42.43	2.90
Plegadis falcinellus	Glossy Ibis	SLC	M	684.43	521.02	163.41	45.33	42.43	2.90

Table notes:
M = Migratory SLC = Special Least Concern
* = No value (i.e. 0) represent areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. For species where no habitat is present within the ecology study area, impact assessment has not occurred, although their habitat requirements and ecology has been considered through the modelling process (refer Appendix K: Matters of National Environmental Significance Technical Report).

TABLE 11.18: PREDICTED HABITAT FOR NC ACT THREATENED, NEAR-THREATENED AND SPECIAL LEAST CONCERN FLORA AND FAUNA SPECIES (EXCLUDING MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE) WITHIN THE ECOLOGY STUDY AREA

			Predicted habitat within the ecology study area (ha)* (12,442.24 ha)				Predicted habitat within the disturbance footprint (ha)* (972.49 ha)			
Species name	**Common name**	**NC Act status**	**Total habitat**	**General**	**Essential**	**Core**	**Total habitat**	**General**	**Essential**	**Core**
NC Act conservation-significant flora										
Callitris baileyi	Bailey's Cypress Pine	NT	993.00	993.00	0.00	0.00	11.43	11.43	0.00	0.00
Marsdenia coronata	Slender Milkvine	V	602.55	602.55	0.00	0.00	61.85	61.85	0.00	0.00
Melaleuca irbyana	Swamp Tea-tree	E	3,254.61	2,293.02	318.82	642.76	237.73	132.42	45.69	59.63
NC Act conservation-significant fauna										
Adelotus brevis	Tusked Frog	V	104.91	104.91	0.00	0.00	10.21	10.21	0.00	0.00
Calyptorhynchus lathami	Glossy-black Cockatoo	V	807.20	786.61	20.59	0.00	50.63	49.96	0.68	0.00
Ninox strenua	Powerful Owl	V	204.29	204.29	0.00	0.00	21.54	21.54	0.00	0.00
NC Act special least concern animals										
Tachyglossus aculeatus	Echidna	SLC	2,147.34	2,147.34	0.00	0.00	67.64	67.64	0.00	0.00

Table notes:
E = Endangered V = Vulnerable NT = Near threatened SLC = Special Least Concern - = Not listed
* = No value (i.e. 0) represent areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. For species where no habitat is present within the ecology study area, impact assessment has not occurred although their habitat requirements and ecology has been considered through the modelling process (refer Appendix K: Matters of National Environmental Significance Technical Report).

11.5.6 Terrestrial flora and fauna species habitat

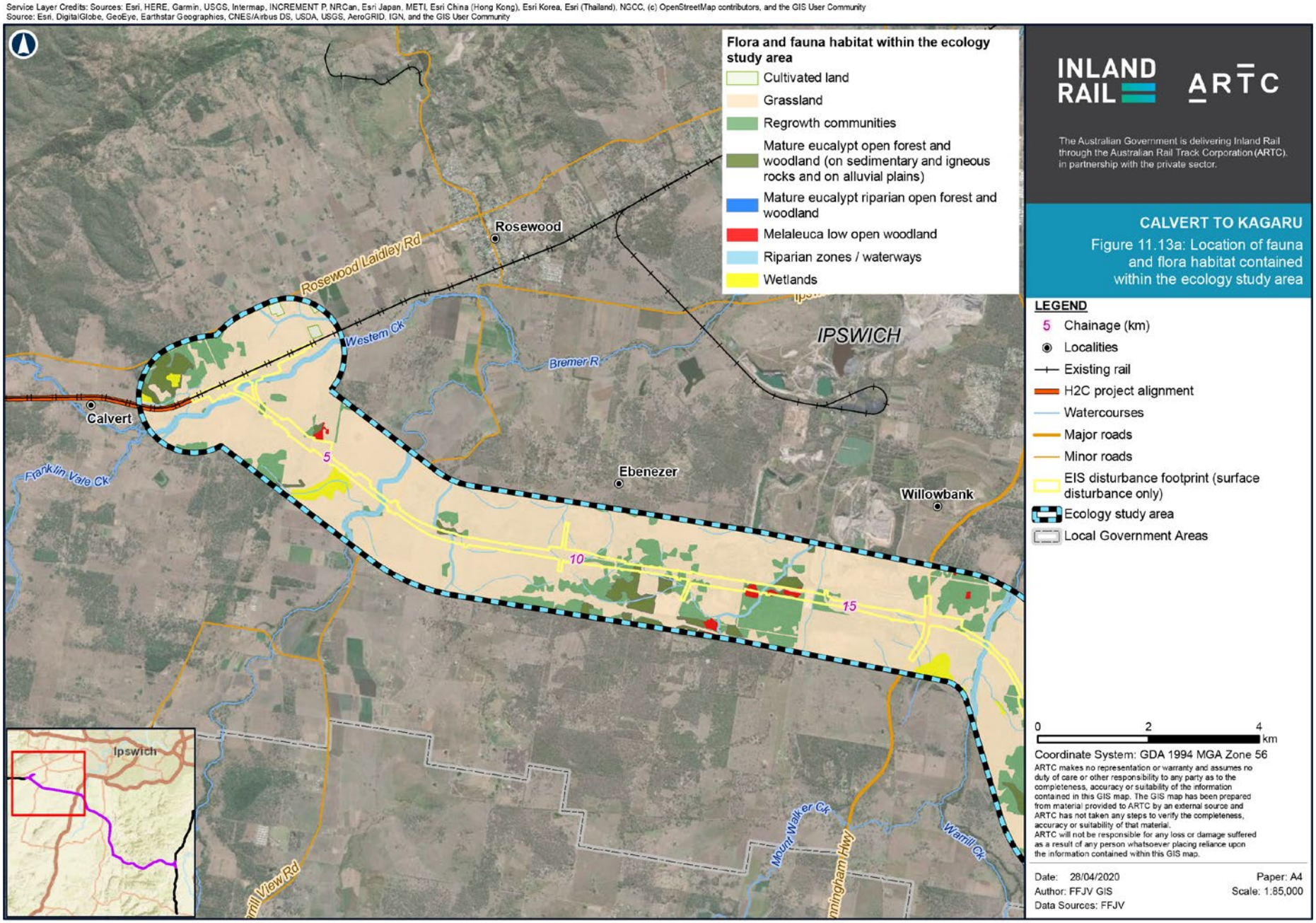
Nine broad fauna habitat types were identified within the ecology study area. Mature eucalypt open forest and woodland are the dominant forest/woodland habitat types in the ecology study area. Areas of habitat ranged in size from small fragments less than 1 ha, which are often degraded as a result of weed invasion and structural simplification, to larger tracts of forest/woodland typically associated with steep topography (e.g. Teviot Range).

The nine broad habitat types and analogous REs identified within the ecology study area are shown in Table 11.19.

A detailed description of each of these broad habitat types is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report. Fauna habitat is shown in Figure 11.14 and quantified in Table 11.19.

TABLE 11.19: QUANTIFICATION OF TERRESTRIAL HABITAT PRESENT WITHIN THE ECOLOGY STUDY AREA AND THE DISTURBANCE FOOTPRINT

		Extent (ha)	
Fauna habitat type (refer Figure 11.14)	**Analogous REs**	**Ecology study area**	**Disturbance footprint**
Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)	12.3.3, 12.3.3d, 12.3.19, 12.8.24, 12.9-10.2, 12.9-10.3, 12.9-10.7, 12.9-10.17, 12.9-10.17a, 12.9-10.27	1,025.45	11.17
Mature eucalypt riparian open forest and woodland	12.3.7, 12.3.7c	18.09	1.39
Araucarian notophyll/microphyll and microphyll vine forest	12.9-10.16	4.34	0.00
Melaleuca low open woodland	12.3.18, 12.9-10.11	80.27	30.31
Wetlands	N/A	69.00	0.75
Grassland (non-remnant)	N/A	8,144.91	729.10
Riparian zones/waterways	N/A	1,050.08	73.44
Cultivated land	N/A	332.09	32.36
Regrowth communities (non-remnant)	N/A	1,690.39	93.87
No Habitat present	N/A	27.60	0.00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Flora and fauna habitat within the ecology study area
Cultivated land
Grassland
Regrowth communities
Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
Mature eucalypt riparian open forest and woodland
Melaleuca low open woodland
Riparian zones / waterways
Wetlands
Rosewood
Rosewood Laidley Rd
Western Ck
Bremer R
IPSWICH
Calvert
Franklin Vale Ck
Ebenezer
Willowbank
5
10
15
Ipswich
Mount Walker Ck
Warrill Ck
INLAND RAIL
ARTC
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CALVERT TO KAGARU
Figure 11.13a: Location of fauna and flora habitat contained within the ecology study area
LEGEND
5 Chainage (km)
Localities
Existing rail
H2C project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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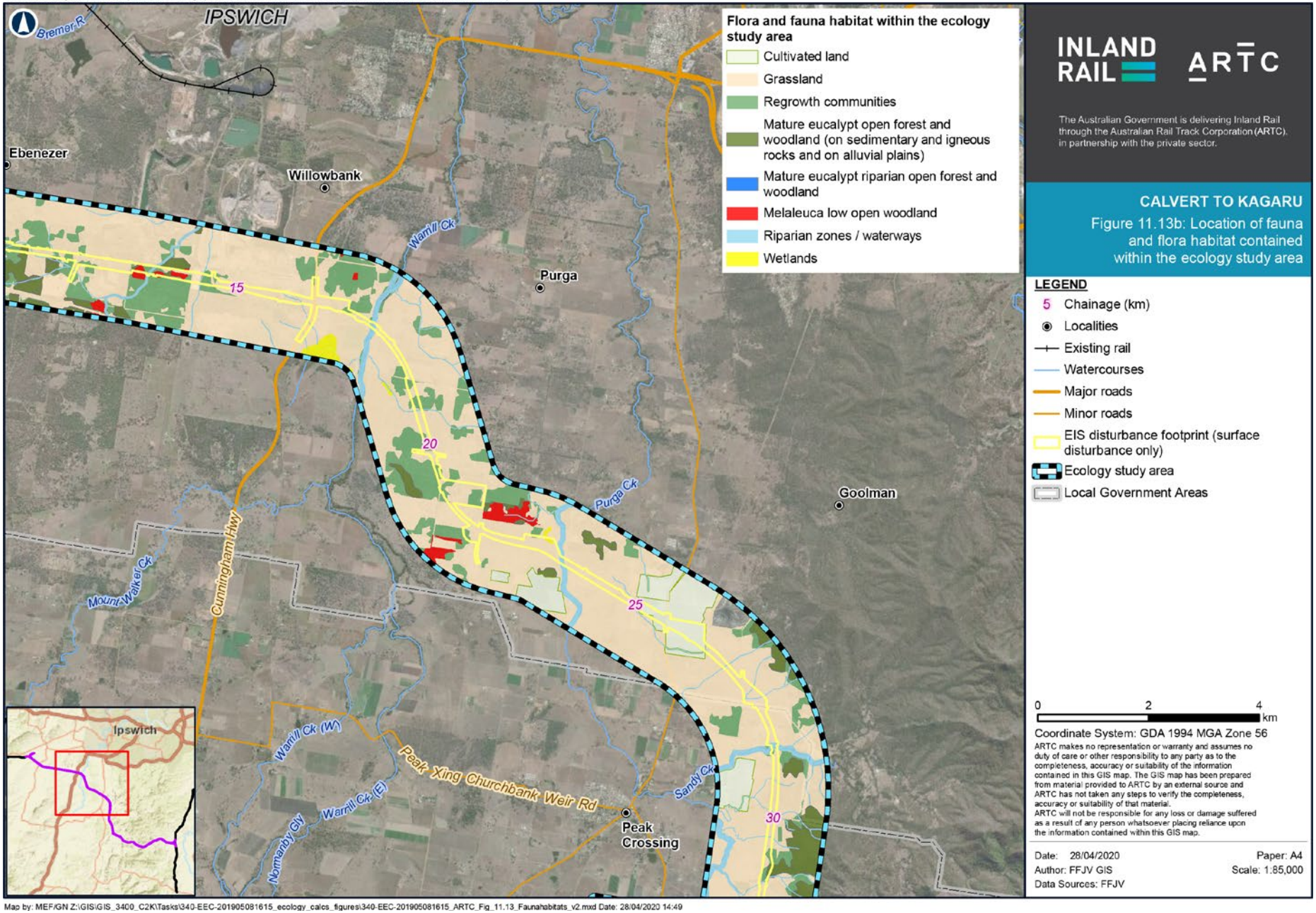
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
IPSWICH
Bremer R
Ebenezer
Willowbank
Warrill Ck
Purga
Goolman
Purga Ck
Cunningham Hwy
Mount Walker Ck
Warrill Ck (W)
Warrill Ck (E)
Normanby Gly
Peak Xing Churchbank Weir Rd
Peak Crossing
Sandy Ck
15
20
25
30
Ipswich
Flora and fauna habitat within the ecology study area
Cultivated land
Grassland
Regrowth communities
Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
Mature eucalypt riparian open forest and woodland
Melaleuca low open woodland
Riparian zones / waterways
Wetlands
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CALVERT TO KAGARU
Figure 11.13b: Location of fauna and flora habitat contained within the ecology study area
LEGEND
5 Chainage (km)
Localities
Existing rail
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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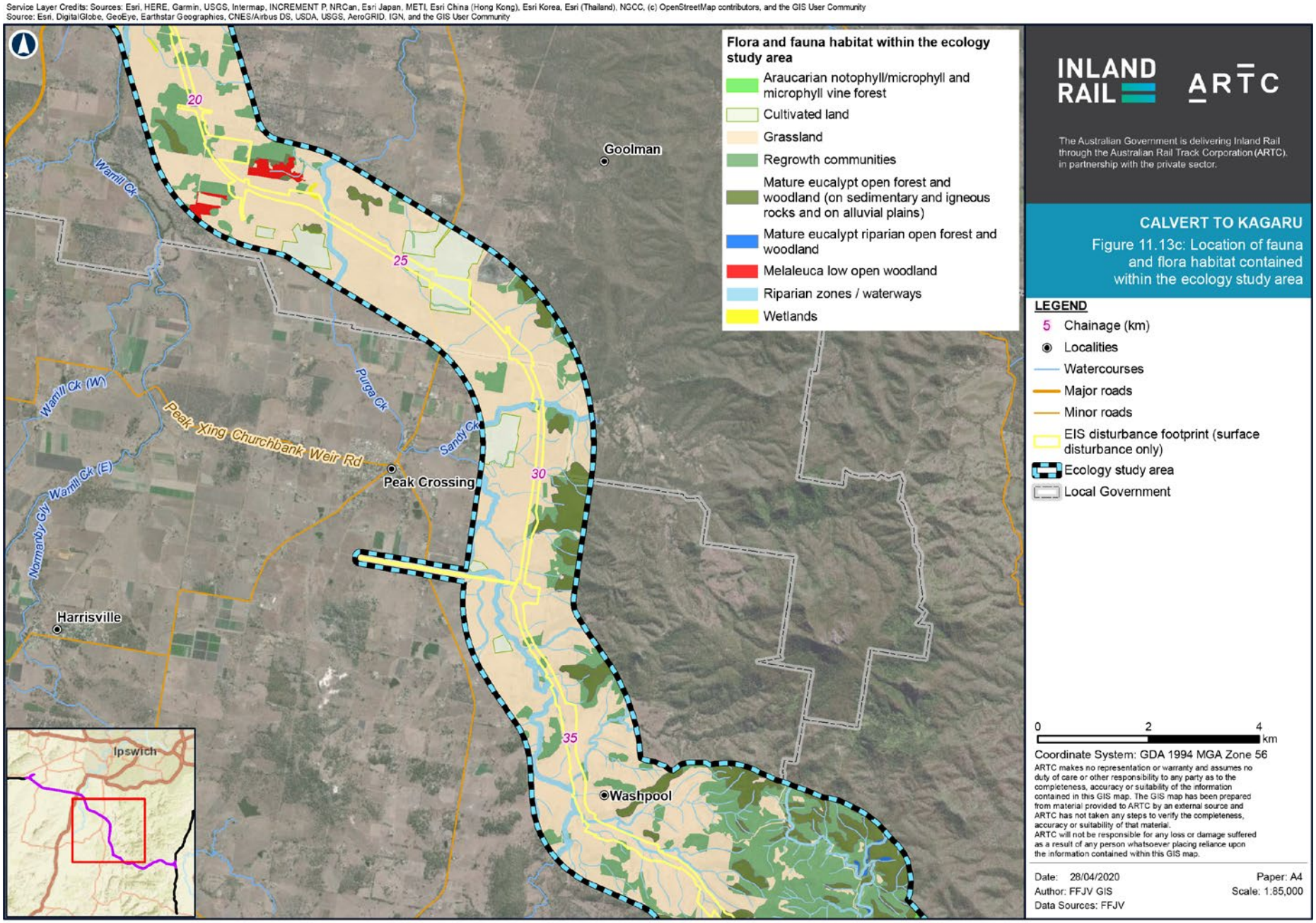
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Flora and fauna habitat within the ecology study area
Araucarian notophyll/microphyll and microphyll vine forest
Cultivated land
Grassland
Regrowth communities
Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
Mature eucalypt riparian open forest and woodland
Melaleuca low open woodland
Riparian zones / waterways
Wetlands
Goolman
Warrill Ck
Warrill Ck (W)
Warrill Ck (E)
Normanby Gly
Peak Xing Churchbank Weir Rd
Peak Crossing
Purga Ck
Sandy Ck
Harrisville
Washpool
Ipswich
20
25
30
35
INLAND RAIL
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CALVERT TO KAGARU
Figure 11.13c: Location of fauna and flora habitat contained within the ecology study area
LEGEND
5 Chainage (km)
Localities
Watercourses
Major roads
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government
0
2
4
km
Coordinate System: GDA 1994 MGA Zone 56
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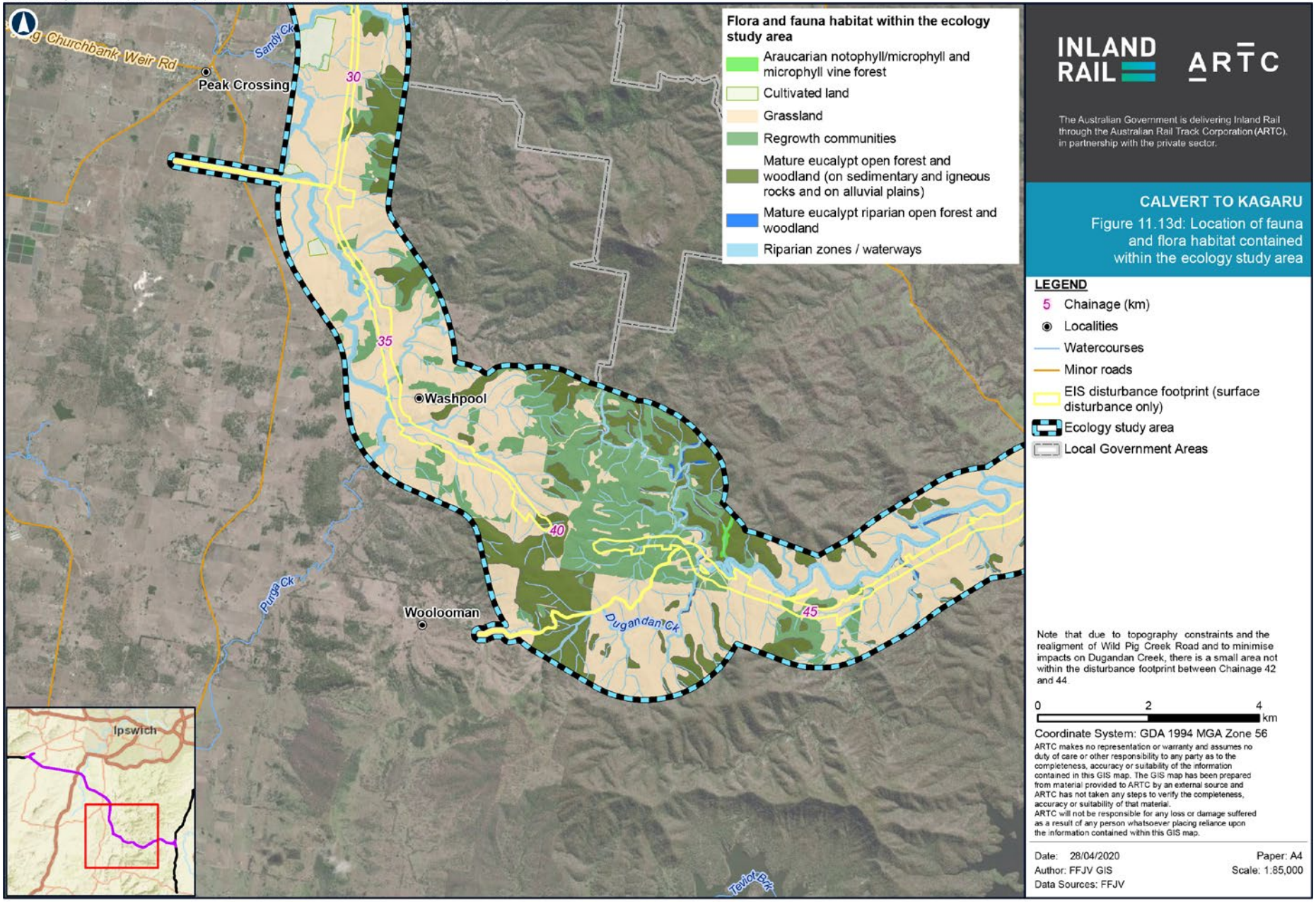
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Churchbank Weir Rd
Peak Crossing
Sandy Ck
30
35
40
45
Washpool
Wooloman
Purga Ck
Dugandan Ck
Taylor Brk
Ipswich
Flora and fauna habitat within the ecology study area
Araucarian notophyll/microphyll and microphyll vine forest
Cultivated land
Grassland
Regrowth communities
Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
Mature eucalypt riparian open forest and woodland
Riparian zones / waterways
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CALVERT TO KAGARU
Figure 11.13d: Location of fauna and flora habitat contained within the ecology study area
LEGEND
5 Chainage (km)
Localities
Watercourses
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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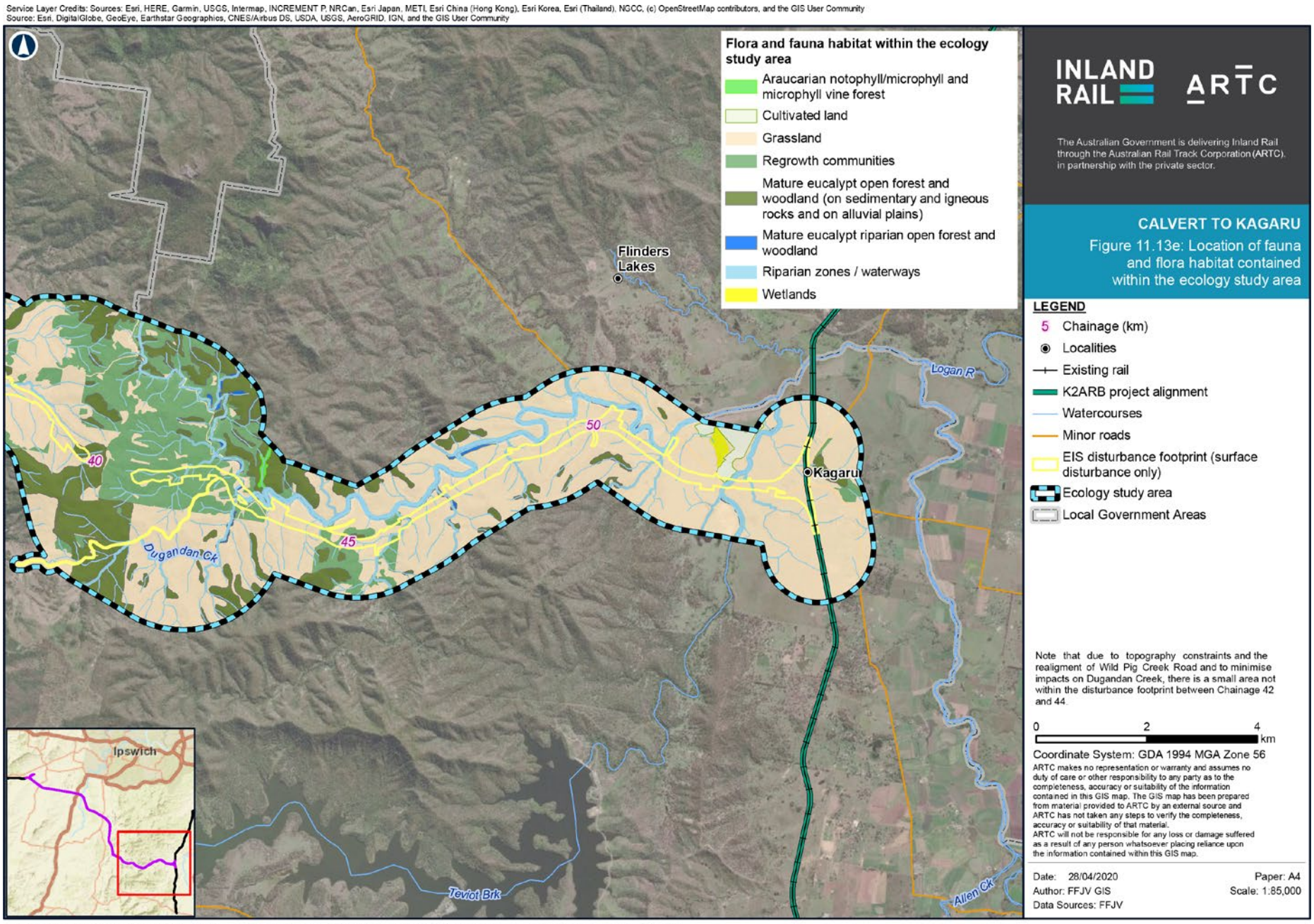
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Flora and fauna habitat within the ecology study area
Araucarian notophyll/microphyll and microphyll vine forest
Cultivated land
Grassland
Regrowth communities
Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
Mature eucalypt riparian open forest and woodland
Riparian zones / waterways
Wetlands
Flinders Lakes
Kagaru
Logan R
Dugandan Ck
Teviot Brk
Allen Ck
40
45
50
Ipswich
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CALVERT TO KAGARU
Figure 11.13e: Location of fauna and flora habitat contained within the ecology study area
LEGEND
5 Chainage (km)
Localities
Existing rail
K2ARB project alignment
Watercourses
Minor roads
EIS disturbance footprint (surface disturbance only)
Ecology study area
Local Government Areas
Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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Map by: MEF/GN Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.13_Faunahabitats_v2.mxd Date: 28/04/2020 14:49

11.5.7 Springs and groundwater dependent ecosystems

GDEs are ecosystems that require access to groundwater on a permanent or periodic basis to meet all or some of their water requirements to maintain their communities of plants and animals, ecological processes and ecosystem services.

The GDE Atlas (BoM, 2020) identifies three types of ecosystems:

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

As the assessment using the GDE Atlas is modelled at a large scale (i.e. typically at the 1:100,000 or 1:50,000 scale), the identification of potential GDEs in the Atlas, therefore, does not confirm whether a particular ecosystem is groundwater dependent. Noting this, the Atlas has identified several potential aquatic and terrestrial groundwater dependent systems, including wetland systems and watercourses.

A review of refined scale potential GDE mapping (DES, 2014) has been undertaken and the following GDEs aquifer categories have the potential to occur within the ecology study area:

- Unconsolidated sedimentary aquifers
- Consolidated sedimentary aquifers
- Metamorphic rock aquifers.

There are no springs known to occur within the ecology study area based on government data sources and ground truthing. However, terrestrial GDEs and surface areas GDEs are mapped within the ecology study area and are quantified in Table 11.20.

TABLE 11.20: EXTENT OF MAPPED SPRINGS, GROUNDWATER-DEPENDENT ECOSYSTEMS AND SURFACE AREAS WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Feature	**Ecology study area**	**Disturbance footprint**
Springs	0.00	0.00
Terrestrial GDEs[1]	329.69	18.31
Aquatic GDEs[2]	109.06	1.17
Total	**438.75**	**19.48**

Table notes:
1. Terrestrial ecosystems that rely on the subsurface presence of groundwater–this includes all vegetation ecosystems.
2. Aquatic ecosystems that rely on the surface expression of groundwater–this includes surface water ecosystems that may have a groundwater component, such as rivers, wetlands and springs. Marine and estuarine ecosystems can also be groundwater-dependent.

No springs were observed during field assessments associated with surface water or identified from the GDE Atlas (BoM, 2020) within the ecology study area. Noting this, several first-order streams intersect the Project alignment and may be associated with natural springs.

As no ground-truthing of these particular environments were undertaken, it has been assumed for the purposes of the EIS, that the modelled extent of the aquatic and terrestrial GDEs are accepted as true presence, and thus form a potentially sensitive environmental receptor.

11.5.8 Aquatic habitat

The proposed alignment intersects identified waterways for waterway barrier works at 34 locations. These points of intersection can be classified as either major, high, moderate or low in accordance with the *Queensland Waterways for Waterway Barrier Works* mapping (QLD Government 2020b) (refer Table 11.21). The 34 waterways are classified (derived from DAF mapped waterways) as follows:

- Low risk of impact (Category 1): 11 waterways mapped as 'low' intersect the alignment
- Moderate risk of impact (Category 2): 11 waterways mapped as 'moderate' intersect the alignment
- High risk of impact (Category 3): 4 waterways mapped as 'high' intersect the alignment
- Major risk of impact (Category 4): 8 waterways mapped as 'major' intersect the alignment.

TABLE 11.21: DEPARTMENT OF AGRICULTURE AND FISHERIES WATERWAYS FOR WATERWAY BARRIER WORKS THAT INTERSECT THE PROPOSED PROJECT ALIGNMENT

Waterway impact risk (DAF)	Waterway (approximate chainage (km))
Major (Category 4)	▸ Western Creek (Ch 1.30, Ch 3.10) ▸ Bremer River (Ch 6.20) ▸ Warrill Creek (Ch 17.60) ▸ Purga Creek (Ch 23.40) ▸ Un-named tributary of Purga Creek (Ch 28.70) ▸ Dugandan Creek (Ch 43.10) ▸ Teviot Brook (Ch 52.80)
High (Category 3)	▸ Un-named tributary of Purga Creek (Ch 35.80, Ch 36.60) ▸ Un-named tributary of Teviot Brook (Ch 42.80, Ch 46.20)
Moderate (Category 2)	▸ Un-named tributary of Bremer River (Ch 7.70) ▸ Ebenezer Creek (Ch 13.40) ▸ Un-named tributary of Purga Creek (Ch 33.30, Ch 37.60, Ch 37.90) ▸ Un-named tributary of Teviot Brook (Ch 41.70, Ch 47.00, Ch 48.30, Ch 53.20) ▸ Woollaman Creek (Ch 51.40, Ch 51.50)
Low (Category 1)	▸ Un-named tributary of Ebenezer Creek (Ch 14.40) ▸ Un-named tributary of Purga Creek (Ch 27.80, Ch 29.90, Ch 31.20, Ch 32.00, Ch 33.90, Ch 38.90, Ch 39.30, Ch 39.60) ▸ Un-named tributary of Teviot Brook (Ch 43.50, Ch 44.20)

Based on the AUSRIVAS assessment, the watercourses within the ecology study area are generally in a poor to fair condition (refer Table 11.22). This is generally in line with the AquaBAMM modelling, which assesses the conservation and ecological value of waterways and wetlands on a series of criteria, including naturalness (aquatic and catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness (DEHP, 2015).

According to AquaBAMM, the majority of the watercourses within the Logan River and Bremer River catchments have a medium AquaBAMM score, including the reaches of Purga Creek, Western Creek and Teviot Brook where the Project intersects the watercourse.

The scores varied based on the structure and composition of the riparian zone and instream habitats, with some of the watercourses having a narrow strip of riparian zone, with the surrounding vegetation cleared for agriculture. A number of impoundments are also located upstream of the project (Warrill Creek and Teviot Brook), which will influence environmental flows.

TABLE 11.22: AQUATIC HABITAT ASSESSMENT SCORE SUMMARY

Location	Waterbody	Habitat assessment score	Category
C2K 1A	Western Creek	57.5%	Fair
C2K 1A (alt)	Western Creek	51.5%	Fair
C2K 2A	Bremer River	62.5%	Fair
C2K 3A	Warrill Creek	70%	Fair
C2K 5A	Impoundment	41.5%	Poor
C2K 5A1	Un-named watercourse	47%	Poor
C2K 6A	Un-named tributary Purga Creek	45.5%	Poor
C2K 7A	Dugandan Creek	50.5%	Fair
C2K 7A (alt)	Un-named watercourse	60.5%	Fair
C2K 8A	Dugandan Creek	55%	Fair
C2K 9A	Woollaman Creek	56%	Fair
C2K 10A	Teviot Brook	55%	Fair
C2K 11A	Impoundment	43%	Poor
C2K 12A	Un-named watercourse	43%	Poor
C2K 13A	Un-named tributary of Purga Creek	51%	Fair
C2K 14A	Un-named tributary of Purga Creek	48%	Fair

Photographic records and water quality information was taken at each aquatic ecology survey site and are provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix M: Surface Water Quality Technical Report.

Wetland habitats within the ecology study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (palustrine). Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants and *Eucalyptus tereticornis* (Queensland Blue Gum). Palustrine wetlands within the ecology study area typically occur on alluvial floodplains and are dominated by grasses (*Poaceae*), rushes (*Restionaceae*) and sedges (*Cyperaceae*). Naturally occurring wetland swamps in the ecology study area may be represented by a variety or remnant and non-remnant habitats but include RE 12.3.8 (specifically described as a swamp community) as well as RE 12.3.7 (riverine wetlands).

There are no Wetlands of International Importance (Ramsar wetlands) or wetlands of national significance located in, or within 10 km of, the ecology study area.

In Queensland, 'high ecological significance' (HES) wetlands are defined by modelling using the AquaBAMM to identify important wetland areas as MSES under State legislation. These wetlands are typically of a 'high' or 'very high' conservation value under the criteria used for AquaBAMM mapping. There are 66 ha of State mapped wetlands (as mapped by DES) considered as HES wetlands that occur within the ecology study area, of which none lie within the current disturbance footprint and will not be directly impacted from activities associated with the Project.

The location of referable wetlands is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report.

Aquatic habitats within the ecology study area are considered to provide suitable habitat for a variety of fish, amphibian, reptile (including turtles) and bird species. Larger Palustrine wetlands such as Ten Mile Swamp potentially provide important refuge habitat for many bird species, including migratory and dispersive species. MNES fauna species that may use wetland habitats within the ecology study area include the Australasian Bittern (*Botaurus poiciloptilus*) and Australian Painted Snipe (*Rostratula australis*).

11.6 Matters specific to matters of national environmental significance

11.6.1 Matters identified within the ecology study area

The following MNES were identified within or in close proximity to the ecology study area:

- Threatened species listed under the EPBC Act and their associated habitat (refer Sections 11.5.3 and 11.5.4)
- TEC listed under the EPBC Act (refer Section 11.5.2 and Table 11.9)
- Habitat for non-threatened EPBC Act listed migratory[2] species and their associated habitat (refer Sections 11.5.3 and 11.5.4)
- Groundwater-dependent ecosystems.[3]

Appendix K: Matters of National Environmental Significance Technical Report provides an in-depth assessment of impacts on MNES.

11.6.2 Matters not within the ecology study area

The following MNES were not identified within or in close proximity to the ecology study area:

- World Heritage areas
- National heritage areas
- Commonwealth marine areas
- Great Barrier Reef Marine Park
- Nuclear actions
- Water resources associated with coal seam gas development and large coal mining development.

11.7 Potential impacts

11.7.1 Project activities

Infrastructure activities proposed as part of the Project have been categorised into four phases, being construction, commissioning and reinstatement, operation and decommissioning. A description of Project-related activities and the duration of their disturbance is provided in Table 11.23.

TABLE 11.23: DESCRIPTION OF PROJECT-RELATED ACTIVITIES ASSOCIATED WITH VARIOUS PROJECT PHASES

Phase	Infrastructure activity	Description of activities	Duration of disturbance
Construction	Site preparation	Vegetation clearing	Permanent
		Topsoil stripping	Medium term/permanent
		Construction of temporary site compounds	Medium term
		Construction of rail access and maintenance roads	Permanent
		Installation of boreholes and construction water storage	Medium term
		Installation of offices, hardstands etc	Medium term
		Stockpiling	Medium term
		Artificial impoundment dewatering	Permanent

2. It is noted that EPBC Act listed migratory species are not a controlling provision of the Project and have been included for completeness. Further detail is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report.
3. It is noted that potential impacts to GDEs are likely to result from potential draw-down as a consequence of 'cut-and-fill activities' located proximate to the GDE. These impacts are considered to be minor–negligible and are therefore not discussed further in this document.

Phase	Infrastructure activity	Description of activities	Duration of disturbance
Construction (continued)	Utility diversions	Excavation	Temporary
		Trenching	Short term
		Modification, diversion and realignment of utilities and associated infrastructure	Short term/medium term
	Drainage	Culvert installation	Permanent
	Structures	Construction of bridges over main waterways	Medium term
		Road/rail bridge construction	Medium term
	Civil works	Cutting construction/excavation	Medium term
		Embankment construction using cut to fill from rail alignment and borrow to fill from external borrow sources, where required	Medium term
		Construction of temporary haul roads	Medium term
		Drainage controls	Medium term
	Road works	Road realignment	Permanent
		Construction of permanent rail maintenance access roads	Permanent
	Rail logistics	Sleeper stockpiling	Medium term
		Rail stockpiling	Medium term
	Rail construction	Drilling	Temporary
		Ballast installation	Short term
		Sleeper placement	Short term
		Rail placement	Short term
		Installation Train signals and communications infrastructure	Short term
		Demobilising site compounds	Short term
	Tunnel construction	Removal of construction material and waste	Temporary
		Roadheader excavation	Short term
		Blasting	Temporary
		Removal of redundant structures	Temporary
		Decommissioning work site signs	Temporary
		Decommissioning access roads	Short term
		Forming and stabilising of spoil mounds	Short term
	Signals and communications installation	Removal of temporary fencing	Temporary
Commissioning and reinstatement	Demobilisation/ Decommissioning	Establish permanent fencing	Permanent
		Restoration of disturbed areas, including revegetation where required	Short term
	Spoil mounds	Conversion of haul roads and construction access roads into permanent roads	Medium term
	Fencing	Train services	Permanent
	Restoration	Minor maintenance works	Temporary

Phase	Infrastructure activity	Description of activities	Duration of disturbance
Commissioning and reinstatement (continued)	Road works	Bridge and culvert inspections	Temporary
		Sleeper replacement	Temporary
		Rail welding	Temporary
		Rail grinding	Temporary
		Ballast dropping	Temporary
		Track tamping	Temporary
		Major periodic maintenance	Temporary
Operation	Train operations	Train movement along rail	Permanent
	Operational maintenance	Ongoing vehicle movement within rail corridor	Permanent
Decommissioning	Lines decommissioned	Increased vehicle movement within rail corridor	Short term

Table notes:
Temporary = Days to months (e.g. 1 to 2 seasons; 3 to 6 months)
Short term = Up to 2 years (i.e. 6 to 24 months)
Medium term = From 2 to 10 years
Long term/long lasting = From 11 to 21 years
Permanent = More than 21 years

11.7.2 Potential impacts to terrestrial and aquatic ecology

Potential impacts to terrestrial and aquatic receptors associated with the Project have been summarised into 13 broad categories, as discussed in the sub-sections below. Quantification of the potential magnitude of impacts is tabulated and described in Section 11.9.1. Further detail is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report.

11.7.2.1 Habitat loss and degradation from vegetation clearing/removal

The removal of vegetation and construction of linear infrastructure resulting in habitat loss is likely to pose the largest risk of adverse impacts for biodiversity arising from the Project. The impact may be direct in the form of vegetation and habitat removal, or indirect, as fauna and flora diversity may become reduced due to shortages in available habitat resources. Habitat loss and degradation can also occur due to the increased risk of fire during construction and maintenance activities. Small-scale clearing within largely in-tact patches of vegetation can cause localised depletion of some species (Kutt et al., 2012) and is particularly relevant to species with small home ranges, or reduced ability to disperse (e.g. small mammals and reptiles such as the Collared Delma (*Delma torquata)*). Vegetation clearing, and habitat loss are likely to occur during the construction phase activities. Habitat loss and degradation has the potential to impact all species listed under the provisions of the EPBC Act and NC Act (including their associated habitats) identified in this assessment.

Of the Project's 972.49 ha that encompasses the disturbance footprint, 33.55 ha is mapped as remnant vegetation and 118.0 ha is mapped as HVR vegetation. The remaining 820.94 ha has been heavily modified (clearing for agriculture/cattle grazing and classified as Category X non-remnant vegetation. While it is acknowledged that the South East QLD bioregion exists in a highly modified state and potential vegetation removal associated with the Project is considered to be relatively small compared to historical broad-scale vegetation clearing that has occurred in the region for agricultural purposes, the significance of such loss should not be diminished. Vegetation clearing and habitat loss that cannot be avoided, particularly in high-constraint areas (e.g. biodiversity corridors, wetlands and areas providing habitat for threatened species), and is likely to result in permanent impacts to threatened biodiversity values.

11.7.2.2 Fauna species injury or mortality

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

Physical trauma to fauna has the potential to occur during all phases of the Project with the highest potential likelihood during construction activities that involve vegetation clearing, earthworks, trenching and increased labour force in the area (through the movement of vehicles). Species most at risk of injuries and mortality are those that are cryptic, difficult to detect and with poorly developed dispersal mechanisms. However, larger species with defined territories and movement patterns (e.g. Greater Glider (*Petauroides volans volans*)) are less likely to be at risk to direct mortality where appropriate mitigation measures are applied (i.e. pre-clearance surveys and the use of fauna spotters during clearing).

Some diurnal (active during the day) and mobile species, such as birds, including migratory species, may move away from areas being disturbed (i.e. vegetation removal) and may not be adversely impacted in terms of direct physical trauma unless fauna are nesting. However, other listed species that are less mobile (i.e. ground-dwelling reptile and mammal species), or those that are nocturnal and nest or roost in trees or tree hollows during the day (e.g. Powerful Owl (*Ninox strenua)*, Greater Glider (*Petauroides volans volans*)), may find it difficult to move away from roosts or active breeding places.

There is the potential for fauna injury or mortality during all phases of the Project through vehicle collision, but a particularly high potential when high volumes of vehicle activity (i.e. vehicle movement to facilitate construction) occur or during the operational stages of the rail. The construction of tracks, as well as the general use of access tracks and roads across the disturbance footprint will result in increased vehicle movements that may cause injury or death to fauna by vehicle strike. In addition, once operational, train strike may also occur. Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly common species (e.g. macropods) that are tolerant of disturbance and/or those species that can use roads for movement pathways or as foraging habitat.

In addition, entrapment of wildlife in utility diversions (e.g. trenches) or other excavations associated with the Project may also cause physical trauma to fauna. Species most likely to become trapped in pits or other excavations during development of the Project are ground-dwelling species that are capable of moving across modified areas and arboreal species, which descend to the ground to disperse.

The unmitigated potential occurrence of fauna species injuries or mortalities resulting from the Project can be permanent, where mortality to the species occurs, or temporary where the species is rehabilitated and re-released.

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

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

Reduction in soil viability may negatively impact flora such as the Swamp Tea-tree (*Melaleuca irbyana)*, Slender Milkvine (*Marsdenia coronata)*, Lloyd's Olive (*Notelaea lloydii*) and Bailey's Cypress Pine (*Callitris baileyi)*. Impacts to soil may also have flow on effects to other threatened fauna species though degradation of their associated habitat.

The most direct effect of soil compaction is an increase in the bulk density of soil that can restrict plant root growth and function. Due to the increase in bulk density, large pores essential for water and air movement in soil are primarily affected. This influence over water and air movement can impact root penetration, seedling emergence and plant growth (Fitzpatrick et al., 1999; Duiker, 2005). This will act directly on recruitment processes and may impact a species' or communities' ability to recolonise following disturbance.

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

The unmitigated potential impacts of soil compaction resulting from the Project are generally short term and temporary.

11.7.2.4 Displacement of flora and fauna species by invasion of weed and pest species

Weed and pest species have the potential to impact terrestrial and aquatic biodiversity as native species can become displaced through predation and competition. In addition, weeds may result in impact to the Swamp Tea-tree (*Melaleuca irbyana)* through competitive processes and displacement, altering nutrient cycling and outcompeting for limited resources. Pest species can also damage native vegetation by grazing and trampling (Adair and Groves, 1998; Clarke et al., 2000; Thorp and Lynch, 2011) or through direction competition/predation (e.g. *Gambusia holbrooki* within aquatic ecosystems). Therefore, weed and pest species may reduce the extent of available habitat and hence population size for specific threatened flora and fauna species. This reduction in habitat and population size may have the effect of increasing mortality and reducing the size and viability of population sizes though resource limitation and associated stresses.

Proliferation of weed and pest species has the potential to occur during all phases of the Project; however, the highest likelihood of weed and pest species occurring is from vegetation clearing and soil disturbance during the construction phase of the Project.

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

Non-native species comprised 27.5 per cent of the flora species recorded in the ecology study area (refer Section 11.5.2). Of these, 27 flora species were restricted matters, listed under the provisions of the Biosecurity Act, some of which are also listed as Weeds of National Significance (WoNS). Weed species such as *Lantana camara* (listed as a WoNS) are noted as a potential threat to a number of threatened species (e.g. Slender Milkvine (*Marsdenia coronata)* and Lloyd's Olive (*Notelaea lloydii*)) and were identified as common throughout the ecology study area.

Project activities also have the potential to introduce new weed species into the ecology study area. The most likely causes of weed dispersal and introduction associated with the Project include earthworks, movement and disturbance of soil and attachment of seed (and other propagules) to vehicles and machinery during all phases.

Soil disturbance during construction may increase the risk of invasion from weed and/or pest species, which can further reduce habitat quality and compromise the integrity of adjacent areas such as those occupied by the Swamp Tee-tree (*Melaleuca irbyana*).

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

Unmitigated Project activities have the potential to disperse pest (fauna) species from the disturbance footprint into the surrounding landscape, due to habitat removal, noise disturbance, and human presence during the construction and operational phases of the Project. Construction of access tracks and the rail infrastructure through large patches of intact vegetation may result in the establishment of pest species (particularly predators such as foxes and cats) into areas where they are currently absent or in low numbers. Therefore, unmitigated potential impacts of the displacement of native species through the invasion of non-native may be temporary or irreversible.

11.7.2.5 Reduction in the connectivity of biodiversity corridors

Corridors can assist ecological functioning at a variety of spatial and temporal scales, from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions, and fragmentation of such corridors have been identified as important threatening process to many fauna species including threatened species such as the Koala (*Phascolarctos cinereus*), Brush-tailed Rock Wallaby (*Petrogale penicillata*), Spotted-tailed Quoll (*Dasyurus maculatus maculatus)*, Greater Glider (*Petauroides volans volans*), Powerful Owl (*Ninox strenua)* and Glossy-black Cockatoo (*Calyptorhynchus lathami*).

However, most of the ecology study area exists in generally fragmented environment. Despite this, functional connectivity is retained through local linkages of remnant and regrowth vegetation, associated with roadside and riparian corridors linking larger patches of vegetation on private land. These linkages are likely to provide landscape permeability for mobile species such as birds and bats. QLD corridor mapping for the SEQ BPA (Version 4.1, 2016) depicts regional and State corridors within the ecology study area.

The potential impacts of linear infrastructure traversing these biodiversity corridors include habitat fragmentation, edge effects and barrier effects, resulting in reduced population size and connectivity (refer Sections 11.7.2.6, 11.7.2.7 and 11.7.2.8). An additional potential impact biodiversity corridors resulting from the Project is the proliferation of weeds and pest species (refer Section 11.7.2.4).

Sensitive environmental receptors involving conservation-significant and migratory species listed under the provisions of the EPBC Act and NC Act, bioregional corridors and wildlife refugia are likely to be impacted the most from these potential impacts due to the importance of habitat quality and linkages for species at a local scale and the cumulative impacts at a regional landscape scale.

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

11.7.2.6 Edge effects

Edge effects refer the changes in environmental conditions (e.g. altered light levels, wind speed, temperature) that occur along the edges of habitats. These new environmental conditions along the habitat edges can promote the growth of different vegetation types (including weed species), promote invasion by pest animals specialising in edge habitats, or change the behaviour of resident native animals (Moenting and Morris, 2006). Edge zones can be subject to higher levels of predation by introduced mammalian and native avian predators. The distance of edge effect influences can vary and has been previously recorded from 50 m to greater than 1 km from an edge (Forman et al., 2003; Bali, 2005).

Within the ecology study area, many patches of vegetation are small, irregularly shaped, and fragmented, and as such are already subject to considerable edge effects. Therefore, it is unlikely that the Project would increase the overall extent of edge effects in these areas. However, in large habitat patches with low edge to area ratios (e.g. in the Teviot Range), Project activities (vegetation clearing, temporary and permanent) may result in fragmentation and reduction of existing habitat along with associated edge effects.

Edge effects have the potential to impact the range of flora and fauna species identified as potentially occurring in the ecology study area, especially on the species with specific micro-habitat requirements that are less tolerant to disturbance (e.g. Glossy-black Cockatoo (*Calyptorhynchus lathami*), Collared Delma (*Delma torquata*), Lloyd's Olive (*Notelaea lloydii*), Slender Milkvine (*Marsdenia coronata*) and Swamp Tea-tree (*Melaleuca irbyana*)).

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

The unmitigated potential impacts of edge effects resulting from the Project are considered to be long term and irreversible.

11.7.2.7 Habitat fragmentation

Habitat fragmentation relates to the physical dividing up of a continuous habitat into separate smaller fragments (Fahrig, 2002). The habitat fragments tend to be smaller and separated from each other by a matrix of less suitable habitat. The new habitat type situated between fragments is often artificial and less suitable to the species remaining within these newly created fragments (Bennett, 1990) or is generally only used by adaptive and aggressive generalist species (Loyn et al., 1983), which further decreases population levels of other species remaining in the fragments.

The landscape in which the Project is situated is highly fragmented with most vegetation occurring as small fragments due to agricultural practices such as pasture, cropping and horticulture. The Project activities will contribute to further fragmentation along with associated edge effects and reduction in habitat. Sensitive environmental receptors involving conservation-significant species, regionally significant vegetation, bioregional corridors and wildlife refugia may be impacted the most from habitat fragmentation. This is due to the importance of connectivity, dispersal opportunities and habitat quality for species at a local scale, and the cumulative impacts at a regional scale.

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

The unmitigated potential impacts of habitat fragmentation resulting from the Project are considered to be long term and irreversible.

11.7.2.8 Barrier effects

Barrier effects (permanent and/or temporary) occur where particular species are either unable or are unwilling to move between suitable areas of habitat due to the imposition of a barrier. This can include a habitat type that has become unsuitable (e.g. cleared areas devoid of vegetation or structure) or a physical barrier such as a fence, alteration to a waterway or installation of a culvert, that does not provide movement opportunities. Sensitive environmental receptors that are most vulnerable to barrier effects include the Short-beaked Echidna (*Tachyglossus aculeatus*) and small, insectivorous migratory birds that depend on interconnected tracts of vegetation to facilitate migratory movements.

Various Project activities may create temporary and/or permanent barrier effects, particularly those that may create a hard barrier that restricts fauna movement (e.g. operational and construction access tracks, temporary waterway barrier works such as the construction of culverts within watercourses, operational rail corridor, construction laydown areas, etc.). Mobile species such as larger mammals (e.g. Grey-headed Flying-fox (*Pteropus poliocephalus*)), birds (e.g. Powerful Owl (*Ninox strenua*)), and bats may not be affected to the same extent.

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

Waterway barrier works have the potential to impair movement of fish species across the works area, decreasing connectivity of habitat and overall ecological service. Although waterway barrier works for the Project are expected to be restricted to bridge infrastructure works within the construction phase, these works will occur along major watercourses and therefore have the potential to cause major (although temporary during the construction period) impacts to waterways. However, it is proposed that bridge construction activities will incorporate piling of pre-fabricated structures outside the low-flow areas of the watercourses thereby avoiding further unmitigated impacts to instream habitat.

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

The unmitigated potential impacts of barrier effects resulting from the Project are considered, in most cases, to be short term and temporary but may, in some cases, be long term and irreversible.

11.7.2.9 Noise, dust, and light impacts

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

The Project may lead to localised increases of airborne dust levels during construction. Increased dust can result in respiratory issues in fauna, adverse impacts on plant photosynthesis and productivity (Chaston and Doley, 2006), changes in soil properties ultimately impacting plant species assemblages' (Farmer, 1993), and mortality and/or decreases in aquatic health in aquatic communities from the toxicity of poor water quality.

Artificial lighting may have a range of impacts across different groups of taxa and between species within these groups. Rodents may avoid brightly lit areas at night. Frogs and nocturnal reptiles may congregate at artificial lights to feed on insects attracted to light (Perry et al., 2008). Similarly, many microbat species may congregate at artificial lighting (Rich and Longcore, 2006), although other species may avoid well-lit areas (Threlfall et al., 2013).

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

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

Sensitive environmental receptors affected by these potential impacts include all threatened flora (impacts associated with dust) and terrestrial fauna species (impacts associated with noise and vibration) listed under the provisions of the EPBC Act and/or NC Act. The Swamp Tea-tree (*Melaleuca irbyana)* is likely to be impacted to a lesser extent and these impacts are likely to be associated with dust alone (i.e. reducing photosynthetic processes following settlement of dust on leaves). These types of impacts are likely to be short-term in duration and localised.

11.7.2.10 Increase in litter (waste)

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

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

11.7.2.11 Aquatic habitat degradation

Without mitigation, activities related to the construction and operation of the Project are likely to impact water quality, thereby degrading habitats for aquatic fauna and flora. Erosion and sedimentation, contamination and an increase in litter are all potential mechanisms that will adversely impact aquatic habitat. In addition, direct loss of waterway habitat may occur though activities associated with waterway crossings during construction and operation. Further loss of ecological services may occur from a removal of riparian vegetation required for both watercourse and drainage feature infrastructure (within construction and operation phases), which may compound physical habitat modification from any changes to hydrological regimes.

The transport of sediment and eroded material can be washed off areas of exposed soil, stockpile locations, or localised areas in proximity to Project infrastructure (e.g. culverts and bridges) during rainfall events, and may also affect terrestrial habitats. This, in turn, may lead to increased sediment loads and turbidity within waterways and potentially increase nutrient loads. In addition to direct impacts to aquatic habitat degradation associated with erosion and sedimentation, flow-on effects from increased sedimentation may impair the functioning of culverts should deposition be too high, exacerbating barrier effects.

There is potential for contaminants and pollutants associated with construction and operation of the Project to enter aquatic environments, resulting in the alteration or loss of potential habitat for terrestrial and aquatic species. Correspondingly, depending on existing conditions, there is the potential to increase exposure of sensitive environmental receptors to contaminants, which could result in a bio-accumulation of contaminants.

Chapter 9: Land Resources identifies potential existing contamination sources and associated potential receptors and indicates where there is a potential for bioaccumulation of contaminants due to direct contact or consumption of contaminants by terrestrial and aquatic receptors. Potential sources of existing contamination are associated with:

- Agricultural use and storage of chemicals and hydrocarbons
- Activities in the existing rail corridor
- Unexploded ordnance (although this is considered unlikely).

Chapter 9: Land Resources also identifies potential land contamination sources associated with proposed Project activities both during construction and operation. Potential sources of impacts on terrestrial and aquatic receptors include hydrocarbon and hazardous materials use and storage, biosecurity management and waste storage (including storage of sewage tanks).

Chapter 13: Surface Water and Hydrology further identifies the low post-mitigation risk of potential for mobilisation of sediment-bound metals and other substances, acting as contaminants from standard construction and operational phase activities. These potential sources are considered to be derived from physical land and stream disturbances, clearing activities, accidental spills, dewatering activities and standard rail maintenance and operating procedures.

Concrete, oil and grease and other chemicals associated with construction and operation may result in localised run-off into adjacent watercourses and waterbodies following rainfall events.

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

11.7.2.12 Erosion and sedimentation

Terrestrial impacts associated with erosion and sedimentation include compaction of soil, loss of soil structure, nutrient degradation, and increased soil salinity, all of which can lead to reductions in the carrying capacity of the terrestrial environment as a result of decreasing habitat value.

Erosion and subsequent sedimentation can also be damaging to the ecological health of waterways and may be a proximate cause of environmental degradation. Mobilised course sandy sediment tends to accumulate in areas of slow-flow and may smother bottom-dwelling organisms and their habitats.

Large sediment accumulations can cause upstream flooding or deflect the flow into the adjacent stream bank or even onto adjacent land, causing further erosion and transported sediments that can fill the deep permanent pools of rivers and degrade this critical refuge habitat.

In addition to secondary impact of erosion and sedimentation on aquatic habitats, the primary impact of erosion on terrestrial habitat has the potential to occur in relation to Project activities. As indicated above, these impacts would be expected to occur within areas of exposed soil, stockpile locations, or localised areas in proximity to Project infrastructure (e.g. culverts and bridges) during rainfall events. The changes to overland flow paths from erosion have the potential to have a localised direct impact on terrestrial habitat. These impacts are principally associated with a loss of substrate stability around vegetation and may result in a loss of vegetation quality and cover.

11.7.2.13 Tunnelling impacts—Teviot Range

The construction and operation of the proposed tunnel through the Teviot Range may have potential to cause a number of localised impacts to habitats located above the tunnel such as subsidence, groundwater drawdown, and vibrations caused by the tunnel construction. There are no MSES flora, TECs or MNES flora identified as present in the tunnel area. The tunnel is proposed to be 1,015 m long with an excavated cross-section of approximately 135 m^2 (internal space dimensions are driven by ventilation requirements). The maximum cover of rock above the tunnel is approximately 90 m.

The tunnel intersects the Gatton Sandstone (part of the Marburg Subgroup), which is a sedimentary rock comprising medium-coarse grained sandstone (refer Chapter 9: Land Resources for further detail). Aboveground subsidence or surface cracking may result from both the tunnelling process itself, or as a result of settlement caused by subsequent groundwater drawdown processes caused by the tunnel. Potential subsidence is unlikely to have any significant impacts on flora, fauna or local ecological communities.

Geotechnical survey works within the tunnel area have so far been limited (Jacobs–GHD, 2016a; Golder Associates, 2019). Nevertheless, initial interpretation of results indicates the potential for minimal settlement and therefore damage to vegetation communities due to subsidence from the tunnel appears to be low. However, ongoing geotechnical investigations will further assess the potential for settlement/subsidence and will inform the final design of the tunnel.

Groundwater monitoring in the Teviot Range area indicates groundwater levels in the Gatton Sandstone ranges from 20.2 metres below ground level (mbgl) to 72 mbgl in the vicinity of the tunnel itself, to 16.9 mbgl approximately 4 km east of the tunnel (Jacobs–GHD, 2016a; Golder Associates, 2019). The vegetation in the range at the tunnel area comprises remnant and regrowth eucalypt woodland dominated by species such as spotted gum (*Corymbia citriodora*), grey gum (*Eucalyptus major*), and narrow-leaf ironbark (*E. crebra*). None of these species are known to require access to groundwater.

Lowered groundwater levels due to long-term seepage into the tunnel have the potential to impact groundwater users and vegetation such as deep-rooted trees (GDEs). Mapping of GDEs (from the BoM GDE Atlas) indicates the potential presence of 'low potential' GDEs associated with local gully lines in the range area, the nearest of which lies to the west and south side of the west portal of the tunnel. The mapped GDEs have not been confirmed as being present. Preliminary predictive numerical modelling of the drained tunnel through the Teviot Range was carried out to estimate potential groundwater drawdown impacts (Golder Associates, 2019). Drawdown is assumed to be ongoing and long-term. Under the base case scenario (estimated typical groundwater levels and three structural features) drawdown impacts may extend up to 1,000 m laterally either side of the tunnel, with a potential GDE within the predicted 5 m drawdown extent. Ongoing and further investigations are anticipated to confirm that risks posed to potential GDEs are acceptable. Should this not be the case, works will be completed during subsequent phases (i.e. detailed design and early works) to develop mitigation and management strategies that achieve acceptable residual risks (refer Chapter 14: Groundwater for further information).

Potential groundborne vibration and associated groundborne noise due to tunnel construction works and during operations (train movements) have been assessed in a conservative fashion relying on technical assumptions for the vibration emitted by the excavation activity and the surrounding geotechnical conditions (refer Chapter 15: Noise and Vibration for further information). The assessment considered the closest sensitive (human) receptors to the tunnel were not expected to experience vibration or groundborne noise levels that could trigger the assessment criteria. There are no guidelines regarding potential impacts of ground vibration to fauna. A tunnelling project in New Zealand adopted human vibration limit criteria to identify potential impact zones on wetland bird species, thereby informing fauna relocation activities (Norman Disney and Young, 2020). Vibration impacts are very likely to be similar to those described for noise (refer Chapter 15: Noise and Vibration). Following the completion of construction vibration will be restricted to train movements (i.e. regular events of relatively short duration). As such, any potential impact on fauna is considered likely to be minor at worst.

11.8 Impact mitigation

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

11.8.1 Design considerations

The mitigation measures presented in Table 11.24 have been incorporated into the Project design. These design measures have been identified through collaborative development of the design and consideration of environmental constraints and issues. These design measures are proposed to minimise the environmental impacts of the Project on flora and fauna and therefore contribute to lowering the initial impact risk rating for each potential impact.

TABLE 11.24: INITIAL MITIGATION MEASURES THROUGH DESIGN RESPONSES

Aspect	Initial design measures

Flora and fauna	▸ The Project is generally located within the existing SFRC, which was gazetted as a future rail corridor in 2010. The Project design has been developed to use the existing rail corridor protection and minimise land severance and impacts to natural and rural landscapes to the greatest extent possible.
	▸ The Project has avoided direct impacts on nationally or regionally protected areas such as the Flinders–Goolman Conservation Estate.
	▸ Clearing of vegetation will be restricted to the minimum required to enable the safe construction, operation and maintenance of the rail corridor, including minimising the disturbance of sensitive areas such as:
	  ▸ Habitat for critically endangered, endangered and vulnerable flora and fauna species
	  ▸ Critically endangered and endangered TECs
	  ▸ Riparian vegetation
	  ▸ Steep slopes and
	  ▸ In-stream habitats.
	▸ The Project incorporates bridge and culvert structures to maintain existing flow paths and flood flow distributions. Twenty-one bridge structures over watercourses are to be constructed to minimise disturbance of aquatic habitats.
	▸ The Project has been developed to minimise impacts to watercourses, riparian vegetation and in-stream flora and habitats by adopting a crossing structure hierarchy where bridges are preferred to culverts to maintain connectivity for species such as Australian Lungfish (*Neoceratodus forsteri)* and riparian fauna conduits that are important to these species.
	▸ The nominated rail corridor has been restricted to the land required to accommodate permanent infrastructure components of the railway, including earthworks, cross drainage and rail maintenance access roads. Habitat for threatened flora and fauna species has been avoided, wherever possible.
	▸ Fauna crossing opportunities for species such as Koala (*Phascolarctos cinereus*), have been co-located with waterway crossing structures to maintain habitat connectivity across the rail corridor (refer Figure 11.14). Where possible, these structures align with regional, State and locally significant fauna movement corridors or areas of important fauna habitat. Six crossing points have been selected for dedicated fauna infrastructure, including bridge sites on Western Creek, Bremer River, Warrill Creek, Woollaman Creek and Teviot Brook. A sixth area within the Teviot Range has been selected for a rope bridge crossing point where the alignment is located within a cutting area. The six locations have been assessed as providing movement opportunities for the greatest number of species. Opportunities to incorporate fauna infrastructure and fauna fencing at these and other potential crossing points (such as large culverts) will be considered during the detailed design process.
	▸ Avoidance of natural moment corridors (e.g. Teviot Range associated with the tunnel) will maintain connectivity for species such as the Koala (*Phascolarctos cinereus*), Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) and Brush-tailed rock-wallaby (*Petrogale penicillata*) Glossy-black Cockatoo (*Calyptorhynchus lathami*), Powerful Owl (*Ninox strenua)* and Short-beaked Echidna (*Tachyglossus aculeatus*), which have habitat with the broader region. For example, the rail tunnel (1,015 m long) occurs where the alignment crosses a higher point in the Teviot Range. Fauna will be able to use the unimpacted section of the range over the tunnel as a movement corridor.

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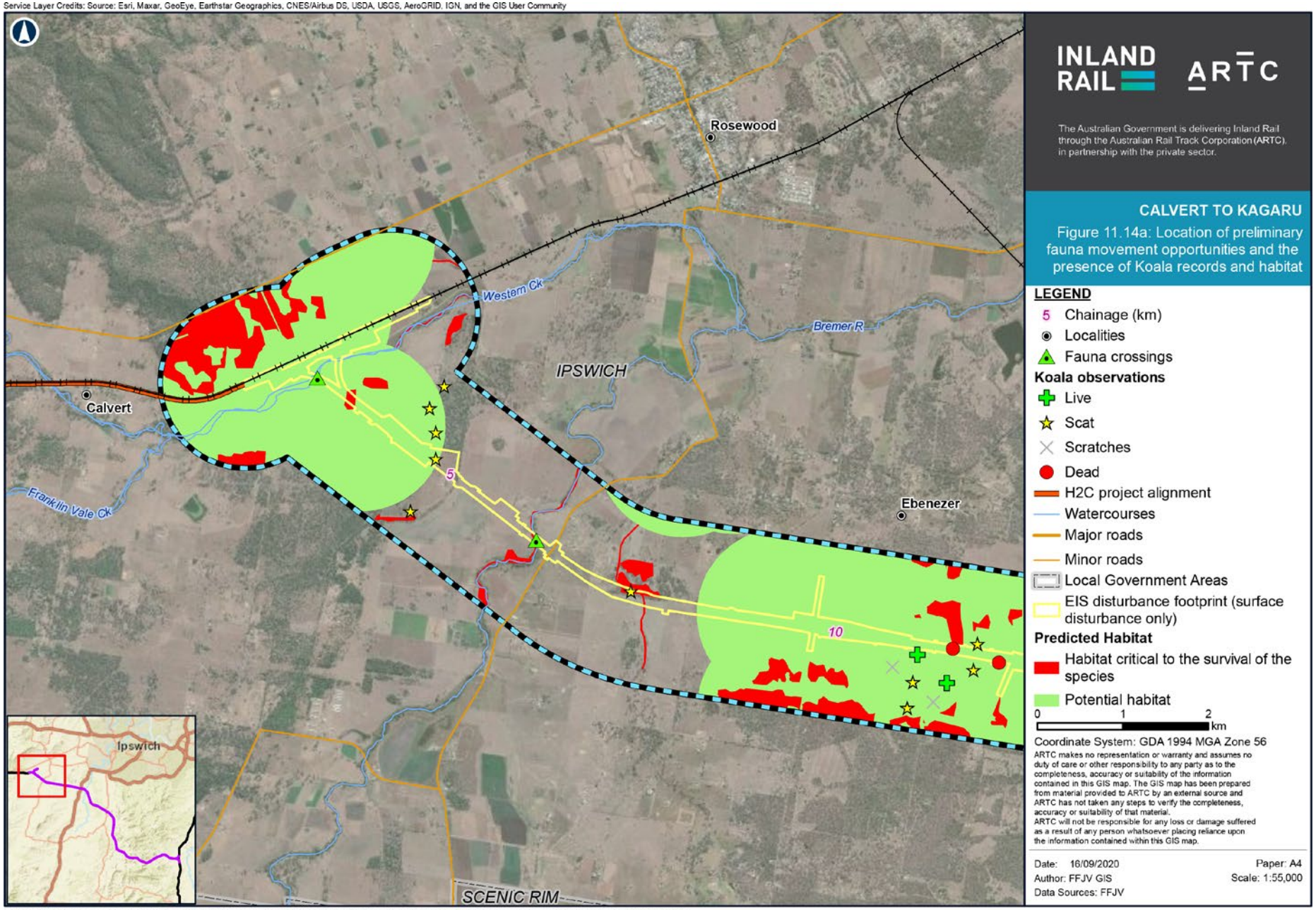

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CALVERT TO KAGARU

Figure 11.14a: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

LEGEND

- 5 Chainage (km)
- Localities
- Fauna crossings

Koala observations

- Live
- Scat
- Scratches
- Dead
- H2C project alignment
- Watercourses
- Major roads
- Minor roads
- Local Government Areas
- EIS disturbance footprint (surface disturbance only)

Predicted Habitat

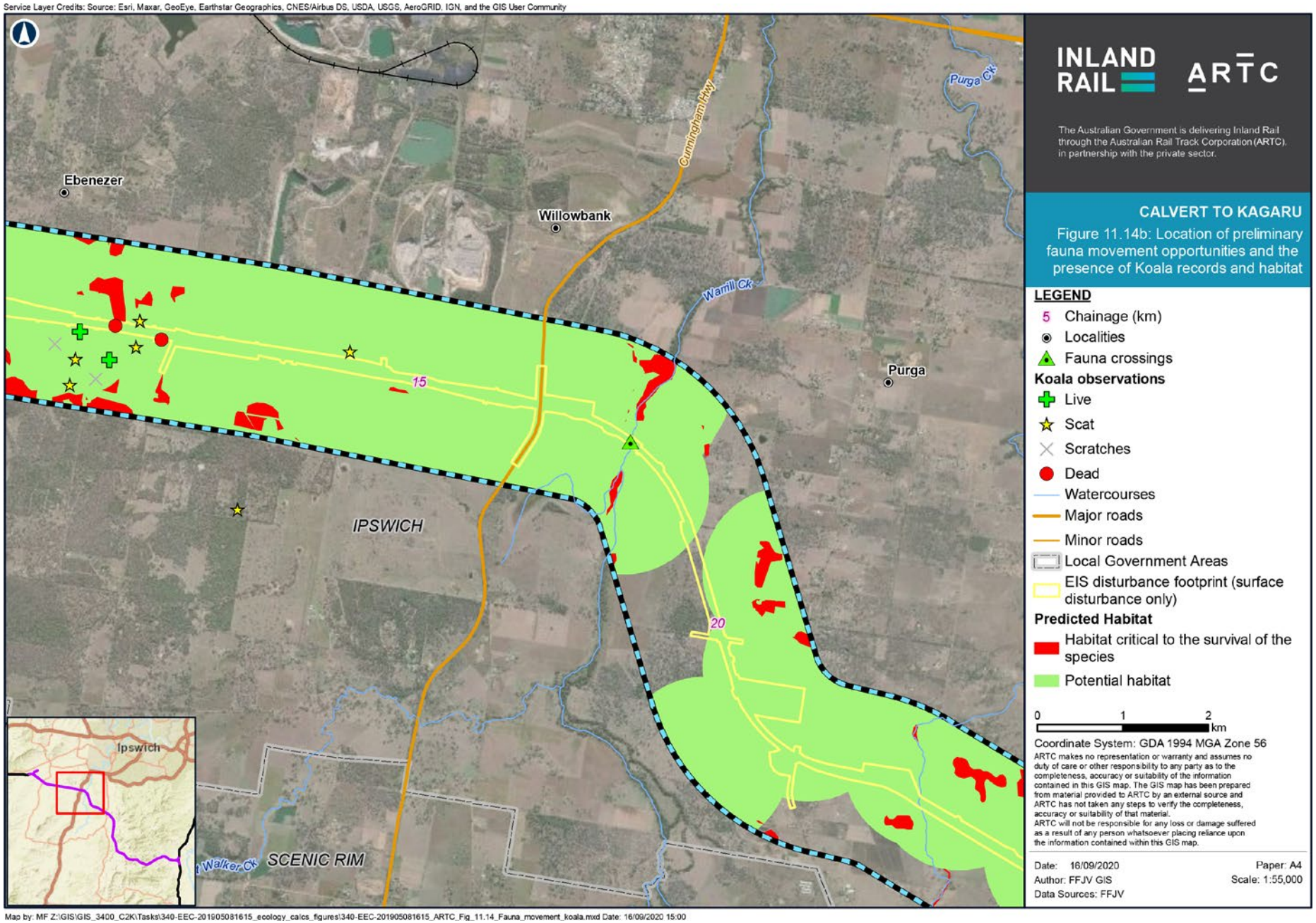
- Habitat critical to the survival of the species
- Potential habitat

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 16/09/2020 Paper: A4
Author: FFJV GIS Scale: 1:55,000
Data Sources: FFJV

Map by: MF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.14_Fauna_movement_koala.mxd Date: 16/09/2020 15:00


Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Ebenezer
Willowbank
Cunningham Hwy
Purga Ck
Warrill Ck
Purga
15
20
IPSWICH
SCENIC RIM
Walker Ck
Ipswich
INLAND RAIL
ARTC
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CALVERT TO KAGARU
Figure 11.14b: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat
LEGEND
5 Chainage (km)
Localities
Fauna crossings
Koala observations
Live
Scat
Scratches
Dead
Watercourses
Major roads
Minor roads
Local Government Areas
EIS disturbance footprint (surface disturbance only)
Predicted Habitat
Habitat critical to the survival of the species
Potential habitat
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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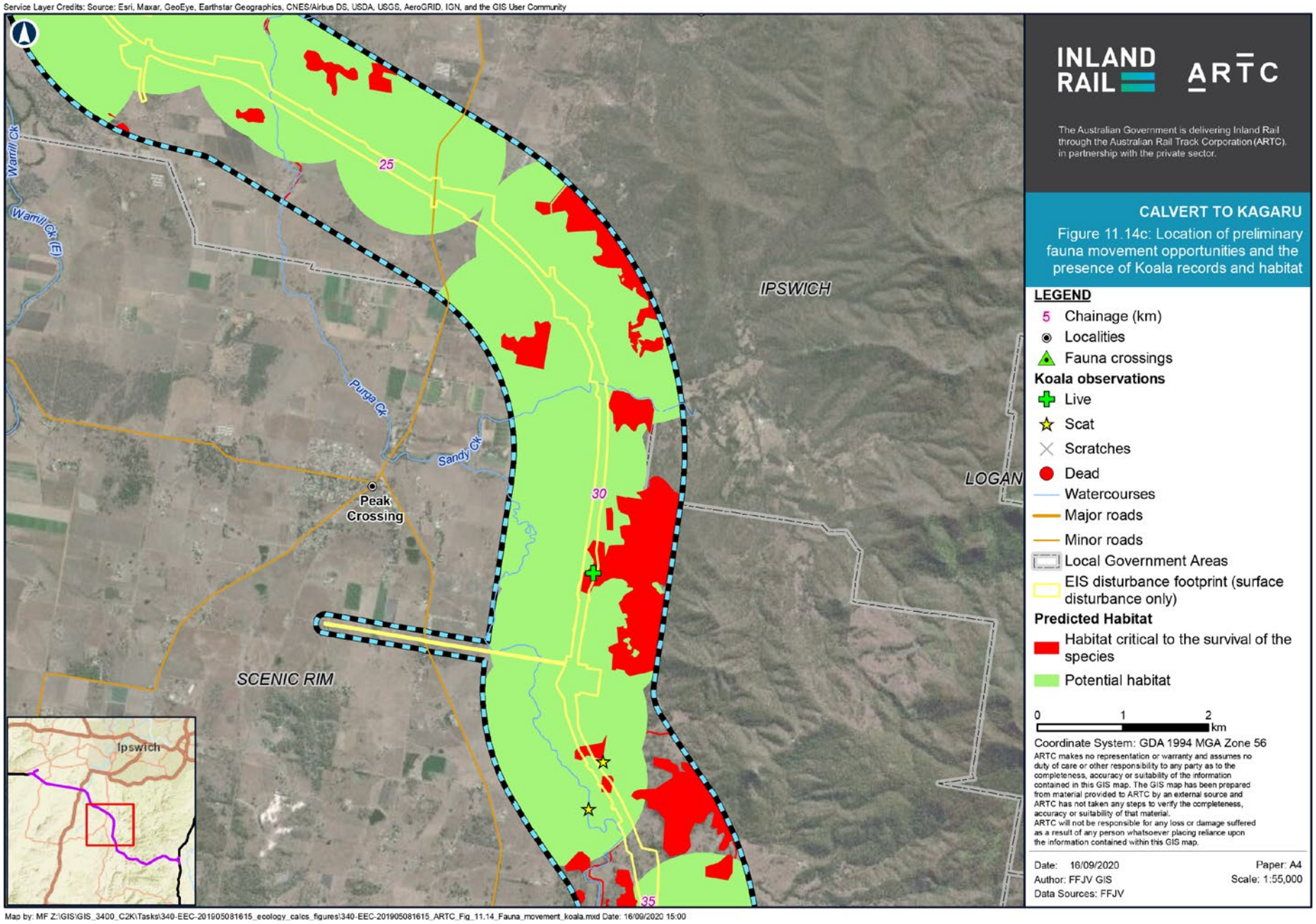
Map by: MF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.14_Fauna_movement_koala.mxd Date: 16/09/2020 15:00


Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Warrill Ck
Warrill Ck (E)
Purga Ck
Sandy Ck
Peak Crossing
IPSWICH
LOGAN
SCENIC RIM
25
30
35
Ipswich
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CALVERT TO KAGARU
Figure 11.14c: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat
LEGEND
5 Chainage (km)
Localities
Fauna crossings
Koala observations
Live
Scat
Scratches
Dead
Watercourses
Major roads
Minor roads
Local Government Areas
EIS disturbance footprint (surface disturbance only)
Predicted Habitat
Habitat critical to the survival of the species
Potential habitat
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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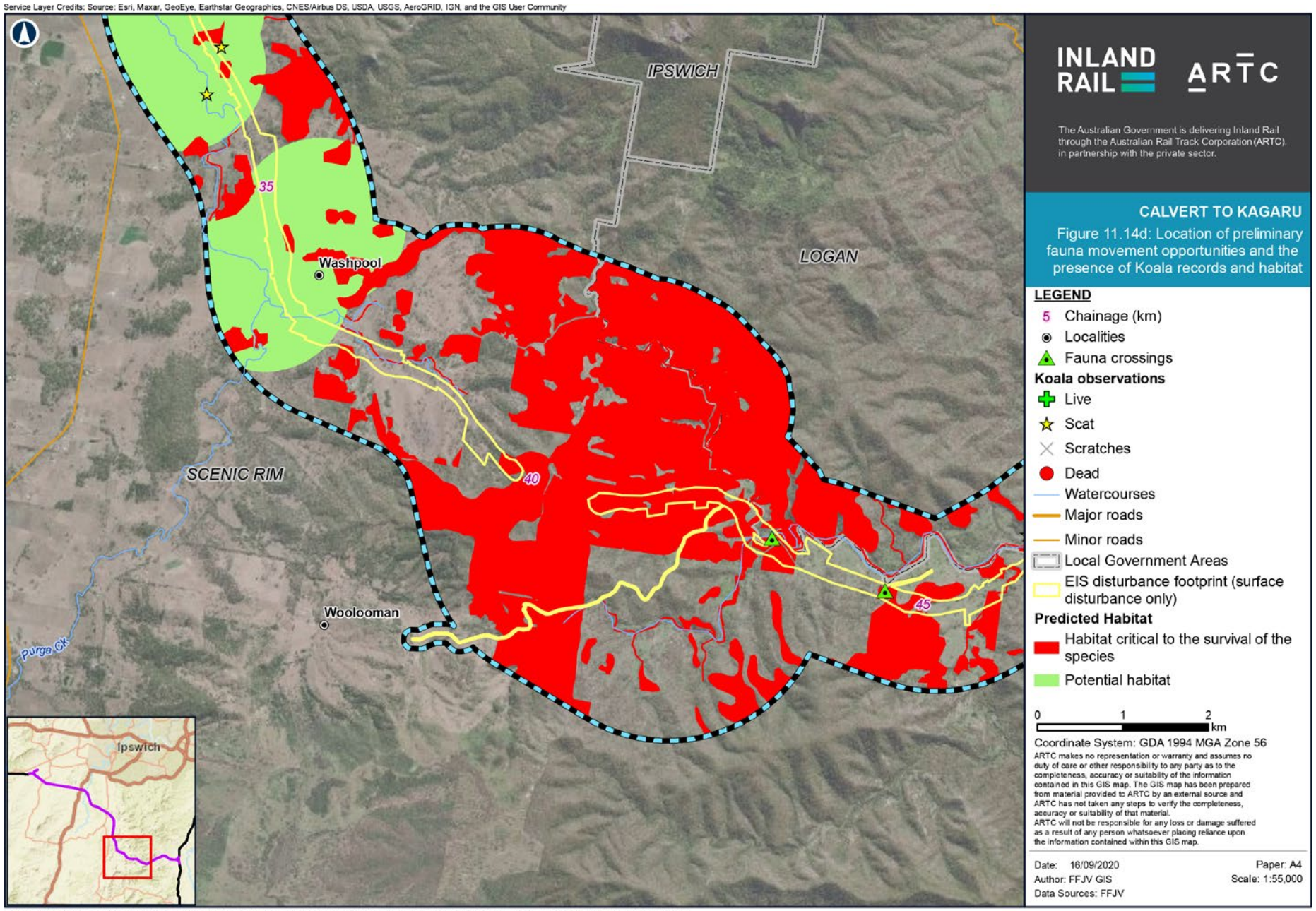
Data Sources: FFJV
Paper: A4
Scale: 1:55,000
Map by: MF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.14_Fauna_movement_koala.mxd Date: 16/09/2020 15:00


Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
IPSWICH
LOGAN
SCENIC RIM
Washpool
Woolooman
Purga Ck
35
40
45
Ipswich
INLAND RAIL
ARTC
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CALVERT TO KAGARU
Figure 11.14d: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat
LEGEND
5 Chainage (km)
Localities
Fauna crossings
Koala observations
Live
Scat
Scratches
Dead
Watercourses
Major roads
Minor roads
Local Government Areas
EIS disturbance footprint (surface disturbance only)
Predicted Habitat
Habitat critical to the survival of the species
Potential habitat
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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Paper: A4
Author: FFJV GIS
Scale: 1:55,000
Data Sources: FFJV
Map by: MF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.14_Fauna_movement_koala.mxd Date: 16/09/2020 15:00

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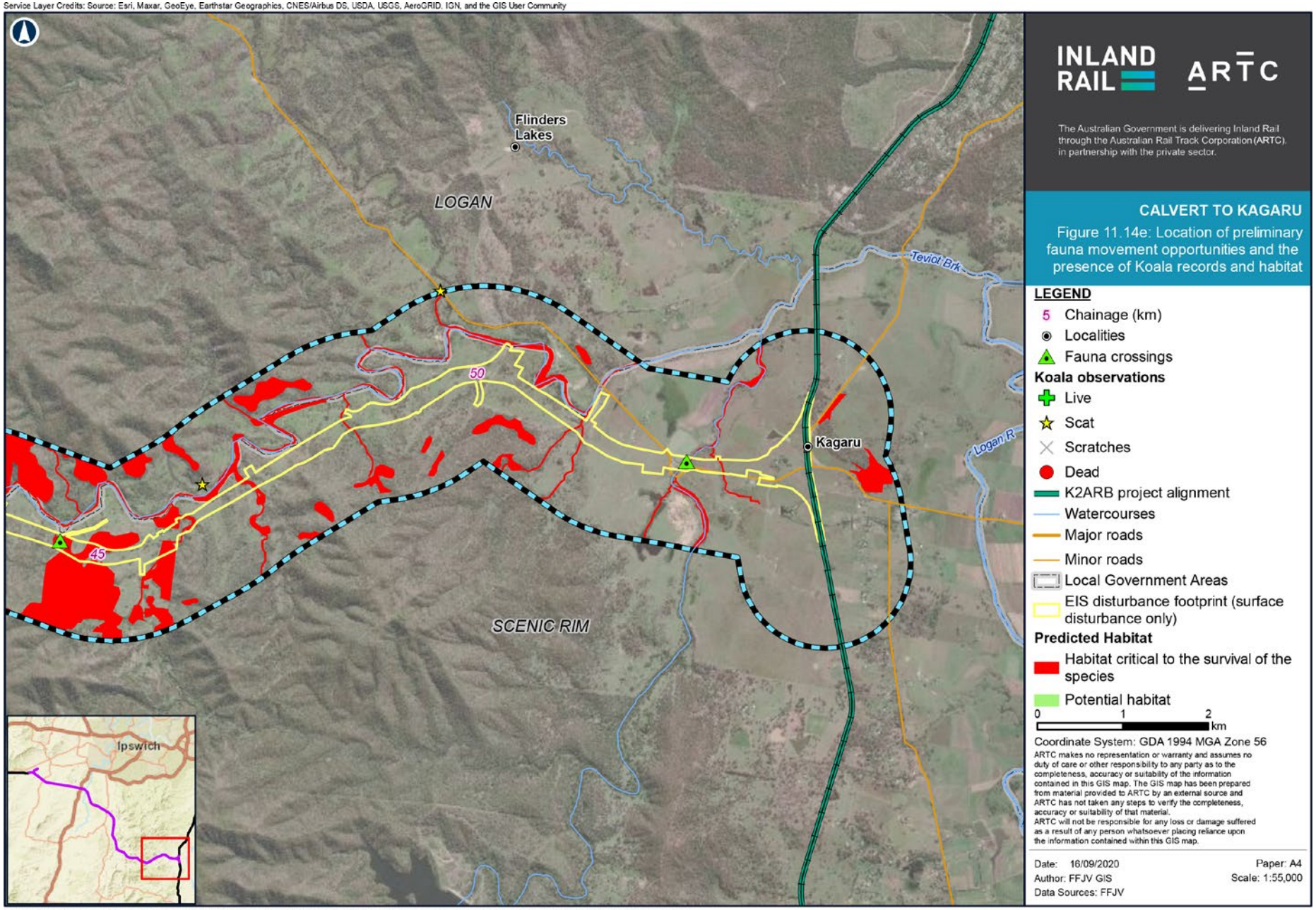

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CALVERT TO KAGARU

Figure 11.14e: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

LEGEND

- 5 Chainage (km)
- Localities
- Fauna crossings

Koala observations

- Live
- Scat
- Scratches
- Dead
- K2ARB project alignment
- Watercourses
- Major roads
- Minor roads
- Local Government Areas
- EIS disturbance footprint (surface disturbance only)

Predicted Habitat

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

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 16/09/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:55,000

Map by: MF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_ARTC_Fig_11.14_Fauna_movement_koala.mxd Date: 16/09/2020 15:00

11.8.2 Proposed mitigation measures

To manage Project risks, a number of mitigation measures have been proposed for implementation in future phases of Project delivery, as presented in Table 11.25. These proposed mitigation measures have been identified to address Project-specific issues and opportunities, address legislative requirements and accepted government plans, policy and practice. Information related to government threat abatement plans and recovery plans has been incorporated into the identified mitigation measures wherever applicable. A summary of threat abatement plans and recovery plans applicable to the identified MNES is provided in Appendix K: Matters of National Environmental Significance Technical Report.

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

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

Table 11.25 identifies the relevant Project phase, the aspect to be managed, and the proposed mitigation measure, which is then factored into the assessment of residual risk/significance in Sections 11.9.2, 11.10.1, 11.10.2 and 11.10.3.

Initial significance ratings of low, moderate, high and major (refer Table 11.31) constitute a potential significant impact to sensitive environmental receptors and, where applicable, were subsequently re-assessed against the MNES/MSES significant impact guidelines to confirm the significance assessment (refer Section 11.10).

Chapter 23: Draft Outline Environmental Management Plan provides further context and the framework for implementation of these proposed mitigation and management measures.

TABLE 11.25: PROJECT IMPACT MITIGATION AND MANAGEMENT MEASURES

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design	Flora and fauna	While the assessment assumes the entire Project disturbance footprint will be cleared, the disturbance footprint will be refined through detailed design as far as practical, to that required to safely and efficiently construct and operate the Project and avoid unnecessary clearing. This will involve inputs from the design team, construction contractor and, where applicable, the Constructing Authority.
		Flora and fauna surveys to be undertaken where they are required to verify prior surveys and assessments, refine potential offsets, inform micro-siting of infrastructure, support secondary approvals and establish baseline conditions against which relevant outcomes of the Reinstatement and Rehabilitation Plan and monitoring activities can be compared. Methods and sequencing of surveys, including seasonal timing, will be in accordance with the relevant published State Government and Australian Government survey guidelines and conservation advice for each target species, such as the *Protected Plants Survey Guidelines* (DES, 2020g) and *Survey guidelines for Australia's threatened birds* (DEWHA, 2010). Flora species to be targeted through these surveys include, but are not limited to the following species: ▸ MSES: ▸ Slender Milkvine (*Marsdenia coronata*) ▸ Bailey's Cypress Pine (*Callitris baileyi*) ▸ Swamp Tea-tree (*Melaleuca irbyana*). ▸ MNES: ▸ Hairy-joint Grass (*Arthraxon hispidus*) ▸ Miniature Moss-orchid (*Bulbophyllum globuliforme*) ▸ Boonah Tuckeroo (*Cupaniopsis tomentella*) ▸ An algae (*Lychnothamnus barbatus*) ▸ Lloyd's Olive (*Notelaea lloydii*) ▸ Shiny-leaved Condoo (*Planchonella eerwah*).
		Fauna surveys, including terrestrial, aquatic habitats and breeding habitats (including burrows and hollow bearing trees/logs, wetlands, existing culverts and structures) will target, but are not limited to the following species: ▸ MSES: ▸ Short-beaked Echidna (*Tachyglossus aculeatus*) ▸ Powerful Owl (*Ninox strenua*) ▸ Tusked Frog (*Adelotus brevis*) ▸ Glossy-black Cockatoo (*Calyptorhynchus lathami*). ▸ MNES: ▸ Regent Honeyeater (*Anthochaera phrygia*) ▸ Australasian Bittern (*Botaurus poiciloptilus*) ▸ Curlew Sandpiper (*Calidris ferruginea*) ▸ Large-eared Pied Bat (*Chalinolobus dwyeri*) ▸ Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) ▸ Collared Delma (*Delma torquata*) ▸ Red Goshawk (*Erythrotriorchis radiatus*) ▸ Painted Honeyeater (*Grantiella picta*) ▸ Swift Parrot (*Lathamus discolor*) ▸ Australian Lungfish (*Neoceratodus forsteri*) ▸ Greater Glider (*Petauroides volans volans*) ▸ Brush-tailed Rock-wallaby (*Petrogale penicillata*) ▸ Koala (*Phascolarctos cinereus*) ▸ Long-nosed Potoroo (*Potorous tridactylus tridactylus*) ▸ New Holland Mouse (*Pseudomys novaehollandiae*) ▸ Grey-headed Flying-fox (*Pteropus poliocephalus*) ▸ Australian Painted Snipe (*Rostratula australis*) ▸ Black-breasted Button-quail (*Turnix melanogaster*).

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Flora and fauna (continued)	Where a species is detected, it will be reported to the relevant agencies along with information on the species habit, habitat in which the species was identified and, where possible, population size and local threatening processes. The information will be used to refine the predictive habitat mapping, significant residual impact assessment, disturbance limits, mitigation measures and offsets. Surveys of representative MNES habitat, remnant and regrowth vegetation communities that will be impacted by the Project will be undertaken during the detailed design phase in accordance with the *Guide to determining terrestrial habitat quality methods for assessing habitat quality under the Queensland Environmental Offsets Policy. Version 1.3* (DES, 2020d) and the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC, 2012) as relevant, to enable a condition assessment of vegetation communities that require offset for the Project.
		Based on the outcome of flora, fauna, vegetation communities and MNES habitat surveys: ▸ Work with the design team and construction team to implement measures to avoid and/or further minimise the extent of impacts (i.e. designate no-go zones, reduce the construction or operational footprint within or adjacent to communities or habitat for MNES, clearing limits) ▸ This information will inform staged and sequential clearing (i.e. clearing of non-habitat trees in area, then a wait period and then the clearing of the remaining habitat) ▸ Identify suitable locations for the release of fauna that may be encountered during pre-clearing or clearing or for the salvaging of microhabitats.
		For any threatened flora species identified through surveys within the disturbance footprint, consult with relevant specialist to determine the feasibility of translocating or propagating specimens in accordance with relevant guidelines (e.g. *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al., 2018)), including the collection of seed. Feasibility will be assessed noting that not all species can be translocated or propagated and that for the majority of the species identified as potentially occurring with the Project disturbance footprint, there is limited evidence of these species being successfully translocated, although some are used in the horticultural industry.
	MNES: Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland	The following TEC-specific measures for Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC will also be implemented: ▸ Undertake a baseline assessment to determine the health and condition of the community to inform offsets and quantify impacts during construction and potentially operations ▸ Work with the design team to minimise the direct impact on Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC. This includes ensuring that communities (remnant and regrowth) identified within the construction disturbance footprint are avoided (e.g. Lots 3 and 4 on RP178669 contain approximately 7 ha of TEC, with these lots identified as a potential laydown area), siting access roads to avoid and minimise impacts in the Warrill Creek area and ensuring that changes to the predicted hydrology outcomes consider this TEC ▸ Continue to refine the Project design in response to hydraulic modelling outcomes to demonstrate continued compliance with the design objectives of the Project including maintaining inundation regimes within the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC as close to natural conditions as possible.
	MNES: Lloyd's Olive	The following species-specific measures for Lloyd's Olive (*Notelaea lloydii*) will also be implemented: ▸ Avoid works above the tunnel as this area is known to support an important population of Lloyd's Olive ▸ Undertake protected flora surveys as per *Protected Plants Survey Guidelines* (DES, 2020g) with a particular focus within the area of Teviot Range identified as habitat for the species (refer species habitat mapping in Appendix G of Appendix K: Matters of National Environmental Significance Technical Report). This includes assessing the condition and health of the population above the tunnel prior to construction to establish the baseline for monitoring during construction to determine if any changes to the population occur as a result of the Project or due to natural attrition. Potential criteria may include recruitment and presence of fertile material, plus signs of water stress ▸ As part of the MNES monitoring plan, continue to monitor this population during construction.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	MNES: Australian Lungfish	The following species-specific measures for Australian Lungfish (*Neoceratodus forsteri*) will also be implemented: ▸ Avoid clearing within and along major watercourses, in particular Bremer River and Teviot Brook, through the use of bridge structures and the placement of pylons away from bed and banks ▸ Pre-construction surveys of waterways identified as potential habitat of species (e.g. Bremer River) to identify whether Australian Lungfish occurs. Surveys will follow the *Survey guidelines for Australia's threatened fish* (DSEWPaC, 2011c) ▸ Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, the Flora and Fauna Sub-plan will include requirements for an appropriately qualified person to be consulted to make an assessment on the method of recovery, transport and release of fish. The Flora and Fauna Sub-plan will include requirements for the application of relevant State (DAF) fish salvage guidelines during construction activities ▸ The Biosecurity Management Plan will include measures to manage the risk of translocating non-endemic flora and fauna through dewatering and fish salvage activities ▸ The Surface Water Sub-plan will be developed to include measures to maintain low flows during drought conditions and avoid fluctuations to water levels downstream during spawning period (i.e. Bremer River) ▸ The Reinstatement and Rehabilitation Plan will establish requirements for instream and riparian habitats impacted by Project works. This includes restoration of natural riparian vegetation and, where possible, reinstatement of instream habitat to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and allow fish passage).

	MNES: Spotted-tailed Quoll	The following species-specific measures for Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) and Brush-tailed Rock-wallaby (*Petrogale penicillata*) will also be implemented:
		▸ Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project
		▸ Targeted surveys for identified mammal species will follow the *Survey guidelines for Australia's threatened mammals* (DSEWPaC, 2011b) and include the identification of species-specific habitat (refer species habitat mapping in Appendix G) and habitat features considered suitable for species presence (e.g. cliff faces/boulder piles for Brush-tailed Rock-wallaby and Spotted-tailed Quoll)
		▸ As part of the MNES monitoring plan, establish camera traps above the tunnel areas to monitor fauna movement across this area during construction
		▸ The Flora and Fauna Sub-plan will include restricted works measures for implementation if the Spotted-tailed Quoll and Brush-tailed Rock-wallaby are observed within or adjacent to disturbance footprint to allow safe movement away from works area. These measures may include, but are not limited to the following:
		  ▸ Measures to remove carrion from the Project disturbance footprint (and the rail corridor), along with waste management measures
		  ▸ Pest control measures in known or potential habitat for the Spotted-tailed Quoll consider risks to the species (e.g. use of baiting to control wild dogs)
		  ▸ Salvage hollow logs and rocky outcrops removed from the Project disturbance footprint into adjoining habitat
		  ▸ Establish buffer zones around known key habitat and den sites
		  ▸ Where possible, avoid clearing within the known habitat (e.g. Teviot Range) during the breeding season for the Spotted-tailed Quoll
		  ▸ Measures to manage the clearing of hollow logs and hollow-bearing trees (e.g. tapping of tree prior to clearing, removal of hollows prior to clearing and grubbing activities).

	MNES: Swift Parrot	The following species-specific measures for the Swift Parrot (*Lathamus discolor*) will also be implemented: ▸ Where possible through design, reduce the disturbance footprint in winter foraging habitat, including avoiding clearing for ancillary works ▸ Incorporate winter foraging species into the landscape design and Reinstatement and Rehabilitation Plan.

Delivery phase	Environmental value impacted	Mitigation and management measures

Detailed design (continued)	MNES: Australian Painted Snipe	The following species-specific measures for the Australian Painted Snipe (*Rostratula australis*) will also be implemented:
		▸ Targeted surveys to be undertaken of potential habitat following the *Survey guidelines for Australia's threatened birds* (DEWHA, 2010)
		▸ Should the Australian Painted Snipe or other target wetland species be found, the CEMP Flora and Fauna sub-plan will include:
		  ▸ Clearing/construction works in potential habitat areas will be timed where possible to avoid wet conditions where habitat is likely to be most suitable
		  ▸ Restricted works/avoidance measures in place should nesting be detected
		▸ The CEMP will include measures to minimise noise as much as feasible and the Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods
		▸ The Biosecurity Management Plan will include site hygiene and waste management measures to ensure pest predator fauna are not attracted to works areas or using the Project disturbance footprint.

	MNES: Collared Delma	The following species-specific measures for the Collared Delma (*Delma torquata*) will also be implemented:
		▸ Targeted surveys to be undertaken as per *Survey guidelines for Australia's threatened reptiles* (DSEWPaC, 2011d) where suitable habitat is identified (refer species habitat mapping in Appendix G of Appendix K: Matters of National Environmental Significance Technical Report)
		▸ The Flora and Fauna Sub-plan will include restricted works measures for implementation if the Collared Delma is observed within or adjacent to disturbance footprint to allow safe movement away from works area. Other measures may include, but are not limited to the following:
		  ▸ Measures to ensure retrieval of potential habitat elements (e.g. loose surface rock, large fallen timber) during vegetation clearing and placement in adjacent unimpacted habitat
		  ▸ Erosion and sediment control measures in steep slopes (and known important habitat for this species) to avoid/minimises slippages
		  ▸ Measures to allow safe handling of fauna (where required) and repatriation in a suitable habitat away from site.

	MNES: Red Goshawk	The following species-specific measures for the Red Goshawk (*Erythrotriorchis radiatus*) will also be implemented: ▸ Pre-clearing surveys of woodlands identified as potential habitat for Red Goshawk (refer species habitat mapping in Appendix G of Appendix K: Matters of National Environmental Significance Technical Report) will be undertaken to identify whether individuals occur and potentially nest within the disturbance footprint. Surveys for nest sites within or near the disturbance footprint will be as per MNES guidelines where suitable nesting habitat (i.e. large emergent trees near water) is identified ▸ Where Red goshawk nesting is identified in pre-clearing surveys, the Flora and Fauna Sub-plan will include restricted works measures for construction to allow nesting to continue undisturbed (e.g. micro-siting of works to avoid nests or maximise separation distance, 100 m buffer and signage around nests, no disturbance to nests until after breeding season (being until fledglings/offspring no longer use the nest / roost for habitat). Some limited works may occur in the buffer zone during this period (e.g. cultural heritage surveys).
	MNES: Koala	The following species-specific measures for Koala (*Phascolarctos cinereus*) will also be implemented: ▸ Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project ▸ Pre-clearing surveys to be undertaken of woodlands (and other relevant habitats) identified as potential habitat of species (refer species habitat mapping in Appendix G of Appendix K: Matters of National Environmental Significance Technical Report) to identify whether individuals occur within disturbance footprint ▸ Project design to incorporate fauna crossing structures to allow fauna movement across alignment. The location and frequency of the passages will be based on an understanding of local Koala movements and in consultation with relevant stakeholders (e.g. DTMR and local councils) ▸ Fauna fencing in accordance with ARTC guidelines and DTMR's *Fauna Sensitive Road Design Manual* (DTMR, 2000; DTMR, 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	MNES: Koala (continued)	▸ Viaducts and the bridge structures will assist in the retention of corridors of at least 100 m width. while the tunnel will ensure a corridor over 1 km wide is maintained through the Teviot Range ▸ The Flora and Fauna Sub-plan will include restricted works measures for implementation within or adjacent koala habitat to allow safe movement away from works area. These measures may include, but are not limited to the following: ▸ Staged and sequential clearing within Koala habitat ▸ In areas where Koalas have been identified as being present, undertake pre-clearing Koala searches on the morning prior to clearing commencing ▸ Measures to allow safe handling of Koalas (where required) and repatriation in suitable habitat away from site ▸ Requirements for Koalas subject to handling to be examined and if suspected of chlamydia infection will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release. ▸ A procedure to guide Koala interactions, including any translocations ▸ Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk ▸ Incorporation of Koala trees in landscape design and rehabilitation works, especially along existing corridors that are to be retained (e.g. riparian corridors).
	MNES: Greater Glider	The following species-specific measures for the Greater Glider (*Petauroides volans volans*) will also be implemented: ▸ Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project ▸ Pre-clearing surveys to be undertaken of woodlands (and other relevant habitats) identified as potential habitat for the species (refer species habitat mapping in Appendix G of Appendix K: Matters of National Environmental Significance Technical Report) to identify whether individuals occur within disturbance footprint, including potential movement pathways, nest sites (.e. hollow bearing trees) and feeder trees ▸ Project design to incorporate fauna crossing structures to allow fauna movement across alignment. The location and frequency of the passages will be based on an understanding of local Greater Glider movements and in consultation with relevant stakeholders (e.g. DTMR and local councils) ▸ Fauna fencing in accordance with ARTC guidelines and DTMR's Fauna Sensitive Road Design Manual (DTMR, 2000; DTMR, 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Also, where possible, avoid the use of barbed wire, particularly on the top strand, to prevent threatened species (particularly Greater Gliders, lying-foxes and microbats) from becoming entangled. Fauna friendly fencing must be used, while being in accordance with landowner and/or structural requirements. ▸ The Flora and Fauna sub-plan will include: ▸ Requirements for pre-clearing surveys to identify and map out hollow-bearing trees, feed trees and potential movement pathways ▸ In consultation with the Project team and construction team to determine whether key microhabitats can be avoided ▸ Where key microhabitats cannot be avoided, develop protocols/procedures to manage these features, including relocating hollow-bearing trees into adjacent habitat and using nesting boxes, tapping hollow-bearing trees or, where possible, by lowering excavator slowly with a claw extension.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	MNES: Grey-headed Flying fox	The following species-specific measures for the Grey-headed Flying-fox (*Pteropus poliocephalus*) will also be implemented: ▸ Pre-clearing surveys to be undertaken of riparian habitat identified as potential roost sites of species to identify whether camps occur within or near the disturbance footprint. No roost sites have been previously identified within 5 km of the Project ▸ Where possible, reduce the disturbance footprint in winter foraging species, including avoiding clearing for ancillary works ▸ Incorporate winter foraging species into the landscape design and Reinstatement and Rehabilitation Plan ▸ Work with the design team and property team to incorporate fencing that minimises the risk of entanglement (e.g. avoid the use of barbed wire fencing with a high tensile wire strand as the top wire) ▸ The Flora and Fauna Sub-plan will include measures to be implemented should a roost site be found. These measures will incorporate the mitigation standards detailed in the Commonwealth's *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE, 2015b).
	MNES, MSES	For other species not listed above, review the outcome of the flora and fauna surveys, and adopt species-specific measures as appropriate for pre-clearing surveys, landscape design, the Reinstatement and Rehabilitation Plan and the Flora and Fauna Sub-plan.
	MNES	Develop a post-construction MNES monitoring plan, with reference to the survey results. The MNES monitoring plan will be developed in consultation with relevant stakeholders and imposed conditions. The MNES monitoring plan will define the TEC or other MNES habitat location, reference condition, assessment framework, infrastructure elements (e.g. erosion and sediment control devices, fauna crossing structures), corrective actions, completion criteria and monitoring timeframes. Criteria and monitoring targets to be considered include (but are not limited to): ▸ For Swamp Tea-tree: level of dieback and recruitment, dust deposition on leaves, changes to the local hydrology through observations of soil moisture with these criteria to be determined in consultation with relevant specialist ▸ For Lloyd's Olive: weed monitoring within identified Lloyd's Olive population, with annual monitoring in accordance with completion criteria ▸ For Painted Snipe: Ongoing annual weed monitoring within wetland habitat in accordance with completion criteria ▸ For Lloyd's Olive: monitor individuals used in rehabilitation activities in accordance with the Rehabilitation and Reinstatement Plan, if included.
	Fauna	Project design to incorporate minimum lighting requirements feasible for Project safety.

	Flora and fauna	The potential for Project works to impact MNES and other ecological receptors through erosion, soil loss, land degradation, sedimentation or decreased surface water or groundwater quality or availability will be managed through the following:
		▸ Soil surveys to further characterise soil conditions across the disturbance footprint at a suitable scale to inform detailed design, including appropriate design responses where reactive or problem soils are present or suspected (e.g. sodosols near Ebenezer, vertosols near Purga and Willowbank, saline hazard areas, potential for acid sulfate soils near artificial waterbodies or impoundments)
		▸ Contaminated land surveys to inform detailed design and subsequent contaminated land strategy
		▸ A Soil Management Plan will be developed to provide the framework for the stripping, storage, treatment and reuse of topsoil
		▸ An Erosion and Sediment Control Plan (ESCP) will be developed as part of the CEMP, in accordance with the *International Erosion Control Association's Best Practice Erosion and Sediment Control* (IECA, 2008). It will include:
		  ▸ Soil/land conservation objectives for the Project
		  ▸ Management of problem soils
		  ▸ Temporary/permanent drainage, erosion and sediment control measures
		  ▸ Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material
		  ▸ Vehicle, machinery and imported fill hygiene protocols and documentation
		  ▸ Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Flora and fauna (continued)	▸ Where practical and/or in accordance with specific flora and fauna management plans, vegetation clearing and ground disturbing works will be staged sequentially across the Project to minimise areas exposed to erosion and sediment risk of receiving waterways and drainage lines in accordance with the general environmental duty of the Environmental Protection Act 1994 (Qld) ▸ Measures for minimising the exposure time of unprotected materials to prevent sedimentation of receiving waterways and subsequent impacts to ecological receptors ▸ A process for site- and activity-specific preparation when forecast large or high-intensity wet weather events are predicted. This may include, but not be limited to, removing equipment out of riparian zones, stabilising/covering live work areas, additional application of soil binders/veneers and pre event treatment and dewatering of sediment basins ▸ Process for the continuous review of effectiveness of erosion and sediment controls ▸ Water quality monitoring requirements as defined in the Surface Water Sub-plan to assess the effectiveness of erosion and sediment controls and reinstatement and rehabilitation programs ▸ The ESCP will align with the Reinstatement and Rehabilitation Plan and will include progressive stabilisation of earth materials and soil consolidation to prevent erosion and sedimentation in areas within the disturbance footprint that do not form part of the permanent works (e.g. temporary construction compounds, temporary waterway barrier works and laydown areas etc.) ▸ The ESCP will be reviewed before the commencement of pre-construction activities, once construction methodology is finalised and to document location specific controls ▸ A surface water monitoring framework, which will inform the development of the Surface Water Sub-plan and construction water quality monitoring program. It will identify monitoring locations including upstream, downstream and at the intersection of the Project disturbance footprint and watercourse. It will include the relevant water quality objectives, parameters, criteria and specific monitoring locations, frequency and duration identified in consultation with relevant regulators to reduce impacts to surface water quality ▸ The Surface Water Sub-plan will establish the construction water quality monitoring program which will include (as a minimum): ▸ Analysis of the representative background monitoring dataset ▸ Identification of Project works and activities during construction and operation, including runoff, emergencies and spill events, that have the potential to impact on surface water quality of potentially affected waterways and riparian land (via discharge points) ▸ A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment, including definition of impacts that trigger contingency and ameliorative measures ▸ Potential aquatic and terrestrial Groundwater Dependent Ecosystems will be field-truthed to confirm presence ▸ Further geotechnical investigations will be undertaken at deep cut sections to inform design and location-specific construction management of groundwater ▸ Risks associated with dewatering (i.e. water table lowering) and environmental management requirements during construction will identified through appropriate baseline groundwater monitoring, modelling and analysis and incorporated into the CEMP.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Riparian vegetation and aquatic habitats	Project design minimises impacts to waterways, riparian vegetation and in-stream flora and habitats by: ▸ Adopting a waterway crossing structure hierarchy: bridges preferred to culverts, to maintain infrastructure permeability for fauna at identified habitat connectivity points, however local conditions and constructability impacts must be considered when determining the preferred environmental solution ▸ Avoiding, then minimising the extent and duration of temporary waterway diversions. Where unavoidable, implement water quality, erosion and sediment control measures to minimise impacts to downstream environments and water users ▸ Avoiding, then minimising, the extent of permanent waterway diversions. Where unavoidable, waterway diversion design to include simulation of natural features e.g. meanders, pools, riffles, shaded and open sections, deep and shallow sections and different types of sub-strata, depending on the pre-disturbance environmental values, as per requirements of relevant and applicable conditions of approval, legislation, regulations and industry guidelines. Maintenance activity locations, construction compounds and storage areas will be defined as part of Project detailed design and positioned away from waterways ▸ Continuing to refine Project design in response to hydraulic modelling outcomes. This includes addressing flood impact objectives, which include consideration of peak water levels, flow distribution, velocities, and duration of inundation, and implications for fish passage. This will confirm bridge lengths, culvert sizing and numbers, localised scour and erosion protection measures for both rail, road and other permanent Project infrastructure ▸ Stormwater controls, such as scour protection, are to be further developed and incorporated where necessary to achieve compliance with established water quality objectives. Temporary and permanent measures must be appropriate to the site conditions, responding to the erosion risk assessment, environmental receptors, climatic zone and seasonal factors. The ESCP will establish and specify the monitoring and performance objectives for handover to operational management on completion of construction ▸ Ensuring the disturbance footprint extents allow sufficient space for provision of the required temporary and permanent erosion and sediment control measures/pollution control measures defined during detailed design ▸ Undertaking rehabilitation of temporary waterway crossings in accordance with the Reinstatement and Rehabilitation Plan ▸ Developing ESCPs for implementation during pre-construction, construction and commissioning.
	Fauna passage[1,2]	Refine fauna passage locations and associated rehabilitation areas in the design in accordance with the fauna crossing strategy to maintain infrastructure permeability, particularly at the six key locations identified as part of the EIS assessment process to maintain and/or re-establish habitat connectivity for the targeted local species, which includes but is not limited to: ▸ Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) ▸ Greater Glider (*Petauroides volans volans*) ▸ Brush-tailed Rock-wallaby (*Petrogale penicillata*) ▸ Koala (*Phascolarctos cinereus*) ▸ New Holland Mouse (*Pseudomys novaehollandiae*). Design of fauna passage structures and associated rehabilitation areas will respond to local topographical and hydrological context, with consideration of safety requirements for the rail corridor and adjoining properties. Design bridges and culverts to accommodate terrestrial fauna passage where assessed as appropriate, in addition to fish passage design requirements. Fauna passage design will be consistent with the intent of DTMR's *Fauna Sensitive Road Design Manual* (DTMR, 2000; DTMR, 2010) and where applicable species-specific requirements.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Fauna fencing[1,2]	Fauna fencing opportunities will be further assessed and, where appropriate, developed during detailed design to limit fauna strike and fauna mortality risk and/or maintain habitat connectivity. This will include: ▸ Assessment of the compatibility of each approach for the targeted local species with the general fencing principles at each proposed fencing location ▸ Consideration of safety requirements for the rail corridor and adjoining properties ▸ Consultation with adjoining landholders ▸ Requirements for maintaining an appropriate clearance buffer between adjacent vegetation and fauna fences ▸ Consideration for maintenance constraints and responsibilities that a fauna connectivity or fencing opportunity may introduce to operations. Fauna fencing will be designed with reference to DTMR's *Fauna-Sensitive Road Design Manual* (DTMR, 2000; DTMR, 2010). Additional expert guidance in relation to specific design features will be sought during the detailed design process. The design will aim to maximise infrastructure permeability by connecting fauna fencing with safe crossing opportunities.
	Aquatic fauna	Design watercourse crossing structures (including culverts and bridges) to maintain fish passage where applicable in accordance with *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF, 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works. The design will aim to minimise the need for ongoing maintenance and inspection to maintain fish passage.
		Dewatering strategies will be required to comply with the *Biosecurity Act 2014* (Qld) to take reasonable measures to avoid the spread of pest species and in accordance with any required aquatic fauna species management plans and water quality objectives defined in the outline CEMP.
	Flora	Where feasible and practicable, locate construction areas including compounds, stockpiles, fuel storage, laydown areas and staff parking outside the tree protection zone as defined in *AS4970-2009 Protection of trees on development sites*. Where practical, existing tracks will be used and the design for new access tracks (permanent and temporary) will be undertaken with the aim of minimising disturbance of substrate and vegetation.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Landscape, rehabilitation and stabilisation (continued)	Landscape design establishes the requirements for rehabilitation of disturbed areas for habitat re-creation, landscaping and stabilisation, including for riparian zones and informs the development of the Reinstatement and Rehabilitation Plan and the Landscape and Rehabilitation Management Plan[1,3]. This should also include criteria for retrieval of potential habitat elements (loose surface rock, large fallen timber) during vegetation clearing for habitat recreation, where appropriate. Develop a Reinstatement and Rehabilitation Plan for areas within the disturbance footprint that do not form part of the permanent works (e.g. construction compounds, laydown areas, temporary access tracks etc). The Plan will include and clearly identify: ▸ Location of areas subject to rehabilitation and/or reinstatement/stabilisation, in accordance with the landscape and rehabilitation design developed during detailed design, including operational rail safety considerations ▸ Objectives and timeframes for rehabilitation and/or reinstatement/stabilisation works (including biodiversity, vegetation establishment and erosion and sediment control outcomes to be achieved) ▸ Where appropriate, the plan describes how the objectives align with relevant recovery plans, threat abatement plans, conservation advices or policy guidance for target species in areas identified for rehabilitation ▸ Details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, consistent with the objectives ▸ Native flora species endemic to the Scenic Rim and Ipswich regions or other suitable species appropriate to the landscape context and nursery/seed stock sources. Where possible (i.e. propagated material is available) include MNES species (i.e. Lloyd's Olive) in rehabilitation activities ▸ Incorporate koala trees in landscape design and rehabilitation works, especially along existing corridors that are to be retained (e.g. riparian corridors) ▸ Procedures, timeframes, measurable performance objectives and responsibilities for monitoring the success of rehabilitation and/or reinstatement/stabilisation areas ▸ Corrective actions if the outcomes of rehabilitation and/or reinstatement/stabilisation are not achieved. A Landscape and Rehabilitation Management Plan will be developed to define post-construction maintenance requirements, monitoring requirements and completion criteria for areas defined in the landscape design and/or identified in the Reinstatement and Rehabilitation Plan.
	Offsets[1,2]	Restriction of the Project disturbance footprint through detailed design as far as practical, to that required to safely and efficiently construct and operate the Project. Significant adverse residual impact to habitat for MNES and MSES will be re-calculated to confirm the Project's offset obligations under Australian Government and State Government requirements1 based on the outcomes of the flora, fauna and MNES habitat surveys. Re-calculated impacts will be used to confirm the Project's offset obligations under Australian Government and State Government requirements A Project offset delivery plan and offset management plans will be developed to provide for the staged delivery of offsets, where appropriate, ahead of relevant clearing works being undertaken and finalised in consultation with relevant Australian Government and State Government regulatory agencies (refer Appendix J of Appendix K: Matters of National Environmental Significance Technical Report for the Environmental Offset Delivery Strategy—Qld).

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

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

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

Delivery phase	Environmental value impacted	Mitigation and management measures
Construction and commissioning (continued)	Flora	Minimise clearance of remnant vegetation to that necessary for construction and safe operation, and in accordance with the disturbance footprint and secondary approvals.[1,2,3] Where practicable and feasible, locate construction areas including compounds, stockpiles, fuel storage, laydown areas, staff parking outside the tree protection zone as defined in *AS4970-2009 Protection of trees on development sites.* Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species. Implement the Soil Management Plan as part of the CEMP, guiding the stripping, stockpiling and management of topsoil where it has the potential to contain seedbank or weed material.[1] Topsoil stockpiles will be managed to maintain the viability of soil seed banks for threatened flora species[1] such as Hairy-joint grass, Boonah Tuckeroo, Lloyd's Olive and Shiny-leaved Condoo. Plan and implement revegetation and rehabilitation works so that they do not create safety, maintenance or performance issues e.g. vegetation does not grow and obscure signals or impact longevity of rail infrastructure.
	Aquatic fauna	Construct temporary and permanent watercourse crossing structures in accordance with the detailed design and *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF, 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier. This is required to minimise impacts to aquatic fauna (i.e. fish passage) and hydrology during construction and operation.
	Fauna fencing	Install fauna exclusion fencing in accordance with detailed design and fencing hierarchy especially in conjunction with the six identified fauna passages/creek crossing locations for the Project to maintain permeability in the alignment.[1,2]
	Weeds and pests	Implement the Biosecurity Management Plan during construction to reduce the potential for the spread of weeds and pests into the surrounding environments and land uses. The effectiveness of weed hygiene measures will be monitored as a component of the environmental monitoring procedure for the Project. Any vegetated material containing, or with the potential to contain, weed seed material will not be used for onsite mulching or erosion protection.[1,2] Implement the Community Engagement Sub-plan in the CEMP to enable members of the public to assist with weed surveillance in the vicinity of Project works.
	Landscape, rehabilitation and stabilisation	Construct landscaping treatments in accordance with the landscape design. Implement the Soil Management Plan to protect soil seedbanks and habitat. Undertake progressive rehabilitation and reinstatement of disturbed areas in accordance with the Reinstatement and Rehabilitation Plan and the Landscape and Rehabilitation Management Plan to minimise threatening process to MNES and MSES such as weed invasion.
	Erosion and sediment control	Vegetation clearing and ground-disturbing activities will be supplemented by the progressive installation of erosion and sediment controls including stabilisation works to minimise areas exposed to erosion and sediment risk. Implement site stabilisation treatments in accordance with: ▸ ESCP ▸ Air Quality Sub-plan ▸ Reinstatement and Rehabilitation Plan. Assess the suitability of cleared vegetation for mulching/erosion protection on a case by case basis. Any vegetated material containing, or with the potential to contain, weed seed material will not be used for onsite mulching or erosion protection without prior treatment. For any unsuitable material i.e. noxious weeds etc, the cleared and grubbed material shall be removed from the site and disposed of in accordance with relevant statutory requirements and the Biosecurity Management Plan. Re-use suitable mulch generated by construction of the Project within appropriate timeframes and manner as specified in the ESCP and the Reinstatement and Rehabilitation Plan.

Delivery phase	Environmental value impacted	Mitigation and management measures
Operation	Riparian vegetation and aquatic habitats	Undertake maintenance activities and refuelling facilities in accordance with *AS1940:2017 The storage and handling of flammable and combustible liquids*. Where maintenance activities within or adjacent to watercourses are required these will be undertaken in accordance with: ▸ *Riverine protection permit exemption requirements* (WSS/2013/726) or conditions of a riverine protection permit issued for the works ▸ *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF, 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works.
	Weeds and pests	Weed management protocols for the operational rail corridor and other ARTC facilities will be in accordance with the requirements of the *Biosecurity Act 2014* (Qld), ARTC operation and maintenance procedures and policies and the Operation EMP.[1,2,3] These protocols will include: ▸ Site hygiene and waste management procedures to deter pest animals ▸ Weed surveillance and treatment during operation and maintenance activities ▸ Requirements in relation to pesticide and herbicide use, including any limitations on use. Restrictions may apply in proximity to watercourses, known areas of MNES or MSES habitat or land uses sensitive to spray-drift from the application of pesticides and herbicides ▸ Vehicle, machinery and imported fill hygiene protocols and documentation ▸ Erosion and sediment control risks associated with broad scale weed removal or treatment ▸ Corrective actions should the outcomes not achieve the adopted objective ▸ ARTC's Enviroline will be advertised for the Project to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.
	Fauna passage	Cross drainage structures will be inspected to assess physical condition and performance, structural integrity and corrective measures in accordance with ARTC's Structures Inspection Engineering Code of Practice (ETE-09-01).[1,2] Fauna passages will be maintained and where applicable monitored during the operational life of the Project (design life of 100-years).
	Fauna fencing	Inspect and maintain fauna fencing in accordance with ARTC's *Engineering (Track and Civil) Code of Practice—Section 17 Right of Way: Inspection and Assessment.* Fauna fencing will be maintained and, where applicable, monitored during the operational life of the Project (design life of 100-years). Record vehicle strikes with Koalas and Greater gliders and investigate potential source of the issue Where applicable implement corrective measures (e.g. erect fauna-friendly fencing, glider poles etc.).

Table notes:

1. Mitigation measure successfully implemented as part of the Toowoomba Second Range Crossing Project (APB Joint Venture, 2016).
2. Mitigation measure approved by the Commonwealth as part of the rail component for the Carmichael Coal Mine and Rail Project (EPBC 2013/6885) (refer measures within Species Management Plans. *Carmichael Rail Project* (ELA, 2019d)).
3. Mitigation measure commonly applied across other projects as approved by the Commonwealth in central and southern Queensland e.g. *Santos Significant Species Management Plan—GFD Project* (Santos, 2017), *Anya Significant Species Management Plans* (Shell, 2017), *Species Management Plans—Carmichael Rail Project* (ELA, 2019d).

11.8.3 Flora and fauna management and monitoring

Mitigation measures have been selected based on the best available information including government guidelines (e.g. DTMR's *Fauna Sensitive Road Design Manual* (DTMR, 2000; DTMR, 2010)) and mitigation measures used on similar projects that have been subject to legislative approval (refer footnotes to Table 11.25). It is acknowledged the effectiveness of these measures may not be subject to rigorous peer-reviewed analysis.

In addition, as the Project moves into the detailed design and construction phases, more focused and comprehensive ecological surveys in accordance with the Commonwealth's survey guidelines will be undertaken under the Project's Flora and Fauna Sub-plan. The surveys will aim to address any changes to the Project design and footprint, along with informing the design and construction, including specific measures to avoid, mitigate, minimise impacts on a particular species, along with ongoing monitoring activities.

The surveys will also have the added benefit in addressing some of the recommendations in conservation advices, recovery plans and threat abatement plans including:

- Surveys may identify extent and quality of habitat
- Identify new populations and knowledge of the species ecology
- Surveys may be designed to monitor known populations for certain species
- The Project is also a mechanism to engage the public about a species.

As part of these surveys, ARTC will look to collaborate and supplement existing studies being undertaken by local councils, environmental groups and government agencies.

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

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

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

Criteria that can be used to measure effectiveness include:

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

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

11.9 Impact assessment

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

Potential impacts to flora and fauna have been assessed in Section 11.7. For the purposes of this impact assessment, the maximum potential disturbance to each sensitive environmental receptor (e.g. areas identified using the predictive habitat mapping or the maximum extent government-certified mapping) have been used.

The initial significance assessment is undertaken on the assumption that the design measures factored into the Project design (refer Section 11.8.1) have been implemented. The residual significance level of the potential impacts is reassessed, taking into consideration the implementation of the proposed additional mitigation measures listed in Table 11.25. This has been split into consideration of the construction phase, the commissioning and reinstatement phase, and operations. Offsets in response to residual impacts are discussed in Sections 11.10 and 11.11.

11.9.1 Quantification of potential magnitude of impacts

Quantitative estimation of the potential magnitude of disturbance was undertaken for each of the sensitive environmental receptors identified during the desktop and field components of the Project EIS using predictive habitat modelling, which was supported by field validation, government GIS datasets and material gathered during the field component of the Project EIS. In addition, the disturbance footprint was used to determine the 'unmitigated' disturbance area as a percentage of the extent of the ecological receptor within the broader Project context (i.e. the ecology study area).

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

- Table 11.26 (EPBC Act controlling provisions of the Project)
- Table 11.27 (non-threatened, migratory species listed under the EPBC Act)
- Table 11.28 (NC Act threatened, near-threatened and special least concern species)
- Table 11.29 (other State- and local-based sensitive environmental receptors).

The magnitude of impacts is determined using techniques and tools that facilitate an estimation of the **extent**, **duration** and **frequency** of the impacts as described in Appendix J: Terrestrial and Aquatic Ecology Technical Report and Appendix K: Matters of National Environmental Significance Technical Report. The criteria used to determine magnitude of impacts is presented in Table 11.30.

TABLE 11.26: ESTIMATION OF POTENTIAL MAGNITUDE OF DISTURBANCE FOR THREATENED (EPBC ACT) FLORA AND FAUNA SPECIES WITHIN THE ECOLOGY STUDY AREA (COMBINED HABITAT TYPES)

MNES	Total coverage of ecology potential habitat (combined habitat types) within the ecology study area (ha)	Total unmitigated potential impact area associated within the disturbance footprint (ha) (combined habitat types)	Percentage (%) disturbance to receptors within the ecology study area based on the unmitigated potential disturbance	Magnitude of disturbance area#
Commonwealth significant ecological constraints				
Threatened ecological communities (EPBC Act)				
Swamp Tea-tree (*Melaleuca irbyana*) Forest of Southeast Queensland TEC	641.57	30.45	4.75	Moderate
Threatened flora habitat* (EPBC Act):				
Hairy-joint Grass (*Arthraxon hispidus*)+	67.47	4.15	6.15	Moderate
Miniature Moss-orchid (*Bulbophyllum globuliforme*) +	6.29	0.00	0.00	Negligible
Boonah Tuckeroo (*Cupaniopsis tomentella*) +	6.29	0.00	0.00	Negligible
A green algae (*Lychnothamnus barbatus*) +	113.45	6.90	6.09	Moderate
Lloyd's Olive (*Notelaea lloydii*) +	1,089.16	26.77	2.46	Moderate
Shiny-leaved Condoo (*Planchonella eerwah*) +	6.29	0.00	0.00	Negligible
Threatened fauna habitat * (EPBC Act):				
Regent Honeyeater (*Anthochaera Phrygia*) +	924.90	11.43	1.24	Low
Australasian Bittern (*Botaurus poiciloptilus*) +	592.72	42.43	7.16	Moderate
Curlew Sandpiper (*Calidris ferruginea*) +	600.53	38.15	6.35	Moderate
Large-eared Pied Bat (*Chalinolobus dwyeri*) +	89.30	2.89	3.23	Moderate
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) +	1,927.68	76.36	3.96	Moderate
Collared Delma (*Delma torquata*) +	898.27	9.56	1.06	Low
Red Goshawk (*Erythrotriorchis radiatus*) +	1,968.90	79.05	4.01	Moderate
Painted Honeyeater (*Grantiella picta*) +	311.23	30.10	9.67	Moderate
Swift Parrot (*Lathamus discolor*) +	2,966.22	141.18	4.76	Moderate
Australian Lungfish (*Neoceratodus forsteri*)	249.15	27.62	11.09	Moderate
Greater Glider (*Petauroides volans volans*) +	1,007.67	16.60	1.65	Low
Brush-tailed Rock-wallaby (*Petrogale penicillata*) +	0.024	0.00	0.00	Negligible

MNES	Total coverage of ecology potential habitat (combined habitat types) within the ecology study area (ha)	Total unmitigated potential impact area associated within the disturbance footprint (ha) (combined habitat types)	Percentage (%) disturbance to receptors within the ecology study area based on the unmitigated potential disturbance	Magnitude of disturbance area#
Koala (*Phascolarctos cinereus*)+	7,613.98	598.48	7.86	Moderate
Long-nosed Potoroo (*Potorous tridactylus tridactylus*)+	865.37	9.56	1.10	Low
New Holland Mouse (*Pseudomys novaehollandiae*)+	880.47	9.56	1.09	Low
Grey-headed Flying-fox (*Pteropus poliocephalus*)	3,084.70	143.89	4.66	Moderate
Australian Painted Snipe (*Rostratula australis*)+	600.53	38.15	6.35	Moderate
Black-breasted Button-quail (*Turnix melanogaster*)+	4.19	0.00	0.00	Negligible

Table notes:
CE = Critically endangered E = Endangered V = Vulnerable M = Migratory LC = Least concern - = Not listed
^ Aerial species, all 'air-space' above the Project is considered habitat. However, these areas will remain unimpacted by the Project. This species has not been subject to impact assessment.
* No value (i.e. 0) represent areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area.
# Criteria associated with the determination of magnitude are provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report
+ Matters of state environmental significance (i.e. listed as threatened under the NC Act)

TABLE 11.27: ESTIMATION OF POTENTIAL MAGNITUDE OF DISTURBANCE FOR EPBC ACT LISTED MIGRATORY SPECIES WITHIN THE ECOLOGY STUDY AREA

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the disturbance footprint (ha)* (972.49 ha)			Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance			Magnitude of disturbance area#
				Total habitat	Potential habitat	Important habitat	Total habitat	Potential habitat	Important habitat	
EPBC Act migratory species										
Pandion haliaetus	Osprey	SLC	M	42.43	42.43	0.00	7.16	8.04	0.00	Moderate
Cuculus optatus	Oriental Cuckoo	SLC	M	7.60	7.60	0.00	4.68	4.84	0.00	Moderate
Myiagra cyanoleuca	Satin Flycatcher	SLC	M	7.60	7.60	0.00	4.68	4.84	0.00	Moderate
Rhipidura rufifrons	Rufous Fantail	SLC	M	7.60	7.60	0.00	4.68	4.84	0.00	Moderate
Monarcha melanopsis	Black-faced Monarch	SLC	M	7.60	7.60	0.00	4.68	4.84	0.00	Moderate
Symposiachrus trivirgatus	Spectacled Monarch	SLC	M	7.60	7.60	0.00	4.68	4.84	0.00	Moderate
Motacilla flava	Yellow Wagtail	SLC	M	45.33	42.43	2.90	6.62	8.14	1.77	Moderate
Actitis hypoleucos	Common Sandpiper	SLC	M	45.33	42.43	2.90	6.62	8.14	1.77	Moderate
Calidris acuminata	Sharp-tailed Sandpiper	SLC	M	45.33	42.43	2.90	6.62	8.14	1.77	Moderate
Gallinago hardwickii	Latham's Snipe	SLC	M	45.33	42.43	2.90	6.62	8.14	1.77	Moderate
Plegadis falcinellus	Glossy Ibis	SLC	M	45.33	42.43	2.90	6.62	8.14	1.77	Moderate

Table notes:
M = Migratory SLC = Special Least Concern
# Criteria associated with the determination of magnitude are provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report

TABLE 11.28: ESTIMATION OF POTENTIAL MAGNITUDE OF DISTURBANCE FOR NC ACT THREATENED, NEAR-THREATENED AND SPECIAL LEAST CONCERN FLORA AND FAUNA SPECIES (EXCLUDING MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE) WITHIN THE ECOLOGY STUDY AREA

			Predicted habitat within the disturbance footprint (ha)* (972.49 ha)				Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance				Magnitude of total habitat disturbance area#
Species name	**Common name**	**NC Act status**	**Total habitat**	**General**	**Essential**	**Core**	**Total habitat**	**General**	**Essential**	**Core**	
NC Act conservation-significant flora											
Callitris baileyi	Bailey's Cypress Pine	NT	11.43	11.43	0.00	0.00	1.15	1.15	0.00	0.00	Low
Marsdenia coronata	Slender Milkvine	V	61.85	61.85	0.00	0.00	10.26	10.26	0.00	0.00	Moderate
Melaleuca irbyana	Swamp Tea-tree	E	237.73	132.42	45.69	59.63	7.30	5.77	14.33	9.28	Moderate
NC Act conservation-significant fauna											
Adelotus brevis	Tusked Frog	V	10.21	10.21	0.00	0.00	9.73	9.73	0.00	0.00	Moderate
Calyptorhynchus lathami	Glossy-black Cockatoo	V	50.63	49.96	0.68	0.00	6.27	6.35	3.28	0.00	Moderate
Ninox strenua	Powerful Owl	V	21.54	21.54	0.00	0.00	10.54	10.54	0.00	0.00	Moderate
NC Act special least concern animals											
Tachyglossus aculeatus	Short-beaked Echidna	SLC	67.64	67.64	0.00	0.00	3.15	3.15	0.00	0.00	Moderate

Table notes:
E = Endangered V = Vulnerable NT = Near threatened SLC = Special Least Concern - = Not listed
# Criteria associated with the determination of magnitude are provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report

TABLE 11.29: ESTIMATION OF POTENTIAL MAGNITUDE OF DISTURBANCE FOR EACH OF THE SENSITIVE ENVIRONMENTAL RECEPTORS (EXCLUDING THREATENED AND MIGRATORY SPECIES) IDENTIFIED FOR THE PROJECT

Sensitive environmental receptor(s)	Total coverage of sensitive environmental receptor within the ecology study area (ha) (12,442.24 ha)	Total unmitigated potential disturbance area associated within the Project (ha) (972.49 ha)	Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance	Magnitude of disturbance area#
Protected areas	98.86	0.36	0.36	Negligible
Regulated vegetation (VM Act)				
Endangered remnant vegetation (REs) (Category B)	154.94	10.56	6.82	Moderate
Of concern remnant vegetation (REs) (Category B)	725.78	9.02	1.24	Low
Least concern remnant vegetation (REs) (Category B)	874.60	13.97	1.60	Low
High value regrowth vegetation (HVR) (Category C)	1,779.10	118.00	6.63	Moderate
MSES wildlife habitat	1,381.79	88.97	6.44	Moderate
Essential habitat	1,259.38	25.89	2.05	Moderate
Nature Conservation (Koala) Conservation Plan 2017 mapping				
Koala Priority Areas	3,770.56	258.48	6.86	Moderate
Koala Habitat Areas	3,006.09	145.57	4.84	Moderate
Koala Habitat Restoration Areas	3,636.14	295.13	8.12	Moderate
Locally Refined Koala Habitat Areas	327.42	27.92	8.53	Moderate
Wetlands				
State significant wetlands (HES)	66.00	0.00	0.00	N/A
Least concern flora and fauna* (NC Act) and Priority Back on Track flora and fauna species				
Least concern flora and fauna	12,442.24	972.49	7.82	Moderate
Priority Back on Track species (not listed under the EPBC Act or NC Act)	12,442.24	972.49	7.82	Moderate
Biodiversity Planning Assessment (BPA)				
BPA habitat values for EVNT taxa (state)	1,110.92	116.92	10.52	Moderate
BPA habitat values for EVNT taxa (regional)	293.23	1.35	0.46	Negligible
Regional Terrestrial corridors	1,005.86	87.86	8.73	Moderate
State Riparian corridors	510.72	40.86	8.00	Moderate
State Terrestrial corridors	1,809.17	119.80	6.62	Moderate

Table notes:

* There is potential for each of the sensitive environmental receptor impacts to overlap spatially. As a result, addition of disturbance values presented in the above table would not represent a true reflection of the total disturbance footprint.

\# Criteria associated with the determination of magnitude are provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report

TABLE 11.30: CRITERIA FOR MAGNITUDE OF DISTURBANCE

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

11.9.2 Initial significance of potential impacts

Following an assessment of the sensitivity of sensitive environmental receptors, identification of the potential impacts to these sensitive environmental receptors and the magnitude of impact, an assessment into the impact of the Project on each sensitive environmental receptor was undertaken. The magnitude of impacts used in Table 11.31 (EPBC Act controlling provisions) and Table 11.32 (non-threatened EPBC Act listed migratory species and State-based sensitive environmental receptors), take into consideration those associated with direct impacts due to direct removal of habitat (refer Table 11.26 (EPBC Act controlling provisions of the project), Table 11.27 (non-threatened, migratory species listed under the EPBC Act), Table 11.28 (NC Act threatened, near-threatened and special least concern species) and Table 11.29 (other State-based sensitive environmental receptors)) and also considers those impacts associated with air quality (refer Chapter 12), surface water and hydrology (refer Chapter 13), groundwater (refer Chapter 14) and noise and vibration (refer Chapter 15).

The impact assessment of the Project on sensitive environmental receptors is provided in Table 11.31 (EPBC Act controlling provisions) and Table 11.32 (non-threatened EPBC Act listed migratory species and State based sensitive environmental receptors), presenting both initial impact significance (i.e. application of mitigation measures already incorporated into the design) of impact for each as well as the significance of impact following the application of project mitigation measures.

In addition to the mitigation measures presented in Section 11.8.1 and Table 11.25, rehabilitation works may also be an effective mitigation measure to minimise potential impacts over time. Given the uncertainty associated with timeframe for decommissioning, this phase has not been considered in this impact assessment.

Significance ratings of low, moderate, high and major may constitute a potential significant residual impact to an MNES (migratory species) or State-based prescribed environmental matters, and were subsequently re-assessed against the MNES significant impact guidelines (for species/communities listed under the EPBC Act, including migratory species) or MSES significant impact guidelines (for prescribed environmental matters) to confirm the initial impact assessment results (refer Section 11.10).

It should be noted that in Table 11.31 and Table 11.32, potential impacts are split into 'pre-construction and construction', 'commissioning and reinstatement' and 'operation'. However, mitigation measures are proposed as 'pre-construction', 'construction and commissioning', and 'operation', consistent with Chapter 23: Draft Outline Environmental Management Plan. For the purposes of the significance of impacts of this assessment, it is important to show the different magnitude and significance of these different stages.

TABLE 11.31: INITIAL ASSESSMENT OF SIGNIFICANCE OF IMPACTS OF THE PROJECT ON IDENTIFIED SENSITIVE ENVIRONMENTAL RECEPTORS (EPBC ACT CONTROLLING PROVISIONS)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
Swamp Tea-tree (*Melaleuca irbyana*) Forest of Southeast Queensland TEC							
High	Pre-construction and construction	Habitat loss from vegetation clearing/ removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora and fauna species from invasion of weed and pest species Edge effects Dust impacts Aquatic habitat degradation Erosion and sedimentation Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation	High	Major	▸ MNES (detailed design) ▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning). **TEC-specific:** Undertake a baseline assessment to determine the health and condition of the community to inform offsets and quantify impacts during construction and potentially during operation. Work with the design team to minimise the direct impact on Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland communities. This includes ensuring that communities (remnant and regrowth) identified within the construction disturbance footprint are avoided (e.g. Lots 3 and 4 on RP178669 contain approximately 7 ha of TEC, with these lots identified as a potential laydown area), siting access roads to avoid and minimise impacts in the Warrill Creek area and ensuring that changes to the predicted hydrology outcomes consider this TEC. Continue to refine the Project design in response to hydraulic modelling outcomes to demonstrate continued compliance with the design objectives of the Project including maintaining inundation regimes within the Swamp Tea-tree (Melaleuca irbyana) Forest of South East Queensland TEC as close to natural conditions as possible. The CEMP Biosecurity Management Plan will consider relevant guidelines to control potential deleterious pathogens including *Phytophthora cinnamomi* and Myrtle rust (*Austropuccinia psidii*) (DotE 2015c) associated with Project activities both of which may impact *Melaleuca* species.	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Pre-construction and construction (continued)		High	Major	The Air Quality Management Sub-plan (refer Chapter 12: Air Quality) will include measures to minimise dust impacts including dust monitoring and suppression methods. The Project design will continue to be refined in response to hydraulic modelling outcomes to demonstrate continued compliance with the design objectives of the Project including maintaining inundation regimes within the TEC as close to natural conditions as possible. Monitor Swamp Tea-tree TEC against relevant key performance criteria in the MNES Monitoring Plan. Potential criteria may include level of dieback and recruitment, dust deposition on leaves, changes to local hydrology through observations of soil moisture with these criteria to be determined in consultation with relevant specialist. Corrective actions are to be implemented if Project-associated impacts are identified.	Moderate	High
High	Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation	Low	Moderate	▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▸ Flora (detailed design, construction and commissioning). In accordance with the MNES Monitoring Plan, regular monitoring and maintenance of erosion and sediment devices/infrastructure will be undertaken with specific reference/controls to identified TEC areas. **TEC-specific:** Swamp Tea-tree (*Melaleuca irbyana)* TEC will be monitored against relevant key performance criteria in the MNES Monitoring Plan. Potential criteria may include level of dieback and recruitment, dust deposition on leaves, changes to the local hydrology through observations of soil moisture with these criteria to be determined in consultation with relevant specialist. Corrective actions to be implemented if Project-associated impacts are identified.	Negligible	Low
	Operation	Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation	Negligible	Low	Weeds and pests (operation).	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
A green algae *(Lychnothamnus barbatus)*							
High	Pre-construction and construction	Habitat loss from temporary waterway impoundment Displacement of flora species from invasion of weed and pest species Dust impacts Aquatic habitat degradation Erosion and sedimentation	High	Major	▸ MNES (detailed design) ▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning). **Species-specific:** Pre-construction surveys of waterways identified as potential habitat of species (e.g. Warrill Creek) will be undertaken to identify whether species occurs within the disturbance footprint. Where found, the area of threatened flora species to be removed should be quantified to enable the Environmental Offsets Delivery Strategy—Qld to be refined Undertake an aquatic and riparian weed assessment of Warrill Creek. The Air Quality Sub-plan (refer Chapter 12: Air Quality) will include measures to minimise dust impacts including dust monitoring and suppression methods. The Surface Water Sub-plan (refer Chapter 13: Surface Water and Hydrology) will be implemented prior to construction.	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Commissioning and reinstatement	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation	Low	Moderate	▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning). Regular monitoring and maintenance of erosion and sediment devices/infrastructure will be undertaken in accordance with the MNES Monitoring Plan, with specific reference/controls to identified MNES areas. **Species-specific:** Previously identified *Lychnothamnus barbatus* habitat will be monitored in accordance with the MNES Monitoring Plan. Corrective actions will be implemented where Project-associated impacts are identified.	Negligible	Low
	Operation	Erosion and sedimentation	Low	Moderate	Weeds and pests (operation).	Negligible	Low
Hairy-joint Grass (*Arthraxon hispidus*) and Lloyd's Olive (*Notelaea lloydii*)							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation	High	Major	▸ MNES (detailed design) ▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning). **Species-specific:** Pre-construction protected flora surveys as per DES guidelines (2020g) to place particular focus within the Teviot Range identified as habitat for Lloyd's Olive (refer species habitat mapping in Appendix K: Matters of National Environmental Significance Technical Report). This includes assessing the condition and health of the population above the tunnel prior to construction and monitoring the population during construction to determine if any changes to the population occur as a result of the Project or due to natural attrition. Potential criteria may include recruitment and presence of fertile material, plus signs of water stress.	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Pre-construction and construction (continued)	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation (continued)	High	Major	Avoid works above the tunnel as this area is known to support an important population of Lloyd's Olive. Where a new population is detected and impacts from the Project are likely, specific measures will be developed in consultation with relevant specialists, the Project team and the construction team. Air Quality Sub-plan (refer Chapter 12: Air Quality) will include measures to minimise dust impacts including dust monitoring and suppression methods.	Moderate	High
High	Commissioning and reinstatement	Displacement of flora species from invasion of weed species Edge effects Erosion and sedimentation	Negligible	Low	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning). In accordance with the MNES Monitoring Plan, undertake regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas. **Species-specific:** Weed monitoring within identified Hairy-joint Grass (*Arthraxon hispidus*) and Lloyd's Olive (*Notelaea lloydii*) habitat in accordance with the MNES Monitoring Plan, with required control protocols in place where weed invasion is identified. Annual monitoring of previously identified Hairy-joint Grass (*Arthraxon hispidus*) and Lloyd's Olive (*Notelaea lloydii*) habitat in accordance with the MNES Monitoring Plan. Corrective actions to be implemented where Project-associated impacts are identified. Ongoing monitoring of the population of Lloyd's Olive in accordance with the MNES Monitoring Plan. Corrective actions to be implemented where Project-associated impacts are identified.	Negligible	Low
	Operation	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation	Negligible	Low	Weeds and pests (operation)	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
Miniature Moss-orchid (*Bulbophyllum globuliforme*), Boonah Tuckeroo (*Cupaniopsis tomentella*) and Shiny-leaved Condoo (*Planchonella eerwah*)							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning). **Species-specific:** Pre-construction protected flora surveys as per DES guidelines (2020g) targeting the relic rainforest and other potential habitat within and adjacent the Project footprint. These surveys should include areas of Woollaman Creek and dense vegetation within the gullies of Teviot (refer species habitat mapping in Appendix K: Matters of National Environmental Significance Technical Report). Where a species is detected, specific measures will be developed in consultation with relevant specialists, the Project team and the construction team (e.g. micrositing to avoid population or minimise impacts, ensuring ancillary works avoid these areas, collection of seed and other fertile material). The Air Quality Sub-plan (refer Chapter 12: Air Quality) will include measures to minimise dust impacts including dust monitoring and suppression methods.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Commissioning and reinstatement	Displacement of flora species from invasion of weed species Edge effects Erosion and sedimentation	Negligible	Low	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning). In accordance with the MNES monitoring plan, undertake regular monitoring and maintenance of erosion and sediment devices/ infrastructure to identified threatened flora habitat areas. **Species-specific:** Weed monitoring within identified Miniature Moss-orchid (*Bulbophyllum globuliforme*), Boonah Tuckeroo (*Cupaniopsis tomentella*) and Shiny-leaved Condoo (*Planchonella eerwah*) habitat in accordance with the MNES monitoring plan with required control protocols in place where weed invasion is identified. Annual monitoring of previously identified Miniature Moss-orchid (*Bulbophyllum globuliforme*), Boonah Tuckeroo (*Cupaniopsis tomentella*) and Shiny-leaved Condoo (*Planchonella eerwah*) habitat in accordance with the MNES monitoring plan. Corrective actions to be implemented where Project-associated impacts are identified.	Negligible	Low
	Operation	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation	Negligible	Low	Weeds and pests (operation).	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
Australian Lungfish							
High	Pre-construction and construction	Habitat loss from temporary waterway impoundment Displacement of fauna species from invasion of weed and pest species Barrier effects Dust impacts Aquatic habitat degradation Erosion and sedimentation	High	Major	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Aquatic fauna (detailed design, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning). **Species-specific:** Pre-construction surveys of waterways identified as potential habitat of species (e.g. Bremer River) to identify whether Australian Lungfish occurs. Surveys will follow the *Survey guidelines for Australia's threatened fish* (DSEWPaC, 2011c). Avoid clearing within and along watercourses, in particular Bremer River and Teviot Brook, through the use of bridge structures and the placement of pylons away from beds and banks. Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, an appropriately qualified person will be consulted to make an assessment on the method of recovery, transport and release of fish and will follow relevant State agency (DAF) fish salvage guidelines during construction activities. Dewatering and fish salvage activities to include measures to manage the risk of translocating non-endemic flora and fauna (i.e. Biosecurity Management Plan). Maintain low flows during drought conditions and avoid fluctuations to water levels downstream during spawning period (i.e. Bremer River). Develop Air Quality Sub-plan (refer Chapter 12: Air Quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods.	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Pre-construction and construction (continued)	Habitat loss from temporary waterway impoundment Displacement of fauna species from invasion of weed and pest species Barrier effects Dust impacts Aquatic habitat degradation Erosion and sedimentation (continued)	High	Major	Although final Project design changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the Australian Lungfish. Surface Water Sub-plan developed and in place prior to construction. The Sub-plan will be developed to include measures to maintain low flows during drought conditions and avoid fluctuations to water levels downstream during spawning period (i.e. Bremer River). To include at a minimum: ▸ Watercourse-specific water quality criteria based on baseline data ▸ A surface water quality sampling monitoring detailing water quality parameters and schedule ▸ Response framework where water quality impacts identified from Project activities.	Moderate	High
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Aquatic habitat degradation Erosion and sedimentation	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning) ▸ Aquatic fauna (detailed design, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning). **Species-specific:** Where possible, in-stream habitat will be reinstated to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and allow fish passage). Surface Water Sub-plan monitoring and evaluation ongoing. Continued aquatic weed monitoring within waterways with required control protocols in place where weed invasion is identified.	Negligible	Low
	Operation	Erosion and sedimentation	Negligible	Low	▸ Weeds and pests (operation) ▸ Fauna passage (operation) including ongoing maintenance of fish passage structures ▸ Riparian vegetation and aquatic habitats (operation)	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
Wetland birds: Australian Painted Snipe, Australasian Bittern and Curlew Sandpiper							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation	Moderate	High	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Fauna fencing (detailed design, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Aquatic fauna (detailed design, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning). **Species-specific:** Flora and Fauna Sub-plan to include pre-construction surveys of wetlands identified as potential habitat of species to identify whether habitat and/or any of these species occurs. Surveys will follow the *Survey guidelines for Australia's threatened birds* (DEWHA, 2010). Restricted works/avoidance measures in place should nesting of Australian Painted Snipe (*Rostratula australis*) or Australasian Bittern (*Botaurus poiciloptilus*) be detected. Though final Project design changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the Australian Painted Snipe (*Rostratula australis*), Curlew Sandpiper (*Calidris ferruginea*) and Australasian Bittern (*Botaurus poiciloptilus*). A Surface Water Sub-plan will be developed and in place prior to construction, including as a minimum: ▸ Wetland and watercourse-specific water quality criteria based on baseline data ▸ A surface water quality sampling monitoring detailing water quality parameters and schedule ▸ Response framework where water quality impacts identified from Project activities. Project lighting is constructed in accordance with Project design.	Low	Moderate

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Pre-construction and construction (continued)	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation (continued)	Moderate	High	Clearing/construction works in potential habitat areas will be timed where possible to avoid wet conditions where habitat is likely to be most suitable. The Project CEMP will include measures to minimise noise as much as feasible and the Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. The CEMP Biosecurity Management Plan will include site hygiene and waste management measures to ensure pest- predator fauna are not attracted to works areas or using disturbance footprint. Should the species be found to occur, the Plan is to include the following for further pre-clearance activities: ▸ Engagement of a qualified fauna spotter/ecologist for further pre-clearance surveys and measures to ensure safe movement of species away from works area should the species still be found to occur ▸ Restricted works/avoidance measures in place should nesting of Australian Painted Snipe (*Rostratula australis*) or Australasian Bittern (*Botaurus poiciloptilus*) be detected.	Low	Moderate
High	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Aquatic fauna (detailed design, construction and commissioning) ▸ Erosion and sediment control (pre-construction, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning). **Species-specific:** Continued aquatic/wetland weed monitoring will be undertaken within waterways with required control protocols in place where weed invasion is identified. Continued monitoring will be undertaken in accordance with the Biosecurity Management Plan to ensure pest predator fauna are not using Project infrastructure for shelter. The Noise and Air Quality Sub-plan measures will continue to be implemented.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Commissioning and reinstatement (continued)	Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation (continued)	Low	Moderate	Project lighting will be constructed and operated in accordance with the Project design. Temporary construction areas will be rehabilitated, including riparian habitat, in accordance with the Reinstatement and Rehabilitation Plan. Continue the implementation of the Surface Water Sub-plan. Undertake ongoing annual weed monitoring within wetland habitat in vicinity in accordance with the MNES Monitoring Plan, with required control protocols in place where weed invasion is identified. Undertake regular monitoring and maintenance of erosion and sediment devices/infrastructure associated with all waterways, in accordance with the MNES Monitoring Plan.	Negligible	Low
High	Operation	Displacement of fauna species from invasion of weed and pest species Light impacts Erosion and sedimentation	Negligible	Low	Weeds and pests (operation) **Species-specific:** Project lighting operated in accordance with the Project design.	Negligible	Low
Koala and Greater Glider							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	High	Major	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning) (refer Figure 11.14). ▸ Fauna fencing (detailed design, construction and commissioning). **Species-specific:** Pre-construction surveys of woodlands identified as potential habitat of species to identify whether individuals occur within disturbance footprint. Measures to ensure safe retrieval of tree hollows during vegetation clearing and allow safe movement of species away from works area. Vegetation clearing within the disturbance footprint in Koala habitat will be carried out in a manner to minimise stress on potential individuals as much as is practicably possible (e.g. sequential clearing and minimising time of disturbance to animals).	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Pre-construction and construction (continued)	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts (continued)	High	Major	Measures to allow safe handling of fauna (where required) and repatriation in suitable habitat away from site. Koalas subject to handling will be examined and if suspected of chlamydia infection will be taken to a predesignated veterinarian/ wildlife care facility for treatment prior to release. A procedure will be developed to guide Koala interactions, including any translocations. Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. The Biosecurity Management Plan will consider relevant guidelines to control potential deleterious pathogens including *Phytophthora cinnamomi* and Myrtle rust (*Austropuccinia psidii)* (e.g. DotE, 2015c) associated with Project activities, both of which may impact eucalypt species. Fauna fencing in accordance with ARTC guidelines and DTMR's *Fauna Sensitive Road Design Manual* (DTMR, 2000; DTMR, 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Also, where possible, avoid the use of barbed wire, particularly on the top strand, to prevent threatened species (such as Greater Gliders, flying-foxes and microbats) from becoming entangled. Fauna-friendly fencing must be used, while being in accordance with landowner and/or structural requirements. Bridge structures will assist in the retention of corridors of at least 100 m width, while the tunnel will ensure a corridor over 1 km wide is maintained through the Teviot Range. The Project CEMP will include measures to minimise noise as much as feasible and the Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. The Project design will incorporate minimum lighting requirements feasible for Project safety. Project lighting will be constructed in accordance with Project lighting design.	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning). **Species-specific:** Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. The Project CEMP will include fauna management and incident register. Fauna crossing structures and fencing will be in place and completed. The Noise and Air Quality Sub-plan measures will continue to be implemented. Project lighting will be constructed operated in accordance with the Project design. Temporary construction areas where woodland habitat has been cleared will be rehabilitated in accordance with the Reinstatement and Rehabilitation Plan. Fauna crossing structures and fencing will be in place and the effectiveness of structures for fauna passage will be monitored in accordance with the post-construction MNES Monitoring Plan.	Negligible	Low
High	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Negligible	Low	▸ Fauna fencing (operation) ▸ Fauna passage (operation) ▸ Weeds and pests (operation). **Species-specific:** The fauna management and incident register will include observed collisions associated with rail operations. Information on collisions will be used to inform the potential for additional measures to be applied to minimise/eliminate incidents. Fauna fencing (operation) including ongoing maintenance of fauna passages and fencing during the operational life of the Project. Record vehicle strikes with Koalas and Greater Gliders and investigate potential source of the issue and, where applicable, implement corrective measures (e.g. erect fauna- friendly fencing, glider poles etc.). Project lighting will be operated in accordance with the Project design.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
New Holland Mouse							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species	Moderate	High	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Fauna fencing (detailed design, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning).	Low	Moderate
		Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Moderate	High	**Species-specific:** Pre-construction survey of species-specific habitat and habitat features considered suitable for species presence (e.g. well-developed ground/shrub layer). Within the disturbance footprint, the Teviot Range may provide habitat for the New Holland Mouse (*Pseudomys novaehollandiae*). Targeted surveys will be undertaken as per relevant QLD guidelines (Eyre et al., 2018) where suitable habitat is identified (note the New Holland Mouse (*Pseudomys novaehollandiae*) is not included in MNES guidelines). Pre-construction weed and *Phytophthora cinnamomi* assessment of potential habitat of New Holland Mouse (*Pseudomys novaehollandiae*) will be undertaken. Project design will incorporate fauna crossing structures to allow fauna movement across alignment. Fauna passage and fauna-proof fencing design will be used to guide fauna to crossing structures.	Low	Moderate
			Moderate	High	Fauna crossings will be consistent with the intent of DTMR's *Fauna-Sensitive Road Design Manual* (DTMR, 2000; DTMR, 2010) and, where applicable, species-specific requirements. Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. The Project CEMP will include measures to minimise noise as much as feasible and the Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. The Project design will incorporate minimum lighting requirements feasible for Project safety. Project lighting will be constructed in accordance with the Project design.	Low	Moderate

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning) ▸ Fauna fencing (detailed design, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning). **Species-specific:** Measures will be implemented to control vehicle speed limits onsite to no more than 40 km/hr. Continued weed and *Phytophthora cinnamomi* monitoring will be undertaken with required control protocols in place where weed invasion is identified. Fauna crossing structures and fencing in place and completed. Noise and Air Quality Sub-plan measures ongoing. Project lighting constructed and operated in accordance with Project design. Rehabilitation of temporary construction areas where woodland habitat has been cleared in accordance with the Reinstatement and Rehabilitation Plan. Revegetation species to be obtained from source certified free of *Phytophthora cinnamomi.* Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out in accordance with the post-construction MNES Monitoring Plan.	Negligible	Low
High	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Low	Moderate	▸ Fauna fencing (operation) ▸ Weeds and pests (operation). **Species-specific** Project lighting operated in accordance with Project design.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
Spotted-tail Quoll, Brush-tailed Rock-wallaby, Collared Delma and Large-eared Pied Bat							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	High	Major	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning) ▸ Fauna fencing (detailed design, construction and commissioning). **Species-specific:** Targeted surveys for identified mammal species will follow the *Survey guidelines for Australia's threatened mammals* (DSEWPaC, 2011b) and include the identification of species-specific habitat (refer species habitat mapping in Appendix K: Matters of National Environmental Significance Technical Report) and habitat features considered suitable for species presence (e.g. cliff faces/boulder piles for Brush-tailed Rock-wallabies, Large-eared Pied bat and Spotted-tailed Quoll). Targeted surveys for the Collared Delma as per *Survey guidelines for Australia's threatened reptiles* (DSEWPaC, 2011d) where suitable habitat is identified. Measures will be put in place to ensure retrieval of potential habitat elements (e.g. loose surface rock, large fallen timber) during vegetation clearing and placement in adjacent unimpacted habitat. Restricted works measures will be in place if larger species (Spotted-tailed Quoll and Brush-tailed Rock-wallaby) are observed within or adjacent to the disturbance footprint to allow safe movement away from works area. Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. Project design will incorporate fauna crossing structures to allow fauna movement across alignment. Fauna passage and fauna fencing design will be used to guide fauna to crossing structures. Fauna crossings will be consistent with the intent of DTMR's *Fauna-Sensitive Road Design Manual* (DTMR, 2000; DTMR, 2010) and where applicable species-specific requirements. Fencing extent will be determined by the availability of suitable habitat adjacent to alignment.	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Pre-construction and construction (continued)	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts (continued)	High	Major	As part of the MNES Monitoring Plan, establish camera traps above the tunnel areas to monitor fauna movement across this area during construction. The Project CEMP to include measures to minimise noise as much as feasible and Air Quality Sub-plan to include measures to minimise dust impacts including dust monitoring and suppression methods. Project design to incorporate minimum lighting requirements feasible for Project safety. Project lighting constructed in accordance with Project design.	Moderate	High
High	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning) ▸ Fauna fencing (detailed design, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning). **Species-specific:** Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. Fauna crossing structures and fencing in place and completed. Noise and Air Quality Sub-plan measures ongoing. Project lighting constructed and operated in accordance with Project design. Rehabilitation of temporary construction areas where woodland habitat has been cleared in accordance with the Reinstatement and Rehabilitation Plan. Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out in accordance with the post-construction MNES Monitoring Plan.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Low	Moderate	▸ Fauna fencing (operation) ▸ Weeds and pests (operation). **Species-specific:** Project lighting operated in accordance with Project design.	Negligible	Low
Grey-headed Flying-fox							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Noise, dust, and light impacts Aquatic habitat degradation	High	Major	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning). **Species-specific:** Pre-construction surveys to be undertaken of riparian habitat identified as potential roost sites of species to identify whether camps occur within or near the disturbance footprint. It is noted no roost sites have been previously identified within 5 km of the Project. Where possible, reduce the disturbance footprint in winter foraging, including avoiding clearing for ancillary works. Incorporate winter foraging species into the rehabilitation/ revegetation plans for the Project. Work with the design team and property team to incorporate fencing that minimises the risk of entanglement (e.g. barbed wire fencing with a high tensile wire strand as the top wire). Should a roost site be found, management actions will incorporate the mitigation standards detailed in *Referral guideline for management actions in Grey-headed and Spectacled Flying-fox camps* (DotE, 2015b). The Project CEMP will include measures to minimise noise as much as feasible and Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. Project design will incorporate minimum lighting requirements feasible for Project safety. Project lighting will be constructed in accordance with Project design.	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Commissioning and reinstatement	Noise, dust, and light impacts Aquatic habitat degradation	Negligible	Low	▸ Riparian vegetation and aquatic habitats (operation). **Species-specific:** Project lighting will be constructed and operated in accordance with Project design. Noise and Air Quality Sub-plan measures will be ongoing.	Negligible	Low
	Operation	Light impacts	Negligible	Low	**Species-specific:** Project lighting operated in accordance with Project design.	Negligible	Low
Woodland birds: Swift Parrot, Painted Honeyeater, Regent Honeyeater and Red Goshawk							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation	High	Major	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning). **Species-specific:** Where possible through design, reduce the disturbance footprint in winter foraging habitat, including avoiding clearing for ancillary works. The Project CEMP will include measures to minimise noise as much as feasible and Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. Surface Water Sub-plan will be in place prior to construction, it will include at a minimum: ▸ Wetland- and watercourse-specific water quality criteria based on baseline data ▸ A surface water quality sampling monitoring, detailing water quality parameters and schedule ▸ Response framework where water quality impacts from Project activities are identified. Project design will incorporate the minimum lighting requirements feasible for Project safety. Project lighting will be constructed in accordance with Project design. Three of these species—Swift Parrot, Painted Honeyeater and Regent Honeyeater—are generalist nectivores that are nomadic, following flowering events. None of these species nest in the area. The Red Goshawk (*Erythrotriorchis radiatus*) requires large areas of woodland habitat and is only likely to occur in the Teviot Range. Incorporate winter foraging species into the rehabilitation/ revegetation plans for the Project.	Moderate	High

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 11.8.1		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase' and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures[3]	
			Magnitude[1]	Significance		Magnitude[1]	Significance
High	Pre-construction and construction (continued)	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation (continued)	High	Major	The Flora and Fauna Sub-plan will detail pre-construction surveys of woodlands identified as potential habitat for the Red Goshawk (*Erythrotriorchis radiatus*) to identify whether individuals occur and potentially nest within the disturbance footprint. Surveys for nest sites within or near the disturbance footprint will be as per MNES guidelines where suitable nesting habitat (i.e. large emergent trees near water) is identified. If an active Red Goshawk (*Erythrotriorchis radiatus*) nest site is identified, the Plan will incorporate restricted works measures during construction to allow nesting to continue undisturbed as determined by pre-clearance surveys (e.g. micrositing of works to avoid nests or maximise separation distance, 100 m buffer and signage around nests, no disturbance to nests until after breeding season (being until fledglings/offspring no longer use the nest/ roost for habitat. Some limited works may occur in the buffer zone during this period (e.g. cultural heritage surveys).	Moderate	High
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▸ Weeds and pests (pre-construction, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning). **Species-specific:** Noise and Air Quality Sub-plan measures will be ongoing. Temporary construction areas where woodland habitat has been cleared will be rehabilitated. Project lighting to be constructed and operated in accordance with Project design. Surface Water Sub-plan monitoring and evaluation ongoing. Continued monitoring to ensure pest predator fauna are not using Project infrastructure for shelter.	Negligible	Low
High	Operation	Displacement of fauna species from invasion of weed and pest species Noise and light impacts	Negligible	Low	▸ Weeds and pests (operation). **Species-specific:** Project lighting operated in accordance with Project design. Continued opportunistic monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter.	Negligible	Low

Table notes:

1. Refer Appendix K: Matters of National Environmental Significance Technical Report for the assessment methodology for 'sensitivity' and 'magnitude' criteria.
2. Potential impacts to terrestrial and aquatic ecology receptors in the above table are based on those presented in Section 11.7.2.
3. The use of offsets has not been considered as a mitigation measure for the purposes of project mitigation for the assessment of potential impacts. Refer Appendix K: Matters of National Environmental Significance Technical Report for information related to the use of offset to compensate Project-related impact that are not sufficiently reduced in the above table.

TABLE 11.32: INITIAL ASSESSMENT OF SIGNIFICANCE OF IMPACTS OF THE PROJECT ON IDENTIFIED SENSITIVE ENVIRONMENTAL RECEPTORS (NON-THREATENED MIGRATORY SPECIES AND STATE BASED SENSITIVE ENVIRONMENTAL RECEPTORS)

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
Commonwealth receptors (EPBC Act listed migratory species)								
Commonwealth Significant Ecological Constraint (Species listed as migratory under the EPBC Act): ▸ Osprey (*Pandion haliaetus*) ▸ Oriental Cuckoo (*Cuculus optatus*) ▸ Satin Flycatcher (*Myiagra cyanoleuca*) ▸ Rufous Fantail (*Rhipidura rufifrons*) ▸ Black-faced Monarch (*Monarcha melanopsis*) ▸ Spectacled Monarch (*Symposiachrus trivirgatus*) ▸ Yellow Wagtail (*Motacilla flava*) ▸ Common Sandpiper (*Actitis hypoleucos*) ▸ Sharp-tailed Sandpiper (*Calidris acuminata*) ▸ Latham's Snipe (*Gallinago hardwickii*) ▸ Glossy Ibis (*Plegadis falcinellus*)	High	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Fauna species injury or mortality ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Noise, dust, and light impacts ▸ Increase in litter (waste) ▸ Aquatic habitat degradation	High	Major	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Moderate	High (refer Appendix J for assessment against MNES Significant impact guidelines for migratory species)
	High	Commissioning and reinstatement	▸ Fauna species injury or mortality ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts ▸ Aquatic habitat degradation	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	High	Operation	▸ Fauna species injury or mortality ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts ▸ Aquatic habitat degradation	Low	Moderate	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State receptors								
State Significant Ecological Constraint (VM Act): ▸ Endangered remnant vegetation (REs) (Category B)	High	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste)	High	Major	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Moderate	High
	High	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	High	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State Significant Ecological Constraint (VM Act): ▸ Of concern remnant vegetation (REs) (Category B)	Moderate	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste)	Moderate	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning)	Low	Low
	Moderate	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	Moderate	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State significant ecological constraint (VM Act): ▸ Least concern remnant vegetation (REs) (Category B)	Low	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste)	Moderate	Low	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning)	Low	Negligible
	Low	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Moderate	Low	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Negligible
	Low	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Moderate	Low	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	Negligible

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State Significant Ecological Constraint (VM Act): ▸ High value regrowth vegetation (Category C)	Moderate	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste) ▸ Aquatic habitat degradation	High	High	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning)	Moderate	Moderate
	Moderate	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Moderate	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Low	Low
	Moderate	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Moderate	Moderate	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Low	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State significant ecological constraint (VM Act): ▸ MSES wildlife habitat ▸ Essential habitat	High	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste)	Moderate	High	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Fauna passage (detailed design, construction and commissioning)	Low	Moderate
	High	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	High	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations) ▸ Fauna fencing (operations)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
Nature Conservation (Koala) Conservation Plan 2017 mapping, including: ▸ Koala Priority Areas ▸ Koala Habitat Areas ▸ Koala Habitat Restoration Areas ▸ Locally Refined Koala Habitat Areas	High	Construction	▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Barrier effects ▸ Noise, dust, and light impacts	Moderate	High	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Fauna passage (detailed design and construction and commissioning)	Low	Moderate
	High	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	High	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts	Low	Moderate	▸ Weeds and pests (operations)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State Significant Ecological Constraint (species listed as threatened under the NC Act): **Flora:** ▸ Bailey's Cypress Pine (*Callitris baileyi*)	High	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Barrier effects ▸ Noise, dust, and light impacts	Moderate	High	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning)	Low	Moderate
	High	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	High	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts	Low	Moderate	▸ Weeds and pests (operations)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State Significant Ecological Constraint (species listed as threatened under the NC Act): **Flora:** ▸ Slender Milkvine (*Marsdenia coronata*) ▸ Swamp Tea-tree (*Melaleuca irbyana*) **Fauna:** ▸ Tusked Frog (*Adelotus brevis*) ▸ Powerful Owl (*Ninox strenua*) ▸ Glossy-black Cockatoo (*Calyptorhynchus lathami*)	High	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Fauna species injury or mortality ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Noise, dust, and light impacts ▸ Increase in litter (waste) ▸ Aquatic habitat degradation	High	Major	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning)	Moderate	High
	High	Commissioning and reinstatement	▸ Fauna species injury or mortality ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	High	Operation	▸ Fauna species injury or mortality ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts ▸ Aquatic habitat degradation	Low	Moderate	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operation)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State significant ecological constraint (Special Least concern fauna species): ▸ Short-beaked Echidna (*Tachyglossus aculeatus*)	Moderate	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Fauna species injury or mortality ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Noise, dust, and light impacts ▸ Increase in litter (waste) ▸ Aquatic habitat degradation	High	High	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Fauna passage (detailed design and construction and commissioning) ▸ Fauna fencing (detailed design and construction and commissioning)	Moderate	Moderate
	Moderate	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	Moderate	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts	Low	Low	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State significant ecological constraint: ▸ Priority Back on Track flora and fauna species (that are not listed under as threatened under the provisions of the EPBC Act or NC Act)	Low	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Fauna species injury or mortality ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Noise, dust, and light impacts ▸ Increase in litter (waste) ▸ Aquatic habitat degradation	High	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Aquatic fauna (detailed design and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Fauna passage (detailed design and construction and commissioning) ▸ Fauna fencing (detailed design and construction and commissioning)	Moderate	Low
	Low	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Negligible	Negligible	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Negligible
	Low	Operation	▸ Fauna species injury or mortality ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts ▸ Aquatic habitat degradation	Moderate	Low	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	Negligible

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State significant ecological constraint: ▸ Flora and fauna species not listed under the EPBC Act but listed as Least concern under the provisions of the NC Act and flora that is listed as special least concern under the provisions of the NC Act	Low	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Fauna species injury or mortality ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Noise, dust, and light impacts ▸ Increase in litter (waste) ▸ Aquatic habitat degradation.	High	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction and construction and commissioning) ▸ Aquatic fauna (design and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Fauna passage (detailed design and construction and commissioning) ▸ Fauna fencing (detailed design and construction and commissioning)	Moderate	Low
	Low	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Negligible	Negligible	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Flora (detailed design, construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Negligible
	Low	Operation	▸ Fauna species injury or mortality ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts ▸ Aquatic habitat degradation	Moderate	Low	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	Negligible

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State significant ecological constraint (BPA): ▸ BPA habitat values for endangered, vulnerable and near threatened taxa	High	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste) ▸ Aquatic habitat degradation	High	Major	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Fauna passage (detailed design and construction and commissioning) ▸ Fauna fencing (detailed design and construction and commissioning)	Moderate	High
	High	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	High	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State significant ecological constraint (BPA): ▸ BPA habitat values for Endangered, Vulnerable and Near Threatened taxa (regional)	Moderate	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste)	Moderate	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Fauna passage (detailed design and construction and commissioning) ▸ Fauna fencing (detailed design and construction and commissioning)	Low	Low
	Moderate	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	Moderate	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State significant ecological constraint (BPA): ▸ State significant corridors	High	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste) ▸ Aquatic habitat degradation	High	Major	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Riparian vegetation and aquatic habitats (detailed design, pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Fauna passage (detailed design and construction and commissioning) ▸ Fauna fencing (detailed design and construction and commissioning)	Moderate	High
	High	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	High	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	Low

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial significance (application of initial mitigation measures presented in Section 11.8.1)		Application of proposed mitigation measures presented in Table 11.25, by 'Environmental value impacted' and 'Delivery phase'	Residual significance following the application of Project mitigation measures presented in Table 11.25[3]	
				Magnitude[1]	Significance		Magnitude	Significance
State Significant Ecological Constraint (BPA): ▸ Regional significant corridors	Moderate	Construction	▸ Habitat loss from vegetation clearing/removal ▸ Reduction in biological viability of soil to support plant growth due to soil compaction ▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Increase in litter (waste)	Low	Low	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Fauna passage (detailed design and construction and commissioning) ▸ Fauna fencing (detailed design and construction and commissioning)	Negligible	Low
	Moderate	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	▸ Flora and fauna (detailed design, pre-construction and construction and commissioning) ▸ Weeds and pests (pre-construction and construction and commissioning) ▸ Erosion and sediment control (pre-construction and construction and commissioning) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction and commissioning)	Negligible	Low
	Moderate	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species	Low	Low	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	Low

Table notes:

1. Refer Appendix J: Terrestrial and Aquatic Ecology Technical Report for the assessment methodology for 'sensitivity' and 'magnitude' criteria.
2. Potential impacts to terrestrial and aquatic ecology receptors in the above table are based on those presented in Section 11.7.2.
3. The use of offsets has not been considered as a mitigation measure for the purposes of project mitigation for the assessment of potential impacts. Refer Section 11.11 and Appendix J: Terrestrial and Aquatic Ecology Technical Report for information related to the use of offset to compensate Project-related impacts that are not sufficiently reduced in this table.

11.10 Significant residual impact assessment

11.10.1 Significant residual impact assessment for matters of national environmental significance (threatened species and communities)

This section assesses the potential for significant residual impacts from the Project on the EPBC Act controlling provisions, using the relevant criteria outlined in the *Matters of National Environmental Significance: Significant impact guidelines 1.1—Environmental Protection and Biodiversity Conservation Act 1999* (DotE, 2013) and the EPBC Act *Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)* (DotE, 2014). Within the guidelines, there are specific criteria depending on if the species or community is listed as critically endangered or endangered or vulnerable. Full assessment in accordance with the guidelines is provided in Appendix K: Matters of National Environmental Significance Technical Report. A summary of the outcomes of this assessment is provide in Table 11.33.

TABLE 11.33: SUMMARY OF THE RESULTS OF THE SIGNIFICANT IMPACT ASSESSMENT THE EPBC ACT CONTROLLING PROVISIONS OF THE PROJECT

MNES species/community	EPBC Act status*	Results of assessment
TECs		
Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC	CE	Project is likely to cause 'significant residual impacts' on this TEC
Flora		
A Green algae *(Lychnothamnus barbatus)*	E	No significant residual impact expected
Shiny-leaved condoo (*Planchonella eerwah*)^	E	No significant residual impact expected
Hairy-joint Grass (*Arthraxon hispidus*)^	V	No significant residual impact expected
Miniature Moss-orchid (*Bulbophyllum globuliforme*)^	V	No significant residual impact expected
Boonah Tuckeroo (*Cupaniopsis tomentella*)^	V	No significant residual impact expected
Lloyd's Olive (*Notelaea lloydii*)^	V	Project is likely to cause 'significant residual impacts' on an important population of Lloyd's Olive
Fauna		
Regent Honeyeater (*Anthochaera phrygia*)^	E	No significant residual impact
Australasian Bittern (*Botaurus poiciloptilus*)^	E	No significant residual impact
Curlew Sandpiper (*Calidris ferruginea*)^	CE	No significant residual impact
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)^	E	Possible that the Project will have a significant impact
Swift Parrot (*Lathamus discolor*)^	CE	Possible that the Project will have a significant impact
Australian Painted Snipe (*Rostratula australis*)^	E	Possible that the Project will have a significant impact
Large-eared Pied Bat (*Chalinolobus dwyeri*) ^	V	No significant residual impact expected
Collared Delma (*Delma torquata*) ^	V	Significant residual impact likely
Red Goshawk (*Erythrotriorchis radiatus*)^	V	Possible that the Project will have a significant impact
Painted Honeyeater (*Grantiella picta*) ^	V	No significant residual impact expected
Australian Lungfish (*Neoceratodus forsteri*)	V	No significant residual impact expected
Greater Glider (*Petauroides volans volans*) ^	V	No significant residual impact expected
Brush-tailed Rock-wallaby (*Petrogale penicillata*)^	V	Possible that the Project will have a significant impact
Koala (*Phascolarctos cinereus*)^	V	Significant residual impact likely
Long-nosed Potoroo (*Potorous tridactylus tridactylus*)^	V	No significant residual impact expected
New Holland Mouse (*Pseudomys novaehollandiae*)^	V	No significant residual impact expected
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	Possible that the Project will have a significant impact

Table notes:
* CE = Critically endangered, E = Endangered, V = Vulnerable;
^ - Matters of state environmental significance (i.e. listed as threatened under the NC Act)

11.10.2 Significant residual impact assessment for matters of national environmental significance (non-threatened migratory species)

This section assesses the potential for significant residual impacts from the Project on the EPBC Act controlling provisions of the Project, using the relevant criteria outlined in the *Matters of National Environmental Significance: Significant impact guidelines 1.1—Environmental Protection and Biodiversity Conservation Act 1999* and the *Draft referral guidelines for 14 birds listed as migratory species under the EPBC Act* (DotE, 2015). Full assessment in accordance with the guidelines is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report. A summary of the outcomes of this assessment is provide in Table 11.34.

TABLE 11.34: SUMMARY OF THE RESULTS OF THE SIGNIFICANT IMPACT ASSESSMENT FOR MIGRATORY SPECIES

Migratory species	EPBC Act status	NC Act status	Results of assessment
Marine migrants			
Common Sandpiper (*Actitis hypoleucos*)	M	SLC	No significant impact likely
Sharp-tailed Sandpiper (*Calidris acuminata*)	M	SLC	No significant impact likely
Latham's Snipe (*Gallinago hardwickii*)	M	SLC	No significant impact likely
Woodland migrants			
Rufous Fantail (Rhipidura rufifrons)	M	SLC	No significant impact likely
Oriental Cuckoo (Cuculus optatus)	M	SLC	No significant impact likely
Spectacled Monarch (Symposiachrus trivirgatus)	M	SLC	No significant impact likely
Black-faced Monarch (Monarcha Melanopsis)	M	SLC	No significant impact likely
Satin Flycatcher (Myiagra Cyanoleuca)	M	SLC	No significant impact likely
Wetland migrants			
Yellow Wagtail (*Motacilla flava*)	M	SLC	No significant impact likely
Osprey (*Pandion haliaetus*)	M	SLC	No significant impact likely
Glossy Ibis (*Plegadis falcinellus*)	M	SLC	No significant impact likely

Table notes:
M = migratory SLC = Special least concern

11.10.3 Significant residual impact assessment for matters of state environmental significance

This section provides details of the outcome of the Significant Impact Assessment for Prescribed Environmental Matters associated with QLD. The Significant Residual Impact (SRI) guideline criteria details when an action is likely to have a 'significant residual impact' to an MSES as defined in the Environmental Offsets Regulation 2014. Full assessment in accordance with the SRI guideline is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report. A summary of the outcomes of this assessment is provide in Table 11.35.

TABLE 11.35: SUMMARY OF THE RESULTS OF THE SIGNIFICANT IMPACT ASSESSMENT OF PRESCRIBED ENVIRONMENTAL MATTERS

Matter	Outcome of assessment
Regulated vegetation	
Endangered' or 'of concern' regional ecosystem (RE)	Significant impact anticipated
A prescribed RE (Category B other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature (Appendix 3 of the *Queensland Environmental Offsets Policy*)	Significant impact anticipated
Remnant vegetation intersection with a VM Act wetland	Significant impact anticipated
Essential habitat	Significant impact anticipated
Connectivity areas	
Connectivity areas	Significant impact anticipated
Wetlands and watercourses	Significant impact not anticipated
Designated precincts in Strategic Environmental Areas	
Designated precincts in Strategic Environmental Areas	Significant impact not anticipated.
Wetlands and watercourses	
A wetland in a wetland protection area, or wetlands of high ecological significance shown on the map of QLD wetland environmental values A wetland or watercourse in high ecological value waters	Significant impact not anticipated
Protected wildlife habitat	
An area contains plants that are endangered wildlife or vulnerable wildlife	Significant impact anticipated
A habitat for an animal that is: ▸ Endangered wildlife ▸ Vulnerable wildlife ▸ A special least concern animal (an echidna or a platypus)	Significant impact anticipated
Fish habitat area	
An area declared under the *Fisheries Act 1994* (Qld) to be a fish habitat area	Significant impact not anticipated
Waterway providing for fish passage	
Any part of a waterway providing for passage of fish only if the construction, installation or modification of waterway barrier works will limit the passage of fish along the waterway	Significant impact not anticipated

11.11 Biodiversity offsets

Residual impacts are those impacts that remain after the successful implementation of the avoidance hierarchy and mitigation measures. The significance of residual impacts reflects the effectiveness of the proposed mitigation measures but allows for the identification of areas where further management measures may be required.

Although sensitive environmental receptors will be avoided, where practicable, and potential impacts will be minimised and mitigated to the greatest extent practical (refer Table 11.32), in some instances the magnitude and significance ratings will remain unchanged following the implementation of the mitigation measures.

There is the potential for some Project activities to have a cumulative, irreversible and/or permanent impact on some terrestrial and aquatic sensitive environmental receptors, even after the implementation of all mitigation measures, including rehabilitation. The Significant Impact Assessment for MNES has been summarised in Section 11.10.

A 'significant impact' is defined as '*an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends on the sensitivity, value, and quality of the environment that is impacted, and on the intensity, duration, magnitude and geographic extent of the impacts*' (DotE, 2013).

An offset is likely to be required for MNES that experience a significant residual impact that may include areas containing habitat critical to the survival of a species or important habitat for EPBC Act listed species and any area occupied by an EPBC Act listed TEC.

Significant Impact Assessment for MNES species/communities potentially impacted by the Project indicated that significant impacts may potentially occur for the MNES provided in Table 11.36. Note that the majority of these sensitive environmental receptors are also MSES.

TABLE 11.36: QUANTIFICATION OF ANTICIPATED SIGNIFICANT RESIDUAL IMPACTS TO MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Sensitive environmental receptor (MNES)	Identified significant residual impact following assessment against the MNES guidelines (refer Sections 11.10.1 and 11.10.2)
Swamp Tea-tree (*Melaleuca irbyana)* Forest of South East Queensland TEC	30.45 ha
Lloyd's Olive *(Notelaea lloydii)*	26.77 ha
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)	6.92 ha
Australian Painted Snipe (*Rostratula australis*)	34.55 ha
Collared Delma (*Delma torquata*)	9.56 ha
Swift Parrot (*Lathamus discolor*)	11.74 ha
Red Goshawk (*Erythrotriorchis radiatus*)	77.25 ha
Brush-tailed Rock-wallaby (*Petrogale penicillata*)	Population fragmentation impact (no direct impact to suitable habitat)
Koala (*Phascolarctos cinereus*)	124.31 ha and potential population fragmentation impact
Grey-headed Flying-fox (*Pteropus poliocephalus*)	71.44 ha

As such the provisions of offsets for the MNES presented above will be required under the EPBC Act Offsets Policy.

For MSES, impacts to prescribed matters that are considered to constitute significant residual impacts will need to be offset consistent with the Offsets Act. The Environmental Offsets Regulation 2014 (Qld) and associated *Queensland Environmental Offsets Policy 2017* (Offsets Policy), provides guidance regarding those offsets related to MSES. The purpose of the Offsets Policy is to provide a decision-support tool to enable administrating agencies the ability to assess offset proposals to ensure they meet the requirements of the Offsets Act.

Assessment of prescribed environmental matters has been summarised in Section 11.10. Analysis indicates that residual impacts for the sensitive environmental receptors in Table 11.37 is likely.

TABLE 11.37: QUANTIFICATION OF ANTICIPATED SIGNIFICANT RESIDUAL IMPACTS TO MSES

Sensitive environmental receptor (MSES)	Identified significant residual impact following assessment against the SRI guidelines (refer Section 11.10.3)
Regulated vegetation	
'Endangered' regional ecosystem (RE)	10.56 ha
'Of concern' regional ecosystem (RE)	9.02 ha
A prescribed RE (Category B other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature	16.09 ha
Remnant vegetation intersection with a VM Act wetland	13.40 ha
Essential Habitat	25.89 ha
Connectivity areas	
Regional Terrestrial corridors	87.86 ha
State Riparian corridors	40.86 ha
State Terrestrial corridors	119.80 ha
Wetlands and watercourses	N/A
Fish habitat area	N/A
Protected wildlife habitat	
Flora	
Bailey's Cypress Pine (*Callitris baileyi*)	11.43 ha
Slender Milkvine (*Marsdenia coronata*)	61.85 ha
Swamp Tea-tree (*Melaleuca irbyana*)	237.73 ha
Fauna	
Glossy-black Cockatoo (*Calyptorhynchus lathami*)	50.63 ha
Powerful Owl (*Ninox strenua*)	21.54 ha

Table notes:
N/A denotes unknown area of impact. The precautionary principle has determined that there is potential for significant residual impact.

ARTC's Environmental Offset Delivery Strategy—Qld is contained in Appendix K: Matters of National Environmental Significance Technical Report and Appendix J: Terrestrial and Aquatic Ecology Technical Report. This strategy informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans. An Environmental Offsets Delivery Plan will be developed and implemented by ARTC prior to construction. The Environmental Offset Plan will:

- Quantify the significant residual impact of the Project on MSES and MNES
- Detail offsets to address significant residual impacts for MSES (except where those matters are also significant residual impacts on MNES)
- Detail offsets to address significant residual impacts for MNES
- Include:
  - Details of milestones to establish the offset
  - Evidence that significant residual impacts can be offset
  - The offset delivery mechanisms comprising one or more of: land-based offsets, direct benefit management plans, offset transfers or offset payments
  - Identification of land required to provide the offset
  - A legally binding mechanism that ensures protection and management of land-based offset areas.

11.12 Cumulative impacts

The cumulative impacts of the identified assessable projects in the vicinity of the Project may contribute to impacts on flora and fauna if not managed appropriately. Six projects have been identified as having the potential to contribute to cumulative impacts on flora and fauna. These include:

- Kagaru to Acacia Ridge and Bromelton
- Helidon to Calvert
- Greater Flagstone Priority Development Area
- Bromelton State Development Area
- Ripley Valley Priority Development Area
- South West Pipeline: Bulk Water Connection to Beaudesert.

The Remondis Waste-to-Energy Facility located in Swanbank Industrial Estate has not been included as part of the cumulative impact assessment for ecological features, as the project is located in a highly disturbed environment and initial investigations indicate this project will not contribute towards impacts to MNES as identified within this chapter.

The cumulative impacts of multiple projects occurring in the vicinity of the ecology study area will likely include the continued loss of biodiversity in the Brigalow Belt and South East Queensland bioregion. The major potential impacts identified as a result of the Project are common to all projects throughout the region and are therefore cumulative in nature, all of which will likely result in some extent of:

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

Cumulative impacts range from short-term to long-term. The total impact area of significant receptors (incorporating all habitat categories) contained within the footprint of the projects occurring within the cumulative impact assessment area, based on bioregional and State extents, is provided in Table 11.38. Given that these values incorporate all habitat categories, residual impacts as a result of the Project (refer Table 11.36) are significantly less than the values presented in Table 11.38.

The results of the significance assessment of these cumulative impacts are presented Table 11.39.

TABLE 11.38: CUMULATIVE IMPACTS AS CALCULATED WITHIN THE CUMULATIVE IMPACT ASSESSMENT AREA

	A. Extent within CIA study area (50 km extent) (ha) (i.e. 1,280,613 ha)	B. Extent within cumulative impact disturbance footprint (i.e. 30,732 ha)	C. Extent within cumulative impact Project disturbance footprint including the Project disturbance footprint	D. Percentage (%) total disturbance to receptors within CIA study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact Project disturbance footprint	F. Magnitude[1] of contribution to disturbance considering D and E
Commonwealth significant sensitive ecological receptors						
Threatened ecological communities (EPBC Act)						
Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC	1,691.90	698.53	728.99	43.09	4.18	Low
Threatened flora habitat (EPBC Act)						
Hairy-joint Grass (*Arthraxon hispidus*)	104,128.13	269.22	273.37	0.26	1.52	Low
A green algae (*Lychnothamnus barbatus*)	8091.83	250.11	256.19	3.17	2.38	Low
Lloyd's Olive (*Notelaea lloydii*)	99,789.76	2,089.02	2115.79	2.12	1.27	Low
Threatened fauna habitat (EPBC Act)						
Regent Honeyeater (*Anthochaera phrygia*)	220,117.11	3,765.80	3,777.23	1.72	0.30	Low
Australasian Bittern (*Botaurus poiciloptilus*)	76,933.28	671.49	713.92	0.93	5.94	Low
Curlew Sandpiper (*Calidris ferruginea*)	78,227.91	801.16	839.31	1.07	4.55	Low
Large-eared Pied Bat (*Chalinolobus dwyeri*)	115,583.01	727.13	730.02	0.63	0.40	Low
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)	288,242.90	3,817.67	3,894.03	1.35	1.96	Low
Collared Delma (*Delma torquata*)	150,679.60	3,646.33	3,655.89	2.43	0.26	Low
Red Goshawk (*Erythrotriorchis radiatus*)	46,570.58	3,279.03	3,356.28	7.21	2.35	Low
Painted Honeyeater (*Grantiella picta*)	29,837.16	1,020.97	1,051.07	3.52	2.86	Low
Swift Parrot (*Lathamus discolor*)	283,706.43	5,841.67	5,982.85	2.11	2.36	Low
Australian Lungfish (*Neoceratodus forsteri*)	34,879.46	302.86	313.36	0.90	3.35	Low
Greater Glider (*Petauroides volans volans*)	157,915.78	4,425.3	4,441.90	2.80	0.37	Low

	A. Extent within CIA study area (50 km extent) (ha) (i.e. 1,280,613 ha)	B. Extent within cumulative impact disturbance footprint (i.e. 30,732 ha)	C. Extent within cumulative impact Project disturbance footprint including the Project disturbance footprint	D. Percentage (%) total disturbance to receptors within CIA study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact Project disturbance footprint	F. Magnitude[1] of contribution to disturbance considering D and E
Brush-tailed Rock Wallaby (*Petrogale penicillata*)	65,921.18	22.70	22.7	0.03	0.00	Negligible
Koala (*Phascolarctos cinereus*)	539,314.06	10,317.02	10,915.50	2.02	5.48	Low
Long-nosed Potoroo (*Potorous tridactylus tridactylus*)	173,217.23	3,513.68	3,523.24	2.03	0.27	Low
New Holland Mouse (*Pseudomys novaehollandiae*)	157,652.17	3,541.13	3,550.69	2.25	0.27	Low
Grey-headed Flying-fox (*Pteropus poliocephalus*)	1,215,056.95	30,732.68	30,876.57	2.54	0.47	Low
Australian Painted Snipe (*Rostratula australis*)	83,861.04	768.06	806.21	0.96	4.73	Low
Migratory bird species habitat (EPBC Act)						
Osprey (*Pandion haliaetus*)	72,174.38	671.49	713.92	0.99	5.94	Low
Oriental Cuckoo (*Cuculus optatus*)	34,032.46	604.76	612.35	1.80	1.24	Low
Satin Flycatcher (*Myiagra cyanoleuca*)	34,032.46	604.76	612.35	1.80	1.24	Low
Rufous Fantail (*Rhipidura rufifrons*)	34,032.46	604.76	612.35	1.80	1.24	Low
Black-faced Monarch (*Monarcha melanopsis*)	34,032.46	604.76	612.35	1.80	1.24	Low
Spectacled Monarch (*Symposiachrus trivirgatus*)	34,032.46	604.76	612.35	1.80	1.24	Low
Yellow Wagtail (*Motacilla flava*)	119,499.11	873.04	918.37	0.77	4.94	Low
Common Sandpiper (*Actitis hypoleucos*)	119,499.11	873.04	918.37	0.77	4.94	Low
Sharp-tailed Sandpiper (*Calidris acuminata*)	119,499.11	873.04	918.37	0.77	4.94	Low
Latham's Snipe (*Gallinago hardwickii*)	119,499.11	873.04	918.37	0.77	4.94	Low
Glossy Ibis (*Plegadis falcinellus*)	119,499.11	873.04	918.37	0.77	4.94	Low

	A. Extent within CIA study area (50 km extent) (ha) (i.e. 1,280,613 ha)	B. Extent within cumulative impact disturbance footprint (i.e. 30,732 ha)	C. Extent within cumulative impact Project disturbance footprint including the Project disturbance footprint	D. Percentage (%) total disturbance to receptors within CIA study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact Project disturbance footprint	F. Magnitude[1] of contribution to disturbance considering D and E
State significant sensitive ecological receptors						
Regulated vegetation (VM Act)						
Category B—Remnant vegetation	153,277.44	3,055.12	3,088.68	2.02	1.09	Low
Category C—High-value regrowth	80,331.37	1,578.96	1,696.96	2.11	6.95	Low
MSES wildlife habitat	252,581.68	1,124.91	1,213.88	0.48	7.33	Low
Essential habitat	345,679.69	4,516.47	4,542.36	1.31	0.57	Low
State Significant Environmental Constraint: Nature Conservation (Koala) Conservation Plan 2017 mapping						
Koala Priority Areas	321,377.89	168.61	427.09	0.13	60.52	Low
Koala Habitat Areas	342,281.26	6,023.90	6,169.47	1.80	2.36	Low
Koala Habitat Restoration Areas	203,926.47	2,050.92	2,346.05	1.15	12.58	Low
Locally Refined Koala Habitat Areas	1,662.53	0.00	27.92	1.68	100.00	Low
Threatened flora habitat (NC Act)						
Bailey's Cypress Pine (*Callitris baileyi*)	181,747.01	3,579.72	3,591.15	1.98	0.32	Low
Slender Milkvine (*Marsdenia coronata*)	47,557.51	64.19	126.04	0.27	49.07	Low
Swamp Tea-tree (*Melaleuca irbyana*)	436,561.90	4,849.88	5,087.61	1.17	4.67	Low
Threatened fauna habitat (NC Act)						
Tusked Frog (*Adelotus brevis*)	62,316.99	512.27	522.48	0.84	1.95	Low
Powerful Owl *(Ninox strenua*)	94,169.65	93.57	115.10	0.12	18.71	Low
Glossy-black Cockatoo (*Calyptorhynchus lathami*)	127,620.97	31.29	81.92	0.06	61.81	Low

	A. Extent within CIA study area (50 km extent) (ha) (i.e. 1,280,613 ha)	B. Extent within cumulative impact disturbance footprint (i.e. 30,732 ha)	C. Extent within cumulative impact Project disturbance footprint including the Project disturbance footprint	D. Percentage (%) total disturbance to receptors within CIA study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact Project disturbance footprint	F. Magnitude[1] of contribution to disturbance considering D and E
NC Act Least concern and Special least concern species						
Short-beaked Echidna (*Tachyglossus aculeatus*)	515,438.17	6,868.68	6,936.32	1.35	0.98	Low
Least concern flora and fauna	1,280,61	30,732.68	31,709.50	2.48	3.08	Low
Priority Back on Track species (not listed under the EPBC Act or NC Act)	1,280,613.21	30,732.68	31,709.50	2.48	3.08	Low
Biodiversity Planning Assessment (BPA)						
BPA habitat values for EVNT taxa (state)	127,231.32	703.16	820.08	0.64	14.26	Low
BPA habitat values for EVNT taxa (regional)	41,086.07	469.04	470.39	1.14	0.29	Low
Regional Terrestrial corridors	259,694.10	3,692.86	3,780.72	1.46	2.32	Low
State Riparian corridors	59,764.92	1,563.59	1,604.45	2.68	2.55	Low
State Terrestrial corridors	245,359.82	52.20	172.00	0.07	69.65	Low

Table notes:

1. Magnitude is calculated based on the proportional disturbance from the Project to each receptor within the cumulative impact assessment area and the percentage contribution of the Project to the overall disturbance of that receptor

TABLE 11.39: SIGNIFICANCE ASSESSMENT OF CUMULATIVE IMPACTS WITHIN THE CUMULATIVE IMPACT ASSESSMENT AREA

Sensitive environmental receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth-significant environmental constraints							
Commonwealth-significant ecological constraint (community listed under the EPBC Act): ▸ Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East QLD TEC	▸ Habitat loss from vegetation clearing/ removal	2	3	1	3	9	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	▸ Fauna species injury or mortality	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	▸ Increase in litter (waste)	1	1	1	3	6	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
Commonwealth-significant ecological constraint (species listed under the EPBC Act): **Flora:** ▸ Hairy-joint Grass (*Arthraxon hispidus*) ▸ A green algae (*Lychnothamnus barbatus*) ▸ Lloyd's Olive (*Notelaea lloydii*) **Fauna:** ▸ Australasian Bittern (*Botaurus poiciloptilus*) ▸ Curlew Sandpiper (*Calidris ferruginea*) ▸ Large-eared Pied Bat (*Chalinolobus dwyeri*) ▸ Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) ▸ Collared Delma (*Delma torquata*) ▸ Red Goshawk (*Erythrotriorchis radiatus*) ▸ Painted Honeyeater (*Grantiella picta*)	▸ Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	2	2	1	3	8	Medium
	▸ Fauna species injury or mortality	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	▸ Increase in litter (waste)	1	1	1	3	6	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

Sensitive environmental receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth-significant ecological constraint (species listed under the EPBC Act): **Fauna:** (continued) ▸ Swift Parrot (*Lathamus discolor*) ▸ Australian Lungfish (*Neoceratodus forsteri*) ▸ Greater Glider (*Petauroides volans volans*) ▸ Brush-tailed Rock Wallaby (*Petrogale penicillata*) ▸ Koala (*Phascolarctos cinereus*) ▸ Long-nosed Potoroo (*Potorous tridactylus tridactylus*) ▸ New Holland Mouse (*Pseudomys novaehollandiae*) ▸ Grey-headed Flying-fox (*Pteropus poliocephalus*) ▸ Australian Painted Snipe (*Rostratula australis*)							Low
State significant environmental constraints							
State-Significant Environmental Constraint (VM Act): ▸ Remnant vegetation (REs) (Category B)	▸ Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	▸ Fauna species injury or mortality	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	▸ Increase in litter (waste)	1	1	1	3	6	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

Sensitive environmental receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State-Significant Environmental Constraint (VM Act): ▸ High-value regrowth (HVR) vegetation (Category C)	▸ Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	▸ Fauna species injury or mortality	1	1	1	2	5	Low
	▸ Dust and light and contaminant disturbance	1	1	1	2	5	Low
	▸ Increase in litter (waste)	1	1	1	2	5	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	▸ Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
State-Significant Environmental Constraint: ▸ MSES wildlife habitat ▸ Essential habitat mapping	▸ Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	2	2	1	3	8	Medium
	▸ Fauna species injury or mortality	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	▸ Increase in litter (waste)	1	1	1	3	6	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

Sensitive environmental receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State-Significant Environmental Constraint: *Nature Conservation (Koala) Conservation Plan 2017* mapping, including: ▸ Koala Priority Areas ▸ Koala Habitat Areas ▸ Koala Habitat Restoration Areas ▸ Locally Refined Koala Habitat Areas	▸ Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	2	2	1	3	8	Medium
	▸ Fauna species injury or mortality	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	▸ Increase in litter (waste)	1	1	1	3	6	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
State-Significant Environmental Constraint (species listed as threatened under the NC Act): **Flora:** ▸ Bailey's Cypress Pine (*Callitris baileyi*) ▸ Slender Milkvine (*Marsdenia coronata*) ▸ Swamp Tea-tree (*Melaleuca irbyana*) **Fauna:** ▸ Tusked Frog (*Adelotus brevis*) ▸ Powerful Owl (*Ninox strenua*) ▸ Glossy-black Cockatoo (*Calyptorhynchus lathami*)	▸ Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	▸ Fauna species injury or mortality	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	▸ Increase in litter (waste)	1	1	1	3	6	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

Sensitive environmental receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Environmental Constraint: ▸ Special least concern fauna species: Short-beaked Echidna *(Tachyglossus aculeatus)*	▸ Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	▸ Fauna species injury or mortality	1	1	1	2	5	Low
	▸ Dust and light and contaminant disturbance	1	1	1	2	5	Low
	▸ Increase in litter (waste)	1	1	1	2	5	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	▸ Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
State Significant Environmental Constraint: ▸ Priority Back on Track flora and fauna species (that are not listed under as threatened under the provisions of the EPBC Act or NC Act).	▸ Habitat loss from vegetation clearing/removal	2	3	1	1	7	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	▸ Fauna species injury or mortality	1	1	1	1	4	Low
	▸ Dust and light and contaminant disturbance	1	1	1	1	4	Low
	▸ Increase in litter (waste)	1	1	1	1	4	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	▸ Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low

Sensitive environmental receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Environmental Constraint: ▸ Flora and fauna species not listed under the EPBC Act but listed as Least concern under the provisions of the NC Act and flora that is listed as Special least concern under the provisions of the NC Act.	▸ Habitat loss from vegetation clearing/removal	3	3	1	1	8	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	▸ Fauna species injury or mortality	1	1	1	1	4	Low
	▸ Dust and light and contaminant disturbance	1	1	1	1	4	Low
	▸ Increase in litter (waste)	1	1	1	1	4	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	▸ Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low
State Significant Environmental Constraint (BPA): ▸ State habitat for EVNT taxa	▸ Habitat loss from vegetation clearing/removal	1	3	1	3	8	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	▸ Fauna species injury or mortality	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	▸ Increase in litter (waste)	1	1	1	3	6	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

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

Sensitive environmental receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Environmental Constraint (BPA): ▸ Regional ecological corridors	▸ Habitat loss from vegetation clearing/removal	1	3	1	2	7	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	▸ Fauna species injury or mortality	1	1	1	2	5	Low
	▸ Dust and light and contaminant disturbance	1	1	1	2	5	Low
	▸ Increase in litter (waste)	1	1	1	2	5	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	▸ Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low

Table notes:

- Low (sum of relevance factors = 1 to 5): Negative impacts need to be managed by standard environmental management practices. Special imposed conditions unlikely to be necessary. Monitoring to be part of general Project monitoring program.
- Medium (sum of relevance factors = 6 to 9): Mitigation measure likely to be necessary and specific management practices to be applied. Specific imposed conditions are likely. Targeted monitoring program required.
- High (sum of relevance factors = 10 to 12): Alternative actions would be considered and/or mitigation measures applied to demonstrate improvement. Specific imposed conditions required. Targeted monitoring program necessary.

11.13 Conclusions

The ecology study area provides suitable habitat for one TEC and for 35 threatened species listed under the provisions of the EPBC Act and/or the NC Act. A number of endangered, of concern and least concern REs are also present within the ecology study area and are protected under the VM Act. The ecology study area contains a suite of other sensitive environmental receptors, including protected areas, high-value regrowth vegetation, conservation significant flora and fauna species, regionally significant species as well as bioregional corridors (local, regional and state significant).

Sixty-two sensitive environmental receptors were identified within the ecology study area for the purposes of this assessment. These varied from broad-scale receptors such as protected areas and bioregional corridors, down to finer species-scale receptors, including TECs and conservation-significant species. These sensitive environmental receptors were grouped into high, moderate and low sensitivity categories based on factors including conservation status, exposure to threatening processes, resilience and representation in the broader landscape.

The construction, operation and decommissioning of the Project has the potential to impact sensitive environmental receptors through:

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

The nature of each unmitigated potential impact was considered in relation to the identified sensitive environmental receptors to derive an initial assessment of impact significance for the Project. This impact was determined by assigning sensitivity and magnitude ratings, which were then allocated a significance rating through the significance assessment approach as outlined in Chapter 4: Assessment Methodology. The potential impacts the sensitive environmental receptors were assigned a major, high, moderate, low or negligible rating.

The proposed mitigation measures for the Project were identified to reduce the significance of the potential impacts the sensitive environmental receptors. The mitigation strategies associated with the Project are presented in Table 11.25. Following the application of the mitigation hierarchy (i.e. avoid, minimise, mitigate), which included a range of mitigation measures and management plans, the residual impacts to the identified sensitive environmental receptors were generally reduced. Aside from avoidance and impact minimisation, the application of additional mitigation measures was not likely to significantly reduce impacts associated with the loss of vegetation through clearing/removal, resulting in a residual impact to each of the sensitive environmental receptors.

Assessment of sensitive environmental receptors against the relevant Commonwealth or State significant impact assessment criteria (refer Section 11.10), indicates that the following will be subject to significant residual impacts as a result of the Project:

Matters listed under the EPBC Act (Project controlling provisions):

- Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East Queensland TEC
- Lloyd's Olive (*Notelaea lloydii*)
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)
- Australian Painted Snipe (*Rostratula australis*)
- Collared Delma (*Delma torquata*)
- Swift Parrot (*Lathamus discolor*)
- Red Goshawk (*Erythrotriorchis radiatus*)
- Brush-tailed Rock-wallaby (*Petrogale penicillata*)
- Koala (*Phascolarctos cinereus*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*).

Prescribed matters for the State of Queensland:

- Endangered or Of concern REs
- Regulated vegetation Category B (other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature)
- Remnant vegetation intersection with a VM Act wetland
- Essential habitat
- Connectivity areas
- Protected wildlife habitat for the following species:
  - Bailey's Cypress Pine (*Callitris baileyi)*
  - Slender Milkvine (*Marsdenia coronata*)
  - Swamp Tea-tree (*Melaleuca irbyana*)
  - Glossy-black Cockatoo (*Calyptorhynchus lathami*)
  - Powerful Owl (*Ninox strenua*).

As such, the provisions of offsets for the MNES and prescribed matters presented above will be required under the EPBC Act Offsets Policy and delivered consistent with the *Queensland Environmental Offsets Policy 2017*.

Predicted cumulative impacts were assessed incorporating the footprints of six other projects that are located within the Project cumulative impact area. The cumulative impacts of multiple similar projects occurring in the vicinity of the Project will potentially include habitat loss from vegetation removal, species injury or mortality, soil compaction, weeds and pest species, biodiversity corridors, edge effects, habitat fragmentation, barrier effects, noise, dust, and light impacts and litter. Cumulative impacts are most appropriately considered at a biologically relevant spatial scale (e.g. 50 km from the disturbance footprint).

The greatest potential predicted cumulative impacts as a result of the Project and other similar projects that occur within the Project cumulative impact area may be on the following environmental receptors:

- EPBC Act listed TEC (i.e. Swamp Tea-tree (*Melaleuca irbyana*) Forest of South East QLD
- EPBC Act listed threatened flora and fauna species (e.g. Lloyd's Olive (*Notelaea lloydii*), Red Goshawk (*Erythrotriorchis radiatus*), Koala (*Phascolarctos cinereus*), Grey-headed Flying-fox (*Pteropus poliocephalus*)
- NCA Act listed threatened flora and fauna species (e.g. Bailey's Cypress Pine (*Callitris baileyi*), Slender Milkvine (*Marsdenia coronata),* Swamp Tea-tree (*Melaleuca irbyana*), Tusked Frog (*Adelotus brevis*), Powerful Owl (*Ninox strenua*), and Glossy-black Cockatoo (*Calyptorhynchus lathami*))
- State (riparian and terrestrial) ecological corridors.

Mitigation measures identified as part of the Project commitments are likely to reduce the Project's contribution to cumulative project impacts within the broader region.

ARTC's Environmental Offset Delivery Strategy—Qld is contained in Appendix J: Matters of National Environmental Significance Technical Report and Appendix K: Terrestrial and Aquatic Ecology Technical Report. This strategy informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans. A Detailed Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction commencement.