Princes Highway Upgrade Program
Jervis Bay Road Intersection Upgrade

Biodiversity Assessment Report

Transport for NSW | November 2021

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Contents

Tables

Figures

Annexures

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Executive summary

Transport for NSW proposes to upgrade the intersection of Jervis Bay Road and the Princes Highway in the vicinity of Falls Creek, NSW, located about 12 kilometres south of Nowra within the City of Shoalhaven local government area. The proposal would provide a grade separated through alignment for the Princes Highway with network access to Jervis Bay Road and the Old Princes Highway provided via dual at grade roundabouts serviced by on and off ramps.

This biodiversity assessment has been prepared to inform the Review of Environmental Factors (REF) being prepared for the proposal and is based on desktop research and field surveys carried out by Arcadis between August 2020 and April 2021.

The site investigation area for the proposal comprises greenfield areas as well as the Princes Highway and local roads and dwellings. The existing land uses are semi-rural residential, recreational, agricultural, commercial and industrial with the township of Falls Creek also located within the site investigation area.

Two Plant Community Types (PCTs) occur in the site investigation area, occupying a total of 21.26 hectares. One PCT in the site investigation area, PCT 1326, meets the criteria for a Threatened Ecological Community (TEC) listed under the *Biodiversity Conservation Act 2016* (BC Act), with some patches of this TEC also meeting the condition threshold for the TEC under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (**Table 0-1**).

Table 0-1: Plant Community Types in the site investigation area and status under the BC Act and EPBC Act

Plant Community Type	BC Act status	EPBC Act status	Area within site investigation area (ha)	Area within proposal construction footprint (ha)
Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion (PCT 1082)	-	-	14.98	11.98
Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion (PCT 1326)	Endangered	Critically Endangered (patches that meet condition criteria)	6.28 (3.98 ha meets EPBC condition criteria)	4.18 (2.29 ha meets EPBC condition criteria)
Total			21.16	16.16

One threatened flora species, *Hibbertia puberula subsp. puberula,* listed as endangered under the BC Act, was recorded within the site investigation area. A total of 13.51 hectares of suitable habitat for the species was recorded within the site investigation area, of which 10.51 hectares is located within the proposal construction footprint.

An additional 10 threatened flora species were initially considered to have moderate or high likelihood of occurrence in the site investigation area but were not recorded during targeted surveys.

Nine threatened fauna species were recorded within the site investigation area as outlined below in **Table 0-2**. One threatened fauna species, Green and Golden Bell Frog, was assumed present within the site investigation area due to presence of potential habitat. Presence of this species will be confirmed following targeted surveys in November 2021 to March 2022. An additional three fauna species have a moderate likelihood of occurrence in the site investigation area.

Table 0-2: Threatened fauna species recorded or assumed present in the site investigation area

Species	Status		Number recorded in site investigation area	Species or ecosystem credit species	Potential habitat in site investigation area (ha)	Potential habitat in proposal construction footprint (ha)
	BC Act	EPBC Act				
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	V	-	Recorded (possible) in the site investigation area using ultrasonic call detectors (Anabats).	Ecosystem	21.26	16.16
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	V	-	Small flocks (up to eight individuals) recorded throughout the site investigation area foraging on Allocasuarina. No breeding individuals or nest sites were identified in the site investigation area during surveys.	Species (breeding habitat)/ ecosystem (foraging habitat)	21.26	16.16
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	V	-	Recorded (possible) in the site investigation area using ultrasonic call detectors (Anabats).	Ecosystem	21.26	16.16
Green and Golden Bell Frog (*Litoria aurea*)	E	V	Assumed present. One dam recorded with suitable habitat.	Species	One dam (377 square metres)	One dam (377 square metres)
Grey-headed Flying-fox	V	V	Two individuals recorded flying over the site	Species (breeding habitat)/	21.26	16.16

(*Pteropus poliocephalus*)			investigation area. The species may use the site for foraging or dispersal. No breeding camps were identified in the site investigation area during surveys.	ecosystem (foraging habitat)		
Large Bent-winged Bat (*Miniopterus orianae oceanensis*)	V	-	Recorded (probable) in the site investigation area using ultrasonic call detectors (Anabats). No breeding habitat was identified in the site investigation area during surveys.	Species (breeding habitat)/ecosystem (foraging habitat)	21.26	16.16
Little Lorikeet (*Glossopsitta pusilla*)	V	-	Two individuals recorded flying over the site investigation area. The species may use the site for foraging or breeding. No breeding individuals or nest sites were identified in the site investigation area during surveys.	Ecosystem	21.26	16.16
Powerful Owl (*Ninox strenua*)	V	-	One individual recorded foraging in the site investigation area. No breeding individuals or nest sites were identified in the site during surveys.	Species (breeding habitat)/ecosystem (foraging habitat)	21.26	16.16

Southern Myotis (*Myotis macropus*)	V	-	Recorded (probable) in the site investigation area using ultrasonic call detectors (Anabats).	Species (breeding and foraging habitat, waterways)	4.61	3.33
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	V	-	One individual recorded flying over the site investigation area. The species may use the site for foraging. No breeding individuals or nest sites were identified in the site investigation area during surveys.	Species (breeding habitat)/ecosystem (foraging habitat)	6.28	4.18

Based on the removal of habitat from within the proposal construction footprint, the proposal is unlikely to have a significant impact on any BC Act or EPBC Act listed species, populations or ecological communities. The proposal is also unlikely to seriously impact any other Matters of National Environmental Significance as defined by the EPBC Act.

Three unnamed tributaries of Parma Creek are situated within the site investigation area. As they are all first order streams they are not defined as key fish habitat by the Department of Primary Industries (2013).

Mitigation measures are proposed where impacts cannot be avoided, and the implementation of these measures will reduce adverse impacts on ecological values within the proposal construction footprint. Mitigation measures include preparation of a Flora and Fauna Management Plan, appropriate sediment and erosion controls, avoiding and minimising removal of vegetation where practicable, site inductions, exclusion fencing, pre-clearance surveys and appropriate weed and hygiene protocols.

Offsets would be required for the proposed impacts to threatened species habitat and ecological communities in accordance with the *RMS Biodiversity Offsets Guidelines*. The NSW Biodiversity Assessment Method calculator has been used to determine the number of credits required for the proposal based on the proposal construction footprint. A total of 373 ecosystem credits and 418 species credits are required. Ecosystem credits comprise the following Plant Community Types:

- Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion (281 credits)
- Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion (92 credits).

Species credits comprise the following species:

- *Hibbertia puberula subsp. puberula* (343 credits)
- Southern Myotis (75 credits)

Offsets may be delivered through a range of mechanisms, including securing offset properties under an appropriate legal instrument, or purchasing and retiring biobanking credits.

Glossary

Definitions	
Biodiversity Assessment Method	The Biodiversity Assessment Method is established under section 6.7 of the BC Act. The Biodiversity Assessment Method is established for the purpose of assessing certain impacts on threatened species and threatened ecological communities (TECs), and their habitats, and the impact on biodiversity values.
Biodiversity offsets	Management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of proposal (OEH, 2017).
Calculator	Biodiversity Assessment Method Credit Calculator. An online application of the Biodiversity Assessment Method. The calculator uses the rules and calculations outlined in the Biodiversity Assessment Method and allows the user to apply the Biodiversity Assessment Method at a site and observe the results of the assessment.
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to Clause 228(2) of the Environmental Planning & Assessment Regulation 2000 for cumulative impact assessment requirements.
Direct impact	Direct impacts on biodiversity values include those related to clearing native vegetation and threatened species habitat and impacts on biodiversity values prescribed by the Biodiversity Conservation Regulation 2017 (the BC Regulation).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component.
Indirect impact	Indirect impacts include but not limited to: (a) indirect impacts on adjacent vegetation and habitat during construction (b) indirect impacts on adjacent vegetation and habitat during operation (c) impacts on adjacent vegetation and habitat arising from a change in land-use patterns (OEH, 2017).
Local population	The population that occurs in the site investigation area. In cases where multiple populations occur in the site investigation area or a population occupies part of the study area, impacts on each subpopulation must be assessed separately (OEH, 2017).
Matters of National Environmental Significance	A matter of national environmental significance protected by a provision of Part 3 of the EPBC Act.
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (OEH, 2017).
Mitigation	Action to reduce the severity of an impact.
Mitigation measure	Any measure that minimises impacts to biodiversity values.

Native vegetation	(a) trees (including any sapling or shrub or any scrub) (b) understorey *plants* (c) groundcover (being any type of herbaceous vegetation) (d) *plants* occurring in a wetland. A *plant* is native to New South Wales if it was established in New South Wales before European settlement (BC Act).
Population	A group of organisms, all of the same species, occupying a particular area (OEH, 2017).
Proposal construction footprint	The area of land that is directly impacted on by the proposal that is being assessed, including access roads, and areas used to store construction materials. It includes the construction and operational areas for the proposal.
Site investigation area	The area investigated during site surveys.
Study area	The broader area subject to desktop assessment, including database searches.
Target species	A species has been identified within the site investigation area or is considered to have a moderate to high likelihood of occurrence and may be impacted by the proposal.

Abbreviations

BAMC	Biodiversity Assessment Method Calculator
BC Act	Biodiversity Conservation Act 2016
CEEC	Critically Endangered Ecological Community
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DoE	Former Commonwealth Department of Environment
DoEE	Former Commonwealth Department of Environment and Energy
DPIE	NSW Department of Planning, Industry and Environment
DPI	NSW Department of Primary Industries
EEC	Endangered Ecological Community
EES	Environment Energy and Science Group, Department of Planning, Industry and Environment
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
FM Act	Fisheries Management Act 1994 (NSW)
GDE	Groundwater Dependent Ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia
NPWS	NSW National Parks and Wildlife Service
OEH	Former NSW Office of Environment and Heritage
PCT	Plant Community Type
TECs	Threatened Ecological Communities
VEC	Vulnerable Ecological Community
VIS	Vegetation Information System

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1 Introduction

1.1 Proposal background

1.1.1 The proposal

Transport for NSW (TfNSW) proposes to upgrade the intersection of Jervis Bay Road and the Princes Highway in the vicinity of Falls Creek, NSW, located about 12 kilometres south of Nowra and within the Jervis sub-region of the Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) bioregion within the Shoalhaven local government area (**Figure 1-1**). The proposal would provide a grade separated through alignment for the Princes Highway with network access to Jervis Bay Road and the Old Princes Highway provided via dual at grade roundabouts serviced by on and off ramps.

Key features of the proposal are shown in **Figure 1-2** and would include:

- A new intersection between Jervis Bay Road and the Princes Highway, incorporating:
  - Realignment of the existing Princes Highway, including widening from two lanes to a four-lane divided highway (two lanes in each direction), with median separation using flexible safety barriers, providing an uninterrupted through alignment for the Princes Highway
  - An overpass bridge over Jervis Bay Road
  - An unsignalised single-lane at-grade double roundabout interchange providing:
    - Direct access from Jervis Bay Road and Old Princes Highway to the Princes Highway
    - Direct access from the Princes Highway to Jervis Bay Road and Old Princes Highway.
  - Direct connection to existing properties and businesses at the Old Princes Highway
  - A connection from Willowgreen Road to Old Princes Highway
  - Tie-ins with the Old Princes Highway and with Jervis Bay Road
- Access road to service Princes Highway properties south east of the intersection
- Shared user paths along Jervis Bay Road, connecting to the new bus bay and the Jervis Bay Road and Old Princes Highway road shoulders
- Adjustments of drainage infrastructure and provision of new drainage infrastructure such as pit and pipe networks, culverts, open channels and retention basins
- Permanent water quality measures such as vegetated swales, bioretention swales and bioretention basins
- Adjustment, protection and relocation of existing utilities
- Other roadside furniture including safety barriers, signage, line marking, lighting and fencing
- A bus bay adjacent to the interchange, including kiss and ride car spots
- Establishment and use of temporary ancillary facilities during construction
- Property works including acquisition, demolition and adjustments to accesses, and at-property noise treatments
- Rehabilitation of disturbed areas and landscaping.

1.1.2 Key construction activities

Key construction activities would include:

- Pre-construction and early works
  - Demarcation of the proposal construction footprint with construction fencing and temporary safety barriers where required
  - Installation of erosion and sediment controls
  - Set up of temporary traffic management arrangements
- Site establishment
  - Site survey, geotechnical and other investigations
  - Pre-clearing biodiversity surveys
  - Vegetation clearing and grubbing

- Mobilisation and establishment of ancillary facilities
- Intersection construction
  - Utilities relocation/protection including overhead power lines
  - Construct temporary Jervis Bay Road alignment
  - Construct access road for south eastern properties
  - Construct the Old Princes Highway connection
  - Construct eastern and western ramps and associated fill embankment
  - Construct bridge, bridge abutments and retaining walls
  - Construct roundabouts and connecting roads
  - Tie-in works
  - Construction of new drainage structures and extension or replacements of existing drainage structures
  - Construction of pavement layers including selected material, sub-surface drainage, subbase and base layers and surfacing.
  - Construction of vegetated swales, bioretention swales and bioretention basins
  - Installation of lighting, safety barriers, traffic signs and bus shelters
  - Line marking and raised pavement markers
  - Fencing
  - Property accesses adjustments
- Finishing work
  - Rehabilitation of disturbed areas and landscaping in accordance with the urban design and landscape plan
  - Installation of safety barriers, street lighting, fencing and roadside furniture
  - Decommission and rehabilitation of ancillary facilities.

Subject to the proposal obtaining planning approval, construction is anticipated to commence in 2022 and is expected to take around 2 years to complete.

1.1.3 Proposal construction footprint and ancillary facilities

The area required to construct the proposal, including ancillary facilities, is presented in **Figure 1-2**. Ancillary facilities are further described in **Table 1-1**. This area is referred to in this report as the proposal construction footprint and all biodiversity values within this area are assumed as potential direct impacts.

Table 1-1: Ancillary facilities

Facility	Location (refer to Figure 1-2)	Purpose
Ancillary Facility 1	24 Jervis Bay Road, Lot 7 DP1093336 921 Princes Highway, Lot 59 DP15507	Offices, Amenities, Workshops, Stockpile and laydown areas, Car park, Storage areas
Ancillary Facility 2	24 Willowgreen Road, Lot 1 DP871596	Stockpile and laydown area, Car park

1.1.4 Site investigation area and study area

Figure 1-3 shows the proposal construction footprint, the site investigation area and the study area.

The area investigated during site surveys, which is inclusive of the proposal construction footprint, is referred to in this report as the site investigation area.

The study area refers to the broader area subject to desktop assessment, including database searches. The study area includes the site investigation area plus a 10 kilometre radius around the site investigation area.

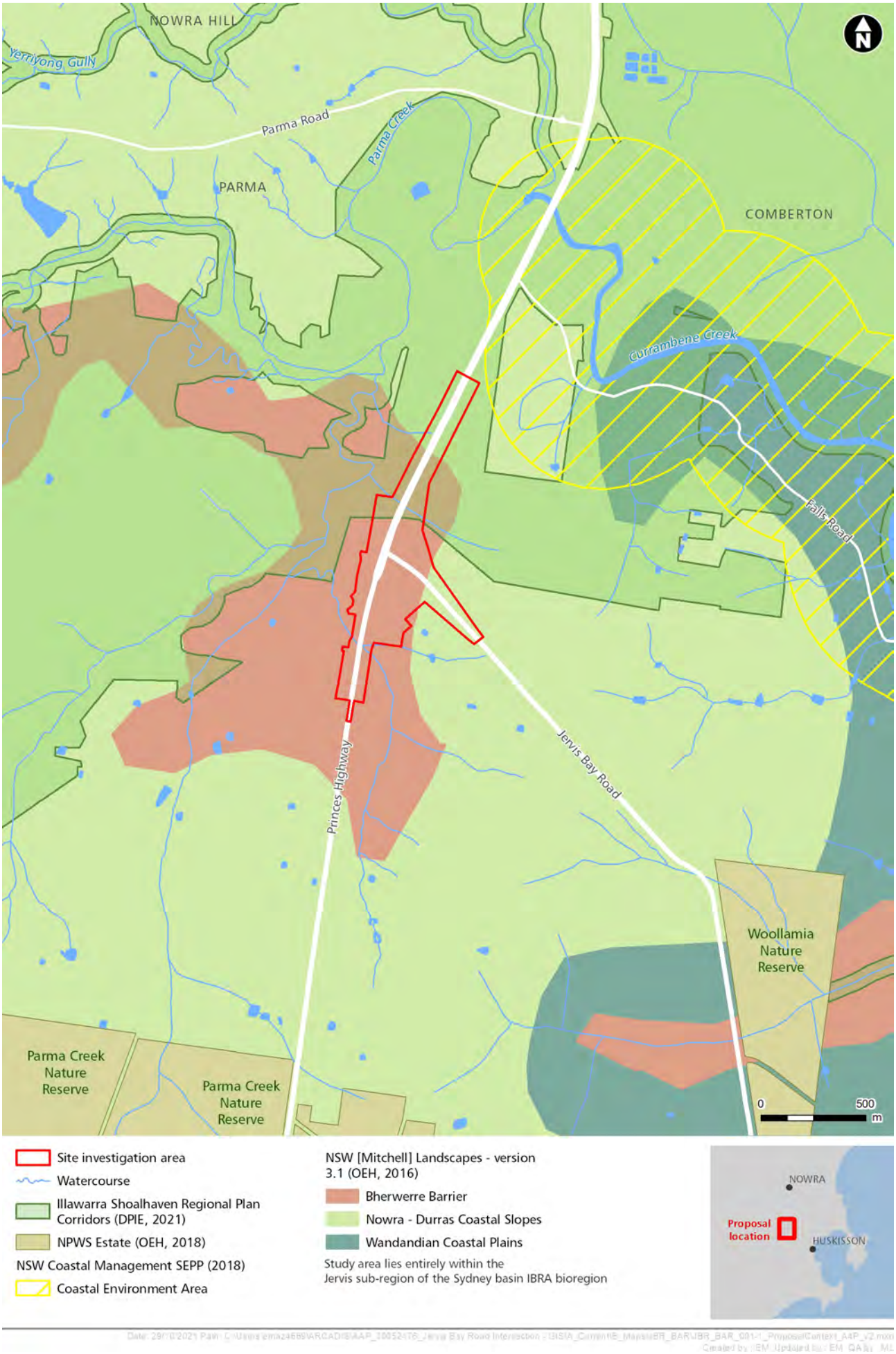


Figure 1-1: Proposal context

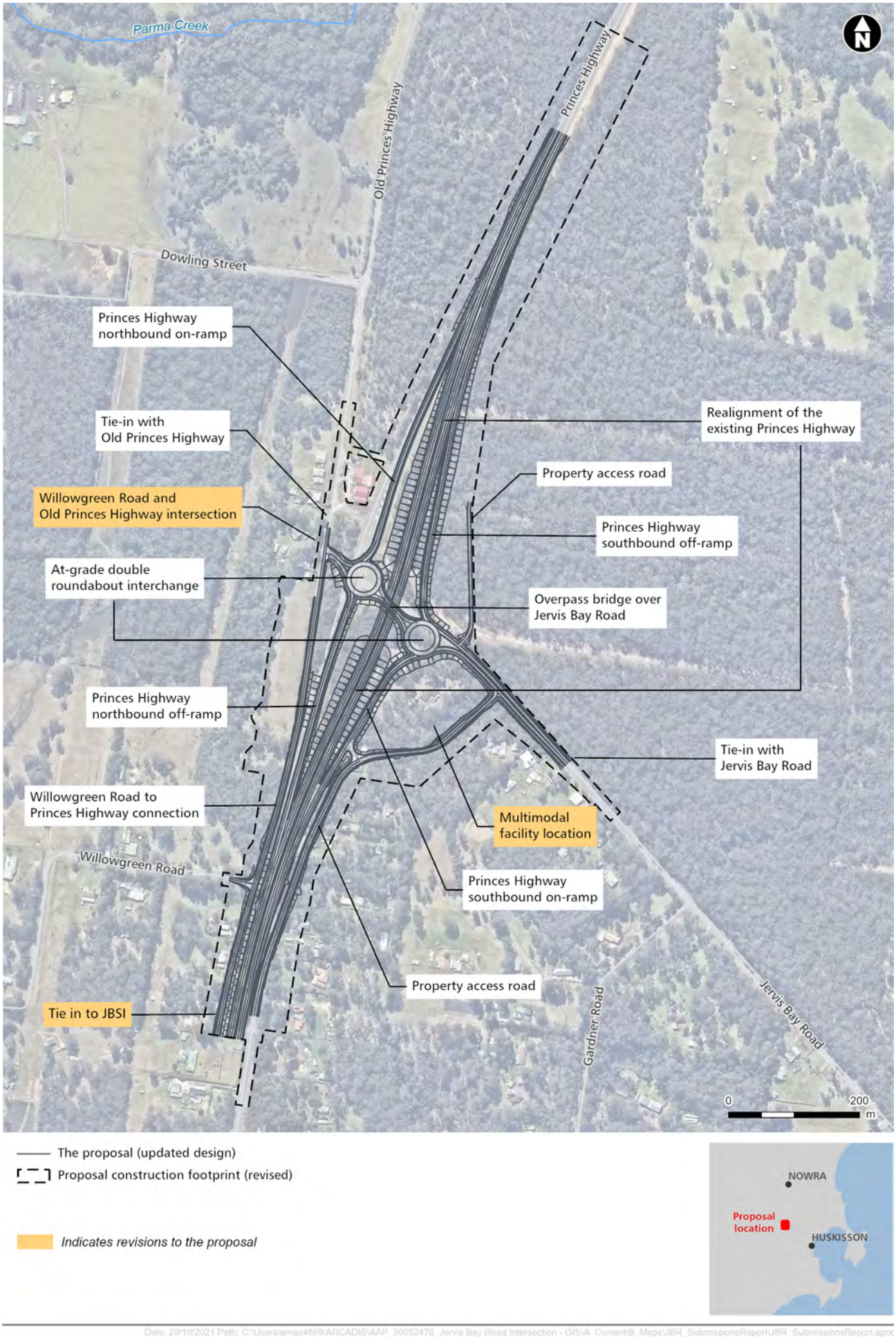


Figure 1-2: Key features of the proposal

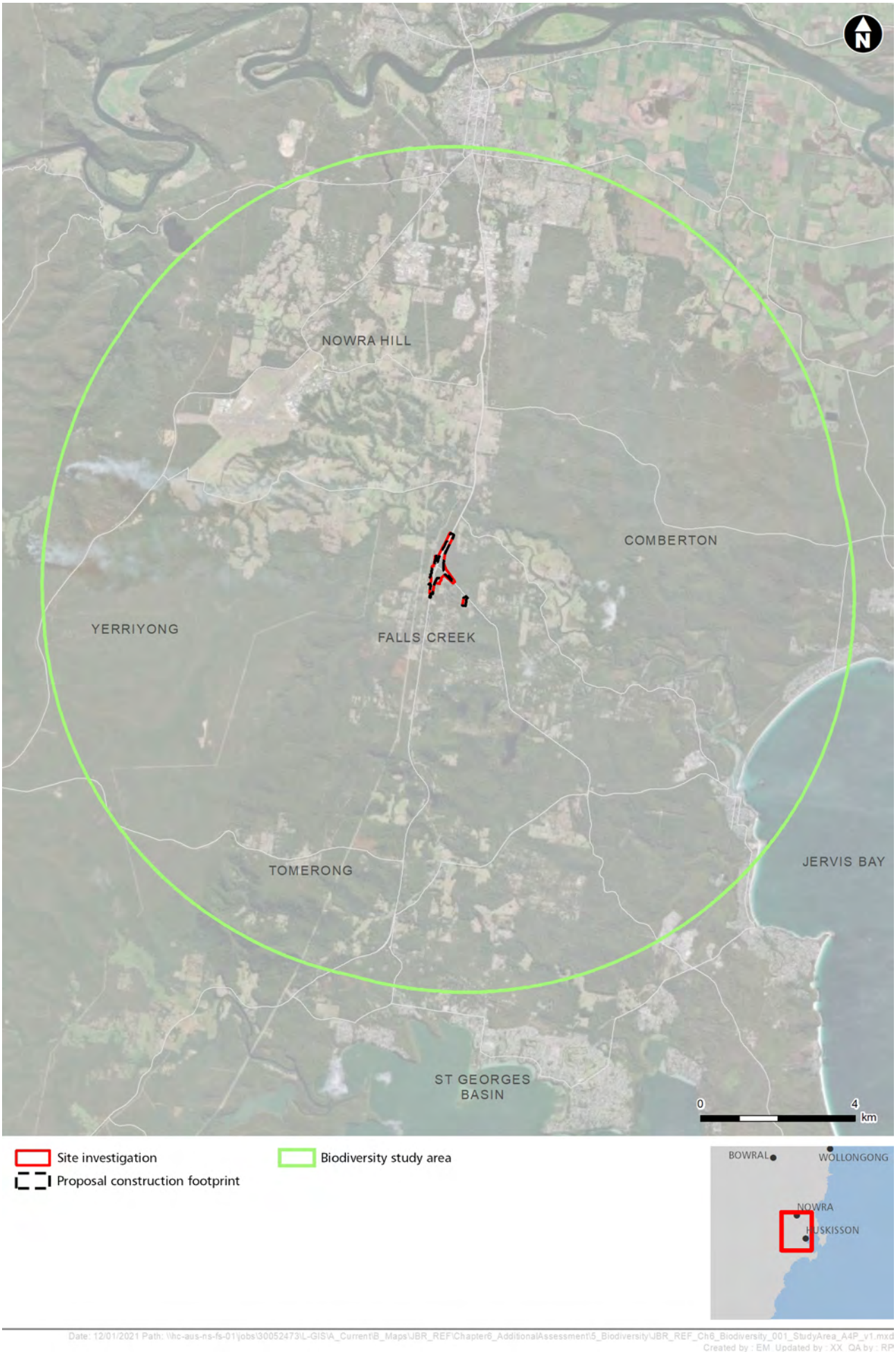


Figure 1-3: Proposal construction footprint, site investigation area and study area

1.2 Legislative context

A Review of Environmental Factors (REF) is prepared to satisfy Transport for NSW duties under division 5.1 of the *Environmental Planning & Assessment Act 1979* to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity" and in making decisions on the likely significance of any environmental impacts. This biodiversity impact assessment forms part of the REF being prepared for the proposal and assesses the biodiversity impacts of the proposal to meet the requirements of the *Environmental Planning & Assessment Act 1979*.

Sections 7.2A of the BC Act and Part 7A of the *Fisheries Management Act 1994* (FM Act) require that the significance of the impact on threatened species, and Endangered Ecological Communities (EECs) is assessed using a five-part test. Where a significant impact is likely to occur, a Species Impact Statement must be prepared in accordance with the Environment Agency Head's requirements or a Biodiversity Development Assessment Report must be prepared by an accredited assessor in accordance with the Biodiversity Assessment Method.

Specific legislation applicable to the proposal are detailed in the sub-sections below. In addition, state environmental planning policies applicable to the proposal and surrounding area are identified in Section 1.2.5.

1.2.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is Commonwealth legislation that provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as Matters of National Environmental Significance. Matters of National Environmental Significance identified in the EPBC Act include:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Threatened species and communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines).

In September 2015, a "strategic assessment" approval was granted by the Minister for the Environment in accordance with the EPBC Act. The approval applies to Transport for NSW activities being assessed under Division 5.1 (formerly Part 5) of the EP&A Act with respect to potential impacts on nationally listed threatened species, ecological communities and migratory species. As a result, Transport for NSW road proposals assessed via a review of environmental factors:

- Must address and consider potential impacts on nationally listed threatened species, populations, ecological communities and migratory species, including application of the "avoid, minimise, mitigate and offset" hierarchy
- Do not require referral to the Department of Agriculture, Water and the Environment (DAWE) for these matters, even if the activity is likely to have a significant impact, provided that all program commitments have been met including the provision of offsets in accordance with Transport for NSW guidelines
- Must use the Biodiversity Offset Scheme to offset proposal impacts where the proposal would result in a significant impact to Matters of National Environmental Significance.

To assist with this, assessments are required in accordance with the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DoE, 2013).

1.2.2 NSW Biodiversity Conservation Act 2016

The purpose of the NSW *Biodiversity Conservation Act 2016* (BC Act) is to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development.

The NSW Biodiversity Offset Scheme is established under Part 6 of the BC Act and the Biodiversity Assessment Method is established under Section 6.7 of the BC Act. The purpose of the Biodiversity Assessment Method is to prescribe requirements for the assessment of certain impacts on threatened species and Threatened Ecological Communities (TECs), and their habitats, and the impact on biodiversity values, where required under the BC Act.

Section 7.3 of the BC Act provides a test for determining whether proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats. Where a significant impact is likely to occur, a Species Impact Statement must be prepared in accordance with the Director-General's requirements or a Biodiversity Development Assessment Report must be prepared by an accredited assessor in accordance with the Biodiversity Assessment Method.

1.2.3 NSW Biosecurity Act 2015

The NSW *Biosecurity Act 2015* requires any person who deals with any biosecurity matter, including who knows (or ought to know) of any biosecurity risk, to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable. Biosecurity matters include weeds and pathogens. Weeds are managed in accordance with control regions. Within each of the regions are listed Priority Weeds. These Priority Weeds are allocated different measures based on their threat level.

The site investigation area for the proposal is located entirely within the South East Local Land Services area. Lists of potentially occurring Priority Weeds for the South East Local Land Services area, and Commonwealth listed Weeds of National Significance (WoNS), were reviewed prior to the commencement of targeted vegetation surveys across the site investigation area.

1.2.4 NSW Fisheries Management Act 2004

The NSW *Fisheries Management Act 1994* (FM Act) provides for the identification, conservation and recovery of threatened fish, aquatic invertebrates and marine vegetation. The Act also covers the identification and management of Key Threatening Processes (which affect threatened species or could cause other species to become threatened).

If a planned development or activity is likely to have any impact on a threatened species listed under the FM Act, an Assessment of Significance must be undertaken. If the impacts are likely to be significant, or if critical habitat is affected, a Species Impact Statement must be prepared.

Section 199 of the FM Act states that consultation with the Minister (Minister for Primary Industries) must be undertaken by a public authority prior to carrying out dredging or reclamation works. Under the FM Act, dredging or reclamation works include the following:

- Dredging work – excavation or removal of material from water land
- Reclamation work – using any materials to fill in water land, or depositing materials for construction of anything on water land (eg bridge) or draining of water from water land for the purposes of reclamation.

Should the activities include either dredging or reclamation, written notice of the proposed work must be given to the Minister, with consideration given to any comments provided within 21 days.

1.2.5 State Environmental Planning Policies

State Environmental Planning Policies (SEPPs) applicable to the proposal and surrounding area are identified in the sub-sections below.

1.2.5.1 State Environmental Planning Policy (Coastal Management) 2018

A Coastal Environment Area (ID250) is mapped under the SEPP (Coastal Management) and is located within 50 metres of the site investigation area The Coastal Environment Area does not lie within the proposal construction footprint and as such would not be impacted by the proposal. Therefore, the *State Environmental Planning Policy (Coastal Management) 2018* does not apply to this proposal.

1.2.5.2 State Environmental Planning Policy (Koala Habitat Protection)

Two State Environmental Planning Policies for Koala Habitat Protection currently apply in NSW:

- *State Environmental Planning Policy (Koala Habitat Protection) 2020* commenced on 30 November 2020, and still applies on an interim basis to land zoned RU1, RU2 and RU3 in 74 local government areas, including Shoalhaven LGA.
- *State Environment Planning Policy (Koala Habitat Protection) 2021* commenced on 17 March 2021 and applies to all other zones in Shoalhaven LGA

The Koala Habitat Protection SEPP aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure that permanent free-living populations are protected in their present range, and to reverse the current trend of population decline.

The site investigation area comprises areas zoned RU2, SP2 and R5 under the Shoalhaven Local Environment Plan 2014; as such, both the 2020 and 2021 Koala Habitat Protection SEPPs could potentially apply. However, as the proposal does not require development consent in accordance with the *State Environmental Planning Policy (Infrastructure) 2007*, the Koala Habitat Protection SEPPs do not apply to the proposal. Regardless, these documents have been considered when assessing potential impacts on koalas and koala habitat.

A review of koala tree use across New South Wales (OEH, 2018b) indicates that the Shoalhaven region (South Coast Koala Management Area (KMA)) contains relatively low Koala numbers and low numbers of tree species with evidence of Koala use (Section 4.4.1, OEH 2018b). As such, Koala populations within the South Coast KMA are sparse and localised. A total of 27 Koala feed trees have been identified within the South Coast KMA (DPIE, 2020e). While the site investigation area contains marginal potential Koala habitat, no Koalas are present and no Koalas have been recorded up to 2.5 kilometres from the site investigation area within the past 18 years (two records, the most recent from 1995, occur within the study area). As such, the site investigation area does not contain core Koala habitat.

2 Methods

2.1 Personnel

A list of personnel involved in this assessment and an overview of their qualifications and experience is provided in **Table 2-1**.

Table 2-1: Personnel involved in assessment

Personnel name		
Jane Rodd	Bachelor of Science (Ecology) Accredited Biodiversity Assessment Method Assessor	Jane Rodd is a Principal Ecologist with over twenty years of experience in biodiversity assessment, maintaining a strong focus on impact assessment and biodiversity offsetting. She has completed specialist assessments for several major road and rail infrastructure projects in the Sydney region and across NSW in recent years. Jane is accredited to apply the Biodiversity Assessment Method under the NSW BC Act.
Meredith Leal	Bachelor of Environmental Management/Arts (Ecology)	Meredith Leal is an Ecologist with over four years of ecological consulting experience and has delivered biodiversity assessments for a range of projects across NSW. She has undertaken extensive flora and fauna surveys including targeted threatened flora surveys, hair tube and pitfall trapping, remote camera sampling, nocturnal surveys and frog auditory surveys. Meredith has completed numerous technical biodiversity reports under the Biodiversity Assessment Method and is informed in current biodiversity acts and legislation.
Jessica Rooke	Bachelor of Advanced Science (Honours) (Ecology)	Jessica Rooke is an Ecologist with over three years of consulting experience and over seven years' experience in ecological assessment. She has worked on a variety of ecological deliverables for clients and has been heavily involved in large, complex projects across NSW. She is highly skilled in targeted searches for threatened flora and fauna species, particularly microchiropteran bats (microbats), birds and frogs, and has experience setting up specialised trapping equipment and analysing ultrasonic calls. Jessica has prepared numerous technical biodiversity reports, is proficient in the Biodiversity Assessment Method and knowledgeable in current biodiversity acts and legislation.
Elvira Lanham	B. Environmental Science (Life Sciences) (Hons.) PhD Reptile Ecology – Flinders University of South Australia BAM Accredited Assessor (BAAS20012)	Elvira has been involved in ecological consultancy and research for the past 25 years and has completed projects throughout Australia and overseas, including QLD, NSW, Victoria and South Australia. She has been the project manager and primary author on more than 400 reports ranging from Environmental Impact Assessments, Review of Environmental Factors (REFs) and a range of biodiversity assessments. She has recently been the primary author on several Commonwealth EPBC referrals. She is an accredited Biodiversity Assessment Method (BAM) assessor. Elvira wrote the Green and Golden Bell Frog significance tests for this assessment.

Personnel name	Qualifications	Experience/ Role
Brian Towle	Bachelor of Environmental Science (Honours)	Brian Towle is a Senior Ecologist and approved expert for threatened orchid species *Calochilus pulchellus, Pterostylis ventricosa* and *Genoplesium baueri* as recognised by DPIE. Brian was engaged to provide advice and assist in the April 2021 surveys for these species to inform this assessment.
Frank Lemckert	Bachelor of Science (Terrestrial Ecology and Marine Management) Master of Science (Population biology of the Common Froglet) PhD (Management of forest frogs in timber production forests of NSW)	Frank Lemckert is a Principal Scientific Ecologist and approved expert for the Green and Golden Bell Frog as recognised by DPIE. Frank was engaged to provide advice on compensatory habitat and technical review of the Assessment of Significance for the species.

2.2 Background research

2.2.1 Database searches

Database searches were undertaken in August 2020 to identify State and Commonwealth records of threatened entities and Commonwealth Matters of National Environmental Significance that occur or have the potential to occur in the study area (ie within 10 kilometres of the site investigation area). Additional database searches were undertaken in relation to fisheries, weeds and vegetation types. Databases searched are listed in **Table 2-2**.

Table 2-2: Database searches carried out

Database	Purpose of search	Date of database search
NSW BioNet Wildlife Atlas, managed by the NSW Department of Planning, Industry and Environment (Environment, Science and Energy) (DPIE EES)	Used to compile a list of threatened species records listed under the BC Act within the study area.	5 August 2020
Protected Matters Search Tool (PMST), managed by the Commonwealth Department of Agriculture, Water and the Environment (DAWE)	Used to compile a list of potentially occurring Matters of National Environmental Significance listed under the EPBC Act within the study area.	5 August 2020
Vegetation Types Database, managed by DPIE EES	Information on PCTs and their relationship to a vegetation formation and vegetation class is managed and maintained in the BioNet Vegetation Classification data collection.	Referenced throughout
NSW WeedWise, managed by DPIE	Identifies species listed as priority weeds for a weed control area and their control requirements.	17 August 2020

Database	Purpose of search	Date of database search
Fisheries NSW Spatial Data Portal	Maps threatened fish species distribution in NSW.	1 September 2020
NSW DPIE's register of critical habitat	To identify any critical habitat for threatened species in the study area.	1 September 2020
The Commonwealth Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE)	Identifies any groundwater dependent ecosystems in the study area.	1 September 2020

2.2.2 Literature review

A review of relevant, existing information was undertaken to identify the existing environment of the study area and provide an understanding of ecological values occurring or potentially occurring in the site investigation area and locality. The review focused on relevant ecological reports from the study area, as well as property boundaries, vegetation maps, topographic maps, aerial photography and relevant GIS layers. Relevant literature included, but was not limited to:

- Princes Highway Upgrade, Jervis Bay Road to Sussex Inlet Road Preliminary Environment Investigation (Transport for NSW, 2020)
- Compilation map: Biometric vegetation types of the Shoalhaven, Eurobodalla and Bega Valley local government areas. Version 2.1 (OEH, 2013)
- Delineation and description of the Eastern Environmental Subregions (provinces) in New South Wales Study (Morgan, 2001)
- Descriptions for NSW (Mitchell) Landscapes Version 2 (NPWS, 2002)
- Key Fish Habitat Maps (DPI, n.d.).

Field surveys and the preparation of this assessment have been undertaken in accordance with, or with reference to:

- The Biodiversity Assessment Method (DPIE, 2020)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities working draft (DEC, 2004)
- Threatened Species Assessment Guidelines: the assessment of significance (DECC, 2007)
- Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (DoE, 2013)
- Surveying threatened plants and their habitats: NSW survey guide for the Biodiversity Assessment Method (DPIE, 2020a)
- NSW BioNet Threatened Biodiversity Data Collection and Wildlife Atlas (DPIE, 2020b)
- Survey guidelines for Australia's threatened mammals: guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (CoA, 2011)
- EPBC Act referral guidelines for the vulnerable koala (CoA, 2014)
- 'Species credit' threatened bats and their habitats: NSW survey guide for the Biodiversity Assessment Method (OEH, 2018a)
- Survey guidelines for Australia's threatened birds: guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (CoA, 2010a)
- Survey guidelines for Australia's threatened bats: guidelines for detecting bats listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (CoA, 2010b).

2.3 Habitat assessment

The results of the searches of BioNet records (DPIE, 2020b) and Protected Matters Search Tool (PMST) (DAWE, 2020) were used to prepare a list of threatened flora, fauna and ecological communities known or considered likely to occur within the study area. This list was then refined based on suitability of habitat features present within the site investigation area, including associated PCTs, soil and geological preferences.

A habitat assessment was then undertaken to determine the likelihood for each of these threatened entities to occur within the site investigation area and proposal construction footprint, and as such, to be potentially impacted by the proposal.

The 'likelihood of occurrence' for each threatened entity identified from the database searches and literature review is provided in Annexure B. Criteria used to determine likelihood of occurrence categories for the assessment are provided in **Table 2-3**.

Marine species were excluded from this habitat assessment due to the distance of the study area from the ocean and consequent lack of marine habitat within the site investigation area.

Table 2-3: Likelihood of occurrence criteria

Likelihood of occurrence	Criteria
Recorded	The species was observed in the site investigation area during the current survey.
High	It is highly likely that a species inhabits the site investigation area and is dependent on identified suitable habitat (ie for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the study area (10 kilometres) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the site investigation area during regular seasonal movements or migration.
Moderate	Potential habitat is present in the site investigation area. Species unlikely to maintain sedentary populations, however, may seasonally use resources within the site investigation area opportunistically or during migration. The species is unlikely to be dependent (ie for breeding or important life cycle periods such as winter flowering resources) on habitat within the site investigation area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the site investigation area and has not been recorded recently in the study area (10 kilometres). It may be an occasional visitor, but habitat similar to the site investigation area is widely distributed in the study area, meaning that the species is not dependent (ie for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the site investigation area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
None	Suitable habitat is absent from the site investigation area.

2.4 Field survey

Field surveys were carried out across the site investigation area by Arcadis ecologists between August 2020 and August 2021 to target specific threatened species and to provide survey results in accordance with current biodiversity assessment guidelines, such as the Biodiversity Assessment Method (DPIE, 2020) as well as the guidelines listed in Section 2.2.2.

All work was carried out under the appropriate licences, including scientific licences as required under Section 2 of the BC Act (licence number: SL100646) and in accordance with the Animal Ethics Committee (license TRIM 13/339).

The weather records from the closest weather station, Nowra (station 068072), for the survey dates are detailed in **Table 2-4**.

Table 2-4: Weather conditions during survey period (BoM, 2020a)

Date	Temperature		Rain	Maximum wind gust	
	Min (°C)	Max (°C)	mm	Direction	Speed (km/h)
19 August 2020	5.7	19.2	0.0	WNW	74
20 August 2020	10.5	16.0	0.8	WNW	76
21 August 2020	10.5	16.6	0.0	W	70
24 September 2020	11.3	19.3	0.0	W	57
06 October 2020	13.2	20.3	0.2	S	28
07 October 2020	14.3	19.0	2.4	SE	22
08 October 2020	12.5	24.3	2.8	NW	65
09 October 2020	13.5	21.6	0.6	W	59
20 October 2020	13.9	21.9	0.0	ENE	35
21 October 2020	9.4	26.3	0.0	ENE	35
03 December 2020	14.2	23.7	0.6	NE	35
04 December 2020	13.4	33.7	0.0	S	69
15 December 2020	18.0	26.6	0.6	NE	39
16 December 2020	20.3	28.5	18.0	W	39
17 December 2020	20.0	30.5	10.0	SSE	30
18 December 2020	19.9	31.5	1.8	NW	41
08 March 2021	14.7	29.8	0.0	NW	59
09 March 2021	15.0	24.8	3.8	SSE	43
13 April 2021	7.9	21.6	0	NE	28
14 April 2021	11.8	26.0	0	WNW	57
20 April 2021	9.9	23.4	0	W	54
17 August 2021	8.4	18.9	0	WNW	35

2.4.1 Vegetation surveys

Vegetation surveys were undertaken over nine days in August, September and October 2020 and April 2021 and consisted of ground truthing of regional vegetation mapping and PCT identification, rapid assessment points and Biodiversity Assessment Method vegetation integrity plots.

2.4.1.1 Vegetation mapping and PCT identification

Vegetation within the site investigation area has previously been stratified and assigned to PCTs by the *Compilation map: Biometric vegetation types of the Shoalhaven, Eurobodalla and Bega Valley local government areas Version 2.1* (OEH, 2013). This data source informed the current assessment of vegetation within the site investigation area.

Vegetation was initially stratified based on the composition of the canopy and vegetation structure (key elements in PCT assignment). Ecotones between vegetation communities were investigated in more detail to determine the functional boundary of each PCT. These discrete vegetation communities were then compared to recognised and accepted PCTs, as described in the BioNet Vegetation Classification data collection (DPIE, 2020c). The identification of PCTs in the site investigation area was predominantly based on:

- Structure and species composition consistent with descriptions in the BioNet Vegetation Classification data collection and other published references
- Characteristic tree species present
- Previous regional mapping as an equivalent vegetation type
- Landscape position.

2.4.1.2 Biodiversity Assessment Method vegetation integrity plots

A total of 11 vegetation integrity plots were used to sample the vegetation of the site investigation area. These quantitative site surveys were conducted in accordance with the methodology described in the BAM, as summarised in **Table 2-5**. **Figure 2-1** shows the plot layout of nested 20 metre by 50 metre, 20 metre by 20 metre and one metre by one metre sub-quadrats used for the assessment of condition attributes at each plot site. Each 20 metre by 20 metre plot was sampled using transects for approximately 30 minutes.

Flora species identified in each vegetation integrity plot are listed in the flora species inventory provided in Annexure A. The locations of vegetation plots are shown in **Figure 2-2**.

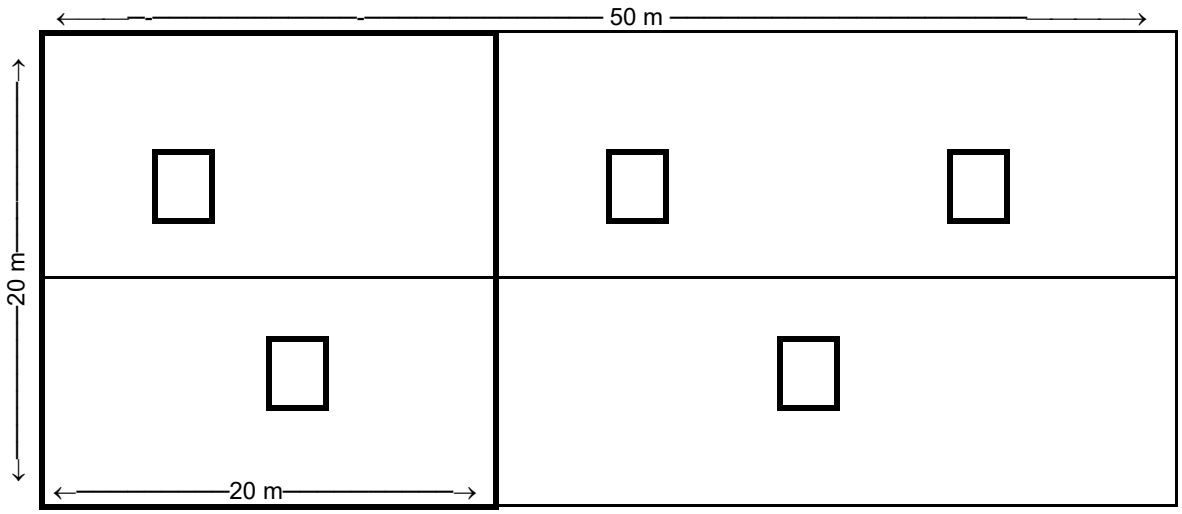


Figure 2-1: Schematic diagram illustrating the vegetation plot layout

Table 2-5: Data collected from vegetation integrity plots

Attribute	Data collected
Location	Geographic co-ordinates (easting and northing; grid type MGA 94, Zone 56) – collected using GPS.
Native and exotic species richness and cover	All plant species identified within the 20 metre by 20 metre nested quadrat were recorded. The cover (percentage of area of quadrat covered) and abundance of each species present was estimated. The growth form, stratum/layer and whether each species was native, exotic, or a high threat weed was recorded.
Number of trees with hollows	The number of living and dead trees with hollows within the 50 metre by 20 metre quadrat was recorded. A hollow was only recorded if: (a) the entrance could be seen; (b) the estimated entrance width was at least five centimetres; (c) the hollow appeared to have depth; (d) the hollow was at least one metre above the ground; and the (e) the centre of the tree was located within the sampled quadrat.
Tree stem size diversity and number of large trees	Tree stem size diversity was recorded by measuring the diameter at breast height (dbh) (ie 1.3 metres from the ground) of living trees (greater than five centimetres dbh) within each 50 metre by 20 metre quadrat. For multi-stemmed living trees, only the largest stem was included in the count. The number of large trees was determined by counting all trees with a dbh greater than the specified dbh of large trees for each vegetation formation, as noted in the VIS Classification Database (DPIE, 2020c).
Evaluation of regeneration	Presence/absence of overstorey species present at the site that were regenerating (defined as seedlings or saplings with a dbh less than or equal to five centimetres.
Total length of fallen logs	Cumulative total of logs within each 50 metre by 20 metre quadrat with a diameter of at least 10 centimetres and a length of at least 0.5 metres.
Litter cover	Estimation of the average percentage groundcover of litter (ie leaves, seeds, twigs, branchlets and branches with a diameter less than 10 centimetres which is detached from a living plant) from within five sub-plots that measured one metre by one metre square spaced evenly on either side of the 50 metre central transect.

The plot requirement per vegetation zone, as determined in reference to Table 3 of the Biodiversity Assessment Method, and number of plots completed are outlined in **Table 2-6**. It should be noted that the Biodiversity Assessment Method plot requirements identified in this table apply to the areas in the site investigation area, and that the proposal construction footprint includes smaller vegetation zones and therefore lower Biodiversity Assessment Method plot requirements.

Table 2-6: Comparison of number of plots required and completed per vegetation zone

Vegetation zone	Vegetation zone area (ha) in site investigation area	Vegetation zone area (ha) in proposal construction footprint	BAM plots required	BAM plots completed	Plots
1082_Good	10.64	7.81	3	4	JB01, JB03, JB05, JB06

Vegetation zone	Vegetation zone area (ha) in site investigation area	Vegetation zone area (ha) in proposal construction footprint	BAM plots required	BAM plots completed	Plots
1082_Moderate _Disturbed	2.50	2.33	2	1	JB12
1082_Poor	1.84	1.84	1	1	JB10
1326_Moderate _Woodland	2.58	1.84	2	2	JB02, JB04
1326_Moderate _Garden	2.13	1.1	2	1	JB11
1326_Poor	1.57	1.24	1	1	JB08

2.4.1.3 Native vegetation survey limitations

Field surveys and survey effort largely met the requirements of the Biodiversity Assessment Method and a majority of the site investigation area was able to be surveyed.

Adequate numbers of vegetation integrity plots were undertaken in all vegetation zones to meet the requirements of the Biodiversity Assessment Method except in 1082_Moderate_Disturbed (Table 2-6). To overcome this limitation, rapid assessment points were undertaken across this vegetation zone. These rapid assessment points recorded dominant species in each stratum and their approximate cover, function data including leaf litter and presence of hollow-bearing trees and regeneration, and any signs of disturbance. The data collected in these rapid assessment points was consistent with the data collected in the vegetation integrity plot in 1082_Moderate_Distrubed, indicating that this plot adequately reflects the vegetation across this vegetation zone.

Vegetation within the site investigation area was assigned to a PCT using the BioNet Vegetation Classification data collection (DPIE, 2020c). Assignment to a PCT was based on the observed species composition, landscape position and underlying geology and soils recorded during field surveys. In some instances, mapped PCTs may not directly correlate to published mapping, as mapping for the proposal is on a localised scale, as opposed to regional, and is supported by on ground observations and quantitative data. Similarly, the boundaries of each vegetation zone may change over time as these are based on both the PCT and the broad condition of vegetation, which is dynamic.

Species recorded in the site investigation area should be treated as an indication of species presence at the time of field surveys, not a fully comprehensive list, as some species are only present or apparent at certain times of the year (eg annual herbs and grasses). Further, some species require specific conditions for optimum detection. For example, orchid species in the *Calochilus*, *Pterostylis* and *Cryptostylis* genera flower at specific times and can remain cryptic at all other times throughout the year.

The conclusions of this report are based upon available data and field surveys and are therefore indicative of the environmental condition of the site investigation area and wider study area at the time of the survey. It should be recognised that conditions, including the presence of threatened species, could change with time. To address this limitation, a precautionary approach has been used which aimed to identify the presence and suitability of the habitat for threatened species (Section 2.5.1, Annexure B).

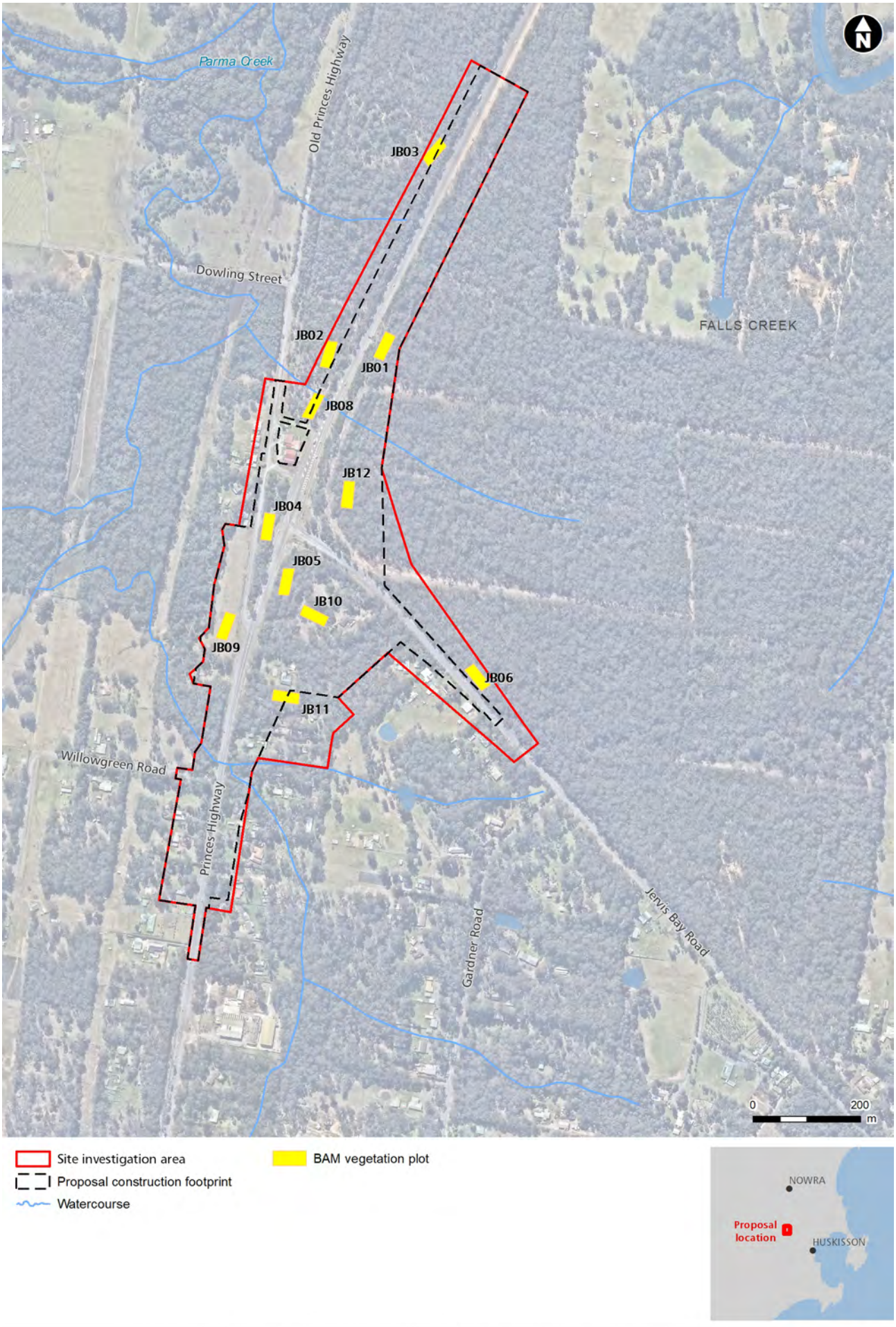


Figure 2-2: Vegetation survey locations

2.4.2 Targeted flora surveys

Targeted flora surveys were undertaken over four days in October 2020, four days in December 2020, two days in March 2021 and three days in April 2021. This ensured that species were surveyed during their time of optimal detectability, and surveys adhered to the timing requirements as detailed in the Threatened Species Profile Database (DPIE, 2020b) for each targeted flora species.

These surveys follow the methods described in the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft (*DEC, 2004) and with reference to the *NSW Surveying threatened plants and their habitats* (DPIE, 2020a) and the *Draft survey guidelines for Australia's threatened orchids* (DoE, 2013). Surveys comprised of parallel field traverses. Targeted flora surveys were completed for all threatened flora species with a 'moderate' or 'high' likelihood of occurrence in the site investigation area within areas of potential habitat. Survey effort and threatened flora targeted during field surveys are summarised in **Table 2-7**. Locations of threatened species surveys are displayed in **Figure 2-3.**

2.4.2.1 Parallel field traverses

Areas of potential habitat for threatened flora species considered likely to occur within the site investigation area were surveyed using the parallel field traverse technique. This survey technique consists of walking in parallel traverses using both a GPS and tablet. The spacing between traverses is determined in accordance with Table 1 of the *NSW Surveying threatened plants and their habitats* (DPIE, 2020a) which specifies that a five metre spacing is appropriate for surveying herbs and forbs in dense vegetation. This spacing is considered to be the most appropriate for the site investigation area, however it was expanded to 10 metre spacing in areas of open vegetation. The timing of the surveys adhere to the survey timing requirements as detailed in the Threatened Species Profile Database (DPIE, 2020b) for each targeted flora species.

2.4.2.2 Reference populations

Cryptic species are species which are difficult to detect and/or distinguish from other species. For cryptic species considered likely to occur within the site investigation area, such as the orchid species, *Pterostylis gibbosa* and *Pterostylis vernalis*, the field survey included visiting a reference population to identify the flowering time. Threatened Species Officers from the Department of Planning, Industry and the Environment were also consulted to provide advice on species' microhabitat and confirm flowering time for species where reference populations could not be visited. By surveying during flowering times, survey times were optimised, as the detectability of the plant was increased. Reference populations of four different orchid species were visited to confirm the species were in flower immediately prior to undertaking targeted surveys within the site investigation area. These reference populations included a population of *Pterostylis gibbosa* in Albion Park (**Photograph 1**), a population of *Pterostylis vernalis* (**Photograph 2**) in West Nowra, a population of *Cryptostylis hunteriana* in Worrowing Heights, and populations of *Pterostylis ventricosa* in Falls Creek and St Georges Basin.

Brian Towle, an expert as recognised by DPIE for the threatened orchids *Calochilus pulchellus, Pterostylis ventricosa* and *Genoplesium baueri* was also engaged to provide advice and assist in surveys for these species to inform this assessment. This is detailed further in section 2.5.1.

Reference populations for the Green and Golden Bell Frog will also be visited during targeted surveys for the species. This will ensure surveys are conducted when individuals within the locality are calling, thus enhancing the likelihood they are detected if present within the site investigation area.

Photograph 1: *Pterostylis gibbosa* in flower at a reference population in Albion Park

Photograph 2: *Pterostylis vernalis* at a reference population near Nowra

2.4.3 Targeted fauna surveys

Targeted fauna surveys were undertaken for all threatened fauna species considered to have a 'moderate' or 'high' likelihood of occurrence in the site investigation area, based on the combined results of background research and the site habitat assessment. Surveys for Green and Golden Bell Frog will be undertaken between November 2021 and March 2022 in accordance with the NSW Guide for Threatened Frogs (DPIE, 2020d) and with reference to the Commonwealth Survey Guidelines for Australia's Threatened Frogs (DEWHA, 2010).

Targeted fauna surveys were designed to address the requirements outlined in the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft* (DEC, 2004). The following guidelines were also used to determine appropriate survey requirements for threatened fauna:

- Threatened Species Assessment Guidelines: the assessment of significance (DECC, 2007)
- Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (DoE, 2013)
- Survey guidelines for Australia's threatened mammals: guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (CoA, 2011)
- EPBC Act referral guidelines for the vulnerable koala (CoA, 2014)
- Species credit' threatened bats and their habitats: NSW survey guide for the Biodiversity Assessment Method (OEH, 2018a)
- Survey guidelines for Australia's threatened birds: guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (CoA, 2010a)
- Survey guidelines for Australia's threatened bats: guidelines for detecting bats listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (CoA, 2010b).
- NSW Survey Guide for Threatened Frogs (DPIE, 2020d)

Methodologies applied for each targeted threatened fauna species within the site investigation area are described below. Survey effort and threatened fauna targeted during field surveys are summarised in **Table 2-8**. Locations of threatened species surveys are displayed in **Figure 2-3**.

2.4.3.1 Fauna habitat assessment

Fauna habitat assessments were initially conducted across the site investigation area. Survey for the following fauna habitat features was carried out:

- Vegetation type, structure and extent
- Wetlands, watercourses, natural and artificial ponds, dams, soaks and drainage channels
- Adjacent habitats and barriers (natural or artificial) between the site investigation area and adjacent lands
- Forage trees including blossom and fruit trees for birds and Grey-headed Flying-fox (*Pteropus poliocephalus*) (listed as vulnerable under the BC Act and EPBC Act), feed trees for Koala (*Phascolarctos cinereus*) (listed as vulnerable under the BC Act and EPBC Act) and *Allocasuarina* spp. for Glossy Black-Cockatoo (*Calyptorhynchus lathami*) (listed as vulnerable under the BC Act)
- Caves and cliffs
- Artificial microbat roosts (culverts, bridges, tunnels, buildings and mine adits)
- Terrestrial shelter habitat such as coarse woody debris, rocky outcrops and artificial shelter (ie corrugated iron sheets, building refuse, rubbish) for invertebrates, amphibians, reptiles and small terrestrial mammals.

During fauna habitat assessments, the following general fauna surveys were also undertaken to detect threatened species and/or important fauna habitat:

- **Hollow-bearing tree surveys:** hollow-bearing trees were recorded opportunistically across the site investigation area to detect potential sheltering, roosting and/or breeding habitat for threatened and non-threatened fauna. Hollow-bearing tree surveys involved traversing the site investigation area and identifying tree hollows with the naked eye and binoculars. Hollow size and the position of the hollow on the tree (eg branch, trunk) was recorded. Signs of fauna occupation, tree species, diameter at breast height, and whether it was living, or a stag were also noted.
- **Canopy searches:** canopy searches were undertaken opportunistically across the site investigation area to detect presence of threatened fauna (in addition to targeted surveys, see below). Canopy searches were also undertaken to detect the presence of important fauna habitat features such as large stick nests. Canopy searches involved traversing the site investigation area and inspecting the canopy of trees with the naked eye and binoculars. Signs of fauna occupation and presence of fauna habitat features (eg nests) were noted.

2.4.3.2 Incidental diurnal fauna surveys

Field surveys also included incidental searches for indirect evidence of fauna, such as scats, nests, burrows, tracks, scratches, chewed cones and diggings. Incidental diurnal fauna surveys also involved recording all fauna species opportunistically seen or heard during surveys (Annexure A).

2.4.3.3 Diurnal bird surveys

Diurnal bird surveys were conducted across the site investigation area in areas of suitable habitat (determined through habitat assessment surveys) to detect threatened and non-threatened birds. Diurnal bird surveys involved a 20 minute point survey and/or two hectare area search detecting species by visual observation (eg through binoculars) and/or call. In addition, species opportunistically seen or heard, or signs of occupancy (eg nests) were recorded while traversing the site investigation area.

2.4.3.4 Diurnal roost searches

Diurnal roost searches were conducted across the site investigation area to identify roosting and/or breeding habitat for the Grey-headed Flying-fox. The site investigation area was traversed to identify individuals and/or potential habitat. Initial database searches were also undertaken to identify breeding camps. No breeding camps were located within the site investigation area or proposal construction footprint.

2.4.3.5 Stag-watching surveys

Stag-watching surveys were conducted at three sites within the site investigation area (with a total of five hollow-bearing trees (**Photograph 3**)). Sites were selected as they contained hollow-bearing trees that classified as potential nest sites for targeted species. Specifically, for cockatoos, trees selected for stag-watching were above eight metres, with stems above 30 centimetres diameter and angled at least 45 degrees and hollows above 15 centimetres diameter. Suitable stag-watching trees for owls contained hollows above 20 centimetres diameter. Stag-watching surveys were conducted over five nights and three survey periods (August, October and December 2020) to identify potential nesting hollows and target breeding Glossy Black-Cockatoo, Gang-gang Cockatoo (*Callocephalon fimbriatum*), Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*) (**Figure 2-3**). Stag-watching involved observing potentially occupied hollow-bearing trees 30 minutes prior to sunset and continuing until 60 minutes after sunset. Species were identified by visual observation (eg through binoculars, by spotlight) and/or call. Where possible, wet and windy conditions were avoided.

Photograph 3: Examples of hollow-bearing trees within the site investigation area targeted for stag-watching surveys

2.4.3.6 Spotlighting surveys

Spotlighting surveys were conducted for a minimum of 30 minutes and a maximum of two hours over ten nights across the site investigation area. Spotlighting surveys were undertaken in August, October and December 2020 (**Figure 2-3**). Spotlighting surveys involved two people searching on-foot for animals using a hand-held spotlight to detect movement and/or eye-shine (ie reflection of light back from the animals' eyes). Specific habitat for threatened birds, mammals and reptiles were targeted, including hollow-bearing trees, potential foraging sites (ie around waterbodies, on rocky outcrops) and sheltering sites (ie under rocks, in crevices). Species were identified by visual observation (eg through binoculars, by spotlight) and/or call. Where possible, wet and windy conditions were avoided.

2.4.3.7 Call play-back surveys

Call play-back surveys were conducted at 15 sites across the site investigation area over eight nights to identify threatened nocturnal birds and mammals, including Barking Owl, Powerful Owl, Masked Owl, Sooty Owl, Bush-stone Curlew (*Burhinus grallarius*), Yellow-bellied Glider (*Petaurus australis*), Greater Glider (*Petaurus volans*), Squirrel Glider (*Petaurus norfolcensis*) and Koala (**Figure 2-3**). Call play-back surveys involved listening for calls of target species for 10 to 15 minutes in the early evening, followed by spotlighting for 10 minutes. Call play-back for each species was then undertaken intermittently for five

minutes, followed by a 10 minute listening period. After all calls had been played, spotlighting and listening for calls was undertaken for 10 minutes. Where possible, wet and windy conditions were avoided.

2.4.3.8 Ultrasonic call detector (Anabat) surveys

Ultrasonic call detector (Anabat) surveys were conducted at two sites within the site investigation area. Two 'Anabat Express' (Titley Pty Ltd) detectors were deployed within areas of suitable habitat (determined through habitat assessment surveys) to target threatened microchiropteran (microbat) species, including Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Southern Myotis (*Myotis macropus*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Little Bent-winged Bat (*Miniopterus australis*) and Large Bent-winged Bat (*Miniopterus orianae oceanensis*). Two Anabat units were deployed for 14 nights (a total of 28 detector nights) in December 2020. Detailed methodology and results of targeted microbat surveys are included in Annexure G.

2.4.3.9 Baited camera trap surveys

Baited camera trap surveys were conducted over two survey periods in October and December 2020. Baited camera traps (**Photograph 4**) were deployed within areas of suitable habitat (determined through habitat assessment surveys) to target Eastern Pygmy-possum (*Cercartetus nanus*), Long-nosed Potoroo (*Potorous tridactylus*), New Holland Mouse (*Pseudomys novaehollandiae*), Southern Brown Bandicoot (*Isoodon obesulus obesulus*), Spotted-tailed Quoll (*Dasyurus maculatus*) and White-footed Dunnart (*Sminthopsis leucopus*) (**Figure 2-3**). A total of ten cameras were deployed for a minimum of two surveys, each of 14 day duration, and timed at least one month apart (October and December 2020). Initial surveys (October 2020) used the 'AlfaView 1080P HD Game and Hunting Camera' and surveys in December 2020 used 'Browning Dark Ops Pro 6PXD' trail cameras. Cameras targeting Eastern Pygmy-possum were deployed up to two metres above the ground in high density nectar areas, facing naturally occurring bait (ie *Banksia* flowers). Cameras targeting Long-nosed Potoroo, New Holland Mouse and Southern Brown Bandicoot were deployed up to 30 centimetres above the ground near potential habitat resources, including burrows, shrubs, near diggings or waterbodies, and used baits comprised of a mixture of rolled oats, peanut butter and honey. Cameras targeting Spotted-tailed Quoll and White-footed Dunnart were deployed up to 30 centimetres above the ground near potential burrows, den and latrine sites, rocky outcrops, ridges and crevices, and used baits comprised of a mixture of sardine oil and flour. Varying degrees of tilt were utilised to optimise angle and view of the baited area and maximise species detection.

Photograph 4: Examples of baited camera traps set-up within the site investigation area

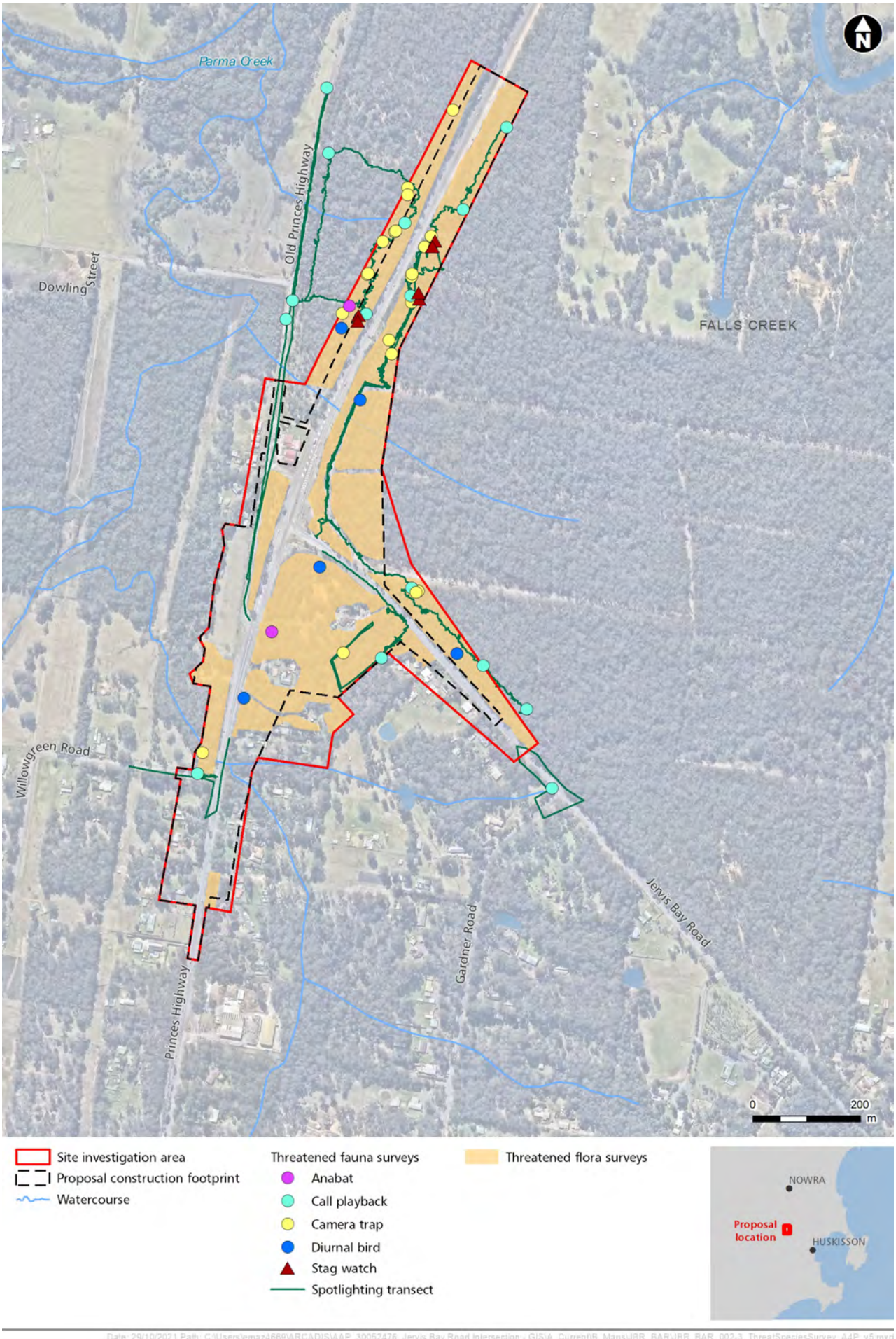


Figure 2-3: Threatened species survey locations

2.4.4 Aquatic surveys

Habitat condition assessment and waterway classification were undertaken at aquatic habitats across the site investigation area (Figure **2-4**). This included three unnamed tributaries of Parma Creek, drainage lines and constructed dams recorded within the site (**Photograph 5**).

At each survey location, attributes of the waterway or dam were collected, including:

- The ecosystem type (eg wetlands, floodplains, streams, estuaries, lakes)
- Dimensions of waterway and depth of water
- Flow characteristics and hydrological features of aquatic habitat, including changes to drainage and filtration and flow regime
- Bed substrate (eg rocks, coral, gravel, sand, mud)
- Habitat features (eg pools, riffles, billabongs, reefs)
- Existing infrastructure and barriers to fish movement (natural or artificial)
- Width and species composition of riparian vegetation including the type of vegetation present (eg macrophytes, snags, seaweeds, seagrasses, mangroves, saltmarsh) and condition
- Water quality (based on visual observation).

Survey data collected was also in accordance with the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge, 2003).

The habitat value of each waterway within the site investigation area is characterised and detailed in Section 3.1.3.

Photograph 5: A tributary of Parma Creek and a drainage line recorded within the site investigation area

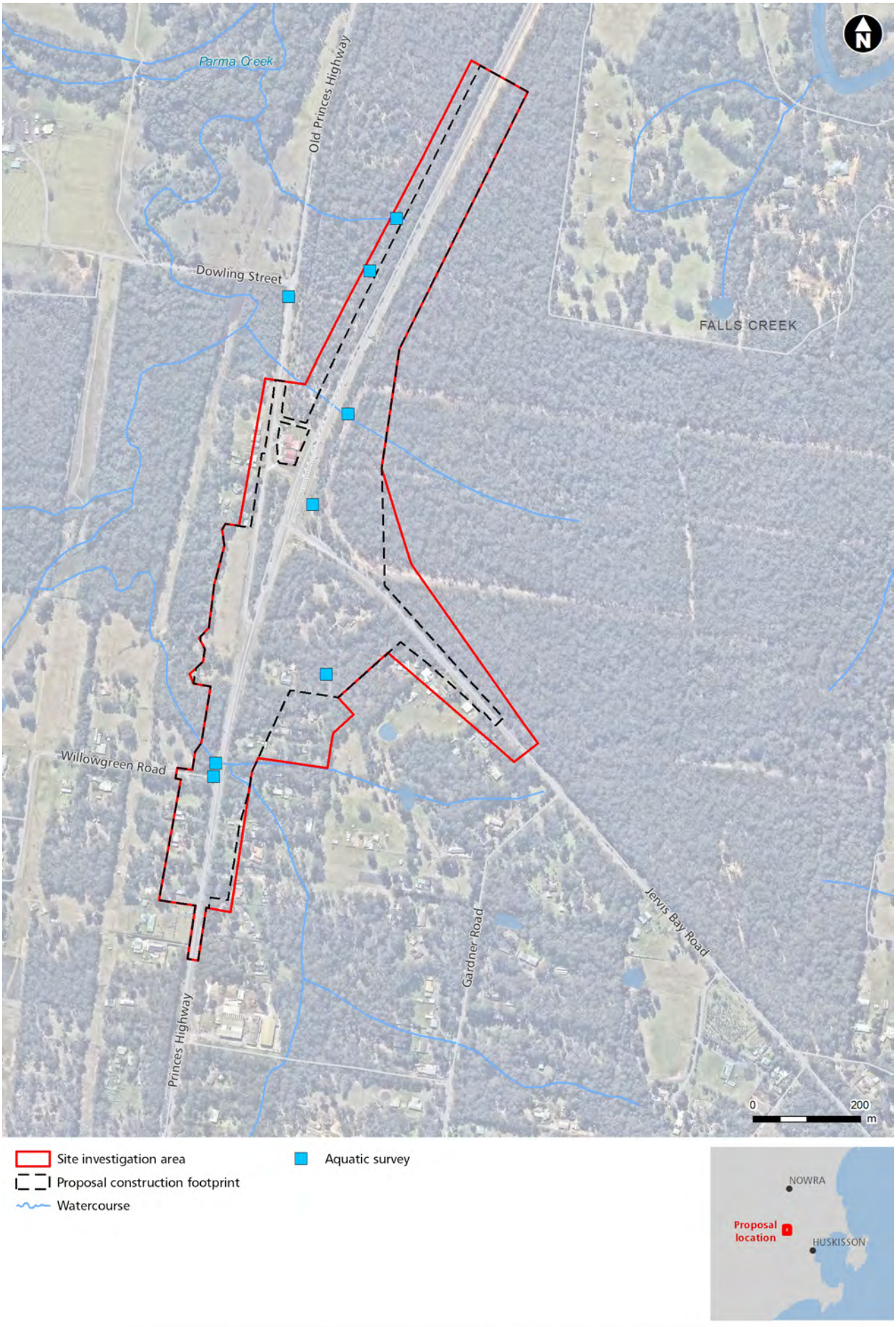


Figure 2-4: Aquatic survey locations

2.5 Summary of threatened species survey effort

Survey effort conducted for threatened species within the site investigation area, including relevant survey guidelines, methodologies, effort and timing, is summarised for threatened flora and threatened fauna in **Table 2-7** and **Table 2-8** respectively.

Table 2-7: Targeted threatened flora species survey details

Scientific name **(common name)**	**BC Act status**	**EPBC Act status**	**Minimum survey requirements**[1]	**Associated PCTs**	**Survey method**	**Seasonal survey requirements**	**Survey timing**	**Adequacy against guidelines**
Acacia bynoeana (Bynoe's Wattle)	E	V	Parallel field traverses. For a small shrub in dense vegetation the recommended maximum distance between field traverses is 10 metres, in open vegetation it is 15 metres.	PCT 1082	Parallel field traverses at five metres spacing	All year (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate
Caladenia tessellata[2] (Thick Lip Spider Orchid)	E	V	Parallel field traverses. For a forb in dense vegetation the recommended maximum distance between field traverses is five metres, in open vegetation it is 10 metres.	PCT 1082	Parallel field traverses at five metres spacing	September – October (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate
Calochilus pulchellus (Pretty Beard Orchid)	E	-	Parallel field traverses. For a forb in dense vegetation the recommended maximum distance between field traverses is five metres, in open vegetation it is 10 metres.	PCT 1082	Parallel field traverses at five metres spacing	October – November (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate
Eucalyptus langleyi[2] (Albatross Mallee)	V, EP	V	Parallel field traverses. For a mallee tree in dense vegetation the recommended maximum distance between field traverses is 20 metres, in open vegetation it is 40 metres.	PCT 1082	Parallel field traverses at five metres spacing	All year (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate

Scientific name (common name)	BC Act status	EPBC Act status	Minimum survey requirements[1]	Associated PCTs	Survey method	Seasonal survey requirements	Survey timing	Adequacy against guidelines
Galium australe[2] (Tangled Bedstraw)	E	-	Parallel field traverses. For a forb in dense vegetation the recommended maximum distance between field traverses is five metres, in open vegetation it is 10 metres.	PCT 1326	Parallel field traverses at five metres spacing	October – February (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate
Hibbertia puberula	E	-	Parallel field traverses. For a small shrub in dense vegetation the recommended maximum distance between field traverses is 10 metres, in open vegetation it is 15 metres.	PCT 1082	Parallel field traverses at five metres spacing	October – December (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate
Melaleuca biconvexa (Biconvex Paperbark)	V	V	Parallel field traverses. For a medium shrub in dense vegetation the recommended maximum distance between field traverses is 10 metres, in open vegetation it is 20 metres.	PCT 1326	Parallel field traverses at five metres spacing	All year (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate
Pterostylis gibbosa (Illawarra Greenhood)	E	E	Parallel field traverses. For a forb in dense vegetation the recommended maximum distance between field traverses is five metres, in open vegetation it is 10 metres.	PCT 1326	Parallel field traverses at five metres spacing	September – October (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate
Pterostylis vernalis[2]	CE	CE	Parallel field traverses. For a forb in dense vegetation the recommended maximum distance between field traverses is five metres, in open vegetation it is 10 metres.	PCT 1082 PCT 1326	Parallel field traverses at five metres spacing	August – October (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate

Scientific name (common name)	BC Act status	EPBC Act status	Minimum survey requirements[1]	Associated PCTs	Survey method	Seasonal survey requirements	Survey timing	Adequacy against guidelines
Triplarina nowraensis[2] (Nowra Heath Myrtle)	E	E	Parallel field traverses. For a small shrub in dense vegetation the recommended maximum distance between field traverses is 10 metres, in open vegetation it is 15 metres.	PCT 1082	Parallel field traverses at five metres spacing	All year (DPIE, 2020b)	06, 07, 08, 09 October 2020	Adequate
Cryptostylis hunteriana (Leafless Tongue Orchid)	V	V	Parallel field traverses. For a forb in dense vegetation the recommended maximum distance between field traverses is five metres, in open vegetation it is 10 metres.	N/A	Parallel field traverses at five metres spacing	November – January (DPIE, 2020b)	15, 16, 17, 18 December 2020	Adequate
Pterostylis ventricosa	CE	-	Parallel field traverses. For a forb in dense vegetation the recommended maximum distance between field traverses is five metres, in open vegetation it is 10 metres.	PCT 1082	Parallel field traverses at five metres spacing	March – May (DPIE, 2020b)	13, 14, 20 April 2021	Adequate
Genoplesium baueri (Bauer's Midge Orchid)	E	E	Parallel field traverses. For a forb in dense vegetation the recommended maximum distance between field traverses is five metres, in open vegetation it is 10 metres.	PCT 1082	Parallel field traverses at five metres spacing	February – March (DPIE, 2020b)	08, 09 March 2021	Adequate

V = Vulnerable, E = Endangered, CE = Critically Endangered, EP = Endangered Population

1. Based on recommended survey guidelines.

2. Some flora species were found to only have marginal suitable habitat present in the site investigation area despite having a high number of records in the study area and locality. Planned targeted surveys for species with a moderate or high likelihood of occurrence overlapped with the recommended survey effort for these species. As such, these species have been included opportunistically within existing targeted surveys.

Table 2-8: Targeted threatened fauna species survey details

Species	BC Act status	EPBC Act status	Minimum survey requirements[1]	Seasonal survey requirements	Survey method	Survey effort	Survey timing	Adequacy against guidelines
Woodland birds Superb Fruit-Dove (Ptilinopus superbus), Gang-gang Cockatoo, Glossy Black-Cockatoo, Little Lorikeet, Dusky Woodswallow (Artamus cyanopterus), Scarlet Robin (Petroica boodang), Flame Robin (Petroica phoenicea)[2], Freckled Duck (Stictonetta naevosa), Turquoise Parrot (Neophema pulchella), Eastern Ground Parrot (Pezoporus wallicus), Varied Sittella (Daphoenositta chrysoptera)	V	-	Area searches (two hectares), transects or 20 minute point surveys in the early morning or late afternoon in areas of suitable habitat. Detection by observation, call, nest hollows and/or indirect evidence (eg foraging signs, moulted feathers) (DEC, 2004, CoA, 2010a).	All year (DPIE, 2020b)	Diurnal bird	Five sites throughout the site investigation area in suitable habitat (heath and woodland).	19, 20, 21 August 2020 06, 07, 08, 09, 20, 21 October 2020 03, 04, 15, 16, 17, 18 December 2020 08, 09 March 2021	Adequate
Eastern Bristlebird (Dasyornis brachypterus)	E	E	Area searches (two hectares; nine hours across three days) in the early morning or late afternoon in areas of suitable habitat. Detection by observation and/or call (CoA, 2010a).	September – May (DPIE, 2020b)	Diurnal bird	Five sites throughout the site investigation area in suitable habitat (heath and woodland).	06, 07, 08, 09, 20, 21 October 2020 03, 04, 15, 16, 17, 18 December 2020	Adequate

Species	BC Act status	EPBC Act status	Minimum survey requirements[1]	Seasonal survey requirements	Survey method	Survey effort	Survey timing	Adequacy against guidelines
Swift Parrot (Lathamus discolor)[2]	E	CE	Area searches (two hectares; 20 hours across eight days) in the early morning or late afternoon in areas of suitable habitat. Detection by observation and/or call (CoA, 2010a).	March – September (peak March – July (DPIE, 2020b, CoA, 2010a))	Diurnal bird	Five sites throughout the site investigation area in suitable habitat (woodland).	19, 20, 21 August 2020 08, 09 March 2021	The Swift Parrot was included opportunistically within surveys[2]. No important areas are mapped within the site investigation area and there is only one record of the species from 2002 within the study area. Therefore, although survey effort does not meet the eight day survey requirement, surveys are considered adequate for assessment.
Regent Honeyeater (Anthochaera phrygia)	CE	CE	Area searches (two hectares; 20 hours across 10 days) in the early morning or late afternoon in areas of suitable habitat. Detection by observation and/or call (CoA, 2010a).	All year (DPIE, 2020b, CoA, 2010a)	Diurnal bird	Five sites throughout the site investigation area in suitable habitat (woodland).	19, 20, 21 August 2020 06, 07, 08, 09, 20, 21 October 2020 03, 04, 15, 16, 17, 18 December 2020 08, 09 March 2021	Adequate No important areas are mapped within the study area.

Species	BC Act status	EPBC Act status	Minimum survey requirements[1]	Seasonal survey requirements	Survey method	Survey effort	Survey timing	Adequacy against guidelines
Gang-gang Cockatoo (breeding)	V	-	Surveying for lone adult males from October to January or identifying potential nest sites (eucalypts with hollows at least nine metres above ground with hollow diameter 10 centimetres+) (DPIE, 2020b).	October – January (DPIE, 2020b) Wet and windy conditions avoided	Stag-watching	Observing three sites (five hollow-bearing trees) over three nights 30 minutes prior to sunset and continuing until 60 minutes after sunset (DEC, 2004).	06, 20 October 2020 03 December 2020	Adequate
Glossy Black-Cockatoo (breeding)	V	-	Surveying for lone adult males from April to August or identifying potential nest sites (eucalypts with hollows at least eight metres above ground with hollow diameter 15 centimetres+) (DPIE, 2020b).	April – August (DPIE, 2020b) Wet and windy conditions avoided	Stag-watching	Observing three sites (five hollow-bearing trees) over two nights 30 minutes prior to sunset and continuing until 60 minutes after sunset (DEC, 2004).	19, 20 August 2020	Adequate
Migratory birds White-throated Needletail (Hirundapus caudacutus), Fork-tailed Swift (Apus pacificus)	-	V (White-throated Needletail)	No standard survey techniques. DoE (2015) suggests surveying in the late afternoon and/or from elevated viewpoints (if present).	November – March (DoE, 2015)	Diurnal bird	Five sites throughout the site investigation area in suitable habitat (woodland).	03, 04, 15, 16, 17, 18 December 2020 08, 09 March 2021	Adequate

Species	BC Act status	EPBC Act status	Minimum survey requirements[1]	Seasonal survey requirements	Survey method	Survey effort	Survey timing	Adequacy against guidelines
Diurnal raptors White-bellied Sea-Eagle (Haliaeetus leucogaster), Square-tailed Kite (Lophoictinia isura), Little Eagle (Hieraaetus morphnoides)[2], Eastern Osprey (Pandion haliaetus)	V	-	Area searches (two hectares), transects or 20 minute point surveys in the early morning or late afternoon in areas of suitable habitat. Detection by observation, call, large stick nests and/or indirect evidence (eg prey remains, pellets, moulted feathers) (DEC, 2004, CoA, 2010a).	All year (optimal September – October (DPIE, 2020b))	Diurnal bird	Five sites throughout the site investigation area in suitable habitat (heath and woodland).	19, 20, 21 August 2020 06, 07, 08, 09, 20, 21 October 2020 03, 04, 15, 16, 17, 18 December 2020 08, 09 March 2021	Adequate
Nocturnal birds Barking Owl, Powerful Owl, Masked Owl, Sooty Owl, Bush Stone-curlew (Burhinus grallarius)[2]	V E (Bush Stone-curlew)	-	Nocturnal call detection, call play-back and observation followed by spotlighting in areas of suitable habitat (DEC, 2004).	All year (optimal September – December) (DPIE, 2020b) Wet and windy conditions avoided	Spotlighting and call play-back	Fifteen call play-back sites (across eight nights) and ten nights of spotlighting throughout the site investigation area in suitable habitat (heath and woodland).	19, 20 August 2020 (spotlighting only) 06, 07, 08, 20 October 2020 03, 15, 16, 17 December 2020	Adequate

Species	BC Act status	EPBC Act status	Minimum survey requirements[1]	Seasonal survey requirements	Survey method	Survey effort	Survey timing	Adequacy against guidelines
Owls (breeding) Barking Owl, Powerful Owl, Masked Owl, Sooty Owl	V	-	Identifying adult pairs or duetting adults or identifying potential nest sites (living or dead trees with hollows at least four metres above ground with hollow diameter 20 centimetres+) (DPIE, 2020b).	May – August (DPIE, 2020b) Wet and windy conditions avoided	Stag-watching	Observing three sites (five hollow-bearing trees) over two nights 30 minutes prior to sunset and continuing until 60 minutes after sunset (DEC, 2004).	19, 20 August 2020	Adequate
Arboreal mammals Yellow-bellied Glider (Petaurus australis), Greater Glider (Petauroides volans), Squirrel Glider (Petaurus norfolcensis)[2], Koala[2]	V	V (Greater Glider (EPBC only), Koala)	Nocturnal call detection, call play-back and observation followed by spotlighting in areas of suitable habitat (DEC, 2004).	All year (DPIE, 2020b) Wet and windy conditions avoided	Spotlighting and call play-back	Fifteen call play-back sites (across eight nights) and ten nights of spotlighting throughout the site investigation area in suitable habitat (heath and woodland).	19, 20 August 2020 (spotlighting only) 06, 07, 08, 20 October 2020 03, 15, 16, 17 December 2020	Adequate
Grey-headed Flying-fox	V	V	Desktop search, habitat assessment and diurnal searches for camps and roosting habitat. Nocturnal call detection and observation followed by spotlighting surveys in areas of suitable habitat (DEC, 2004, CoA, 2010b).	All year (optimal October – December) (DPIE, 2020b)	Diurnal roost search Spotlighting	Diurnal searches and habitat assessment. Ten nights of spotlighting throughout the site investigation area in suitable habitat (heath and woodland).	19, 20 August 2020 06, 07, 08, 20 October 2020 03, 15, 16, 17 December 2020	Adequate

Species	BC Act status	EPBC Act status	Minimum survey requirements[1]	Seasonal survey requirements	Survey method	Survey effort	Survey timing	Adequacy against guidelines
Terrestrial mammals Eastern Pygmy-possum, Long-nosed Potoroo[2], New Holland Mouse, Southern Brown Bandicoot, Spotted-tailed Quoll, White-footed Dunnart[2]	V E (Southern Brown Bandicoot)	V (Long-nosed Potoroo, New Holland Mouse (EPBC only)) E (Southern Brown Bandicoot, Spotted-tailed Quoll)	Placement of baited camera traps in areas of suitable habitat. Minimum of two surveys, each of 14 days duration, and timed at least one month apart (baits comprising natural resources, standard bait and meat bait depending on target species) (DEC, 2004) (CoA, 2011).	October – March (optimal October – December) (DPIE, 2020b)	Baited camera trap	Ten camera traps deployed for 14 nights across two survey periods (total of 28 nights) in areas of suitable habitat (heath and woodland).	06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 October 2020 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16 December 2020	Adequate
Microbats Yellow-bellied Sheathtail-bat, Eastern Coastal Free-tailed Bat, Large-eared Pied Bat, Southern Myotis, Eastern False Pipistrelle, Greater Broad-nosed Bat, Little Bent-winged Bat, Large Bent-winged Bat	V	V (Large-eared Pied Bat)	Placement of Anabats in woodlands, valley floors, riparian areas, and relatively fertile parts of the study area (where possible) for a total of 16 detector nights (ie four Anabats, four nights) (DEC, 2004) (CoA, 2010) (OEH, 2018).	December – January (DPIE, 2020b)	Ultrasonic call detector (Anabat)	Two Anabat units deployed for 14 nights (total of 28 detector nights) at two sites in areas of suitable habitat (heath and woodland).	03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16 December 2020	Adequate

Species	BC Act status	EPBC Act status	Minimum survey requirements[1]	Seasonal survey requirements	Survey method	Survey effort	Survey timing	Adequacy against guidelines
Green and Golden Bell Frog	E	V	Aural-visual (4 surveys) or acoustic recorder (14 days) surveys can be completed along the edges of suitable breeding habitat or, if feasible, through shallow wetlands. Tadpole surveys can be used to replace up to two of the aural-visual surveys. Tadpole searches should target areas of shallow and open water where the tadpoles are likely to congregate.	November – March (DPIE, 2020d)	Combination of survey techniques	4 nights	November 2021 – March 2022	Anticipated to be adequate

V = Vulnerable, E = Endangered, CE = Critically Endangered

1. Based on recommended survey guidelines.

2. Habitat assessments identified potential habitat for threatened species within the site investigation area but BioNet records indicated that the species were unlikely to occur due to a low number of records and/or historical records (ie over 20 years old) within the study area. Planned targeted surveys for species with a moderate or high likelihood of occurrence overlapped with the recommended survey effort for these species. As such, these species have been included opportunistically within existing targeted surveys.

2.5.1 Threatened species survey limitations

Field surveys and survey effort met the requirements of the Biodiversity Assessment Method and relevant guidelines. As some threatened flora species can remain cryptic throughout the year, such as species in the *Calochilus*, *Pterostylis* and *Cryptostylis* genera, reference sites and populations were visited where possible to determine the possibility of detection within the site investigation area, and ensure surveys were conducted at the optimal time of year.

As some species are only present or apparent at certain times of the year (eg migratory birds), species recorded in the site investigation area and proposal construction footprint should be treated as an indication of species presence at the time of field surveys, not a fully comprehensive list. Further, some species require specific conditions for optimum detection. For example, owls can be detected year-round however the optimal seasonal timing to detect breeding is between May and August, during nesting. In addition, peak activity periods for fauna can also be correlated with weather conditions (eg higher activity levels for the Southern Brown Bandicoot is associated with higher levels of rainfall).

The conclusions of this report are based upon available data and field surveys and are therefore indicative of the environmental condition of the site investigation area at the time of the survey. It should be recognised that conditions, including the presence of threatened species, could change with time. To address this limitation, a precautionary approach has been used which aimed to identify the presence and suitability of the habitat for threatened species (Annexure B).

Access restrictions

In some areas, seasonal surveys were constrained by access restrictions. As a result, not all threatened flora species initially identified as having potential to occur within the site investigation area were surveyed within their required survey timing in particular areas.

To overcome this limitation, the vegetation within these lots was initially assessed using data gathered from a preliminary survey on the lots to identify potential habitat and refine the list of threatened flora species considered moderately or highly likely to occur on the lots. Following this preliminary assessment, two threatened flora species, *Calochilus pulchellus* and *Genoplesium baueri* were identified as having potential to occur within these lots but due to access restrictions could not be surveyed during the required survey timing. To overcome this, Brian Towle, an expert for *Calochilus pulchellus* and *Genoplesium baueri* as approved by DPIE, was engaged to provide further advice on the species and assess the habitat on the lots. This advice is provided in Annexure E. The areas with access restrictions were also surveyed outside the survey period for *Calochilus pulchellus* and *Genoplesium baueri* which informed the habitat assessment for the two species.

3 Existing environment

3.1 Landscape features

This section describes the landscape scale characteristics of the site investigation area.

3.1.1 Landscape context

3.1.1.1 Interim Biogeographic Rationalisation for Australia bioregions and sub-regions

The site investigation area is located within the Jervis sub-region of the Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) bioregion.

The Jervis sub-region is situated along the coastal area between Nowra and Durras. The geology is dominated by Permian quartz sandstone and mixed shale and lithic sandstones. Soils consist of poor shallow sands on quartz sandstone plateaus, with deep texture contrast soils and loam topsoils found on coastal shales. Soils have moderate fertility, but valley floors are likely to be waterlogged, with organic sands and muds predominate in swamps and estuaries. Coastal barriers extend from clean dune sands to deep podsols in Pleistocene dunes. Characteristic landforms consist of west and south facing escarpments, sandstone plateaus and low hills. Waterfalls and gorges are present off the escarpment, with Pleistocene cliff top dunes and fresh lakes along the peninsula (Morgan, 2001).

3.1.1.2 NSW Landscape Regions (Mitchell Landscapes)

The site investigation area is largely situated within the Nowra-Durras Coastal Slopes Mitchell Landscape, with an area of Bherwerre Barrier mapped around the Jervis Bay Road and Princes Highway intersection, as mapped by the NSW National Parks and Wildlife Service (NPWS, 2002).

The Nowra-Durras Coastal Slopes are comparable to Dapto-Wollongong slopes but have a lower relief, undulating slopes and lower rainfall. Soils are dominated by Permian lithic sandstone and pebbly siltstone with yellow and yellow-red texture-contrast soils. General elevation is 20 to 80 metres, with a local relief of 30 metres (NPWS, 2002).

The Bherwerre Coastal Barrier comprises beach, dune and intermittently closed and open lagoon complexes of the South Coast. Soils consist of Quaternary quartz sand in dunes with muddy sands in lagoons. General elevation is zero to 15 metres, with local relief typically five to 10 metres. Coastal barriers extend from clean sand dunes to deep podsols in Pleistocene dunes (NPWS, 2002).

3.1.2 Soils and geology

Two soil landscapes are mapped within the site investigation area: Nowra and Shoalhaven (DPIE, 2020d). A majority of the site investigation area comprises the Nowra soil landscape, with an area in the central west of the site, surrounding the intersection, mapped as Shoalhaven. A small area of Disturbed Terrain has been mapped in the north-west of the site investigation area, near the proposal construction footprint boundary.

The Nowra soil landscape is characterised by moderately to gently undulating rises to low hills on Nowra Sandstone. Relief is typically above 40 metres, with slopes greater than five percent. The landscape contains broad ridges and crests, with benched sandstone outcrops adjacent to drainage lines. In general, tall open forest has been moderately to extensively cleared. Soils consist of moderately deep (50 to 100 centimetres) brown podzolic soils on crests and upper slopes, with soloths and/or yellow earths occurring on midslopes. Lower slopes and drainage lines typically contain yellow podzolic soils. Limitations of the Nowra soil landscape include run-on, localised rocky outcrops, localised shallow soils, stoniness, hard-setting, sodicity, low permeability and low wet-bearing strength in the subsoil (DPIE, 2020d).

The Shoalhaven soil landscape is typically level to gently undulating, containing riverbeds and banks. Active floodplains with levees and backwater swamps on alluvium are also

present. Relief is generally less than five metres with slopes less than three percent. Typically, the landscape is completely cleared. Soils comprises moderately deep (50 to 100 centimetres) prairie soils on levees, red earths and yellow and red podzolic soils on terraces, and alluvial and gleyed podzolic (potentially acid sulfate) soils occurring on the floodplain. The Shoalhaven soil landscape is limited by flood hazards, seasonal waterlogging, permanently high water tables, hard-setting, acid sulfate soils, sodicity and strong acidity (DPIE, 2020d).

Disturbed Terrain occurs within other landscapes, with varying topography. Original soils are likely to have been removed, greatly disturbed or buried and original vegetation completely cleared. Limitations are dependent on the nature of fill material and include subsidence resulting in mass movement hazards, lack of soil permeability (leading to poor drainage) and low fertility (DPIE, 2020d).

3.1.3 Rivers and streams

The site investigation area is situated within the overall catchment of Currambene Creek, one of a series of short streams which train the coastal strip of the South Coast of NSW. Another major tributary sub-catchment, known as Parma Creek, joins Currambene Creek upstream (ie to the west) of the Princes Highway. Three unnamed tributaries of Parma Creek lie within the proposal construction footprint, intersecting north-west, central and southern areas. Drainage lines and constructed dams were also recorded within the site investigation area.

Parma Creek lies approximately 270 metres to the west of the site investigation area and runs for approximately 16 kilometres between Yerriyong and Falls Creek, flowing in a north-east direction. Based on the Strahler method of stream ordering (Strahler, 1952) and using the *Water Management (General) Regulation 2018 Hydro Line spatial data* (DPI, 2018), Parma Creek is classified as a second order stream (downstream of the junction of two first order streams). The unnamed tributaries of Parma Creek are classified as first order streams (top of a catchment with headwater flow paths).

Currambene Creek lies approximately 700 metres northeast of the site investigation area and is classified as a third order stream (major permanently or intermittently flowing waterway) (Strahler, 1952) (DPI, 2018). Currambene Creek is a saline coastal lagoon with an intermittently closed entrance. Parts of the Creek are protected, including the estuary where it meets the bay (Currambene Creek Mudflats Sanctuary Zone) and the upper reaches of Currambene Creek upstream from a point west of Goodland Road (Upper Currambene Creek Sanctuary Zone). The Environment Protection Authority (EPA) recently released precautionary diet advice for six fish species within Currambene Creek, after testing recorded levels of PFAS (per and poly fluoroalkyl substances) (EPA, 2018).

3.1.3.1 Key Fish Habitat

No key fish habitat occurs in the site investigation area. The nearby Parma Creek and Currambene Creek are mapped as key fish habitat for the Shoalhaven area (DPI, n.d.).

The *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) outlines habitat types and sensitivity classes for assessing potential impacts of certain activities and developments on key fish habitat. These descriptions have been utilised for classifying key fish habitat that has been mapped as occurring within the site investigation area. **Table 3-1** outlines key fish habitat types and descriptions adapted from the guidelines. In addition to habitat type, the waterway class is also used to assess the functionality and determine the requirement to maintain long term fish passage. The criteria by which the waterway class is derived are outlined in **Table 3-2**.

Table 3-1: Key fish habitat types and descriptions (adapted from DPI, 2013)

Habitat type	Description
TYPE 1 – Highly sensitive key fish habitat	Posidonia australis (strapweed) Zostera, Heterozostera, Halophila and Ruppia species of seagrass beds more than five square metres in area Coastal saltmarsh more than five square metres in area Coral communities Coastal lakes and lagoons that have a natural opening and closing regime (ie are not permanently open or artificially opened or are subject to one off unauthorised openings) Marine park, an aquatic reserve or intertidal protected area SEPP coastal wetlands, wetlands recognised under international agreements (eg Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia Freshwater habitats that contain in-stream gravel beds, rocks greater than 500mm in two dimensions, snags greater than 300mm in diameter or 3m in length, or native aquatic plants Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act.
TYPE 2 – Moderately sensitive key fish habitat	Zostera, Heterozostera, Halophila and Ruppia species of seagrass beds less than five square metres in area Mangroves Coastal saltmarsh less than five square metres in area Marine macroalgae such as Ecklonia and Sargassum species Estuarine and marine rocky reefs Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (eg managed in line with an entrance management plan) Aquatic habitat within 100 metres of a marine park, an aquatic reserve or intertidal protected area Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1 Weir pools and dams up to full supply level where the weir or dam is across a natural waterway.
TYPE 3 – Minimally sensitive key fish habitat	Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna Coastal and freshwater habitats not included in TYPES 1 or 2 Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation.

Habitat type	Description
TYPE 4 – Not key fish habitat	First and second order streams on gaining streams (based on the Strahler method of stream ordering) Farm dams on first and second order streams or unmapped gullies Agricultural and urban drains Urban or other artificial ponds (eg evaporation basins, aquaculture ponds) Sections of stream that have been concrete-lined or piped (not including a waterway crossing) Canal estates.

Table 3-2: Classification of waterways for fish passage (adapted from DPI, 2013)

Class type	Description
CLASS 1 – Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (eg river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
CLASS 2 – Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.
CLASS 3 – Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (eg fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats.
CLASS 4 – Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free-standing water or pools post rain events (eg dry gullies or shallow floodplain depressions with no aquatic flora present).

While the three unnamed tributaries located within the site investigation area are mapped as key fish habitat they do not meet the definition of key fish habitat in accordance with the *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) as they are all classified as first order streams. Similarly, any drainage lines and/or dams within the site investigation area are not considered key fish habitat.

3.1.3.2 Wetlands

There are no natural wetlands present within the site investigation area, including wetlands listed under the *State Environment Planning Policy (Coastal Management) 2018* (Coastal Management SEPP) or important wetlands listed in the Directory of Important Wetlands in Australia (DIWA). Further, no wetlands of international importance (Ramsar) are located within or near the site investigation area. Artificial wetlands (ie farm dams, detention basins, roadside drains, effluent treatment systems) are scattered throughout the site investigation area.

The site lies within 50 metres of a Coastal Environment Area (ID 250) listed under the *State Environmental Planning Policy (Coastal Management) 2018*. The nearest Coastal Management SEPP coastal use and coastal environment zones are within Currambene

Creek and located about 300 metres and 40 metres northeast of the proposal, respectively. Further information is detailed in Section 1.2.5.1.

3.2 Regional vegetation mapping

The regional vegetation mapping *Compilation map: Biometric vegetation types of the Shoalhaven, Eurobodalla and Bega Valley local government areas. Version 2.1* (OEH, 2013) provides classification of native vegetation types across the Shoalhaven, Eurobodalla and Bega Valley local government areas, including the vegetation within the site investigation area.

This vegetation mapping identifies two Plant Community Types (PCTs) as occurring in the site investigation area, as shown in **Figure 3-1**. One of these vegetation types is listed as a Threatened Ecological Community (TEC) under the *Biodiversity Conservation Act 2016* (BC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). **Table 3-3** lists these PCTs, their status under the BC Act and EPBC Act, and their mapped extent within the site investigation area.

Table 3-3: Vegetation within the site investigation area from regional vegetation mapping (OEH, 2013).

PCT No.	PCT Name	BC Act status	EPBC Act status	Area within site investigation area (ha)
1082	Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion	-	-	14.48
1326	Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	Endangered	Critically Endangered	0.06
Total area of mapped vegetation				15.14

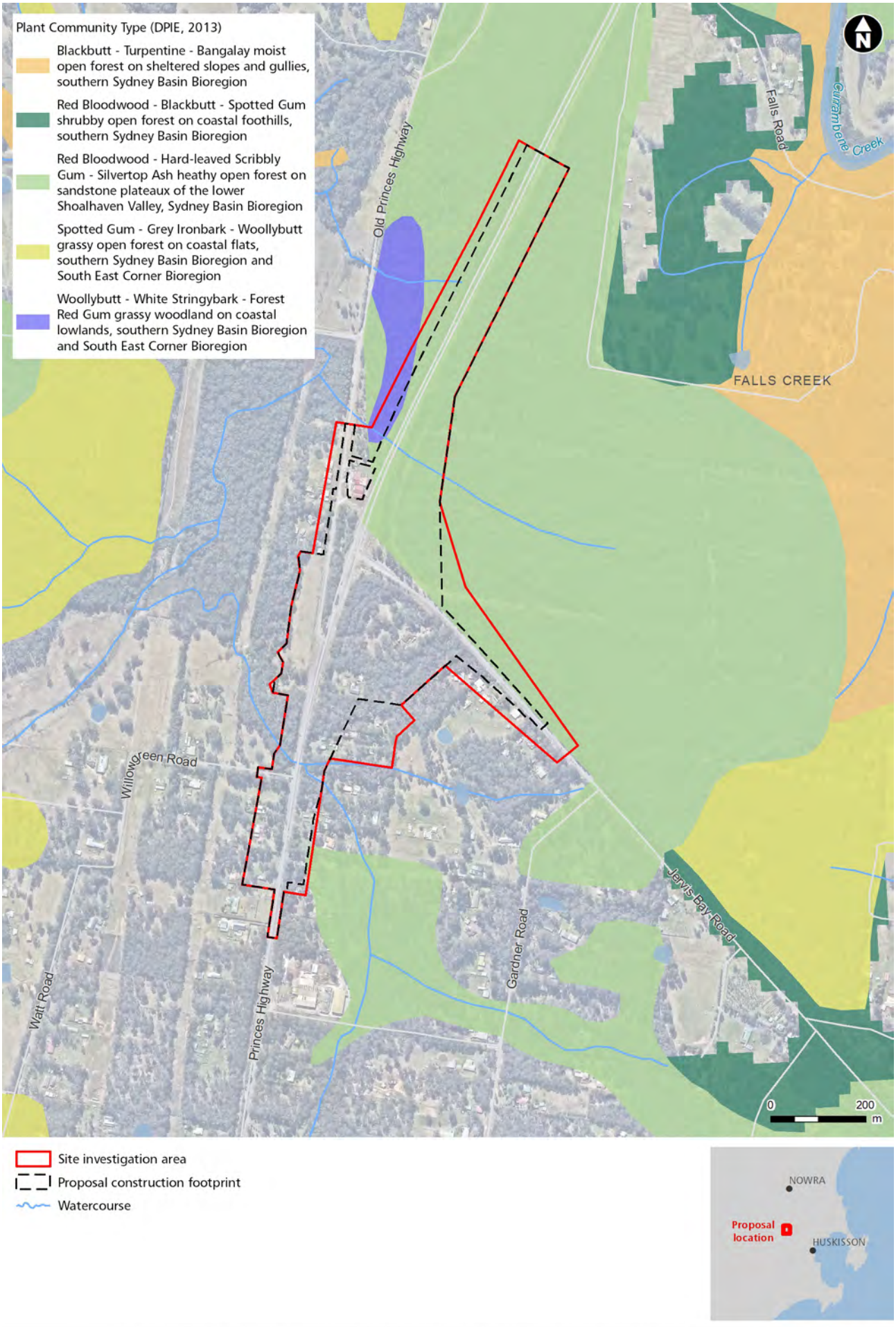


Figure 3-1: Regional vegetation mapping of the study area (DPIE, 2013)

3.3 Plant Community Types

Following the ground truthing of the vegetation in the site investigation area, it was confirmed that two PCTs occur within the site. The location of these PCTs is shown in the ground truthed vegetation mapping (**Figure 3-2**) and their extent within the site investigation area is listed in **Table 3-4**.

Table 3-4: PCTs within the site investigation area from ground-truthed vegetation mapping

PCT No.	PCT Name	Area within site investigation area (ha)
1082	Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion	14.98
1326	Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	6.24 (3.98 ha meets EPBC condition criteria)
Total		21.26

3.3.1 Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaus of the lower Shoalhaven Valley, Sydney Basin Bioregion (PCT 1082)

Vegetation formation: Dry Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: South East Dry Sclerophyll Forests

PCT: 1082

BVT: SR594

Other mapping sources: Compilation map: Biometric vegetation types of the Shoalhaven, Eurobodalla and Bega Valley local government areas. Version 2.1 **(OEH, 2013)**

Conservation status: N/A

Estimate of percent cleared: 20%

Condition: Poor to Good

Extent in the site investigation area: 14.98

Plots completed: Six (JB01, JB03, JB05, JB06, JB10, JB12)

Vegetation zone	Composition condition score	Structure condition score	Function condition score	Vegetation integrity score
1082_Good	74.4	88.1	57.8	75.5
1082_Moderate_ Disturbed	40.2	42.2	65.1	48
1082_Poor	45	15.3	24.1	25.5

Growth form	Typical species
Trees	*Corymbia gummifera, Eucalyptus racemosa, Allocasuarina littoralis*
Shrubs	*Lambertia formosa, Hakea sericea, Banksia spinulosa, Persoonia levis*
Grass and grass like	*Lepidosperma laterale, Lomandra multiflora, Lomandra obliqua, Caustis flexuosa, Entolasia stricta*
Forb	*Patersonia sericea, Hovea linearis, Lagenophora stipitata, Rhytidosporum procumbens*
Fern	N/A
Other	*Billardiera scandens, Xanthorrhoea sp.*
High threat weeds	*Andropogon virginicus, Asparagus aethiopicus, Lonicera japonica, Stenotaphrum secundatum*

Description: Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion (PCT 1082) is recognised as an open forest or woodland with an understorey of sclerophyll shrubs and a groundcover of sedges. The community is associated with sandstone plateau in the lower Shoalhaven area and occurs in elevations of up to 700 metres (DPIE, 2020c).

The canopy of PCT 1082 typically includes *Corymbia gummifera* (Red Bloodwood), *Eucalyptus racemosa* (Narrow-leaved Scribbly Gum) (previously *Eucalyptus sclerophylla* (Hard-leaved Scribbly Gum)) and *Eucalyptus sieberi* (Silvertop Ash) with a variety of other eucalypts such as *Eucalyptus piperita* (Sydney Peppermint) and *Eucalyptus consideniana* (Yertchuk) also present. The shrub layer is dominated by sclerophyll shrubs such as *Banksia spinulosa* (Hairpin Banksia), *Lambertia formosa* (Mountain Devil), *Hakea laevipes* and *Lomatia ilicifolia* (Holly Lomatia) while the ground layer typically contains a sparse cover of sedges (DPIE, 2020c).

Within the site investigation area, PCT 1082 is situated in the northern extent on both the east and west sides of the Princes Highway and in the eastern extent along Jervis Bay Road. This covers a total of 14.98 hectares. This area generally consists of the higher elevations across the site, between 30 and 40 metres, and the soil has a strong sandstone influence.

The canopy of this community is dominated by *Corymbia gummifera, Eucalyptus racemosa* and *Eucalyptus globoidea* (White Stringybark) with *Corymbia gummifera* becoming dominant in the higher elevations of the community, while *Angophora floribunda* (Rough-barked Apple) increases in abundance further south. *Eucalyptus punctata* (Grey Gum) is also present in the lower elevations of this PCT within the site investigation area. A diverse shrub layer (1.5 metres to four metres tall) is present, with *Lambertia formosa* often in high abundance, as well as *Hakea sericea, Banksia spinulosa, Kunzea ambigua* (Tick Bush), *Persoonia levis* (Broad-leaved Geebung) and *Leptospermum trinervium* (Slender Tea-tree).

The ground layer of PCT 1082 in the site investigation area is sparse and typically dominated by native graminoids such as *Lepidosperma laterale* (Variable Sword-sedge), *Lomandra multiflora* (Many-flowered Mat-rush) and *Caustis flexuosa* (Curly Wig). A sparse but diverse cover of forbs is also present including *Patersonia sericea* (Silky Purple-Flag), *Lagenophora stipitata* (Blue Bottle-daisy), *Xanthosia tridentata* (Rock Xanthosia) and *Hovea linearis.*

The areas of PCT 1082 within the site investigation area form three vegetation zones. Most areas of PCT 1082 within the site are in Good condition, while an area in the central section of the site investigation area is in Moderate_Disturbed condition. There is also a small area to the south-east of the intersection in Poor condition (Figure 3-2).

Areas of PCT 1082 in Good condition are dominated by native species in all strata with very few exotic species present (**Photograph 6**). PCT 1082 in Good condition in the site investigation area covers an area of 10.64 hectares.

The vegetation zone 1082_Moderate_Disturbed is dominated by native species with an intact canopy of *Eucalyptus racemosa, Angophora floribunda* and *Eucalyptus globoidea.* Understorey species are largely absent from this vegetation zone and are restricted to small patches of undisturbed vegetation. Surrounding these patches, the groundcover consists of a dense layer of mulch and is devoid of shrubs (**Photograph 7**). PCT 1082 Moderate_Disturbed condition in the site investigation area covers an area of 2.50 hectares.

The area of PCT 1082 in Poor condition has been subject to historical disturbances such as clearing and grazing by horses, as well as ongoing disturbances including mowing. As a result, this area has a sparse canopy cover and the shrub layer is generally absent (**Photograph 8**). Exotic species cover is also higher here, as a result of planted exotic trees and lawn grasses including *Stenotaphrum secundatum* (Buffalo Grass). PCT 1082 in Poor condition covers 1.84 hectares in the site investigation area.

PCT 1082 does not correspond to any TECs listed under the BC Act or EPBC Act.

Photograph 6: PCT 1082 at Plot 3 in the north-west of the site investigation area

Photograph 7: PCT 1082_Moderate_Disturbed with understorey species absent and a groundlayer consisting of mulch

Photograph 8: 1082_Poor at Plot 10, south east of the intersection

3.3.2 Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion (PCT 1326)

Vegetation formation: Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

PCT: 1326

BVT: SR669

Other mapping sources: Compilation map: Biometric vegetation types of the Shoalhaven, Eurobodalla and Bega Valley local government areas. Version 2.1 **(OEH, 2013)**

Conservation status: BC Act: endangered – forms Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion; EPBC Act: critically endangered – patches that meet size and condition thresholds form Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Estimate of percent cleared: 95%

Condition: Poor to Moderate

Extent in the site investigation area: 6.28 hectares (3.98 ha meets EPBC condition criteria)

Plots completed: Four (JB02, JB04, JB08, JB11)

Vegetation zone	Composition condition score	Structure condition score	Function condition score	Vegetation integrity score
1326_Moderate_ Woodland	68.8	58.7	29.7	49.3
1326_Moderate_ Garden	46.1	55.9	52.2	51.2
1326_Poor	17.9	42.2	38.3	30.7

Growth form	Typical species
Trees	*Eucalyptus longifolia, Eucalyptus globoidea, Eucalyptus botryoides, Eucalyptus tereticornis, Allocasuarina littoralis*
Shrubs	*Acacia mearnsii, Melaleuca decora, Leucopogon juniperinus, Kunzea ambigua, Pimelea linifolia*
Grass and grass like	*Microlaena stipoides, Entolasia stricta*
Forb	*Oxalis perennans, Pratia purpurascens, Veronica plebeia, Lagenophora stipitata, Brunoniella pumilio*
Fern	Adiantum aethiopicum
Other	*Parsonsia straminea, Glycine tabacina, Cassytha pubescens*
High threat weed	*Ehrharta erecta, Senecio madagascariensis, Asparagus aethiopicus*

Description: Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion (PCT 1326) is recognised as a grassy woodland typically occurring between the Illawarra and Moruya. The community is associated with flats below 100 metres above sea level with sandy loam soils and partially impeded drainage (DPIE, 2020c).

PCT 1326 typically has a canopy dominated by *Eucalyptus globoidea, Eucalyptus longifolia* (Woollybutt)*, Eucalyptus tereticornis* (Forest Red Gum) and *Corymbia maculata* (Spotted Gum). *Melaleuca decora* is often present in the shrub layer, as is *Pittosporum undulatum* (Sweet Pittosporum) and *Leucopogon juniperinus* (Prickly Beard-heath) while the ground layer is dominated by grasses including *Echinopogon caespitosus* (Bushy Hedgehog-grass), *Entolasia stricta* (Wiry Panic) and *Microlaena stipoides var. stipoides* (Weeping Grass) as well a range of forbs (DPIE, 2020c).

The largest areas of PCT 1326 in the site investigation area occur in the central section between the Princes Highway and the Old Princes Highway. Smaller patches also occur along the Princes Highway south of the Jervis Bay Road intersection and in a small patch in the eastern extent of the site investigation area along Jervis Bay Road (**Figure 3-2**). Most patches of PCT 1326 are located on areas mapped as consisting of quaternary alluvial deposits (Department of Regional NSW, 2009) and with an elevation of below 30 metres. The patch in the southern extent occurs on a higher elevation of approximately 40 metres. PCT 1326 within the site investigation area covers 6.28 hectares.

The canopy of PCT 1326 within the site investigation area is characterised by the presence of *Eucalyptus longifolia* and *Eucalyptus tereticornis* as well as the absence of *Corymbia gummifera* and scarce presence of *Eucalyptus racemosa.* Other dominant canopy species in PCT 1326 include *Eucalyptus globoidea* and *Eucalyptus botryoides* (Bangalay)*. Melaleuca decora* and *Acacia mearnsii* (Black Wattle) form a tall shrub layer throughout the PCT, while *Kunzea ambigua* and *Leucopogon juniperinus* is often present in the mid and small shrub layers. The ground layer of PCT 1326 varies across the site, from areas of dense leaf litter with a sparse but diverse cover of native grasses and forbs, to areas of high exotic and low native species cover.

PCT 1326 within the site investigation area forms three vegetation zones: 1326_Moderate_Woodland, 1326_Moderate_Garden and 1326_Poor.

The vegetation zone 1326_ Moderate_Woodland generally has a dense shrub layer and high cover and diversity of native species within the ground layer (**Photograph 9**). In comparison, areas of 1326_Moderate_Gardens are situated in the front and back yards of rural residential properties and are therefore subject to ongoing disturbances including mowing. As a result, they have a lower cover and diversity of native species and a sparse or absent shrub layer. However, 1326_Moderate_Gardens have several remnant large Eucalypts, including hollow-bearing trees and as a result these areas are also considered to be in moderate condition.

The vegetation zone 1326_Poor is also subject to ongoing disturbances including mowing and historical clearing, as well as grazing from livestock (**Photograph 10**). As a result, the shrub layer in these patches is often absent or sparsely present and the ground layer has a high cover of exotic species.

The 6.28 hectares of PCT 1326 within the site investigation area meets the description of the TEC Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion, as listed under the BC Act. Some patches of PCT 1326 also meet the size and condition threshold criteria for the TEC Illawarra and south coast lowland forest and woodland as listed under the EPBC Act. This is discussed further in Section 3.14.1.

Photograph 9: PCT 1326 in Good condition in the eastern extent of the site investigation area

Photograph 10: Plot JB08 in area of 1326_Poor regularly grazed by Highland Cattle

3.4 Other vegetation types

3.4.1 Exotic grassland

Extent in the site investigation area: 3.2

Plots completed: One (JB09)

Growth form	Typical species
Trees	N/A
Shrubs	N/A
Grass and grass like	*Stenotaphrum secundatum*, Anthoxanthum odoratum*, Cynodon dactylon, Briza maxima**
Forb	*Senecio madagascariensis*, Plantago lanceolata*, Taraxacum officinale*, Pratia purpurescens*
Fern	N/A
Other	N/A

* = exotic species

Description: Areas of exotic grassland are present to the west of the Old Princes Highway and within the stockpile site along Jervis Bay Road to the south of Gardner Road (**Figure 3-2)** (**Photograph 11**). This vegetation type covers a total of 3.2 hectares.

These areas are characterised by a groundcover dominated by exotic grasses, herbs and forbs and an absent canopy and shrub layer. Exotic grasses such as *Stenotaphrum secundatum* (Buffalo Grass) and *Anthoxanthum odoratum* (Sweet Vernal Grass) are dominant, while exotic forbs and herbs such as *Plantago lanceolata* (Plantain) and *Taraxacum officinale* (Common Dandelion) are also abundant. Native species are sparsely present and largely limited to *Pratia purpurescens* and *Cynodon dactylon*.

Historical aerial imagery shows these areas have been cleared from as early as 1949 and are not currently displaying signs of native regrowth. This is due to ongoing land use, grazing and maintenance activities, such as slashing and mowing, which prevent the regeneration of trees and shrubs in these cleared and disturbed areas.

This vegetation type is not representative of any PCT known from the Jervis subregion, nor does it conform with the definition of any TECs listed under the BC Act or EPBC Act.

Photograph 11: Exotic grassland to the west of the Old Princes Highway

3.4.1 Planted native/exotic vegetation and remnant trees

Extent in the site investigation area: 0.34

Plots completed: Nil

Growth form	Typical species
Trees	*Grevillea robusta, Salix sp.*, Eucalyptus racemosa, Eucalyptus globoidea, Eucalyptus punctata*
Shrubs	*Syzygium sp.*
Grass and grass like	*Stenotaphrum secundatum*, Pennisetum clandestinum*, Imperata cylindrica, Microlaena stipoides*
Forb	*Einadia hastata*
Fern	N/A
Other	*Glycine tabacina, Lonicera japonica**

* = exotic species

Description: Areas of planted native and exotic vegetation and remnant trees are scattered across the site investigation area in small patches, concentrated along Jervis Bay Road and the Princes Highway (**Figure 3-2**). This vegetation zone covers a total of 0.34 hectares in the site investigation area. As these patches are present in narrow strips and small patches which cross multiple properties, no plots were completed in this vegetation zone.

These patches are typically located in the front yards of properties and are characterised by the presence of a high number of planted exotic and non-locally native species. These include *Grevillea robusta* (Silky Oak), *Salix sp.* (Willow Tree) and *Syzygium sp.* (Lilly Pilly). Remnant Eucalypts including *Eucalyptus racemosa, Eucalyptus globoidea, Eucalyptus punctata* and *Eucalyptus longifolia* are also scattered throughout these areas (**Photograph 12**).

The ground cover in this vegetation zone is dominated by exotic lawn grasses including *Stenotaphrum secundatum* and *Pennisetum clandestinum* as well as cultivated exotics such as *Lonicera japonica.* Native groundcover species including *Imperata cylindrica, Glycine tabacina* and *Microlaena stipoides* are also present, with varying abundance across the patches.

While these patches contain some remnant native species characteristic of PCTs in the area, the vegetation has been subject to historical and ongoing disturbances, in particular clearing, edge effects and planting of exotic species, which has substantially altered the vegetation. As a result, the vegetation patches no longer reflect the floristic composition and structure of any PCTs known from the Jervis subregion. The patches also do not conform with the definition of any TECs listed under the BC Act or EPBC Act.

Photograph 12: Planted exotic, native and remnant native vegetation along the Princes Highway

3.5 Vegetation zones

The two PCTs identified in the site investigation area were categorised into six vegetation zones based on the condition and structure of the vegetation. These vegetation zones are identified and discussed in Section 3.3, listed in **Table 3-5** and shown in **Figure 3-2** .

Vegetation integrity scores are a measure of the condition of native vegetation and is assessed for each vegetation zone by calculating the scores for a range of condition attributes collected in plots, as listed in Section 2.4.1, against the benchmark values for each PCT.

Vegetation integrity scores within PCTs across the site investigation area ranged from 25.5 to 75.5, indicating a wide variability in vegetation condition. Vegetation zone categories were based on a combination of vegetation integrity score and observations of condition during field assessment.

The patch size class for each vegetation zone was calculated as defined by section 4.3.2 of the Biodiversity Assessment Method. The highest patch size class of greater than 100 hectares was given to all vegetation zones as each area of native vegetation within the site investigation area, is part of or has a gap of less than 100 metres to, an area of native vegetation greater than 100 hectares.

Table 3-5: Vegetation zones and vegetation integrity scores

PCT	Vegetation zone	Vegetation integrity score	Patch size (ha)	TEC?
Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest (PCT 1082)	1082_Good	75.5	>100	No
Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest (PCT 1082)	1082_Poor	25.5	>100	No
Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest (PCT 1082)	1082_Moderate_ Disturbed	48	>100	No
Woollybutt - White Stringybark - Forest Red Gum grassy woodland (PCT 1326)	1326_Moderate_ Woodland	49.4	>100	Yes
Woollybutt - White Stringybark - Forest Red Gum grassy woodland (PCT 1326)	1326_Moderate_ Garden	51.2	>100	Yes
Woollybutt - White Stringybark - Forest Red Gum grassy woodland (PCT 1326)	1326_Poor	30.7	>100	Yes

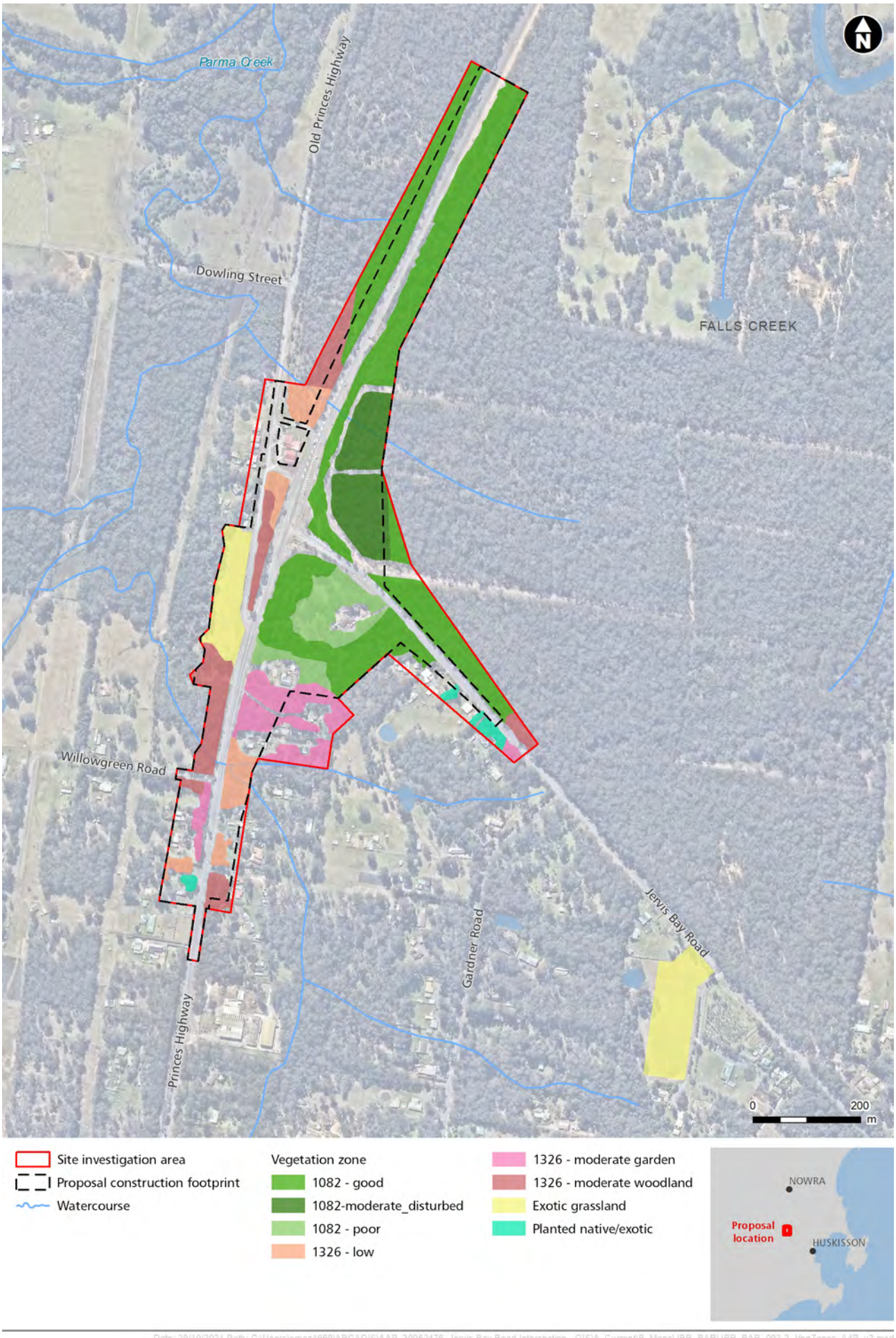


Figure 3-2: Vegetation zones

3.6 Threatened Ecological Communities

The BioNet Vegetation Classification data collection (DPIE, 2020c) predicts the equivalence of PCTs with Commonwealth and NSW TECs. However, these must be used with caution as they can often only be consistent with a part of the PCT or there can be multiple equivalent TECs provided. The final determination which is published by the NSW Scientific Committee provides the legal definition of each TEC and these are the documents that are used to determine equivalence of PCTs with TECs in the sections below.

One PCT identified within the site investigation area, PCT 1326, is known to be associated with TECs listed under the BC Act and/or the EPBC Act. In the site investigation area, this PCT meets the criteria for the listed TEC under the BC Act and is detailed below. The associated TEC listed under the EPBC Act for this PCT was also identified within the site investigation area and is discussed in detail in section 3.14.1. All TECs identified within the site investigation area are shown in **Figure 3-3**.

Table 3-6: TECs listed under the BC Act recorded within the site investigation area

TEC	BC Act status	Corresponding PCT(s)	Area within site investigation area (hectares)
Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	Endangered	1326	6.28

3.6.1 Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion is listed as an endangered ecological community (EEC) under the BC Act. This TEC occurs along the Illawarra coastal plain and escarpment foothills on flats below 100m ASL with sandy loam soils and partially impeded drainage. Characteristic canopy species include *Eucalyptus tereticornis, Eucalyptus eugenioides* (Thin-leaved Stringybark*), Eucalyptus longifolia, Eucalyptus bosistoana* (Coast Grey Box) and *Melaleuca decora*.

PCT 1326 is recognised in the BioNet Vegetation Classification data collection as corresponding to Illawarra Lowlands Grassy Woodland in the Sydney Basin. This PCT occurs in the central section of the site investigation area between the Princes Highway and the Old Princes Highway as well as in patches along the Princes Highway south of the Jervis Bay Road intersection and in the eastern extent of the site investigation area.

A comparison of the vegetation mapped as PCT 1326 in the site investigation area with the relevant paragraphs of the final determination for Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion was undertaken (**Table 3-7**).

Table 3-7: Comparison of areas mapped as PCT 1326 in the site investigation area with the final determination for Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCT 1326
Location	Paragraph 3: Illawarra Lowlands Grassy Woodland has been recorded from the local government areas of Wollongong City, Shellharbour City and Kiama Municipality (within the Sydney Basin Bioregion).	The site investigation area is located within the Shoalhaven local government area which is not listed in the final determination. However, the Shoalhaven local government area is listed as an associated local government area in the threatened species profile for the TEC.

Final determination identification attributes	Final determination paragraph extract	Comparison with areas mapped as PCT 1326
Soils and landscape position	Paragraph 6: Illawarra Lowlands Grassy Woodland occurs on relatively gently sloping to undulating lands less than about 200 metres elevation on Berry Siltstone, Budgong Sandstone and Quaternary alluvium.	Within the site investigation area, PCT 1326 is mapped on the Nowra and Shoalhaven soil landscapes in areas between 20 and 45 metres elevation. Most of the underlying geology comprises Quaternary alluvium.
Floristic composition	Paragraph 1: Illawarra Lowlands Grassy Woodland is characterised by the following assemblage of species: [72 species listed]	Of the 72 species listed, 26 were recorded in the site investigation area, and 17 were recorded in areas mapped as PCT 1326.
Characteristic tree species	Paragraph 5: Characteristic tree species in the Illawarra Lowlands Grassy Woodland are Eucalyptus tereticornis, Eucalyptus eugenioides, Eucalyptus longifolia, Eucalyptus bosistoana and Melaleuca decora.	PCT 1326 in the site investigation area is characterised by a canopy of Eucalyptus longifolia with Eucalyptus tereticornis and Melaleuca decora also frequently occurring.
Disturbance	Paragraph 9: Most remnants are small and fragmented, and their long term viability is threatened. Some remnants consist of regrowth after clearing or other disturbances.	Some patches of PCT 1326 within the site investigation area are subject to ongoing disturbance including grazing and mowing. Patches near Willowgreen Road have also been historically cleared but have now regrown with a developed structure and diverse range of native species present.

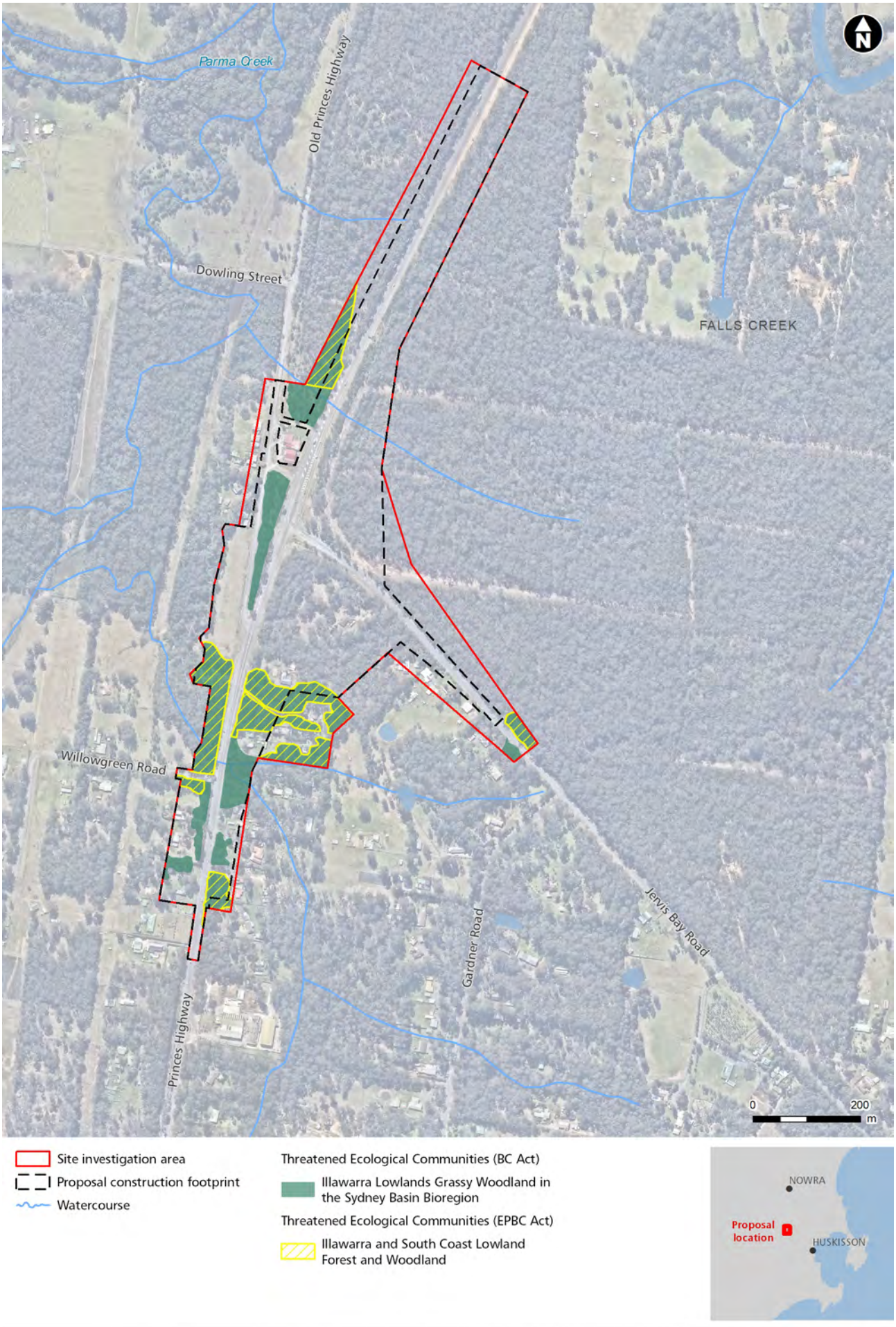


Figure 3-3: TECs mapped within the site investigation area

3.7 Weeds

The abundance of weeds is generally low across the site investigation area and concentrated in areas subject to high levels of disturbance including along the road verge, and within grazed areas and residential properties. Surveys identified 35 exotic species within the site investigation area, of which four are listed as Priority Weeds for the South East region under the *Biosecurity Act 2015*. These four species are also included on the Commonwealth list of 32 Weeds of National Significance (WoNS).

Nine exotic species recorded in the site investigation area are considered by DPIE (2020f) to be high threat weeds. The presence of high threat weeds is used when determining the integrity of vegetation, based on its composition. The names, classification and legal requirements for high threat weed species identified in the site investigation area are listed in **Table 3-8**.

Table 3-8: High threat weeds recorded in the site investigation area

Species	Common Name	WoNS	Priority Weed	*Biosecurity Act 2015* status
Andropogon virginicus	Whiskey Grass	No	No	N/A
Asparagus aethiopicus	Asparagus Fern	Yes	Yes	Prohibition on dealings Must not be imported into the State or sold.
Bidens pilosa	Cobblers Pegs	No	No	N/A
Ehrharta erecta	Panic Veldt-grass	No	No	N/A
Lonicera japonica	Japanese Honeysuckle	No	No	N/A
Rubus fruticosus agg.	Blackberry complex	Yes	Yes	Prohibition on dealings Must not be imported into the State or sold.
Salix sp.	Willow	Yes	Yes	Prohibition on dealings Must not be imported into the State or sold.

Species	Common Name	WoNS	Priority Weed	*Biosecurity Act 2015* status
Senecio madagascariensis	Fireweed	Yes	Yes	Prohibition on dealings Must not be imported into the State or sold. Regional Recommended Measure Exclusion zone: Whole of region except the core infestation area of Wollongong, Kiama, Shellharbour, Eurobodalla, Shoalhaven, Bega Valley and Wingecaribee councils. Whole region: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Core area: Land managers reduce impacts from the plant on priority assets.
Stenotaphrum secundatum	Buffalo Grass	No	No	N/A

3.8 Feral fauna and pests

Feral fauna refers to significant pest animals as described by DPIE (EES), including Feral Cat (*Felis catus*), Feral Deer (eg *Cervus timorensis*), Feral Goat (*Capra hircus*), Feral Pig (*Sus scrofa*), European Rabbit (*Oryctolagus cuniculus*), European Red Fox (*Vulpes vulpes*), Wild Dog (*Canis familiaris*), Wild Horse (*Equus caballus*) and Cane Toad (*Rhinella marina*). Three introduced feral fauna species, the Feral Cat, European Rabbit and European Red Fox, were recorded within the site investigation area during current surveys. In addition, eight other fauna species that are considered introduced pest species were recorded (Annexure A).

3.9 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are ecological communities that are dependent, either entirely or in part, on the presence of groundwater for their health or survival. The DPI *Water risk assessment guidelines for Groundwater Dependent Ecosystems* (Serov *et al.*, 2012) adopts the definition of a GDE as "*Ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater*".

The Bureau of Meteorology's (BoM) GDEs Atlas (BoM, 2020b) was reviewed in August 2020 to determine the occurrence of potential GDEs within the site investigation area and surrounding study area. Associated potential GDEs have been summarised in **Table 3-9**.

Figure 3-4 identifies the areas mapped within the site investigation area which have potential for groundwater interaction.

Table 3-9: Potential GDEs identified in the site investigation area and surrounding study area from the GDEs Atlas (BoM, 2020b)

Type	GDE potential	Geomorphology	Ecosystem type	Recorded in site investigation area?
Terrestrial	Low potential GDE – from regional studies	Deeply dissected steeply sloping plateau margin in metamorphics and granite. Bounded in the west by the Great Escarpment	Vegetation	Yes
Terrestrial	Moderate potential GDE – from regional studies	Deeply dissected sandstone plateaus	Vegetation	Yes
Terrestrial	Moderate potential GDE – from regional studies	Deeply dissected steeply sloping plateau margin in metamorphics and granite. Bounded in the west by the Great Escarpment	Vegetation	Yes
Terrestrial	High potential GDE – from regional studies	Deeply dissected sandstone plateaus	Vegetation	No, nearest approximately 270 metres north and north-west of the site investigation area

The vegetation associated with areas of low and moderate GDE potential mapped within the site investigation area include:

- Woollybutt – White Stringybark – Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion (PCT 1326)
- Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion (PCT 1082).

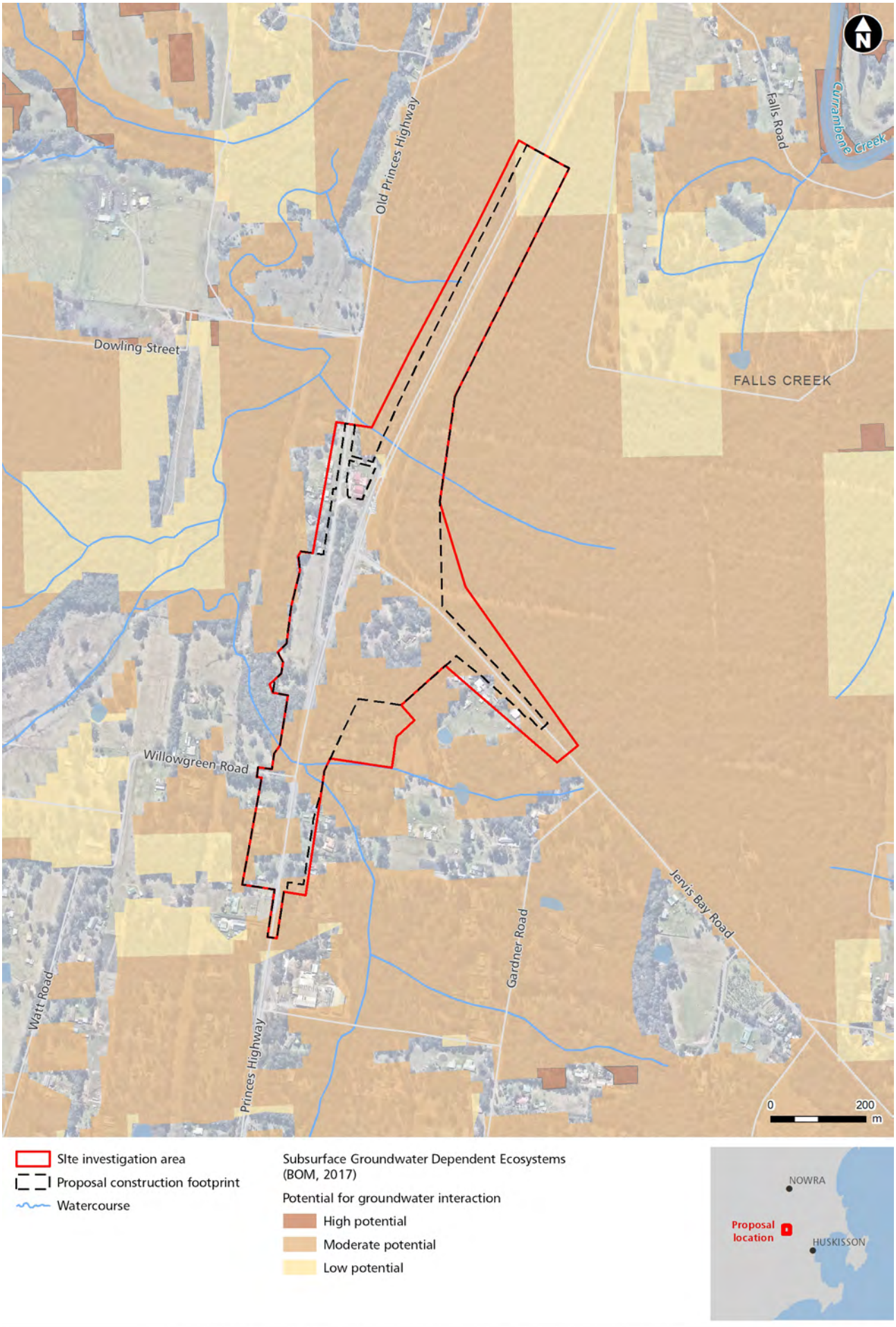


Figure 3-4 Potential Groundwater Dependent Ecosystems

3.10 Threatened species

The results of the threatened species surveys are outlined in **Table 3-10** with revised likelihood of occurrences following surveys. All recorded threatened species are described in the sub-sections below. All threatened species assigned a low likelihood of occurrence, including species with a revised low likelihood of occurrence, are not considered further in this report, as they were not recorded during targeted surveys and are unlikely to utilise habitat within the site investigation area.

The 11 threatened flora species that were initially assigned a moderate or high likelihood of occurrence within the site investigation area (Annexure B) were subject to targeted seasonal surveys. One threatened flora species was recorded (*Hibbertia puberula* subsp. *puberula*). The other 10 species not recorded during targeted surveys are deemed to have a low likelihood of occurrence within the site investigation area following targeted surveys, and are not considered further in this assessment (**Table 3-10**).

The two orchid species *Calochilus pulchellus* and *Genoplesium baueri* that could not be surveyed within the seasonal survey timeframe in parts of the site investigation area were subject to further assessment by expert Brian Towle (Annexure E). The assessment concluded that the more specific microhabitat features associated with the two orchid species (i.e. increased moisture availability and open midstorey) appear to be absent from the areas mapped as potential habitat. Consequently, there is a very low likelihood that either species is present within these areas. All other areas of suitable habitat for the species within the site investigation area were surveyed and the species were not detected.

The locations of all recorded threatened species and areas of important habitat in the site investigation area (eg hollow-bearing trees) are shown in **Figure 3-5** and **Figure 3-6**.

Species polygons have been established for threatened flora species recorded within the site investigation area by identifying all areas of suitable habitat (**Figure 3-5**). Species polygons have not been prepared for dual-credit species as no breeding habitat was identified within the site investigation area. Species polygons for the Southern Myotis and Green and Golden Bell Frog, species credit species, are shown in **Figure 3-6**.

Table 3-10: Habitat assessment and surveys results

Scientific name	Common name	BC Act status	EPBC Act status	Results and final likelihood of occurrence (Low, Moderate, High, Recorded)
FLORA				
Acacia bynoeana	Bynoe's Wattle	E	V	Low – not recorded during targeted surveys.
Caladenia tessellata	Thick Lip Spider Orchid	E	V	Low – not recorded during targeted surveys.
Calochilus pulchellus	Pretty Beard Orchid	E	-	Low – not recorded during targeted surveys.
Eucalyptus langleyi	Albatross Mallee	V, EP	V	Low – not recorded during targeted surveys.
Galium australe	Tangled Bedstraw	E	-	Low – not recorded during targeted surveys.
Hibbertia puberula	-	E	-	**Recorded** – 58 individuals recorded across the site investigation area within PCT 1082. Samples confirmed by NSW Herbarium. 13.51 hectares of suitable habitat present.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Low – not recorded during targeted surveys.
Pterostylis gibbosa	Illawarra Greenhood	E	E	Low – not recorded during targeted surveys.
Pterostylis vernalis		CE	CE	Low – not recorded during targeted surveys.
Triplarina nowraensis	Nowra Heath Myrtle	E	E	Low – not recorded during targeted surveys.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Low – not recorded during targeted surveys.
Pterostylis ventricosa		CE	-	Low – not recorded during targeted surveys.
Genoplesium baueri	Bauer's Midge Orchid	E	E	Low – not recorded during targeted surveys.
FAUNA				

Scientific name	Common name	BC Act status	EPBC Act status	Results and final likelihood of occurrence (Low, Moderate, High, Recorded)
Apus pacificus	Fork-tailed Swift	-	-	Low – migratory species. Limited number of recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	Low – large number (40) of recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	**Recorded** – small, foraging flocks (up to eight individuals) and chewed Allocasuarina seed cones observed in the site investigation area. Targeted surveys determined that breeding is unlikely to occur within the site investigation area.
Cercartetus nanus	Eastern Pygmy-possum	V	-	Low – some (11) recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Low – some (7) recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Low – some (12) recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	**Recorded (possible)** – possible (indistinguishable complex) Anabat recording of the species within the site investigation area.
Glossopsitta pusilla	Little Lorikeet	V	-	**Recorded** – two individuals recorded flying over the site investigation area. The species may use the site for foraging or breeding. No breeding individuals or nest sites were identified in the site investigation area during current surveys.
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	-	**Recorded** – one individual recorded flying over the site investigation area. The species may use the site for foraging. No breeding individuals or nest sites were identified in the site investigation area during current surveys.

Scientific name	Common name	BC Act status	EPBC Act status	Results and final likelihood of occurrence (Low, Moderate, High, Recorded)
Hirundapus caudacutus	White-throated Needletail	-	V	Low – migratory species. Limited number of recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Isoodon obesulus obesulus	Southern Brown Bandicoot	E	E	Low – some (8) recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Litoria aurea	Green and Golden Bell Frog	E	V	**Assumed present** – one dam is present within the site investigation area which comprises potential habitat for the species. Targeted surveys are scheduled for November 2021 – March 2022 which will confirm presence or absence of the species.
Lophoictinia isura	Square-tailed Kite	V	-	Moderate – large number (23) of recent records within 10 kilometres of the site investigation area. While the species was not detected during targeted surveys, the site contains potential foraging and dispersal habitat. No breeding individuals or nest sites were identified in the site investigation area during current surveys.
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	V	-	Low – some (9) recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Miniopterus australis	Little Bent-winged Bat	V	-	Low – one recent record within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-	**Recorded (probable)** – probable (indistinguishable complex) Anabat recording of the species within the site investigation area. Targeted surveys determined that breeding is unlikely to occur within the site investigation area.
Myotis macropus	Southern Myotis	V	-	**Recorded (probable)** – probable (indistinguishable complex) Anabat recording of the species within the site investigation area.
Ninox connivens	Barking Owl	V	-	Low – one recent record within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.

Scientific name	Common name	BC Act status	EPBC Act status	Results and final likelihood of occurrence (Low, Moderate, High, Recorded)
Ninox strenua	Powerful Owl	V	-	**Recorded** – one individual recorded foraging in the site investigation area. Targeted surveys determined that breeding is unlikely to occur within the site investigation area.
Petauroides volans	Greater Glider	-	V	Low – large number (20) of recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Petaurus australis	Yellow-bellied Glider	V	-	Moderate – large number (348) of recent records within 10 kilometres of the site investigation area. While the species was not detected during targeted surveys, the site investigation area contains potential foraging, breeding and dispersal habitat.
Potorous tridactylus[1]	Long-nosed Potoroo	V	V	Low – one historical record within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Pseudomys novaehollandiae	New Holland Mouse	-	V	Low – one recent record within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	**Recorded** – two individuals observed flying over the site investigation area. Targeted surveys determined that no camps (for breeding/roosting) were located within the site. The nearest camps are Bomaderry Creek (Camp ID 233; approximately 14km north of the site investigation area) and Bewong Creek (Camp ID 232; approximately 10km south-west of the site investigation area).
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Low – some (4) recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	**Recorded (possible)** – possible (indistinguishable complex) Anabat recording of the species within the site investigation area.
Sminthopsis leucopus[1]	White-footed Dunnart	V	-	Low – some (7) historical records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.

Scientific name	Common name	BC Act status	EPBC Act status	Results and final likelihood of occurrence (Low, Moderate, High, Recorded)
Tyto novaehollandiae	Masked Owl	V	-	Moderate – large number (26) of recent records within 10 kilometres of the site investigation area. While the species was not detected during targeted surveys, the site investigation area contains potential foraging and dispersal habitat. Targeted surveys determined that breeding is unlikely to occur within the study area.
Tyto tenebricosa	Sooty Owl	V	-	Low – large number (24) of recent records within 10 kilometres of the site investigation area. Limited suitable habitat present within the site investigation area. Not recorded during targeted surveys.

V = Vulnerable, E = Endangered, CE = Critically Endangered

[1] Habitat assessments identified potential habitat for threatened species within the site investigation area, however BioNet records indicated that the species were unlikely to occur due to a low number of records and/or historical records (ie over 20 years old) in the study area. Planned targeted surveys for species with a moderate or high likelihood of occurrence overlapped with the recommended survey effort for these species. As such, these species have been included opportunistically within existing targeted surveys.

3.10.1 Hibbertia puberula subsp. puberula

Hibbertia puberula subsp. *puberula* is listed as endangered under the BC Act. Fifty-eight individuals of the species were recorded in four clusters across the site investigation area (**Figure 3-5**). The largest population of *Hibbertia puberula* subsp*. puberula* was recorded in a property to the southeast of the intersection where individuals were situated on the edge of a mown grassland. Other individuals of the species were recorded within more intact areas of PCT 1082 to both the east and west of the Princes Highway. Most individuals of *Hibbertia puberula* subsp*. puberula* across the site investigation area were in flower during surveys and appeared healthy (**Photograph 13**). As records of *Hibbertia puberula subsp. puberula* were widespread across PCT 1082, a large area of this PCT is deemed suitable habitat for the species. Suitable habitat for *Hibbertia puberula* subsp*. puberula* within the site investigation area is 13.51 hectares.

As the species is botanically similar to several other species within the *Hibbertia* genus, the identification of *Hibbertia puberula* subsp*. puberula* is complex and subtle. Therefore, samples of the species were sent to the NSW Herbarium for identification confirmation. In January 2021 the NSW Herbarium confirmed that all samples were of *Hibbertia puberula* subsp. *puberula.*

Photograph 13: *Hibbertia puberula* subsp. *puberula* in bud and flower within the site investigation area

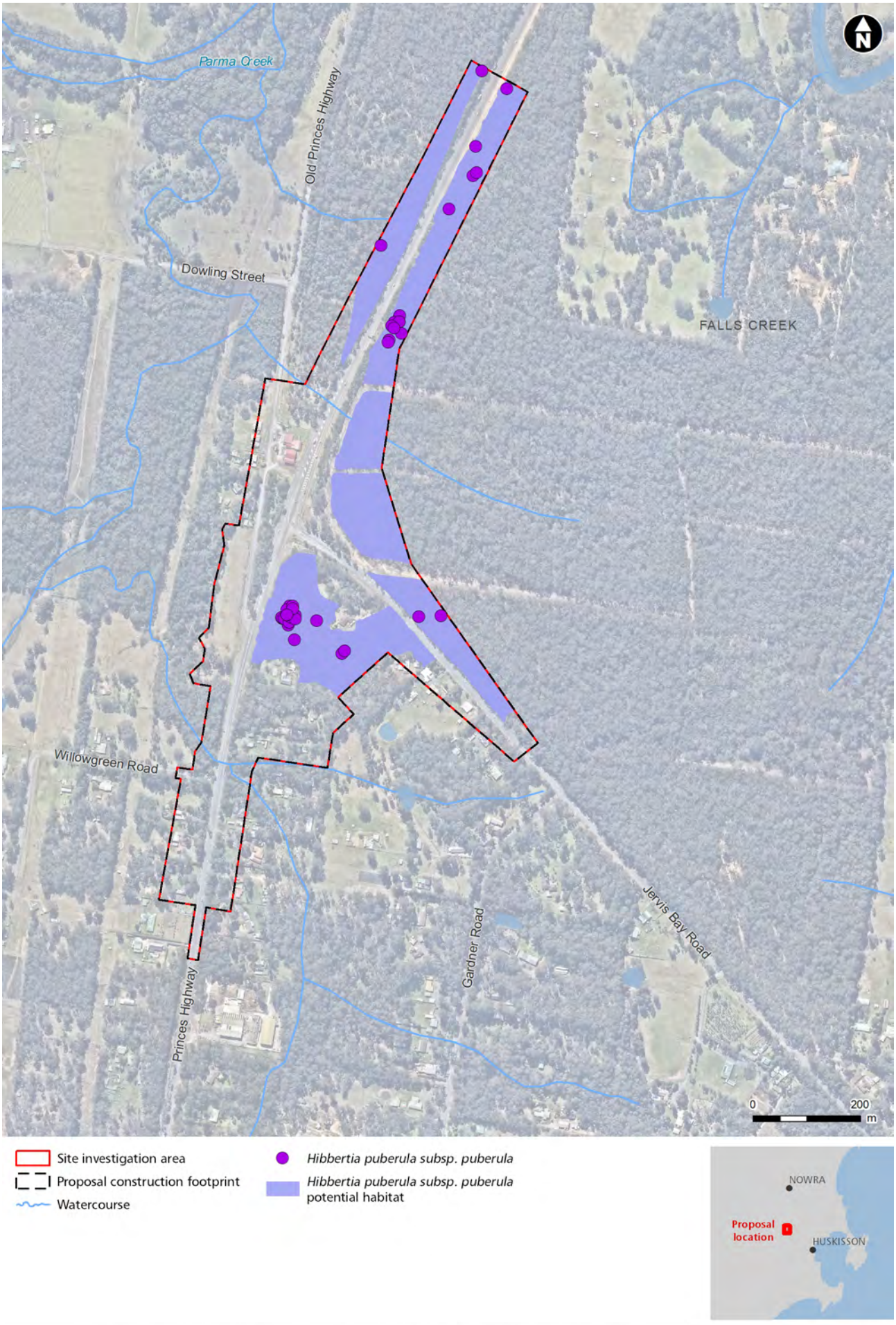


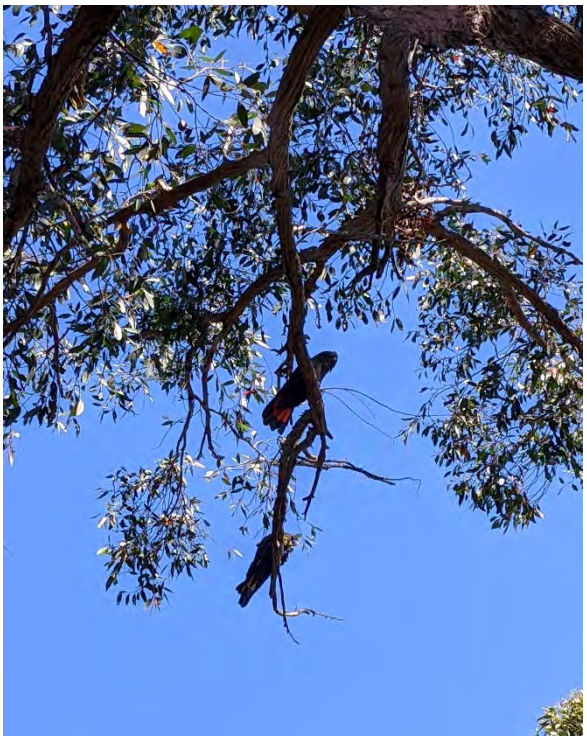
Figure 3-5: Recorded threatened flora species and habitat

3.10.2 Glossy Black-Cockatoo

A small flock (up to eight individuals mixed males, females and juveniles) of Glossy Black-Cockatoo (listed as vulnerable under the BC Act) were observed foraging in *Allocasuarina* along the Princes Highway and Jervis Bay Road during targeted surveys (**Figure 3-6**) (**Photograph 14**). In addition, this species was recorded by indirect evidence (chewed seed cones) present throughout the site investigation area.

The Glossy Black-Cockatoo is a dual credit species. The species credit component is based on the presence of suitable breeding habitat (ie eucalypt tree species with hollows at least eight metres above the ground and fifteen centimetres diameter). There are 339 records of the species within the study area, the most recent from 2020. *Allocasuarina* and hollow-bearing trees within the site investigation area provide potential habitat for the species.

While the site investigation area supports several large hollow-bearing trees (**Photograph 3**) that are required for breeding by the Glossy Black-Cockatoo, stag-watching surveys did not detect any breeding individuals. As such, the species is unlikely to breed within the site investigation area and consequently no species credit habitat is present. Foraging habitat for the Glossy Black-Cockatoo is assumed as ecosystem credits. Potential impacts to the Glossy Black-Cockatoo are detailed in Section 5.



Photograph 14: Glossy Black-Cockatoo recorded foraging within the site investigation area

3.10.3 Powerful Owl

One individual Powerful Owl (listed as vulnerable under the BC Act) was recorded foraging within the site investigation area during targeted nocturnal surveys (**Figure 3-6**) (**Photograph 15**). The Powerful Owl is a dual credit species. The species credit component is based on the presence of suitable breeding habitat (ie living or dead trees with hollows greater than 20 centimetres diameter). There are 49 records of the species within the study area, the most recent from 2019. Vegetation and hollow-bearing trees within the site investigation area provide potential habitat for the species.

While the site investigation area supports several large hollow-bearing trees (**Photograph 3**) that are required for breeding by the Powerful Owl, stag-watching surveys did not detect any breeding individuals. As such, the species is unlikely to breed within the site investigation

area and consequently no species credit habitat is present. Foraging habitat for the Powerful Owl is assumed as ecosystem credits. Potential impacts to the Powerful Owl are detailed in Section 5.

Photograph 15: One individual Powerful Owl recorded foraging within the site investigation area

3.10.4 White-bellied Sea-Eagle

One individual White-bellied Sea-Eagle (listed as vulnerable under the BC Act) was recorded flying overhead the site investigation area during targeted surveys (**Figure 3-6**). The White-bellied Sea-Eagle is a dual credit species. The species credit component is based on the presence of suitable breeding habitat (ie large, old trees within one kilometre of a waterbody with a large stick nest present). There are 12 records of the species within the study area, the most recent from 2018. Vegetation within the site investigation area provides potential habitat for the species.

While the site investigation area supports several large trees that are required for breeding by the White-bellied Sea-Eagle, targeted surveys did not identify any large stick nests or detect any breeding individuals. In addition, the site investigation area is limited to small farm dams, drainage lines and creeks. As such, the species is unlikely to breed within the site investigation area and consequently no species credit habitat is present. Foraging habitat for the White-bellied Sea-Eagle is assumed as ecosystem credits. Potential impacts to the White-bellied Sea-Eagle are detailed in Section 5.

3.10.5 Little Lorikeet

Two individual Little Lorikeet (listed as vulnerable under the BC Act) were recorded flying overhead the site investigation area during targeted surveys (**Figure 3-6**). The Little Lorikeet is an ecosystem credit species as it is highly mobile, and the small hollows required for breeding are relatively common. There are 22 records of the species within the study area, the most recent from 2020. Vegetation and hollow-bearing trees within the site investigation area provide potential habitat for the species. This habitat is classified as ecosystem credits. Potential impacts to the Little Lorikeet are detailed in Section 5.

3.10.6 Grey-headed Flying-fox

Two individual Grey-headed Flying-fox (listed as vulnerable under the BC Act and EPBC Act) were recorded flying overhead the site investigation area during targeted surveys (Figure 3-6). The Grey-headed Flying-fox is a dual credit species. The species credit component is based on localised breeding camps. There are 145 records of the species within the study area, the most recent from 2019.

Vegetation within the site investigation area provides potential foraging and dispersal habitat for the species. However, the site does not contain any camps required for roosting and/or breeding (the nearest camps are Bomaderry Creek (Camp ID 233; approximately 14 kilometres north of the site) and Bewong Creek (Camp ID 232; approximately 10 kilometres south-west of the site)). Consequently, no species credit habitat is present. Foraging habitat for the Grey-headed Flying-fox is assumed as ecosystem credits. Potential impacts to the Grey-headed Flying-fox are detailed in Section 5.

3.10.7 Southern Myotis

The Southern Myotis (listed as vulnerable under the BC Act) was recorded as 'Probable' within the site investigation area using ultrasonic call detectors (Anabats). Details of call analysis and likelihood are provided in Annexure G. The Southern Myotis is a species credit species as it is dependent on waterways with pools three metres wide or greater for foraging. In addition, habitat surrounding waterways is used for breeding and roosting. There are ten records of the species within the study area, the most recent from 2018.

A species polygon for the Southern Myotis within the site investigation area has been mapped and is shown in **Figure 3-6**. Habitat mapped within the site investigation area is within 200 metres of waterbodies greater than three metres wide, and within PCT 1326 (the PCT that this species is associated with). The only waterway within the site investigation area which has a width of three metres or greater is the southernmost unnamed tributary of Parma Creek. Potential impacts to the Southern Myotis are detailed in Section 5.

3.10.8 Other threatened microbats

The Eastern False Pipistrelle, Greater Broad-nosed Bat and Large Bent-winged Bat (all listed as vulnerable under the BC Act) were recorded as 'Possible', 'Possible' and 'Probable' respectively within the site investigation area using ultrasonic call detectors (Anabats). Details of call analysis and likelihood are provided in Annexure G.

The Eastern False Pipistrelle and Greater Broad-nosed Bat are ecosystem credit species, of which there are seven (most recent from 2018) and nine (most recent from 2016) records of each respective species within the study area. The Large Bent-winged Bat is a dual credit species, with the species credit component based on highly specific breeding habitat (eg caves, tunnels, mines or other structures). There are 15 records of the species within the study area, the most recent from 2018. Vegetation within the site investigation area provides potential foraging and dispersal habitat for the species. However, the site does not contain any roosting and/or breeding habitat. Consequently, no species credit habitat is present.

Foraging habitat for these three threatened microbats is assumed as ecosystem credits. Potential impacts to the Eastern False Pipistrelle, Greater Broad-nosed Bat and Large Bent-winged Bat are detailed in Section 5.

3.10.9 Green and Golden Bell Frog

The Green and Golden Bell Frog, listed as endangered under the BC Act and vulnerable under the EPBC Act, has been assumed as present within the site investigation area. The Green and Golden Bell Frog is a species credit species and has 588 records within 10km of the site investigation area. This species has been assumed present due to the presence of potential habitat for the species in the form of a constructed dam in a property to the south of Willowgreen Road within the site investigation area. Details of this habitat and the

potential presence of Green and Golden Bell Frog is described in a report by Green and Golden Bell Frog expert Frank Lemckert (Lemckert, 2021) (Annexure H).

Accessible habitat for Green and Golden Bell Frog is described in Annexure H and comprises the dam and the surrounding grassy vegetation and nearby woodland (PCT 1326 and PCT 1082) likely used for overwintering, within a 1000 metre radius from the centre of the dam (Hamer 2016). Potential impacts to the constructed dam are detailed in Section 5.

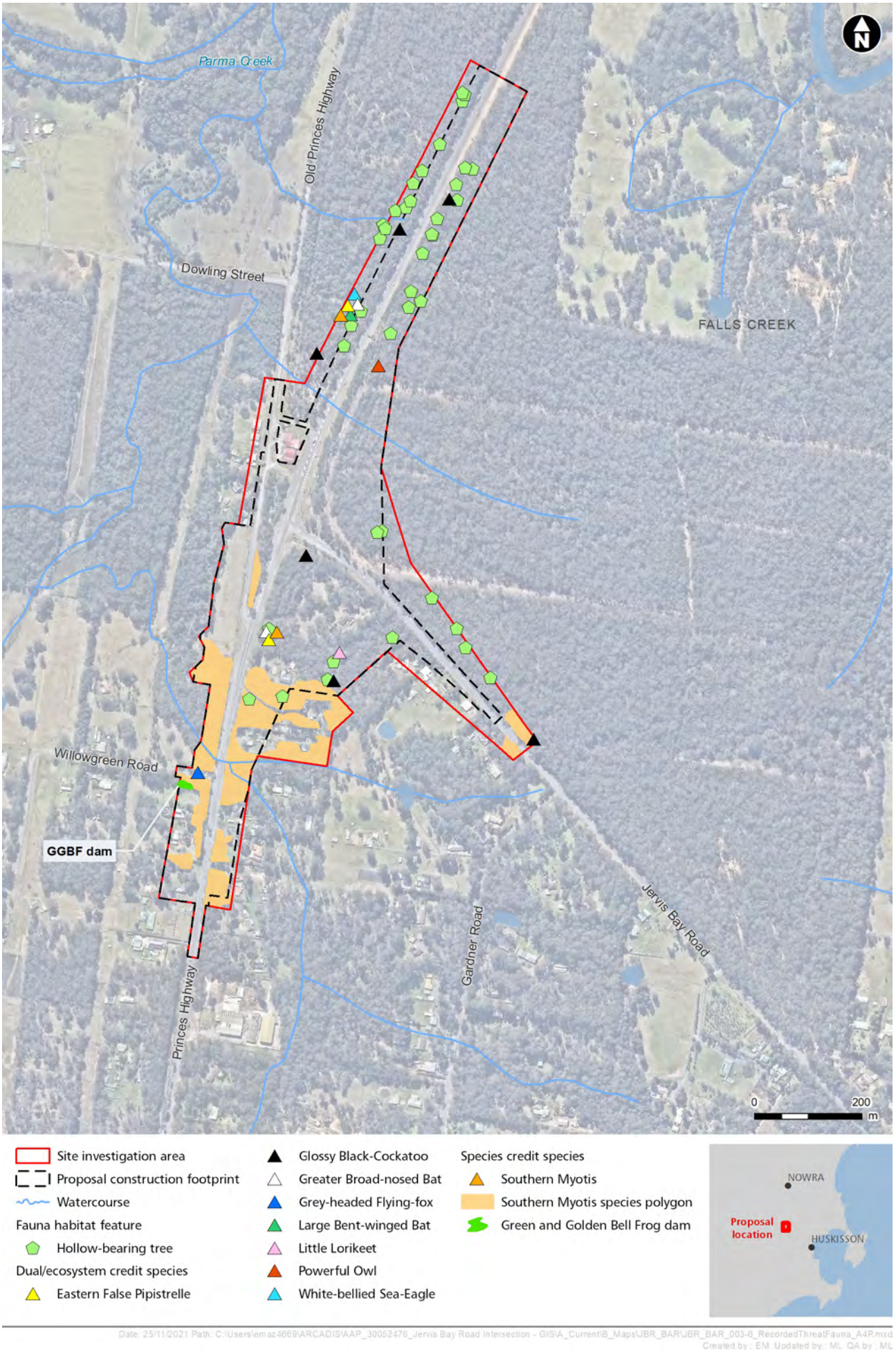


Figure 3-6: Recorded threatened fauna species and habitat

3.11 Aquatic results

Section 2.4.4 outlines the habitat condition assessment and waterway classifications undertaken at aquatic habitats across the site investigation area. Most of the existing aquatic habitats within the site investigation area are minor and/or ephemeral (eg drainage lines and small, constructed farm dams) however three unnamed tributaries of Parma Creek lie within the site investigation area.

The unnamed tributaries within the site investigation area are considered streams/ ephemeral streams. No important substrates, habitat features, or vegetation was recorded within any of the tributaries. Water quality, based on visual observation, appeared poor (ie signs of pollutants, excess sediments and nutrients) and contained a high density of weeds. In addition, these waterways are adjacent to the Princes Highway and are subject to edge effects and regular disturbance (ie vegetation trimming for powerlines, road works).

No threatened aquatic species were recorded within the site investigation area, and none are expected to occur. While Parma Creek is mapped as key fish habitat for the Shoalhaven area (DPI, n.d.), the three unnamed tributaries located within the site investigation area do not meet the definition of key fish habitat in accordance with the *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) as they are all classified as first order streams (see Section 3.1.3). Similarly, any drainage lines and/or dams within the site investigation area are not considered key fish habitat.

3.12 Areas of outstanding biodiversity value

There are no areas of outstanding biodiversity value mapped within the site investigation area or wider study area.

3.13 Wildlife connectivity corridors

The Biodiversity Assessment Method (DPIE, 2020) defines connectivity as a '*measure of the degree to which an area(s) of native vegetation is linked with other areas of vegetation'*. The site investigation area is situated within a modified landscape which has undergone extensive historical vegetation clearing for major transport infrastructure and residential, agricultural and industrial development. As a result, vegetation throughout most of the site investigation area is fragmented and exists in small patches. However, the site investigation area borders areas of intact vegetation within Parma Creek Nature Reserve, which provides connectivity to expansive areas of high quality vegetation in the surrounding Nature Reserves, Conservation Areas and National Parks to the east, south and west of the site investigation area. The regional biodiversity corridor mapped in the Illawarra Shoalhaven Regional Plan, Shoalhaven Local Environmental Plan, and the South Coast Corridor mapping is also generally aligned within the vicinity of the proposal and intersects the northern section of the proposal construction footprint (Figure 1-1).

Parma Creek Nature Reserve provides a good pathway to extensive areas of good condition vegetation surrounding the site investigation area. Fauna species may use vegetation within Parma Creek Nature Reserve, and connected vegetation surrounding the Princes Highway and Jervis Bay Road, to travel to areas of higher quality habitat (eg Jerrawangala National Park, Booderee National Park). However, vegetation within the site investigation area borders major regional roads, including the Princes Highway and Jervis Bay Road, and is fragmented by housing and infrastructure which provide potential barriers to habitat connectivity. As such, the viability of this connectivity corridor is reduced, and connectivity is likely restricted to more mobile fauna (eg birds and bats).

3.14 Matters of National Environmental Significance

Matters of National Environmental Significance are environmental values that require approval from the Commonwealth Minister for the Environment if an action that may have a significant impact on one or more of these values is proposed.

There are nine Matters of National Environmental Significance categories listed under the EPBC Act:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines)
- A water resource, in relation to coal seam gas development and large coal mining development.

The relevant Matters of National Environmental Significance to the proposal are:

- Listed threatened species and ecological communities
- Migratory species.

Other Matters of National Environmental Significance, including World heritage places, National heritages places and Wetlands of international importance (declared Ramsar wetlands) are not relevant to the proposal.

3.14.1 EPBC Act listed ecological communities

Details about the methods for investigation of EPBC Act listed ecological communities, including targeted surveys are included in Section 2.4.

The Protected Matters Search Tool report identified five EPBC Act listed TECs with the potential to occur within the study area, including:

- Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community (Endangered)
- Illawarra and south coast lowland forest and woodland ecological community (Critically Endangered)
- Illawarra-Shoalhaven Subtropical Rainforest of the Sydney Basin Bioregion (Critically Endangered)
- Subtropical and Temperate Coastal Saltmarsh (Vulnerable)
- Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion (Endangered).

The presence, extent and condition of these communities was further investigated using a combination of GIS analysis, site inspection and field data collection. The outcome of this investigation was that areas of one PCT in the site investigation area, PCT 1326, met the condition and extent criteria required to be the listed TEC under the EPBC Act. This TEC is the Illawarra and south coast lowland forest and woodland ecological community and has a total area of 3.98 hectares in the site investigation area. A comparison of the condition and extent criteria of this TEC with the areas of PCT 1326 within the site investigation area is provided in Table 3-11.

Areas of EPBC Act listed TECs within the site investigation area are shown in **Figure 3-3**.

Table 3-11: Condition criteria for EPBC Act listed TECs within the site investigation area

TEC Name (EPBC Act)	EPBC Act Status	Summary of EPBC Act condition criteria	Meets criteria?
Illawarra and south coast lowland forest and woodland ecological community	Critically Endangered	Patch 0.5 hectares or greater in size. One of the below applies: • At least 50 per cent of the understorey vegetation cover is comprised of native species and at least six native plant species per 0.5 hectares in the ground layer are present. • At least 30 per cent of total perennial understorey vegetative cover is comprised of native species and: • The patch is contiguous with another patch of native vegetation (at least one hectare in area) or the patch has at least one large locally indigenous tree (at least 50 centimetres dbh) or at least one tree with hollows (DAWE, n.d.).	Yes – only some patches of 1326_Moderate_Gardens and some patches of 1326_Moderate_Woodland. These patches are over 0.5 hectares and have over 50 per cent native perennial understorey vegetative cover and at least six native ground layer plant species per 0.5 hectares. Patches of 1326_Poor and one patch of 1326_Moderate_Gardens have a native perennial understorey vegetative cover of less than 30per cent. One patch of 1326_Moderate_Woodland and one patch of 1326_Moderate_Gardens are less than 0.5 hectares in size.

3.14.2 Threatened species

Flora

Database searches of EPBC Act listed threatened flora predicted to occur within the study area identified 25 species (Appendix B). This was refined to eight species considered likely to occur within the site investigation during desktop research based on available information on the PCTs present and other habitat information.

No EPBC listed flora species were recorded within the site investigation area.

Fauna

Database searches of EPBC Act listed threatened fauna predicted to occur within the study area identified 62 species (Appendix B). This was refined to 11 species considered likely to occur within the site investigation during desktop research based on available information on the PCTs present and other habitat information.

Two EPBC listed fauna species, the Grey-headed Flying-fox and Green and Golden Bell Frog, was recorded or assumed present within the site investigation area. The Grey-headed Flying-fox is a dual credit species with the species credit component based on localised breeding camps. While the site investigation area provides potential foraging and dispersal habitat for the species, it does not contain any camps required for roosting and/or breeding (the nearest camps are Bomaderry Creek (Camp ID 233; approximately 14 kilometres north of the site) and Bewong Creek (Camp ID 232; approximately 10 kilometres south-west of the site)).

The Green and Golden Bell Frog was assumed present due to the presence of potential habitat in the form of a constructed dam. Surveys for the species will be conducted between November 2021 and March 2022.

Potential impacts to the Grey-headed Flying-fox and Green and Golden Bell Frog are detailed in Section 5.

3.14.3 Listed migratory species

The PMST and BioNet searches identified 52 migratory species listed as migratory under the EPBC Act, or under the Bonn, CAMBA, JAMBA and/or ROKAMBA conventions with the potential to occur within the study area (Annexure B).

The likelihood of occurrence of migratory species was first determined using desktop assessment, and two species were identified as having the potential to occur within the site investigation area (**Table 3-12**). Marine species were excluded due to the distance of the study area from the ocean and consequent lack of marine habitat within the site investigation area.

On-site habitat assessment and field surveys concluded that both species had a low likelihood of occurrence within the site investigation area (Annexure B). Species likelihoods are summarised in **Table 3-12**. Survey effort is summarised in **Table 2-8**.

Table 3-12: Likelihood of occurrence of migratory species in the site investigation area

Common name	Scientific name	Habitat requirements	Number of records and source	Potential occurrence
Fork-tailed Swift	Apus pacificus	In NSW, the Fork-tailed Swift is recorded in all regions. They often occur over cliffs and beaches as well as over islands and sometimes out to sea. In addition, they occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. They sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines. The species forages aerially, up to hundreds of metres above ground, but also less than 1m above open areas or over water.	One (2017) BioNet, PMST	Low – one recent record within the study area. The species may fly over the site investigation area while dispersing and foraging in the surrounding area. However, the species was not recorded during targeted surveys.
White-throated Needletail	Hirundapus caudacutus	White-throated Needletails are non-breeding migrants in Australia between late spring and early autumn, but most common in summer. The species often occur in large numbers over eastern and northern Australia. White-throated Needletails are aerial birds and for a time it was commonly believed that they did not land while in Australia. It has now been observed that birds will roost in trees, and radio-tracking has since confirmed that this is a regular activity.	Seven (2016) BioNet, PMST	Low – some (seven) recent records within the study area. The species may fly over the site investigation area while dispersing and foraging in the surrounding area. However, the species was not recorded during targeted surveys. As they are a non-breeding migrant to Australia, breeding habitat is not present in the site investigation area.

4 Avoidance and minimisation

To achieve the proposal objective of upgrading the Princes Highway and Jervis Bay Road intersection to improve its safety and reliability, impacts on ecological values could not be completely avoided.

An options assessment was completed in November 2020 which investigated four potential designs for the proposal (Transport for NSW, 2020). This options assessment and subsequent selection of the preferred option have considered biodiversity values which, as a result, has minimised impacts to high value biodiversity.

The preferred option has minimal vegetation clearing to the west of the Princes Highway, where the largest and highest condition patches of the TEC Illawarra Lowlands Grassy Woodland is present. Direct impacts on clearing of native vegetation and habitat associated with the proposal have also been minimised by:

- Locating two proposed ancillary facilities in areas where there are limited biodiversity values (ie within disturbed areas mapped as exotic grassland);
- Making provision for the demarcation, ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat within the proposal construction footprint.

5 Impact assessment

5.1 Construction impacts

5.1.1 Removal of native vegetation

Clearing of native vegetation is required for the proposal. The areas of PCT 1082 and PCT 1326 and other vegetation types to be cleared from the impact area are listed in **Table 5-1**.

For the purpose of this assessment, the impact area comprises the proposal construction footprint. It is assumed that all vegetation within the proposal construction footprint would be removed.

The total proposal construction footprint covers 27.88 hectares, of which 16.16 hectares has been mapped as native vegetation and 3.29 hectares has been mapped as exotic vegetation. Of this 16.16 hectares of native vegetation, 4.18 hectares is listed as a TEC under the BC Act and 2.29 hectares meets the condition thresholds to be listed as a TEC under the EPBC Act and would be removed as a result of the proposal.

Table 5-1: Impacts on vegetation

PCT	Condition class	Status		Extent in the site investigation area (ha)	Extent in the proposal construction footprint (ha)
		BC Act	EPBC Act		
Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion (PCT 1082)	1082_Good	-	-	10.64	7.81
	1082_Moderate_Disturbed	-	-	2.50	2.33
	1082_Poor	-	-	1.84	1.84
Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion (PCT 1326)	1326_Moderate_ Woodland	Endangered	Critically Endangered (patches that meet condition criteria)	2.58	1.84
	1326_Moderate_ Garden	Endangered	Critically Endangered (patches that meet condition criteria)	2.13	1.1
	1326_Poor	Endangered	-	1.57	1.24
Other vegetation types	Exotic grassland	-	-	3.20	3.20
	Planted native/exotic vegetation and remnant trees	-	-	0.34	0.09
Total area native vegetation				21.26	16.16
Total area vegetation				24.8	19.45

5.1.2 Removal of threatened species habitat

A total of 16.16 hectares of known or potential habitat for threatened species would be cleared from within the proposal construction footprint. Threatened species habitat to be removed is comprised of 11.98 hectares of PCT 1082, and 4.18 hectares of PCT 1326, which includes loss of important habitat features such as hollow-bearing trees and foraging resources (eg blossoms). The 3.29 hectares of exotic grassland and planted exotic/native vegetation and remnant trees is not considered to provide suitable habitat for any threatened flora or fauna species.

A total of 38 hollow-bearing trees were identified within the site investigation area. Approximately 24 hollow-bearing trees are located within the proposal construction footprint and would be cleared. This includes a range of hollow sizes from several centimetres wide up to 50 centimetres wide, providing habitat for a range of fauna including microbats, frogs, arboreal mammals, reptiles and birds. The removal of hollow-bearing trees could potentially impact several threatened species as noted in **Table 5-2**. Targeted surveys did not identify breeding within the site investigation area, and there are hollow resources within the site investigation area and surrounding area that would provide habitat for impacted species.

The impacts of the proposal on threatened species and habitat are summarised in **Table 5-2**.

Table 5-2: Impacts on threatened species and habitat

Species	Potential occurrence (Moderate, High, Recorded)	Impacted by proposal?	Impact (ha/ individuals)
FAUNA			
Eastern False Pipistrelle	Recorded (Possible)	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082. Loss of potential roosting habitat in the removal of tree bark and hollow-bearing trees.
Glossy Black-Cockatoo	Recorded	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082. Loss of potential breeding habitat (hollows more than eight metres above ground and more than 15 centimetres wide; stems more than 30 centimetres and more than 45 degrees). However, targeted surveys did not identify breeding within the site investigation area.
Greater Broad-nosed Bat	Recorded (Possible)	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082. Loss of potential roosting and breeding habitat in the removal of hollow-bearing trees.
Green and Golden Bell Frog	Assumed present	Yes	Loss of 377 square metres of potential habitat in the form of a constructed dam.
Grey-headed Flying-fox	Recorded	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082.

Species	Potential occurrence (Moderate, High, Recorded)	Impacted by proposal?	Impact (ha/ individuals)
Large Bent-winged Bat	Recorded (Probable)	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082.
Little Lorikeet	Recorded	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082. Loss of potential breeding habitat (hollows more than two-15 metres above ground and around three centimetres wide). However, targeted surveys did not identify breeding within the site investigation area.
Masked Owl	Moderate	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082. Loss of potential breeding habitat (hollows more than 20 centimetres wide). However, targeted surveys did not identify breeding within the site investigation area.
Powerful Owl	Recorded	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082. Loss of potential breeding habitat (hollows more than 20 centimetres wide). However, targeted surveys did not identify breeding within the site investigation area.
Southern Myotis	Recorded (Probable)	Yes	Loss of 3.33 hectares of potential habitat in the form of PCT 1326 buffered to 200 metres around the southern creek line (waterbody above three metres wide).
Square-tailed Kite	Moderate	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082.
White-bellied Sea-Eagle	Recorded	Yes	Loss of 4.18 hectares of potential habitat in the form of PCT 1326.
Yellow-bellied Glider	Moderate	Yes	Loss of 16.16 hectares of potential habitat in the form of PCT 1326 and PCT 1082. Loss of potential shelter and breeding habitat in the removal of hollow-bearing trees (generally more than 30 centimetres).
FLORA			
Hibbertia puberula subsp. puberula	Recorded	Yes	Loss of 10.51 hectares of suitable habitat in the form of PCT 1082 and 55 individuals to be cleared.

5.1.3 Removal of threatened flora

One threatened flora species, *Hibbertia puberula* subsp*. puberula* listed as endangered under the BC Act, has been identified in the site investigation area and would be removed as a result of the proposal. The area of habitat and counts of individuals of this species to be directly impacted by the proposal are detailed in **Table 5-3**.

Table 5-3: Impacts on threatened flora

Threatened species	Status		Habitat or individuals in the site investigation area	Habitat or individuals to be impacted
	BC Act	EPBC Act		
Hibbertia puberula subsp*. puberula*	Endangered	-	13.51 ha (58 individuals)	10.51 ha (55 individuals)

5.1.4 Aquatic impacts

Details of changes to surface water and hydrological regimes as a result of the proposal are outlined in Jervis Bay Road Intersection Upgrade Flood and Surface Water Assessment (Arcadis, 2021).

While the three unnamed tributaries located within the site investigation area are mapped as key fish habitat they do not meet the definition of key fish habitat in accordance with the *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) as they are all classified as first order streams. Similarly, any drainage lines and/or dams within the site investigation area are not considered key fish habitat. As such, the proposal would not impact upon any key fish habitat (see Section 3.1.3.1).

The proposal would result in the upgrade of an existing culvert near the southern extent of the site investigation area. This would lead to a reduction in upstream flood levels but increased flow capacity and flood levels to a small, localised area immediately downstream. As a result, the proposal may lead to changes on localised areas of inundation. This is not anticipated to substantially affect or displace threatened species or result in a significant loss of riparian and aquatic habitat.

Temporary crossings have the potential to impact fish by temporarily altering the hydrological regimes of the waterways, reducing stream width and reducing water quality from an increase in sedimentation and turbidity from the placement of material instream and vehicle/plant use of the crossing. Though fish passage may be altered, it would not impact upon any threatened species, or be blocked for the construction of the waterway crossings. Any temporary waterway crossings would take into consideration the requirements of the *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) and *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).

Most watercourses within the site investigation area are ephemeral and therefore impacts would be confined to periods of higher rainfall when water is flowing. However, for more permanent watercourses, particularly the unnamed tributary in the southern extent of the site investigation area, impacts to aquatic habitats would occur during construction from instream works, including culvert construction. There would be direct impacts to aquatic vegetation due to the removal of snags from creek adjustments and culvert footprints. Removal of riparian vegetation would be minimised, and vegetation connectivity retained across the riparian zone where possible.

There is potential for sedimentation and spills to affect water quality in watercourses during the construction process which could also affect native fish and frogs, including downstream of the proposal construction footprint. Water quality management measures during construction would minimise the likelihood and extent of potential impacts to creeks (eg using appropriate sediment and erosion control procedures and keeping high risk

activities such as concrete pouring and earth works away from watercourses where practicable).

Shading regimes may be altered as a result of culvert structures over small and limited areas of creeks within the proposal construction footprint. Due to the small areas to be impacted, and the absence of threatened fish within the site investigation area, fish movements are unlikely to be substantially impacted. Water temperature would be reduced in these areas compared with unshaded areas, however this reduction would be minor and form part of a mosaic of micro differences in water temperature along existing creek lines.

5.1.5 Fauna injury and mortality

The proposal has the potential to result in an increase to injury and mortality of native fauna during both the construction and operation stages. The primary cause of increased fauna injury and mortality during the construction stage of the proposal would be as a result of vegetation clearing activities (eg unexpected species finds during the felling of hollow-bearing trees) or may result from collisions with work vehicles or plant, or accidental entrapment in plant, trenches or other works.

The removal of fauna habitat has inherent risks that can, in part, be mitigated through implementing appropriate clearing procedures. The majority of native and threatened fauna species that have habitat within the site investigation area are highly mobile and typically vacate the vegetation in which they reside at the commencement of vegetation clearing. Other, typically ground dwelling, species are less mobile and at higher risk of construction phase mortality. Measures to reduce accidental injury or mortality to fauna are proposed in Section 6.

The primary cause of increased fauna injury and mortality during the operational stage of the proposal is anticipated to be vehicle collisions. The most susceptible species to vehicle strike are likely to be common, mobile and gregarious, such as arboreal mammals (eg Common Brushtail Possum) or larger terrestrial mammals (eg Eastern Grey Kangaroo) as well as the Common Wombat.

An assessment was undertaken to identify the number of records reported on BioNet within a 10 kilometre radius of the proposal that have been entered as ‘roadkill’. The assessment found 98 records of 22 fauna species entered as roadkill, with the records dating back to 1994. Of the 22 species recorded, eight were listed as threatened species under the *Biodiversity Conservation Act 2016* (BC Act), and three of these species were also listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). **Table** 5-4 summarises these records.

Table 5-4 BioNet records identified as roadkill within 10 kilometres of the site investigation area

Species	Status		Year last recorded	Number of records
	BC Act	EPBC Act		
Barking Owl	Vulnerable	-	2013	1
Common Brushtail Possum	-	-	2008	2
Common Wombat	-	-	2018	38
Eastern Blue-tongue	-	-	2017	3
Eastern Bristlebird	Endangered	Endangered	2005	1
Eastern Brown Snake	-	-	2005	1

Species	Status		Year last recorded	Number of records
	BC Act	EPBC Act		
Eastern Ground Parrot	Vulnerable	-	2006	1
Eastern Pygmy Possum	Vulnerable	-	2016	1
Fox*	-	-	2006	21
Green and Golden Bell Frog	Endangered	Vulnerable	2009	7
Lace Monitor	-	-	2019	1
Long-nosed Bandicoot	-	-	2018	5
Masked Owl	Vulnerable	-	2017	1
Nankeen Kestral	-	-	1997	1
Painted Button Quail	-	-	1999	1
Rosenberg's Goanna	Vulnerable	-	1995	1
Short-beaked Echidna	-	-	2006	5
Southern Boobook	-	-	2016	3
Southern Emu-wren	-	-	1997	1
Spotted-tailed Quoll	Vulnerable	Endangered	2009	1
Swamp Harrier	-	-	1997	1
Swamp Rat	-	-	1994	1

Two at-grade roundabouts are included within the proposal design, which would slow traffic down at the intersection. How fast a vehicle is travelling plays a major role in vehicle strike. The likelihood of collision increases with vehicle speeds over 60 kilometres per hour because of the reduction in reaction time to avoid a collision. Studies have shown that reduction in vehicle speeds can reduce the incidence of wildlife vehicle strike (Huijser, Mosler-Berger, Olsson, & Strein, 2015). The inclusion of the overpass bridge would also divert some of the high speed traffic away from the vegetation edges where roadkill is most likely to ocur.

Strike rates of fauna are not likely to significantly increase given the proposal does not represent a substantial change in land use as a major highway. Measures to encourage safe passage for fauna species across the road corridor are outlined in Section 6.

5.2 Indirect/operational impacts

5.2.1 Wildlife connectivity and habitat fragmentation

The regional biodiversity corridor mapped in the Illawarra Shoalhaven Regional Plan, Shoalhaven Local Environmental Plan, and the South Coast Corridor mapping is generally aligned within the vicinity of the proposal and intersects the northern section of the proposal construction footprint (Figure 1-1). Here, patches of good condition vegetation within the site provide habitat connectivity to large areas of adjacent vegetation in the surrounding Nature Reserves, Conservation Areas and National Parks to the east, south and west of the site investigation area (see Section 3.13). As such, fauna species are likely to use the site investigation area for habitat and dispersal, and the proposal has the potential to impact wildlife connectivity and habitat corridors by:

- Reducing the area of vegetation comprising habitat corridors
- Reducing the width of habitat corridors
- Increasing the width of existing gaps in habitat corridors
- Creating new gaps in habitat corridors
- Introducing or moving edge effects in habitat corridors.

The regional biodiversity corridor mapping crosses the Princes Highway which acts as a barrier to the east-west movement of fauna. The Princes Highway in the location of the mapped biodiversity corridor is a dual carriageway with a speed limit of 100 kilometres per hour and a width of about 35 metres. The proposal would not substantially widen this gap in the corridor and is unlikely to have a substantial impact on the current viability of the corridor given the existing barrier of the Princes Highway.

All threatened fauna species that have been recorded on the site or are considered highly likely to occur within the site are highly mobile bird and bat species. As such, clearing for the proposal is not anticipated to result in a barrier to connectivity for these fauna species.

Many native ground dwelling and common arboreal fauna species are known to occur in the area such as wombats, possums, echidnas and kangaroos. East-west connectivity across the Princes Highway is currently limited for these species, leading to roadkill frequently occurring, as described in Section 5.1.5.

To contribute to the enhancement of the regional biodiversity corridor, measures to promote fauna connectivity would be introduced as part of the proposal.

Existing culverts under the Princes Highway within the proposal construction footprint would be enhanced through retaining and planting vegetation near culvert entrances as well as installing other habitat features such as logs, rocks and leaf litter near culvert entrances, provided this does not negatively impact the function or maintenance of the culverts. This would encourage small ground dwelling and arboreal animals to utilise this infrastructure and support an increase east-west connectivity.

To further contribute to the enhancement of the regional biodiversity corridor, a fauna rope bridge crossing and one set of glider poles (that is, one glider pole on each side of the highway) would be installed as part of the proposal. The rope bridge and glider poles would be located in the northern extent of proposal construction footprint, within the mapped regional biodiversity corridor, in consultation with DPIE and Council. The rope bridge and glider poles would support east-west movement through the regional biodiversity corridor for common arboreal mammals, such as the Common Ringtail Possum, Common Brushtail Possum and Sugar Glider, as well as threatened species that may occur in the area from time to time such as the Yellow-bellied Glider and Greater Glider.

5.2.2 Edge effects on adjacent native vegetation and habitat

Edge effects refer to changes in population or vegetation structure that occur along the edges of habitats (ie in any cleared or disturbed environment). Edge effects occur when environmental conditions are altered (eg light levels, wind speed and temperature) and consequently, can promote the growth of different vegetation types (including weeds), invasion by feral fauna, or change the behaviour of resident fauna (Moenting & Morris,

2006). The extent of influence of edge effects can vary, depending on the type and intensity of impact, and have the potential to impact on a range of flora and fauna species identified as occurring or having the potential to occur within the site investigation area.

Vegetation occurring along the road verges of the Princes Highway, the Old Princes Highway and Jervis Bay Road is currently subject to edge effects. Residential and industrial development and agricultural activities including clearing have also created edge effects in adjacent areas of vegetation. All vegetation zones mapped within the site investigation area are subject to some level of edge effects. In particular, ground layer vegetation surrounding the road intersection has been degraded by the abundance of exotic species, run-off from the highway and dumping of rubbish. The proposal could potentially result in expansion of some of the existing edge effects as a new edge is created along PCT 1082 to the east of the Princes Highway, and the edge along the west of the highway encroaches into PCT 1326 and the TEC Illawarra Lowlands Grassy Woodland. Edge effects resulting from enriched run-off may be reduced through capture and diversion of enriched surface flows to bioretention basins as part of the proposal.

5.2.3 Invasion and spread of weeds

The invasion and spread of weeds poses a high risk to biodiversity and is a potential consequence of construction and operation activities when the appropriate management strategies are not implemented. Weeds present a high biodiversity risk as they compete with native vegetation and invade and transform ecosystems (Downey & Grice, 2008). This is particularly harmful to threatened species and TECs which are already under environmental stress. Disturbance such as vegetation removal, is often an important precursor to the invasion of weeds (Adair, 1995) and as such, the proposal has a high risk of weed establishment.

Four exotic species recorded in the site investigation area are listed as Priority Weeds in the South East region, which includes Shoalhaven local government area: *Asparagus aethiopicus* (Asparagus Fern) *Rubus fruticosus* sp*. agg*. (Blackberry), *Salix sp.* and *Senecio madagascariensis* (Fireweed) (see Section 3.7).

Invasive exotic grasses such as *Ehrharta erecta* also represent a threat to native vegetation. If unmanaged, an increase in the movement of people, vehicles, machinery, vegetation waste and soil during and following construction of the proposal may facilitate the introduction or spread of exotic grasses and other weeds that currently occur within the site investigation area.

Disturbed areas, such as those in which earthworks are to be carried out, would be particularly susceptible to weed establishment. Management measures would be required to minimise the risk of introduction and spread of weeds.

5.2.4 Invasion and spread of pests

Pest species pose some of the greatest threats to biodiversity as they can displace native species through predation and competition, and damage vegetation by overgrazing and trampling (Adair & Groves, 1998). The proposal may directly or indirectly result in the invasion and spread of pest species, and consequently, impact biodiversity in the site investigation area.

A total of 11 vertebrate fauna species that are considered introduced pest species were recorded in the site investigation area during surveys. These are:

- Black Rat (*Rattus rattus*)
- Cattle (*Bos taurus*)
- Common Blackbird (*Turdus merula*)
- Common Myna (*Acridotheres tristis*)
- Common Starling (*Sturnus vulgaris*)
- European Rabbit (*Oryctolagus cuniculus*)
- European Red Fox (*Vulpes vulpes*)
- Feral/Domestic Cat (*Felis catus*)
- Horse (*Equus caballus*)

- Sheep (*Ovis aries*)
- Shetland Cattle (*Bos taurus taurus*).

Activities such as vegetation clearing, habitat removal, increased noise and human presence as a result of the proposal have the potential to disperse pest species across the surrounding landscape and increase the ability of such species to utilise habitats during construction and operation phases. Vegetation clearing, and consequent fragmentation can result in the establishment of predator pest species including the European Red Fox, which pose a high risk to birds and small terrestrial fauna.

Within the site investigation area, most patches of vegetation are small and fragmented, and pest species are already well established. As such, many of the areas of vegetation and fauna habitat within and directly adjacent to the construction footprint are impacted by pest fauna. Consequently, while the pest species listed above are likely to capitalise on the disturbance associated with construction and development activities, the proposal is unlikely to significantly increase the overall impact of pest species within the site investigation area.

5.2.5 Invasion and spread of pathogens and disease

The proposal has the potential to increase the spread of pathogens that threaten native biodiversity values. Pathogens specific to the proposal are the soil-borne pathogen *Phytophthora cinnamomi* (Phytophthora), *Austropuccinia psidii* which causes the disease Myrtle rust, and Psittacine beak and feather disease (PBFD). All three of these pathogens are listed as Key Threatening Processes under the BC Act. While no indicators of Phytophthora, Myrtle Rust or PBFD were detected within the site investigation area during surveys, these pathogens are known to be highly invasive and have a wide distribution across eastern New South Wales and are therefore relevant to the proposal.

Phytophthora infects roots and is associated with damage and death to native plants. It may be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of Phytophthora may also be dispersed by vehicles (eg cars and earth moving equipment), animals, walkers and movement of soil (DAWR, 2018).

Myrtle rust causes deformed leaves and defoliation, reduced fertility, dieback and plant death of plant within the Myrtaceae family. This includes native Australian plants such as *Callistemon* spp*., Melaleuca* spp., and *Eucalyptus* spp*.* The spores of Myrtle rust can be easily dispersed via contaminated clothing, hair, skin and infected plant material as well as via wind dispersal and animal movement (DoEE, n.d.).

The proposal may increase the risk of dispersal of Phytophthora and Myrtle rust as a result of construction activities which involve the disturbance of soil and the movement of plant across the site investigation area.

Psittacine beak and feather disease is a highly infectious viral disease which affects parrots. It is an often fatal disease which causes feather, beak and skin abnormalities and is transmitted orally or in faeces or feathers. It can remain alive for years in nest hollows, making the virus extremely stable in the environment (DoEE, n.d.). PBFD can have a significant impact on threatened parrot species with small populations, however, larger populations of parrot species can sustain losses and develop immunity to the disease (DoEE, n.d.). Glossy Black-Cockatoo, a threatened species of parrot, have been recorded within the site investigation area. A large population of this species occurs within the Shoalhaven region. As such, PBFD is unlikely to have a major impact within the site investigation area.

To minimise the risk of these pathogens being spread as a result of the proposal, pathogens will be managed in accordance with Guide 7: Pathogen management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011a) as outlined in Section 6.

5.2.6 Changes to hydrology

Changes to hydrology as a result of the proposal are detailed within the Jervis Bay Road Intersection Upgrade Flood and Surface Water Assessment (Arcadis, 2021) prepared for the proposal review of environmental factors.

Alterations to natural flow regimes is recognised as a major factor contributing to loss of biological diversity and ecological function in aquatic ecosystems and is recognised as a Key Threatening Process under the BC Act. Culvert upgrades in the site investigation area has the potential to alter flow patterns, however these impacts are expected to be localised and minor (as discussed in Section 5.1.4). Such alterations to the local hydrology would have a negligible impact on aquatic species (eg fish), since this type of flow is ephemeral. However, it may change microhabitat features for common frog species. This potential impact is considered minor as these species are already adapted to a disturbed peri-urban environment.

5.2.7 Noise, light and vibration

Noise, light and vibration can impact on surrounding biodiversity during the construction and operation phases of the proposal. In addition, impacts from linear infrastructure (ie roads) can extend into adjacent vegetation and areas surrounding the site investigation area.

Noise and vibration sources can include vehicles, machinery and human activity. The proposal would change existing noise conditions through elevated vehicle activity on existing roads, new roads and interchanges, and from construction activities.

The proposal is within a semi-rural area, where noise and vibration from existing roads and residences is already present. However, sudden additional noise and vibration has the potential to disrupt foraging, breeding and/or movement behaviour of both common and threatened fauna.

Noise and vibration impacts from construction activities would be unlikely to have a substantial, long-term impact on fauna, including threatened fauna, as impacts are considered to be short-term and would reduce after construction, and remaining vegetation would provide refuges for fauna to retreat to. Within the site investigation area, some sensitive species (eg woodland birds) may avoid the noise and vibrations, while some more tolerant species (eg small mammals) are likely to habituate over the longer-term (Byrnes, Goosem, & Turton, 2012).

While the proposal is likely to increase the amount of artificial lighting within the site investigation area and surrounds during the construction and operation phase, roads within the locality already currently experience a high level of light exposure. The existing Princes Highway and Jervis Bay Road also experience increased light pollution due to traffic and regular road works. Sudden additional lighting however, has the potential to affect fauna, particularly nocturnal fauna, by interrupting their life cycle or impacting on species more vulnerable to predation (eg small mammals and amphibians).

Light pollution can also increase the susceptibility of fauna to vehicle collisions. For example, species such as amphibians are attracted to artificial light sources, due to the increased availability of insects, and as such can be drawn to roads with increased lighting (Perry *et al.,* 2008). In addition, increased artificial lighting can lead to the congregation of highly adaptable species, including pest species, which can lead to an impact on the community structure of fauna populations (Perry *et al.,* 2008).

These impacts are not considered to have a significant, long-term impact on fauna, including threatened fauna, as fauna within the site investigation area would already be adapted to light pollution, and the increased artificial lighting associated with the proposal is unlikely to have a substantial effect.

Management measures have been provided in Section 6 to minimise noise, light and vibration impacts.

5.2.8 Groundwater dependent ecosystems

Ecosystems with potential reliance on subsurface groundwater have been mapped within and adjoining the site investigation area in the Groundwater Dependent Ecosystem Atlas (BOM, 2020). A total of 18.59 hectares mapped by BOM (2020) as potential GDEs would be removed for the proposal.

Impacts to groundwater as a result of the proposal are detailed within the review of environmental factors. The proposal does not require any deep cuts or excavations and therefore no dewatering of large amounts of groundwater, groundwater drawdown or changes to groundwater flows would occur. Impacts to GDEs as a result of the proposal are therefore unlikely. Effects of changes to groundwater flows and depth on GDEs have been assessed in accordance with the *Risk assessment guidelines for Groundwater Dependent Ecosystems* (DPI, 2012).

5.3 Cumulative impacts

Cumulative biodiversity impacts may arise from the interaction of construction and operation activities of the proposal and other existing or planned projects in the wider area. This may include other Transport for NSW proposals or large scale proposals within the Shoalhaven region.

When considered in isolation, specific project impacts may be considered minor. These minor impacts may be more substantial, however, when the impact of multiple projects on the same receivers is considered. Consequently, the extent to which the proposal contributes to the cumulative impacts of existing and planned developments, or activities on threatened species, ecological communities, habitats, Areas of Outstanding Biodiversity Value and Key Threatening Processes has been assessed.

Recently completed, ongoing, or proposed projects within proximity to the site investigation area and their associated impacts to biodiversity have been described in **Table 5-5**. This analysis was prepared where information was readily available (ie published) and considered, at a minimum, impacts to vegetation and habitat removal, threatened species, ecological communities and water quality.

Table 5-5: Present and future projects within proximity to the site investigation area

Project	Proximity	Project description	Project status	Biodiversity value impacted	Construction impacts	Operational impacts	Project benefits
Nowra bridge project	About 12 kilometres north-north-east of site investigation area	A new four lane bridge over the Shoalhaven River, upgraded intersections, and additional lanes on the Princes Highway	In construction (completion 2024)	19 *Syzygium paniculatum* individuals (E – BC Act) Potential habitat for 16 threatened fauna species 2.18 hectares of native vegetation, including 0.09 hectares of Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC – BC Act, E – EPBC Act) (RMS, 2018)	Vegetation removal, threatened species, ecological communities, waterways, fragmentation of habitat, loss of connectivity, air quality and dust emissions, increased traffic, visual impacts, social infrastructure, local businesses, local tourism facilities (RMS, 2018)	Increased traffic, increased light, noise and vibration, impacts to water quality (RMS, 2018)	Improves safety (eg road, pedestrian and cyclist safety), efficiency and connectivity (eg Scenic Drive, Bridge Road, Pleasant Way) in the South Coast region (RMS, 2018)
Princes Highway and Island Point Road intersection improvements at Tomerong	About 10 kilometres south-south-west of the site investigation area	A roundabout at the intersection of the Princes Highway and Island Point Road in Tomerong	In construction (completion 2020)	42 *Melaleuca biconvexa* individuals (V – BC Act, V – EPBC Act) Potential habitat for 16 threatened fauna species 0.95 hectares of native vegetation (RMS, 2019)	Vegetation removal, threatened species, fauna habitat, aquatic impacts, fauna injury and mortality (RMS, 2019)	Wildlife connectivity and habitat fragmentation, edge effects, invasion and spread of weeds and pests, increased light, noise and vibration (RMS, 2019)	Improves safety, traffic efficiency and connectivity around the Bay and Basin areas (RMS, 2019)

Project	Proximity	Project description	Project status	Biodiversity value impacted	Construction impacts	Operational impacts	Project benefits
Jervis Bay Road to Sussex Inlet upgrade	The identified corridor would connect with the site investigation area, forming a 20 kilometre section of the Princes Highway	A proposed upgrade on the Princes Highway between Jervis Bay Road and Sussex Inlet Road	Strategic investigation and design	N/A – this project is currently in the first stages. Due to the timing and proximity of this upgrade, is it expected that there will be associated impacts to the proposed intersection			Creates better and more mobile regional centres, delivers a more resilient transport network, improves safety, eases traffic congestion and grows regional economies

The cumulative impacts associated with these proposals and projects are summarised above and broadly include:

- The removal of native vegetation that is listed as Critically Endangered or Endangered Ecological Communities under the BC Act and/or EPBC Act
- The removal of threatened flora species listed under the BC Act and/or EPBC Act
- The removal of habitat for threatened fauna species listed under the BC Act and/or EPBC Act
- The fragmentation of riparian corridors and wildlife connectivity corridors
- The degradation of waterways and waterbodies associated with the loss of riparian vegetation

The impacts of the proposal would contribute to the continued loss of threatened flora, fauna, ecological communities and their habitat within the locality. While the threatened flora species and threatened ecological communities to be impacted differ between the projects and proposals and are relatively minor, their combined loss does negatively impact on the biodiversity of the locality.

5.4 Assessments of Significance

5.4.1 BC Act listed entities

Assessments of significance have been carried out for threatened species, populations, and/or ecological communities listed under the BC Act which have been recorded, assumed present, or are considered to have a high or moderate likelihood of occurrence within the site investigation area (see **Table 3-10**). Where threatened species share similar life histories or habitat requirements, the assessments of significance have been grouped (eg woodland birds, large forest owls, diurnal raptors), allowing similar assessment.

The assessments of significance adhered to the *Threatened Species Assessment Guidelines: the assessment of significance* (DECC, 2007).

The results of the assessments of significance are summarised in **Table 5-6** and provided in full in Annexure D.

Table 5-6: Summarised findings of BC Act assessments of significance tests

Threatened entity	Significance assessment question[1]					Likely significant impact?
	a	b	c	d	e	
FLORA						
Hibbertia puberula subsp. puberula	N	X	N	N	Y	No
FAUNA						
Eastern False Pipistrelle	N	X	N	N	Y	No
Glossy Black-Cockatoo	N	X	N	N	Y	No
Greater Broad-nosed Bat	N	X	N	N	Y	No
Green and Golden Bell Frog	N	X	Y	N	Y	No
Grey-headed Flying-fox	N	X	N	N	Y	No
Large Bent-winged Bat	N	X	N	N	Y	No

Threatened entity	Significance assessment question[1]					Likely significant impact?
	a	b	c	d	e	
Little Lorikeet	N	X	N	N	Y	No
Masked Owl	N	X	N	N	Y	No
Powerful Owl	N	X	N	N	Y	No
Southern Myotis	N	X	N	N	Y	No
Square-tailed Kite	N	X	N	N	Y	No
White-bellied Sea-Eagle	N	X	N	N	Y	No
Yellow-bellied Glider	N	X	N	N	Y	No
ECOLOGICAL COMMUNITIES						
Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	X	N	N	N	Y	No

Y = Yes (negative impact), N = No (no or positive impact), X = not applicable, ? = unknown impact.

1. Significance assessment questions for BC Act listed entities are provided in Annexure D.

5.4.2 EPBC Act listed entities

Significant impact criteria assessments have been carried out for threatened species, populations, and/or ecological communities listed under the EPBC Act which have been recorded or are considered to have a high or moderate likelihood of occurrence within the site investigation area (see **Table 3-10**). Where threatened species share similar life histories or habitat requirements, the significant impact criteria assessments have been grouped (eg woodland birds, large forest owls, diurnal raptors).

Referrals under the EPBC Act for impacts to biodiversity are not required for Transport for NSW road proposals under Division 5.1 of the EP&A Act in accordance with the Strategic Assessment process. However, significant impact criteria assessments are still required to be completed.

The significant impact criteria assessments adhered to the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DoE, 2013).

The results of the significant impact criteria assessments are summarised in **Table 5-7** and provided in full in Annexure F.

Table 5-7: Summarised findings of EPBC Act assessment of significance tests

Threatened entity	Significance assessment question[1]									Important population[2]	Likely significant impact?
	a	b	c	d	e	f	g	h	i		
FAUNA											
Grey-headed Flying-fox	N	N	N	N	N	N	N	N	N	No	No
Green and Golden Bell Frog	N	N	N	N	N	Y	N	N	N	Yes	No

Threatened entity	Significance assessment question[1]									Important population[2]	Likely significant impact?
	a	b	c	d	e	f	g	h	i		
ECOLOGICAL COMMUNITIES											
Illawarra and south coast lowland forest and woodland ecological community	Y	N	N	N	N	N	Y	X	X	X	No

Y = Yes (negative impact), N = No (no or positive impact), X = not applicable, ? = unknown impact.

1. Significance assessment questions for EPBC Act listed entities are provided in Annexure F.

2. The definition of an Important Population of a species is provided in Annexure F.

6 Mitigation

Where impacts cannot be avoided, safeguards would be implemented to mitigate these impacts during construction and operation. Mitigation measures proposed to be implemented are described in **Table 6-1**.

Table 6-1: Mitigation measures

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Biodiversity	A Flora and Fauna Management Plan will be prepared and implemented as part of the Construction Environmental Management Plan. It will include, but not be limited to: • Plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas, carried out in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) • Pre-clearing survey requirements, carried out in accordance with Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) • Procedures for unexpected threatened species finds and fauna handling • Protocols to manage weeds and pathogens.	Detailed design/prior to construction	Effective	No residual impacts anticipated
Removal of native vegetation, threatened species habitat and habitat features, and threatened plants	The detailed design and construction of the proposal will minimise native vegetation clearing and habitat removal, prioritising the avoidance of threatened ecological communities.	Detailed design Construction	Effective	No residual impacts anticipated
	Vegetation and habitat removal will be undertaken in accordance with Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011a).	During construction	Effective	
	Any revegetation will be carried out in accordance with Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Post construction	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	The unexpected species find procedure under Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) is to be followed if threatened flora, fauna and/or ecological communities not assessed in the review of environmental factors are identified in the proposal construction footprint.	During construction	Proven	
	Any fauna habitat replacement or reinstatement will be carried out in accordance with Guide 5: Re-use of woody debris and bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	During construction	Proven	
	A nest box strategy will be developed and implemented in accordance with Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Detailed design Pre-construction	Proven	
	Seasonally appropriate targeted surveys will be conducted for the Green and Golden Bell Frog in accordance with the NSW Survey Guide for Threatened Frogs (DPIE, 2020d) and with reference to the Commonwealth Survey Guidelines for Australia's Threatened Frogs (DEWHA, 2010) prior to construction.	Pre-construction	Proven	
	A compensatory habitat management plan will be prepared and implemented for the Green and Golden Bell Frog in the event the species is recorded during targeted surveys and impact to the dam cannot be avoided. This management plan would detail the design and habitat requirements for the creation of compensatory habitat including its location near the existing area of habitat and the inclusion of appropriate fencing or other barrier to Green and Golden Bell Frog movement onto the Princes Highway. The compensatory habitat management plan would also consider the accessible habitat requirements (Hamer, 2016), habitat creation guidelines as per DECC (2008) and lessons learnt from previous habitat creation projects.	Pre-construction During construction Post construction	Effective	No residual impacts anticipated

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Aquatic impacts	Aquatic habitat will be protected in accordance with Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011a) and Section 3.3.2 Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013 (DPI, 2013).	During construction	Effective	No residual impacts anticipated
Injury and mortality of fauna	Fauna will be managed in accordance with Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011a).	During construction	Effective	No residual impacts anticipated
Invasion and spread of weeds	Weeds will be managed in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011a).	During construction	Effective	No residual impacts anticipated
Invasion and spread of pathogens and disease	Pathogens will be managed in accordance with Guide 7: Pathogen management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011a).	During construction	Effective	No residual impacts anticipated
Noise, light and vibration	Lighting will only be used as necessary at night and will be turned off when not needed.	Construction	Effective	No residual impacts anticipated
Enhancement of identified habitat corridors	Habitat features suitable for native fauna will be installed near culvert entrances where feasible to promote fauna connectivity.	Construction	Effective	No residual impacts anticipated
	A rope crossing and glider poles will be installed within the identified regional biodiversity corridor to facilitate the crossing of gliders and other arboreal fauna.	Construction	Proven	
Biodiversity offsets	A biodiversity offset strategy will be developed in accordance with the Guideline for Biodiversity Offsets (Roads and Maritime Services, 2016) to identify required offsets for potential impacts to the BC Act and EPBC Act listed threatened ecological communities, threatened species and threatened species habitat.	Pre-Construction		

7 Offset strategy

7.1 Quantification of offset or revegetation requirements

If impacts are unable to be avoided or mitigated against, and exceed thresholds, a biodiversity offset strategy would be required in accordance with the *Guideline for Biodiversity Offsets* (Roads and Maritime Services, 2016).

The Guideline lists a number of activities of impacts of projects assessed by a review of environmental factors and guidance on whether offsets should be considered. The biodiversity values identified in the proposal construction footprint were compared with the requirements to consider offsets in the guideline table (**Table 7-1**).

Table 7-1: Comparison of biodiversity values of the site investigation area with Table 1 of the *Guideline for Biodiversity Offsets* (Roads and Maritime Services, 2016)

Description of Activity or Impact	Consider Offsets?	Values within the proposal construction footprint
Activities in accordance with Environmental assessment procedure: Routine and Minor Works (RTA, 2011c).	No	N/A
Works on cleared land, plantations, exotic vegetation where there are no threatened species or habitat present.	No	3.20 hectares of exotic grassland and 0.09 hectares of planted exotic/native vegetation and remnant trees.
Work involving clearing of vegetation planted as part of a road corridor landscaping program (this includes where threatened species or species comprising listed ecological communities have been used for landscaping purposes)	No	N/A
Work involving clearing of national or NSW listed critically endangered ecological communities (CEEC)	Where there is any clearing of a CEEC in moderate to good condition	One CEEC has been recorded in the proposal construction footprint and patches are in either moderate or good condition: Illawarra and south coast lowland forest and woodland ecological community – listed as critically endangered under the EPBC Act (2.29 hectares).
Work involving clearing of nationally listed threatened ecological community (TEC) or nationally listed threatened species habitat	Where clearing more than one hectare of a TEC or habitat in moderate to good condition	No additional nationally listed TECs have been recorded in the proposal construction footprint. Threatened species habitat for one nationally listed species, Green and Golden Bell Frog – listed as vulnerable under the EPBC Act (one constructed dam and 23.48 hectares of accessible habitat) is present in the proposal construction footprint.

Description of Activity or Impact	Consider Offsets?	Values within the proposal construction footprint
Work involving clearing of NSW endangered or vulnerable ecological community	Where clearing more than five hectares or where the ecological community is subject to a Species Impact Statement	One NSW listed TEC has been recorded in the proposal construction footprint: Illawarra Lowlands Grassy Woodland - listed as endangered under the BC Act (4.18 hectares). As there is less than 5 hectares of this TEC in the proposal footprint no offsets are required.
Work involving clearing of NSW listed threatened species habitat where the species is a species credit species as defined in the OEH Threatened Species Profile Database (TSPD)	Where clearing more than one hectare or where the species is the subject of a Species Impact Statement	10.51 hectares of habitat for the species credit species *Hibbertia puberula* subsp. *puberula* – listed as endangered under the BC Act. 3.33 hectares of habitat for the species credit species Southern Myotis – listed as vulnerable under the BC Act. One constructed dam (377 square metres) comprising potential habitat for the species credit species Green and Golden Bell Frog – listed as endangered under the BC Act.
Work involving clearing of NSW listed threatened species habitat and the species is an ecosystem credit species as defined in OEH's Threatened Species Profile Database (TSPD)	Where clearing more than five hectares or where the species is the subject of a Species Impact Statement	There is a total of 16.16 hectares of native vegetation associated with or forming potential habitat for ecosystem credit species in the proposal construction footprint.
Type 1 or Type 2 key fish habitats (as defined by NSW Fisheries)	Where there is any net loss of habitat	No key fish habitat occurs within the proposal construction footprint.

Based on the comparison in **Table 7-1**, offsets would be required under the *Guideline for Biodiversity Offsets* (Roads and Maritime Services, 2016) for potential impacts to the BC Act and EPBC Act listed threatened ecological community and threatened species habitat. Offsets may be delivered through a range of mechanisms, including securing offset properties under an appropriate legal instrument, or purchasing and retiring biodiversity credits.

Mitigation requirements for the Green and Golden Bell Frog would be determined following targeted surveys for the species in November 2021 – March 2022. If the species is present, compensatory habitat would be installed near to the existing area of habitat to mitigate impacts to the species. As outlined in Section 6, a compensatory habitat management plan would be prepared and implemented which would detail the design and habitat requirements of the compensatory habitat. As no significant residual impacts are anticipated from the mitigation, offsets are not required. As such, no species credits are required for the Green and Golden Bell Frog.

To determine the likely biodiversity credit requirements for the impacts of the proposal, the data collected in the proposal construction footprint was entered into the Biodiversity Assessment Method (BAM) calculator. The biodiversity credit values of the native vegetation and threatened species habitat in the proposal construction footprint are presented in **Table 7-2** and **Table 7-3**.

Table 7-2 Ecosystem credit values for impacts in vegetation zones identified in the proposal construction footprint

	Vegetation zone	Vegetation integrity score	Biodiversity risk weighting	Total area impacted requiring offsets (ha)	Area impacted meeting EPBC TEC criteria (ha)	Total ecosystem credits required (including credits required to offset EPBC TEC impacts)	Ecosystem credits required to offset EPBC TEC impacts only
PCT 1082: Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion	1082_Good	75.5	1	7.81	N/A -not listed	221	N/A
	1082_Moderate_Disturbed	48	1	2.33	N/A -not listed	42	N/A
	1082_Poor	25.5	1	1.84	N/A -not listed	18	N/A
	Total			11.98		281	
PCT 1326: Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion	1326_Moderate_Woodland	49.3	1.5	1.84	1.43	45	35
	1326_Moderate_Garden	51.2	1.5	1.1	0.86	28	22
	1326_Poor	30.7	1.5	1.24	0	19	0
	Total			4.18	2.29	92	57
Total				16.16		373	

Table 7-3: Species credit values for the species identified in the proposal construction footprint

Species name	Vegetation zone	Area of potential habitat within vegetation zones (ha)	Credits
Hibbertia puberula subsp. puberula	1082_Good	7.32	276
	1082_Moderate_Disturbed	2.33	56
	1082_Poor	0.85	11
	Total	**10.51**	**343**
Southern Myotis	1326_Low	0.81	12
	1326_Moderate_Garden	1.1	28
	1326_Moderate_Woodland	1.42	35
	Total	**3.33**	**75**
Total			**418**

8 Conclusion

Transport for NSW proposes to upgrade the intersection of Jervis Bay Road and the Princes Highway near Falls Creek in the Shoalhaven LGA. The proposal would provide a grade separated through alignment for the Princes Highway with network access to Jervis Bay Road and Old Princes Highway provided via dual at grade roundabouts serviced by on and off ramps. This biodiversity assessment has been prepared to inform the REF and is based on desktop research and field surveys, carried out by Arcadis in 2020 and 2021.

Two PCTs, PCT 1082 and PCT 1326, occur within the site investigation area, occupying a total of 21.26 hectares, of which 16.16 hectares lies within the proposal construction footprint. PCT 1326 meets the condition and extent criteria required to be the listed EEC Illawarra and south coast lowland forest and woodland ecological community, under the BC Act, with some patches also meeting the condition threshold for the Illawarra and south coast lowland forest and woodland CEEC under the EPBC Act. The BC Act TEC occupies a total area of 6.24 hectares within the site investigation area, with 3.98 hectares meeting the EPBC Act condition criteria. A total of 4.18 hectares of the BC Act TEC occurs within the proposal construction footprint, of which 2.29 hectares meets the EPBC Act condition criteria.

One threatened flora species, *Hibbertia puberula* subsp*. puberula,* listed as endangered under the BC Act, was recorded within the site investigation area. A total of 13.51 hectares of suitable habitat for the species was recorded within the site investigation area, of which 10.51 hectares is located within the proposal construction footprint. An additional 10 threatened flora species were initially considered to have moderate or high likelihood of occurrence in the site investigation area but were not recorded during targeted surveys.

Nine threatened fauna species, the Eastern False Pipistrelle (possible recording), Glossy Black-Cockatoo, Greater Broad-nosed Bat (possible recording), Grey-headed Flying-fox, Large Bent-winged Bat (probable recording), Little Lorikeet, Powerful Owl, Southern Myotis (probable recording) and White-bellied Sea-Eagle, all listed as vulnerable under the BC Act, were recorded within the site investigation area. Targeted surveys did not detect any breeding sites for dual credit species. Consequently, no species credit habitat is present, and impacts to potential foraging habitat is assumed as ecosystem credits. A total of 3.33 hectares of suitable habitat for the Southern Myotis, a species credit species, was recorded within the site investigation area. Green and Golden Bell Frog, also a species credit species, was assumed present within the site investigation area due to presence of potential habitat. Presence of this species will be confirmed following targeted surveys in November 2021 to March 2022. An additional three threatened fauna species, the Masked Owl, Square-tailed Kite and Yellow-bellied Glider, have a moderate likelihood of occurrence in the site investigation area.

Significant impact assessments concluded that, based on the removal of habitat from within the proposal construction footprint, the proposal is unlikely to have a significant impact on any BC Act or EPBC Act listed species, populations or ecological communities. The proposal is also unlikely to seriously impact any MNES, and no significant waterways or key fish habitat have been recorded within the site investigation area.

Where impacts cannot be avoided, mitigation measures are proposed that would reduce adverse impacts on ecological values. These include preparation of a Flora and Fauna Management Plan, compensatory habitat management plan for Green and Golden Bell Frog, appropriate sediment and erosion controls, avoiding and minimising removal of vegetation where practicable, site inductions, exclusion fencing, pre-clearance surveys and appropriate weed and hygiene protocols.

The Biodiversity Assessment Method calculator has been used to determine the number of credits required for the proposal based on the proposal construction footprint. A total of 373 ecosystem credits and 418 species credits would be required. Ecosystem credits comprise the following PCTs:

- Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateau of the lower Shoalhaven Valley, Sydney Basin Bioregion (281 credits)
- Woollybutt - White Stringybark - Forest Red Gum grassy woodland on coastal lowlands, southern Sydney Basin Bioregion and South East Corner Bioregion (92 credits).

Species credits comprise the following species:

- *Hibbertia puberula subsp. puberula* (343 credits)
- Southern Myotis (75 credits).

Offsets may be delivered through a range of mechanisms, including securing offset properties under an appropriate legal instrument, or purchasing and retiring biobanking credits.

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Annexure A

Species recorded

Recorded flora

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Acanthaceae	Brunoniella pumilio	Dwarf Blue Trumpet	-	-		0.3	0.1	0.1							0.1	
Adiantaceae	Adiantum aethiopicum	Common Maidenhair	-	-				0.1								
Anthericaceae	Laxmannia gracilis	Slender Wire Lily	-	-				0.1					0.1	0.1		
Apiaceae	Centella asiatica	Indian Pennywort	-	-		0.2		0.1								
Apiaceae	Hydrocotyle bonariensis		-	-												X
Apiaceae	Platysace linearifolia		-	-			0.1									
Apiaceae	Trachymene incisa	Trachymene	-	-	0.1	0.1										
Apiaceae	Xanthosia tridentata	Rock Xanthosia	-	-	0.5		0.1		0.1				0.1			
Apocynaceae	Parsonsia straminea	Common Silkpod	-	-		0.1		2.0	10.0	0.1						

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Asparagaceae	Asparagus aethiopicus	Asparagus Fern	-	-					0.4					0.1		
Asteraceae	Arctotheca calendula	Capeweed	-	-							5.0					
Asteraceae	Bidens pilosa	Cobbler's Pegs	-	-												X
Asteraceae	Cotula coronopifolia	Water Buttons	-	-							0.1					
Asteraceae	Gamochaeta pensylvanica	Cudweed	-	-							0.2					
Asteraceae	Lagenifera stipitata	Blue Bottle-daisy	-	-		0.5	0.1	0.1		0.1				0.1		
Asteraceae	Senecio madagascariensis	Fireweed	-	-		0.1					0.1	0.1		0.1		
Asteraceae	Soliva sessilis	Bindyi	-	-							0.1					
Asteraceae	Taraxacum officinale	Dandelion	-	-								5.0	0.5	1.0		
Campanulaceae	Pratia purpurascens	whiteroot	-	-		2.0		0.1			8.0	0.1		0.1		
Campanulaceae	Wahlenbergia gracilis	Sprawling Bluebell	-	-							0.1					

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Caprifoliaceae	Lonicera japonica	Japanese Honeysuckle	-	-							0.1		0.1			
Caryophyllaceae	Stellaria media	Common Chickweed	-	-							0.1					
Casuarinaceae	Allocasuarina littoralis	Black She-Oak	-	-	6.0	5.0	10.0	3.0	4.0	20.0					2.0	
Chenopodiaceae	Einadia hastata	Berry Saltbush	-	-												X
Convolvulaceae	Dichondra repens	Kidney Weed	-	-										0.1		
Cyperaceae	Carex breviculmis		-	-							0.1					
Cyperaceae	Caustis flexuosa	Curly Wig	-	-			2.0									
Cyperaceae	Cyathochaeta diandra		-	-	3.0	0.1				1.0			0.1		1.0	
Cyperaceae	Lepidosperma laterale	Variable Sword-sedge	-	-			8.0		6.0	3.0					0.1	
Cyperaceae	Ptilothrix deusta		-	-												X
Dennstaedtiaceae	Pteridium esculentum	Bracken	-	-					2.0							

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Dilleniaceae	Hibbertia puberula		-	-							0.1		0.1			
Dilleniaceae	Hibbertia spp.		Endangered	-			0.1								0.2	
Ericaceae	Epacris pulchella	Wallum Heath	-	-			0.1			0.1						
Ericaceae	Leucopogon juniperinus	Prickly Beard-heath	-	-		0.2		0.5	0.1	0.1			0.1	0.1		
Fabaceae (Faboideae)	Bossiaea heterophylla	Variable Bossiaea	-	-												X
Fabaceae (Faboideae)	Daviesia ulicifolia	Gorse Bitter Pea	-	-				0.1								
Fabaceae (Faboideae)	Glycine clandestina	Twining glycine	-	-	0.1			0.1	0.1	0.1						
Fabaceae (Faboideae)	Glycine microphylla	Small-leaf Glycine	-	-									0.1	0.1		
Fabaceae (Faboideae)	Glycine tabacina	Variable Glycine	-	-		0.1					0.1					
Fabaceae (Faboideae)	Gompholobium grandiflorum	Large Wedge Pea	-	-			0.1									

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Fabaceae (Faboideae)	Hardenbergia violacea	False Sarsaparilla	-	-						0.1				0.1		
Fabaceae (Faboideae)	Hovea linearis		-	-			0.1									
Fabaceae (Faboideae)	Kennedia rubicunda	Dusky Coral Pea	-	-												X
Fabaceae (Faboideae)	Lotus angustissimus	Slender Birds-foot Trefoil	-	-								0.1				
Fabaceae (Faboideae)	Mirbelia rubiifolia	Heathy Mirbelia	-	-	0.1		0.1			0.1			0.1			
Fabaceae (Faboideae)	Platylobium formosum		-	-						0.1						
Fabaceae (Faboideae)	Pultenaea daphnoides	Large-leaf Bush-pea	-	-						0.1						
Fabaceae (Faboideae)	Pultenaea villosa	Hairy Bush-pea	-	-				2.0	0.1							
Fabaceae (Faboideae)	Trifolium dubium	Yellow Suckling Clover	-	-								2.0				
Fabaceae (Faboideae)	Trifolium repens	White Clover	-	-							0.1					

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Fabaceae (Faboideae)	Trifolium spp.	A Clover	-	-								0.1				
Fabaceae (Mimosoideae)	Acacia brownii	Heath Wattle	-	-			0.1									
Fabaceae (Mimosoideae)	Acacia mearnsii	Black Wattle	-	-		1.0		5.0	0.5					1.0		
Fabaceae (Mimosoideae)	Acacia ulicifolia	Prickly Moses	-	-	1.0											
Iridaceae	Patersonia glabrata	Leafy Purple-flag	-	-						3.0						
Iridaceae	Patersonia longifolia		-	-												X
Iridaceae	Patersonia sericea	Silky Purple-Flag	-	-	3.0	0.1	6.0									
Iridaceae	Tritonia lineata	Lined Tritonia	-	-												X
Lauraceae	Cassytha pubescens	Downy Dodder-laurel	-	-		0.1										
Lindsaeaceae	Lindsaea linearis	Screw Fern	-	-	0.1					0.1					0.1	
Lomandraceae	Lomandra brevis		-	-		0.1	0.1									

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Lomandraceae	Lomandra glauca	Pale Mat-rush	-	-	0.1		0.1		0.5							
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush	-	-	5.0					0.2			0.1	0.1		
Lomandraceae	Lomandra multiflora	Many-flowered Mat-rush	-	-	3.0		3.0	0.5	0.2	2.0					0.1	
Lomandraceae	Lomandra obliqua		-	-	0.1		2.0			0.1						
Malvaceae	Modiola caroliniana	Red-flowered Mallow	-	-	1.0						0.1					
Myrtaceae	Angophora floribunda	Rough-barked Apple	-	-	5.0			2.0	25.0		15.0		2.0		8.0	
Myrtaceae	callistemon linearis	Narrow-leaved Bottlebrush	-	-	2.0	0.5									0.1	
Myrtaceae	Corymbia gummifera	Red Bloodwood	-	-			20.0			2.0						
Myrtaceae	Eucalyptus amplifolia	Cabbage Gum	-	-				2.0								

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Myrtaceae	Eucalyptus botryoides	Bangalay	-	-				30.0								
Myrtaceae	Eucalyptus globoidea	White Stringybark	-	-	10.0		5.0			15.0						
Myrtaceae	Eucalyptus longifolia	Woollybutt	-	-		15.0			5.0		20.0			20.0	1.0	
Myrtaceae	Eucalyptus moluccana	Grey Box	-	-												X
Myrtaceae	Eucalyptus punctata	Grey Gum	-	-					5.0	2.0			6.0	10.0		
Myrtaceae	Eucalyptus sclerophylla	Hard-leaved Scribbly Gum	-	-	10.0		15.0		5.0	3.0			3.0		30.0	
Myrtaceae	Eucalyptus tereticornis	Forest Red Gum	-	-					2.0		6.0					
Myrtaceae	Kunzea ambigua	Tick Bush	-	-	10.0	20.0	3.0	6.0	5.0						0.4	
Myrtaceae	Leptospermum polygalifolium	Tantoon	-	-	25.0		0.1	0.1							0.1	
Myrtaceae	Leptospermum trinervium	Slender Tea-tree	-	-	6.0		1.0		0.1	2.0						

Family	Scientific name	Common name	Status		Cover in each plot												
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Myrtaceae	Melaleuca decora		-	-	5.0	15.0										
Myrtaceae	Melaleuca ericifolia	Swamp Paperbark	-	-	0.5											
Myrtaceae	Melaleuca thymifolia	Thyme Honey-myrtle	-	-				5.0								
Orchidaceae	Acianthus pusillus	Gnat Orchid	-	-			0.1		0.1							
Orchidaceae	Acianthus spp.	Mosquito Orchid	-	-											0.1	
Orchidaceae	Genoplesium laminatum ined.		-	-												X
Orchidaceae	microtis spp.		-	-								0.1	0.1			
Orchidaceae	Pterostylis spp.	Greenhood	-	-		0.1										
Orchidaceae	Thelymitra spp.		-	-					0.1							
Oxalidaceae	Oxalis perennans		-	-		0.3		0.1	0.1		0.1			0.1		
Phormiaceae	Dianella caerulea	Blue Flax-lily	-	-						0.5			0.1	0.1		
Phormiaceae	Dianella longifolia	Blueberry Lily	-	-				0.5								

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Pittosporaceae	Billardiera scandens	Hairy Apple Berry	-	-	0.1		0.1		1.0	0.1				0.1		
Pittosporaceae	Pittosporum revolutum	Rough Fruit Pittosporum	-	-												X
Pittosporaceae	Pittosporum undulatum	Sweet Pittosporum	-	-					1.0				0.5	0.5		
Pittosporaceae	Rhytidosporum procumbens		-	-	0.1	0.1	0.1			0.1						
Plantaginaceae	Plantago lanceolata	Lamb's Tongues	-	-							0.1	0.2	0.1	0.1		
Plantaginaceae	Veronica plebeia	Trailing Speedwell	-	-	0.5	0.1		0.1	0.5	0.1						
Poaceae	Andropogon virginicus	Whisky Grass	-	-	2.0											
Poaceae	Anthoxanthum odoratum	Sweet Vernal Grass	-	-								50.0		10.0		
Poaceae	Aristida spp.	A Wiregrass	-	-	0.5				0.1				0.1			
Poaceae	Aristida vagans	Threeawn Speargrass	-	-					0.5	0.1						

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Poaceae	Avena fatua	Wild Oats	-	-							0.5					
Poaceae	Briza maxima	Quaking Grass	-	-								0.2				
Poaceae	Briza minor	Shivery Grass	-	-								0.1				
Poaceae	Cynodon dactylon	Common Couch	-	-	0.1			1.0				10.0				
Poaceae	Echinopogon caespitosus	Bushy Hedgehog-grass	-	-												X
Poaceae	Ehrharta erecta	Panic Veldtgrass	-	-							30.0			2.0		
Poaceae	Entolasia marginata	Bordered Panic	-	-			0.5	2.0	8.0							
Poaceae	Entolasia stricta	Wiry Panic	-	-	10.0	1.0	0.1			3.0	2.0		0.1	0.1	0.1	
Poaceae	Holcus lanatus	Yorkshire Fog	-	-								0.1				
Poaceae	Hordeum leporinum	Barley Grass	-	-							3.0					
Poaceae	Imperata cylindrica	Blady Grass	-	-				35.0	4.0					0.1		

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Poaceae	Lolium perenne	Perennial Ryegrass	-	-		0.1					10.0					
Poaceae	Microlaena stipoides	Weeping Grass	-	-	1.0	10.0	0.5	5.0	12.0	2.0	8.0		5.0	25.0	0.1	
Poaceae	Oplismenus imbecillis		-	-												X
Poaceae	Pennisetum clandestinum	Kikuyu Grass	-	-										0.1		
Poaceae	Poa pratensis	Kentucky Bluegrass	-	-							10.0					
Poaceae	Setaria pumila	Pale Pigeon Grass	-	-	1.0											
Poaceae	Sporobolus africanus	Parramatta Grass	-	-												X
Poaceae	Stenotaphrum secundatum	Buffalo Grass	-	-								50.0	20.0			
Poaceae	Themeda triandra		-	-	3.0			1.0	10.0	0.5			10.0	10.0		
Primulaceae	Lysimachia arvensis	Scarlet Pimpernel	-	-							0.1					
Proteaceae	Banksia serrata	Old-man Banksia	-	-												X

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Proteaceae	Banksia spinulosa	Hairpin Banksia	-	-	6.0		2.0		0.1	0.5					0.5	
Proteaceae	Grevillea robusta	Silky Oak	-	-												X
Proteaceae	Hakea dactyloides broad leaf form		-	-						0.1			0.1			
Proteaceae	Hakea laevipes		-	-	0.1		0.1									
Proteaceae	Hakea salicifolia	Willow-leaved Hakea	-	-					4.0							
Proteaceae	Hakea sericea	Needlebush	-	-	12.0		4.0						0.1		0.5	
Proteaceae	Hakea teretifolia	Needlebush	-	-												X
Proteaceae	Lambertia formosa	Mountain Devil	-	-	0.5		8.0			0.5						
Proteaceae	Persoonia levis	Broad-leaved Geebung	-	-			1.0									
Proteaceae	Persoonia linearis	Narrow-leaved Geebung	-	-	0.5				0.1	0.2						

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Proteaceae	Petrophile pedunculata		-	-			0.1									
Proteaceae	Petrophile pulchella	Conesticks	-	-												X
Proteaceae	Telopea speciosissima	Waratah	-	-			0.1			0.1						
Pteridaceae	Cheilanthes sieberi	Rock Fern	-	-		0.1										
Ranunculaceae	Clematis glycinoides	Headache Vine	-	-				0.1								
Rhamnaceae	Pomaderris spp.		-	-					0.1							
Rosaceae	Rubus fruticosus	Blackberry complex	-	-				0.1								
Rubiaceae	Richardia humistrata		-	-								0.1				
Rutaceae	Boronia pinnata		-	-												X
Santalaceae	Exocarpos cupressiformis	Cherry Ballart	-	-		0.2			0.1							
Sapindaceae	Dodonaea triquetra	Large-leaf Hop-bush	-	-	0.5					10.0						

Family	Scientific name	Common name	Status		Cover in each plot											
			BC Act	EPBC Act	JB01	JB02	JB03	JB04	JB05	JB06	JB08	JB09	JB10	JB11	JB12	Incidental observation
Thymelaeaceae	Pimelea linifolia	Slender Rice Flower						0.1	0.1		0.1			0.1	0.1	
Xanthorrhoeaceae	Xanthorrhoea spp.						0.5						0.1			

Recorded fauna

Common name	Scientific name	Observation type	Status	
			BC Act	EPBC Act
BIRDS				
Australian King-Parrot	*Alisterus scapularis*	OW	-	-
Australian Magpie	*Gymnorhina tibicen*	OW	-	-
Australian Raven	*Corvus coronoides*	OW	-	-
Black Kite	*Milvus migrans*	O	-	-
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	OW	-	-
Brown Goshawk	*Accipiter fasciatus*	O	-	-
Brown Thornbill	*Acanthiza pusilla*	OW	-	-
Common Blackbird*	*Turdus merula*	O	-	-
Common Bronzewing	*Phaps chalcoptera*	Q	-	-
Common Myna*	*Acridotheres tristis*	O	-	-
Common Starling*	*Sturnus vulgaris*	O	-	-
Crimson Rosella	*Platycercus elegans*	OW	-	-
Eastern Spinebill	*Acanthorhynchus tenuirostris*	OW, Q	-	-
Eastern Yellow Robin	*Eopsaltria australis*	OW, E, Q	-	-
Emu	*Dromaius novaehollandiae*	O	-	-
Galah	*Eolophus roseicapilla*	O	-	-
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	OW, G	V	-
Golden Whistler	*Pachycephala pectoralis*	OW	-	-
Grey Fantail	*Rhipidura albiscapa*	OW	-	-
Grey Shrike-thrush	*Colluricincla harmonica*	O	-	-
Laughing Kookaburra	*Dacelo novaeguineae*	OW, Q	-	-
Little Lorikeet	*Glossopsitta pusilla*	OW	V	-
Noisy Friarbird	*Philemon corniculatus*	OW	-	-

Common name	Scientific name	Observation type	Status	
			BC Act	EPBC Act
Oriental Dollarbird	*Eurystomus orientalis*	OW	-	-
Pallid Cuckoo	*Cacomantis pallidus*	W	-	-
Powerful Owl	*Ninox strenua*	O	V	-
Rainbow Lorikeet	*Trichoglossus haematodus*	W	-	-
Red Wattlebird	*Anthochaera carunculata*	OW	-	-
Satin Bowerbird	*Ptilonorhynchus violaceus*	O	-	-
Scarlet Honeyeater	*Myzomela sanguinolenta*	W	-	-
Silvereye	*Zosterops lateralis*	OW	-	-
Southern Boobook	*Ninox boobook*	W	-	-
Spotted Pardalote	*Pardalotus punctatus*	W	-	-
Striated Thornbill	*Acanthiza lineata*	OW, E	-	-
Sulphur-crested Cockatoo	*Cacatua galerita*	OW	-	-
Superb Fairy-wren	*Malurus cyaneus*	OW	-	-
Variegated Fairy-wren	*Malurus lamberti*	Q	-	-
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	O	V	-
White-faced Heron	*Egretta novaehollandiae*	O	-	-
White-necked Heron	*Ardea pacifica*	O	-	-
White-throated Treecreeper	*Cormobates leucophaea*	OW	-	-
Yellow Thornbill	*Acanthiza nana*	OW	-	-
Yellow-faced Honeyeater	*Caligavis chrysops*	OW	-	-
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	OW	-	-
MAMMALS				
Black Rat*	*Rattus*	Q	-	-
Bush Rat	*Rattus fuscipes*	Q	-	-
Cattle*	*Bos taurus*	O, P	-	-
Common Brushtail Possum	*Trichosurus vulpecula*	O, Q	-	-

Common name	Scientific name	Observation type	Status	
			BC Act	EPBC Act
Common Ringtail Possum	*Pseudocheirus peregrinus*	O	-	-
Common Wombat	*Vombatus ursinus*	P, FB, Q	-	-
Eastern Broad-nosed Bat	*Scotorepens orion*	AR (Possible)	-	-
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	AR (Possible)	V	-
Eastern Grey Kangaroo	*Macropus giganteus*	O, P, F, Q	-	-
European Rabbit*	*Oryctolagus cuniculus*	P, F, Q	-	-
European Red Fox*	*Vulpes*	P, Q	-	-
Feathertail Glider	*Acrobates pygmaeus*	O, Q	-	-
Feral/Domestic Cat*	*Felis catus*	Q	-	-
Gould's Wattled Bat	*Chalinolobus gouldii*	AR (Definite)	-	-
Greater Broad-nosed Bat	*Scoteanax rueppellii*	AR (Possible)	V	-
Grey-headed Flying-fox	*Pteropus poliocephalus*	O	V	V
Horse*	*Equus caballus*	O	-	-
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	AR (Probable)	V	-
Large Forest Bat	*Vespadelus darlingtoni*	AR (Probable)	-	-
Little Forest Bat	*Vespadelus vulturnus*	AR (Definite)	-	-
Long-nosed Bandicoot	*Perameles nasuta*	Q	-	-
Red-necked Wallaby	*Macropus rufogriseus*	Q	-	-
Sheep*	*Ovis aries*	O, P	-	-
Shetland Cattle*	*Bos taurus*	O, P	-	-
Short-beaked Echidna	*Tachyglossus aculeatus*	Q, P	-	-
Southern Myotis	*Myotis macropus*	AR (Probable)	V	-
Sugar Glider	*Petaurus breviceps*	O, Q	-	-
Swamp Wallaby	*Wallabia bicolor*	O, P, F, Q	-	-
White-striped Free-tailed Bat	*Tadarida australis*	AR (Definite)	-	-
-	*Nyctophilus sp.*	AR (Definite)	-	-

Common name	Scientific name	Observation type	Status	
			BC Act	EPBC Act
AMPHIBIANS				
Bleating Tree Frog	*Litoria dentata*	W	-	-
Common Eastern Froglet	*Crinia signifera*	W	-	-
Peron's Tree Frog	*Litoria peronii*	W	-	-
Striped Marsh Frog	*Limnodynastes peronii*	OW	-	-
Tyler's Tree Frog	*Litoria tyleri*	W	-	-
REPTILES				
Bar-sided Skink	*Eulamprus tenuis*	O	-	-
Dark-flecked Garden Sunskink	*Lampropholis delicata*	O	-	-
Eastern Brown Snake	*Pseudonaja textilis*	O	-	-
Eastern Water Skink	*Eulamprus quoyii*	O	-	-
Lace Monitor	*Varanus varius*	O, F, Q	-	-
Mustard-bellied Snake	*Drysdalia rhodogaster*	O	-	-

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Annexure B

Habitat assessment table

Likelihood of occurrence criteria

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey
High	It is highly likely that a species inhabits the study area and is dependant on identified suitable habitat (ie. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10km) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration.
Moderate	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (ie. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10km). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (ie. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
None	Suitable habitat is absent from the study area. Based on a field assessment of the habitat constraints or microhabitats on the study area , the habitat is identified as being substantially degraded such that the species is unlikely to utilise the study area (or specific vegetation zones), or an expert report that is prepared that states the species is unlikely to be present on the study area or specific vegetation zones.

FLORA

Scientific name (Common name)	Family	Status		Habitat requirements	Number of records and source	Likelihood of occurrence
		BC Act	EPBC Act			
Cynanchum elegans (White-flowered Wax Plant)	Apocynaceae	E	E	This species is restricted to eastern NSW from Brunswick Heads to Gerroa. Locations include the Cumberland Plain, the Forster area, Manning Valley, Hunter Valley, Yabbra State Forest, Brunswick Heads, Gerroa, Merriwa and northeast of Tenterfield. It is most common in the Kempsey region. The species occurs on a variety of lithologies and soil types, usually on steep slopes with varying degrees of soil fertility. It occurs mainly at the ecotone between dry subtropical rainforest and sclerophyll forest/woodland communities.	PMST	Low – No records in the locality and no suitable habitat present.
Xerochrysum palustre (Swamp Everlasting)	Asteraceae	-	V	Grows in swamps and bogs which are often dominated by heaths and also at the edges of bog margins on peaty soils with a cover of shrubs and grasses. Found in Kosciuszko National Park and the eastern escarpment south of Badja. Also found in eastern Victoria.	PMST	Low – No records in the locality and no suitable habitat present.
Hibbertia puberula subsp. puberula	Dilleniaceae	E	-	Widespread but not common. Populations extend from Wollemi NP to Morton NP and south to Nowra. Early records indicates populations in Hawkesbury River and South Coogee. Grows on sandy soil often associated with sandstone or on clay. Flowers October to December.	22 – BioNet (2015), BAMC	**Recorded** (samples confirmed by NSW Herbarium)
Hibbertia stricta subsp. furcatula	Dilleniaceae	E	-	Occurs in two populations, one in the southern outskirts of Sydney (on either side of the Woronora River) and one near Nowra. Species usually grows in gravelly loam or clay soil in heath under open woodland. Sydney population is in dry eucalypt forest and woodland. Flowers in Spring and Summer.	2 –BioNet (2009), BAMC	Low – Low number of records in the locality and study area outside known population.
Acacia bynoeana (Bynoe's Wattle)	Fabaceae (Mimosoideae)	E	V	The species is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. Found in heath or dry sclerophyll forest on sandy soils, often in slightly disturbed areas, in association with Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leaved Apple.	PMST, BAMC	**Moderate** – Suitable habitat present.

Scientific name **(Common name)**	**Family**	**Status**		**Habitat requirements**	**Number of records and source**	**Likelihood of occurrence**
		BC Act	**EPBC Act**			
Acacia pubescens (Downy Wattle)	Fabaceae (Mimosoideae)	V	V	Concentrated around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Occurs in on alluviums, shales and between shales and sandstones in open woodland and forest. Occurs in a variety of plant communities including Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland.	3 – BioNet (2016)	Low – Low number of records and no suitable habitat present.
Haloragis exalata subsp. exalata (Square Raspwort)	Haloragaceae	V	V	Occurs in four widely scattered localities in eastern NSW including the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW. The species requires protected and shaded damp situations in riparian habitats.	PMST, BAMC	Low – No records in the locality and no suitable habitat present.
Prostanthera densa (Villous Mint-bush)	Lamiaceae	V	V	Populations occur in Jervis Bay, Royal NP, Cronulla, Garie Beach and Port Stevens. Generally grows in sclerophyll forest and shrubland on coastal headlands and near coastal ranges, chiefly on sandstone and rocky slopes near the sea.	PMST	Low – No records in the locality and no suitable habitat present.
Eucalyptus langleyi (Albatross Mallee)	Myrtaceae	V/EP	V	The main occurrence of the Albatross Mallee is to the south-west of Nowra as far as Yarramunmun Creek. It is also found to a limited extent north of the Shoalhaven River in the vicinity of Bomaderry Creek. Found in mallee shrubland on poorly-drained, shallow, sandy soils on sandstone. The species regenerates from rootstock after fire	50 – BioNet (2017), PMST	**Moderate** – Large number of recent records in the locality but only marginal habitat present.
Eucalyptus sturgissiana (Ettrema Mallee)	Myrtaceae	V	-	The Ettrema Mallee is mostly restricted to the Northern Budawang Range in Morton National Park, with a few occurrences on the nearby coastal plain. Usually grows as an emergent in low shrub-heath. Grows on sandy, swampy soils.	3 – BioNet (1975), BAMC	Low – No recent records in the locality.
Melaleuca biconvexa (Biconvex Paperbark)	Myrtaceae	V	V	Only found in NSW with scattered and dispersed populations in the Jervis Bay area in the south and Gosford-Wyong area in the north. Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	250 – BioNet (2020), PMST	**Moderate** – High number of records in the locality and some suitable habitat present.

Scientific name (Common name)	Family	Status		Habitat requirements	Number of records and source	Likelihood of occurrence
		BC Act	EPBC Act			
Melaleuca deanei (Deane's Paperbark)	Myrtaceae	V	V	Species occurs in two distinct areas, Ku-ring-gai/Berowra and Holsworthy/Wedderburn. There are also isolated occurrences in Springwood, Wollemi National Park, Yalwal and Central Coast (Hawkesbury River areas). Occurs mostly in ridgetop woodland, with only 5% of sites in heath and sandstone.	PMST	Low – No records in the locality.
Rhodamnia rubescens (Scrub Turpentine)	Myrtaceae	CE	-	Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils. Occurs in coastal districts north from Batemans Bay in New South Wales, approximately 280 km south of Sydney, to areas inland of Bundaberg in Queensland. Populations of R. rubescens typically occur in coastal regions and occasionally extend inland onto escarpments up to 600 m a.s.l. in areas with rainfall of 1,000-1,600 mm.	8 – BioNet (2019)	Low – No suitable habitat in the study area.
Syzygium paniculatum (Magenta Lilly Pilly)	Myrtaceae	E	V	Found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. South coast populations occur on grey soils over sandstone, restricted mainly to remnant stands of littoral rainforest. On the central coast, populations occur on gravels, sands, silts and clays in rainforest communities.	10 – BioNet (2019), PMST	Low – No suitable habitat in the study area.
Triplarina nowraensis (Nowra Heath Myrtle)	Myrtaceae	E	E	There are five known populations of Nowra Heath Myrtle. Three of these form a cluster to the immediate west of Nowra. A fourth, much smaller population is found 18km south-west of Nowra in the Boolijong Creek Valley. The fifth population is located north of the Shoalhaven River on the plateau above Bundanon. Nowra Heath Myrtle occurs on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone. The sites are often either treeless or have a very open tree canopy due to the impeded drainage.	90 – BioNet (2016), PMST, BAMC	**Moderate** – High number of recent records in the locality. Marginal habitat present.

Scientific name **(Common name)**	**Family**	**Status**		**Habitat requirements**	**Number of records and source**	**Likelihood of occurrence**
		BC Act	**EPBC Act**			
Caladenia tessellata (Thick Lip Spider Orchid)	Orchidaceae	E	V	Known in the Sydney area, Wyong, Ulladulla and Braidwood. Populations in Kiama and Queanbeyan presumed extinct. Has been recorded in Huskisson. Found in grassy sclerophyll woodland on clay loam or sandy soils. Flowers September to November.	2 – BioNet (1931), PMST, BAMC	Low – No recent records in the locality and vegetation in study area unlikely to be suitable.
Calochilus pulchellus (Pretty Beard Orchid)	Orchidaceae	E	-	Known from the Sydney Basin Bioregion, where a total of less than 30 adult plants have been recorded in three sites over a range of 40 km on the South Coast of NSW, at altitudes from 20-560 m above sea level. All currently known sites are within the Shoalhaven local government area. At Vincentia the species grows in low Scribbly Gum dominated woodland with a low wet heath understorey. The soil is a sandy loam overlying sandstone. In Booderee National Park it grows in a tall heathy association. In Morton National Park on the Little Forest Plateau it occurs in low heath among scattered clumps of emergent eucalypts and Banksia in shallow coarse white sand over sandstone, in a near-escarpment area subject to strong orographic precipitation.	1 – BioNet (2019), BAMC	**Low/Moderate** – Only one individual recorded in the locality but some suitable habitat present.
Cryptostylis hunteriana (Leafless Tongue Orchid)	Orchidaceae	V	V	Can occur along almost the entire NSW eastern coast with recent records between Batemans Bay and Nowra. It is found in a range of communities, including swamp-heath and woodland. Larger populations often occur in woodlands dominated by Eucalyptus sclerophylla, E. sieberi, Corymbia gummifera and Allocasuarina littoralis with populations preferring open areas in the understorey of this type of community.	103 – BioNet (2019), PMST	**Moderate/High** – High number of records in the locality and suitable habitat present.
Genoplesium baueri (Bauer's Midge Orchid)	Orchidaceae	E	E	Species recorded between Ulladulla and Port Stevens with historic recordings in Sydney suburbs. Likely to be in Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Grows in dry sclerophyll forest and moss gardens over sandstone.	7 – BioNet (2016), PMST, BAMC	**Moderate** – Some records in the locality and some suitable habitat present.

Scientific name **(Common name)**	**Family**	**Status**		**Habitat requirements**	**Number of records and source**	**Likelihood of occurrence**
		BC Act	**EPBC Act**			
Genoplesium vernale (East Lynne Midge Orchid)	Orchidaceae	V	V	The East Lynne Midge Orchid is currently known from only a narrow belt, approximately 12 km wide, of predominantly Dry Sclerophyll Forest from 17 km south of Batemans Bay to 24 km north of Ulladulla. The East Lynne Midge Orchid grows in 'poorer' dry sclerophyll woodland and forest on the south coast of New South Wales between Mogo and Ulladulla. It is confined to areas with good drainage and shallow, low fertility soils. Flowering and fruiting in mid-November to late December.	PMST	Low – No records in the locality
Prasophyllum affine (Jervis Bay Leek Orchid)	Orchidaceae	E	E	Jervis Bay Leek Orchid is currently known from three areas south-east of Nowra on South Coast. These are Kinghorne Point, Wowly Gully near the town of Callala Bay, and near the township of Vincentia. Grows on poorly drained clay soils that support low heathland and sedgeland communities. Flowers are followed by a fleshy seed capsule. Plants retreat into subterranean tubers after fruiting, so are not visible above-ground.	PMST	Low – No records in the locality
Pterostylis gibbosa (Illawarra Greenhood)	Orchidaceae	E	E	Known in Milbrodale, Albion Park, Yallah and the Shoalhaven region. Grows in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum, Woollybutt and White Feather Honey-Myrtle. In Nowra, it grows amongst Spotted Gum, Forest Red Gum and Grey Ironbark. In the Hunter, it grows amongst Narrow-Leaved Ironbark, Forest Red Gum and Black Cypress Pine.	109 – BioNet (2020), PMST, BAMC	**Moderate/High** – High number of records in the locality and suitable habitat present.
Pterostylis ventricosa	Orchidaceae	CE	-	Pterostylis ventricosa is known from one population at St Georges Basin and three populations at Sussex Inlet, south of Nowra on the NSW south coast. Surveys carried out at various times between 2007 to 2010 estimate a total population of about 1,200 plants.	11 – BioNet (2018), BAMC	**Moderate** – Study area is not in close proximity to a known population but marginal suitable habitat present.

Scientific name **(Common name)**	**Family**	**Status**		**Habitat requirements**	**Number of records and source**	**Likelihood of occurrence**
		BC Act	**EPBC Act**			
Pterostylis vernalis	Orchidaceae	CE	CE	Pterostylis vernalis is only known from the Nowra area on the NSW south coast. There are five known populations located to the west and south-west of Nowra. Four are within a few kilometres of each other, and one is located approximately 18 km to the south-west. The total population is approximately 450-500 known individuals.	17 – BioNet (2018), PMST, BAMC	**Moderate –** Study area is not in close proximity to a known population but marginal suitable habitat present.
Rhizanthella slateri (Eastern Australian Underground Orchid)	Orchidaceae	V	E	Occurs from south-east QLD to south-east NSW. In NSW it occurs in Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry, Agnes Banks and Nowra. Habitat requirements are poorly understood with no particular vegetation type associated although it can occur in sclerophyll forest.	1 – BioNet (1997)	Low – No recent records in the locality.
Thelymitra kangaloonica (Kangaloon Sun Orchid)	Orchidaceae	CE	CE	Endemic to NSW and is only known to occur on the southern tablelands of NSW in the Moss Vale/Kangaloon/Fitzroy Falls area at 550-700 m above sea level. It is known to occur at three swamps (Butlers Swamp, Stockyard Swamp and Wildes Meadow Swamp) that are above the Kangaloon Aquifer. The swamp habitat in which the species occurs has an extent of occurrence of 300 km2 and an area of occupancy of 10 km2. The species grows amongst tall sedges and rushes in seasonally swampy sedgeland on grey silty clay loam at 600-700 m above sea level.	PMST	Low – No records in the locality and no suitable habitat present. Landscape features including altitude also not suitable within the study area.
Persicaria elatior (Tall Knotweed)	Polygonaceae	V	V	Recorded in south-eastern NSW (Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW it is known from Raymond Terrace (near Newcastle) and the Grafton area (Cherry Tree and Gibberagee State Forests). The species also occurs in Queensland. Typically grows in damp places, especially beside streams and lakes. Occasionally is found in swamp forest or associated with disturbance.	PMST	Low – No records in the locality and no suitable habitat present.

Scientific name (Common name)	Family	Status		Habitat requirements	Number of records and source	Likelihood of occurrence
		BC Act	EPBC Act			
Banksia vincentia	Proteaceae	CE	CE	Known from only one site at Vincentia, NSW. Occurs in low sedgeland and grassy heath, sometimes amongst emergent mallee Eucalyptus gummifera and other tall shrubs of Banksia and Hakea. Found on coastal sands over clay on sandstone.	PMST	Low – No records in the locality and no suitable habitat present.
Pomaderris cotoneaster (Cotoneaster Pomaderris)	Rhamnaceae	E	E	Cotoneaster Pomaderris has a very disjunct distribution, being known from the Nungatta area, northern Kosciuszko National Park (near Tumut), the Tantawangalo area in South-East Forests National Park and adjoining freehold land, Badgery's Lookout near Tallong, the Yerranderie area, the Canyonleigh area and Ettrema Gorge in Morton National Park. The species has also been recorded along the Genoa River in Victoria. Cotoneaster Pomaderris has been recorded in a range of habitats in predominantly forested country. The habitats include forest with deep, friable soil, amongst rock beside a creek, on rocky forested slopes and in steep gullies between sandstone cliffs.	PMST	Low – No records in the locality and no suitable habitat present.
Galium australe (Tangled Bedstraw)	Rubiaceae	E	-	Recorded in Nowra, Narooma and Nadgee NR. Flowers late Spring to early Autumn. In NSW it is recorded in Turpentine forest and coastal Acacia shrubland.	BAMC	Low – No records in the locality and no suitable habitat present.
Thesium australe (Austral Toadflax)	Santalaceae	V	V	Found in small populations scattered across eastern NSW, the coast, and the Northern and Southern Tablelands. Populations occur in grassland on coastal headlands or grassland and grassy woodland away from the coast. The species is often found in association with Kangaroo Grass (Themeda australis).	PMST	Low – No records in the locality and no suitable habitat present.
Solanum celatum	Solanaceae	E	-	Grows from Wollongong to Nowra and west to Bungonia. Grows in rainforest clearings or in wet sclerophyll forests, flowering from August to October.	2 – BioNet (1937)	Low – No recent records in the locality and no suitable habitat present.

Scientific name (Common name)	Family	Status		Habitat requirements	Number of records and source	Likelihood of occurrence
		BC Act	EPBC Act			
Pimelea spicata (Spiked Rice-flower)	Thymelaeaceae	E	E	Occurs in two populations; the Cumberland Plain (Marayong, Prospect Reservoir, Narellan and Douglas Park) and the Illawarra (Landsdowne, Shellharbour and Kiama).The species is found on well-structured clay soils. The Cumberland population is associated with canopy species Eucalyptus moluccana, E. tereticornis and E. crebra. Other co-occurring species include Bursaria spinosa and Themeda australis. In the Illawarra population, it is associated with coastal woodland and coastal grassland species.	PMST	Low – No records in the locality and no suitable habitat present.

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Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Australasian Bittern	Botaurus poiciloptilus	E	E	The Australasian Bittern is widespread but uncommon across south-eastern Australia. In NSW, they can be found over most of the state except for the far north-west. The species favours permanent freshwater wetlands with tall, dense vegetation, particularly bulrushes (Typha spp.) and spikerushes (Eleocharis spp.).	6	2017	BioNet, PMST	Low – limited number of recent records within 10km of the study area. No suitable habitat present within the study area.
Australian Painted Snipe	Rostratula australis	E	E	The Australian Painted Snipe is restricted to Australia. Most records are from the south-east, particularly surrounding the Murray Darling Basin. Scattered records exist across northern Australia and historical records exist around Perth in Western Australia. In NSW, many records are from the Murray-Darling Basin, including the Paroo wetlands, Lake Cowal, Macquarie Marshes, Fivebough Swamp and swamps surrounding Balldale and Wanganella. Other important locations include wetlands on the Hawkesbury River, and the Clarence and Lower Hunter Valleys. The species prefers fringes of swamps, dams and nearby marshes where there is a cover of grasses, lignum, low scrub or open timber.	1	2012	BioNet, PMST	Low – limited number of recent records within 10km of the study area. No suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Barking Owl	Ninox connivens	V	-	The Barking Owl is found throughout Australia except for the central arid regions. The species has greatly declined in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains and some north-east coastal and escarpment forests. The species inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use and hunting can extend in to closed forest as well as more open areas. Occasionally, the species can breed successfully along timbered watercourses in heavily cleared habitats, such as in western NSW, due to the higher density of prey on these fertile riparian soils. Roost in tree canopies including tall midstorey trees (eg Acacia and Casuarina species).	1	2013	BioNet	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Black Bittern	Ixobrychus flavicollis	V	-	The Black Bittern has a wide distribution, from southern NSW north to Cape York and along the north coast to the Kimberley region. The species also occurs in the south-west of Western Australia. In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves.	2	1987	BioNet	Low – no recent records (within the past 20 years) within 10km of the study area. Limited suitable habitat present within the study area.
Black-faced Monarch	Monarcha melanopsis	-	-	The Black-faced Monarch is found along the coast of eastern Australia, becoming less common further south. The Black-faced Monarch is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	-	-	PMST	Low – migratory species. No records and limited suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Broad-headed Snake	Hoplocephalus bungaroides	E	V	The Broad-headed Snake is largely confined to Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and Shoalhaven groups, within the coast and ranges in an area within approximately 250 km of Sydney. The species is nocturnal and shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in cervices or hollows in large trees within 500m of escarpments in summer. Feeds mostly on geckos and small skinks; will also eat frogs and small mammals occasionally.	1	2011	BioNet, PMST	Low – limited number of recent records within 10km of the study area. No suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Brush-tailed Phascogale	Phascogale tapoatafa	V	-	The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are occasional records west of the divide. The species prefers dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter but also inhabits heath, swamps, rainforest and wet sclerophyll forest. The Brush-tailed Phascogale is an agile climber foraging preferentially in rough barked trees of 25 centimetres DBH or greater. Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Females have exclusive territories of approximately 20 - 40 hectares, while males have overlapping territories often greater than 100 ha. Nest and shelter in tree hollows with entrances 2.5 - 4 centimetres wide and use many different hollows over a short time span.	-	-	BAMC (Candidate)	Low – no records and limited suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Brush-tailed Rock-wallaby	Petrogale penicillata	E	V	The Brush-tailed Rock-wallaby is distributed from south-east Queensland to the Grampians in western Victoria, roughly following the lines of the Great Diving Range. In NSW, the species occurs from the Queensland border in the north, to Shoalhaven in the south. The population in the Warrumbungle Ranges is the western limit of the species range. Brush-tailed Rock-wallaby occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges often facing north.	2	1990	BioNet, PMST	Low – no recent records (within the past 20 years) within 10km of the study area. Limited suitable habitat present within the study area.
Bush Stone-curlew	Burhinus grallarius	E	-	The Bush Stone-curlew is distributed throughout Australia except for the central southern coast and island, the far south-east corner, and Tasmania. In the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with sparse grassy groundlayer and fallen timber. Nest on the ground, and feed on insects and small vertebrates.	1	2003	BioNet, BAMC (Candidate)	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Common Greenshank	Tringa nebularia	-	-	In NSW, the species has been recorded in most coastal regions. It is widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions. Widely distributed throughout a range of inland wetlands and sheltered coastal habitats. Occurs in habitats with varying salinity.	-	-	PMST	Low – migratory species. No records or suitable habitat present in the study area.
Common Sandpiper	Actitis hypoleucos	-	-	Inhabits a wide range of coastal and inland wetlands, often with muddy or rocky margins. Also known to occur at estuaries, billabongs, dams, pools and lakes, often associated with mangroves.	-	-	PMST	Low – migratory species. No records and limited suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Dusky Woodswallow	Artamus cyanopterus cyanopterus	V	-	The Dusky Woodswallow is widespread in eastern, southern and south-western Australia. The species occurs throughout most of NSW, but is sparsely scattered in, or largely absent from, much of the upper western region. The species primarily inhabits dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and groundcover of grasses, sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. It has also been recorded in farmland, usually at the edges of forest or woodland.	10	2015	BioNet, BAMC (Predicted)	Low – some (10) recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Eastern Bristlebird	Dasyornis brachypterus	E	E	The distribution of the Eastern Bristlebird has contracted to three disjunct areas of south-eastern Australia. There are three main populations: Northern (southern Queensland/northern NSW), Central (Barren Ground Nature Reserve, Budderoo Nature Reserve, Woronora Plateau, Jervis Bay National Park, Booderee National Park and Beecroft Peninsula) and Southern (Nadgee Nature Reserve and Croajingalong National Park near the NSW/Victorian border). Habitat for central and southern populations is characterised by dense, low vegetation including heath and open woodland with a heathy understorey. In northern NSW, habitat occurs in open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone; all of which are prone to fire. Age of habitat since fire is of paramount importance to this species.	109	2018	BioNet, PMST	Low – large number (109) of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.
Eastern Coastal Free-tailed Bat	Micronomus norfolkensis	V	-	The Eastern Coastal Free-tailed Bat is found along the east coast from south Queensland to southern NSW. The species occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. They roost mainly in tree hollows but will also roost under bark or in man-made structures.	9	2016	BioNet, BAMC (Predicted)	Low – some (9) recent records within 10km of the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Eastern Curlew	Numenius madagascariensis	-	CE	The Eastern Curlew migrates to Australia for the non-breeding season. Within Australia, the Eastern Curlew is found across all States, and has a primarily coastal distribution, with birds rarely recorded inland. In NSW, the species occurs across the entire coast but is mainly found in estuaries such as the Hunter River, Port Stephens, Clarence River, Richmond Ricer and Intermittently Closed and Open Lakes and Lagoons (ICOLLs) of the south coast. The species generally occupies coastal lakes, inlets, bays and estuarine habitats. In NSW, it is mainly found in intertidal mudflats and sometimes saltmarsh of sheltered coasts. Occasionally, the species is found on ocean beaches (often near estuaries) as well as coral reefs, rock platforms or rocky islets.	2	2017	BioNet, PMST	Low – limited number of recent records within 10km of the study area. No suitable habitat present within the study area.
Eastern False Pipistrelle	Falsistrellus tasmaniensis	V	-	The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. The species prefers moist habitats, with trees over 20 m tall. The Eastern False Pipistrelle generally roosts in eucalypt hollows but has also been found under loose bark on trees, or in buildings.	7	2018	BioNet	**Recorded (possible)** – possible (indistinguishable complex) Anabat recording of the species within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Eastern Ground Parrot	Pezoporus wallicus	V	-	There are three recognised subspecies of the Ground Parrot in Australia. The eastern subspecies (wallicus) inhabits south-eastern Australia from southern Queensland through NSW to western Victoria. In NSW populations have declined and contracted to islands of coastal or subcoastal heathland and sedgeland habitats. The species is found in relatively large numbers on the north coast and in smaller numbers at Myall Lakes on the central coast. There are also large populations on the NSW south coast, particularly Barren Grounds Nature Reserve, Budderoo National Park, the Jervis Bay area and Nadgee Nature Reserve. Small numbers are recorded at Morton and Ben Boyd National Parks and other areas on the south coast. Estimated population size is about 2000 birds.	1	2014	BioNet	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area.
Eastern Osprey	Pandion cristatus	V	-	The Eastern Osprey occurs between Sulawesi (in Indonesia), Australia and New Caledonia. Eastern Ospreys are found around the coastline of mainland Australia, except for Victoria. The species is common around the northern coast, especially on rocky shorelines, islands and reefs. Eastern Osprey are uncommon to rare, or absent, from closely settled parts of south-eastern Australia. A few records exist inland. The species favours coastal areas, especially the mouths of large rivers, lagoons and lakes.	4	2008	BioNet, PMST	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Eastern Pygmy-possum	Cercartetus nanus	V	-	The Eastern Pygmy Possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW, the species is found from the coast to inland on the western slopes, around the Pilliga, Dubbo, Parkes and Wagga Wagga. The Eastern Pygmy Possum is found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath. Woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently found in rainforests. The species feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (Pseudocheirus peregrinus) dreys or thickets of vegetation, (eg grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.	11	2019	BioNet, BAMC (Candidate)	Low – some (11) recent records within 10km of the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Flame Robin	Petroica phoenicea	V	-	The Flame Robin is endemic to south-eastern Australia, ranging from the Queensland border to south-east South Australia and Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW: one in the Northern Tablelands, and one ranging from the Central to Southern Tablelands. The species breeds in upland tall moist eucalypt forests and woodlands, often of ridges and slopes. The Flame Robin prefers clearings or areas with open understoreys and are often found in recently burnt areas. The species occasionally occurs in temperate rainforest, as well as herbfields, heathlands, shrublands and sedgelands at high altitudes. Breeding habitat is typically dominated by native grasses and the shrub layer may either be sparse or dense.	-	-	BAMC (Predicted)	Low – no records and limited suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Fork-tailed Swift	Apus pacificus	-	-	In NSW, the Fork-tailed Swift is recorded in all regions. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. The sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines. They forage aerially, up to hundreds of metres above ground, but also less than 1 m above open areas or over water.	1	2017	BioNet, PMST	Low – migratory species. Limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.
Freckled Duck	Stictonetta naevosa	V	-	The Freckled Duck is found primarily in south-eastern and south-western Australia. It breeds in large temporary swamps in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina. The duck is forced to disperse during extensive inland droughts when wetlands in the Murray River basin provide important habitat. The species may also occur as far as coastal NSW and Victoria during such times.	2	2013	BioNet	Low – vagrant species. Limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Gang-gang Cockatoo	Callocephalon fimbriatum	V	-	The Gang-gang Cockatoo is distributed from southern Victoria through south and central-eastern NSW. In NSW, the species is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. The Gang-gang Cockatoo occurs regularly in the ACT and is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. During spring and summer, the species is generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species typically moves to lower altitudes to inhabit drier, open eucalypt forests and woodlands (particularly Box-Gum and Box-Ironbark assemblages) or in dry forest in coastal and urban areas. It may also occur in sub-alpine Snow Gum (Eucalyptus pauciflora) woodland, and occasionally in temperate rainforests. The species favours old growth forest and woodland for nesting and roosting.	40	2020	BioNet, BAMC (Candidate), BAMC (Predicted)	Low – large number (40) of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Giant Burrowing Frog	Heleioporus australiacus	V	V	The Giant Burrowing Frog is distributed in south eastern NSW and Victoria and appears to exist as two distinct populations: Northern (largely confined to the sandstone geology of the Sydney Basin, extending as far south as Ulladulla) and Southern (occurring from north of Narooma through to Walhalla, Victoria). The species is found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. The Giant Burrowing Frog requires ephemeral and permanent freshwater wetlands, ponds and dams with an open aspect and fringed by Typha, as well as free from predatory fish. The species spends more than 95% of its time in non-breeding habitat, burrowing below the soil surface or in the leaf litter. Individuals occupy a series of burrow study areas, some of which are used repeatedly. Non-breeding study areas are usually located up to 300 m from breeding study areas, and home ranges are approximately 0.04 hectares in size.	4	2019	BioNet, PMST	Low – limited number of recent records within 10km of the study area. No suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Glossy Black-Cockatoo	Calyptorhynchus lathami	V	-	The Glossy Black-Cockatoo is widespread but uncommon throughout suitable forest and woodland habitats from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population also exists on Kangaroo Island in South Australia. The species inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of Sheoak occur. The species feeds almost exclusively on Casuarina and Allocasuarina species, with Black Sheoak (Allocasuarina littoralis) and Forest Sheoak (A. torulosa) being important foraging resources for the species. Inland populations feed on a wider range of Sheoaks, and Belah may also be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak and Belah.	339	2020	BioNet, BAMC (Candidate), BAMC (Predicted)	**Recorded** – foraging flocks and chewed seed cones observed in the study area. Targeted surveys determined that breeding is unlikely to occur within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Greater Broad-nosed Bat	Scoteanax rueppellii	V	-	The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Diving Range, from north-eastern Victoria to the Atherton Tableland. The species extends to the coast over much of its range. In NSW, the Greater Broad-nosed Bat is widespread over the New England Tablelands, however it does not occur at altitudes above 500 m. The species utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although the species predominantly roosts in tree hollows, it has also been recorded roosting in buildings.	9	2016	BioNet	**Recorded (possible)** – possible (indistinguishable complex) Anabat recording of the species within the study area.
Greater Glider	Petauroides volans	-	V	The Greater Glider is endemic to eastern Australia, ranging from Windsor Tableland in far northern Queensland to the Wombat Forest in central Victoria, except in altitudes above 1,200 m. The species is largely restricted to eucalypt forests and woodlands, with higher abundances occurring in taller, denser, montane, moist eucalypt forests with old trees and abundant hollows.	20	2017	BioNet, PMST	Low – large number (20) of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Green and Golden Bell Frog	Litoria aurea	E	V	The Green and Golden Bell Frog exists in approximately 50 recorded locations across NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range; however, they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and the mid-north coast (with one island population). There is only one known population on the NSW Southern Tablelands. The species inhabits marshes, dams and stream-sides, particularly those containing bulrushes (Typha spp.) or spikerushes (Eleocharis spp.). Optimal habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow/Mosquito Fish (Gambusia holbrooki), have a nearby grassy area and available sheltering study areas. Some study areas, particularly in the Greater Sydney region, occur in highly disturbed areas.	588	2020	BioNet, PMST	**Assumed present** – large number (588) of recent records within 10km of the study area. Potential habitat present within the proposal construction footprint.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Grey Falcon	Falco hypoleucos	-	V	The Grey Falcon is sparsely distributed in NSW, primarily throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. The breeding range has contracted since the 1950s with most breeding now confined to arid parts of the range. There are possibly less than 5000 individuals left. Population trends are unclear, though it is believed to be extinct in areas with more than 500mm rainfall in NSW.	-	-	PMST	Low – vagrant species. No records and limited suitable habitat present in the study area.
Grey-headed Flying-fox	Pteropus poliocephalus	V	V	The Grey-headed Flying-fox is generally found within 200 km of the coast in eastern Australia, from Rockhampton in Queensland to Adelaide in South Australia. In times of natural resource shortages, the species can occur in unusual locations. The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of regular food sources, and are commonly found in gullies, close to water, in vegetation with a dense canopy. Study area fidelity to camps are high, and the species travels up to 50 km from these camps to forage, typically commuting distances up to 20 km from the camp study area.	145	2019	BioNet, BAMC (Candidate), BAMC (Predicted), PMST	**Recorded** – two individuals observed flying over the study area. Targeted surveys determined that no camps (for breeding/roosting) were located within the study area. The nearest camps are Bomaderry Creek (Camp ID 233; approximately 14km north of the study area) and Bewong Creek (Camp ID 232; approximately 10km south-west of the study area).

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Koala	Phascolarctos cinereus	V	V	The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW, it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. It also has sparse and possibly disjunct populations in the Southern Tablelands. The Koala is also known from several study areas on the Southern Tablelands. The species inhabits eucalypt woodlands and forests, and feeds on select species; about 70 eucalypt species and 30 non-eucalypt species but will select preferred browse species in any one area.	2	1995	BioNet, BAMC (Candidate), BAMC (Predicted), PMST	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area.
Large Bent-winged Bat	Miniopterus orianae oceanensis	V	-	The Large Bent-winged Bat (formerly the Eastern Bentwing-bat) occurs along the east and north-west coasts of Australia. Their primary roosting habitat are caves, but the species is also known to use derelict mines, stormwater tunnels, buildings and other man-made structures.	15	2018	BioNet, BAMC (Candidate), BAMC (Predicted)	**Recorded (probable)** – probable (indistinguishable complex) Anabat recording of the species within the study area. Targeted surveys determined that breeding is unlikely to occur within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Large-eared Pied Bat	Chalinolobus dwyeri	V	V	The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, and in well-timbered areas containing gullies, from Rockhampton in Queensland to Bungonia in the NSW Southern Highlands. In NSW, the species is generally rare with a very patchy distribution. Scattered records exist from the New England Tablelands and North West Slopes. The species roosts in cave entrances, crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of Fairy Martins (Petrochelidon ariel), frequenting low to mid-elevation dry open forest and woodland close to these features.	7	2016	BioNet, BAMC (Candidate), PMST	Low – some (7) recent records within 10km of the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Latham's Snipe	Gallinago hardwickii	-	-	Latham's Snipe is a non-breeding visitor to south-eastern Australia and is a passage migrant through northern Australia. The species has been recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia (including the Adelaide plains and Mount Lofty Ranges, and the Eyre Peninsula). Most birds spend the non-breeding period at sites located south of the Richmond River in NSW. Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000m above sea-level, usually inhabiting open, freshwater wetlands with low, dense vegetation (eg swamps, flooded grasslands or heathlands, around bogs and other water bodies). The species can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity.	-	-	PMST	Low – migratory species. No records or suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Little Bent-winged Bat	Miniopterus australis	V	-	The Little Bent-winged Bat (formerly the Little Bentwing-bat) occurs along the east coast of Australia, ranging from Cape York in Queensland to Wollongong in NSW. The species inhabits moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and Banksia scrub. The bat is generally found in well-timbered areas, and roosts in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings	1	2018	BioNet, BAMC (Candidate)	Low – one recent record within 10km of the study area. Not recorded during targeted surveys.
Little Eagle	Hieraaetus morphnoides	V	-	The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. It occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. The species nest in tall living trees within a remnant patch, where pairs build a large stick nest in winter.	1	2000	BioNet, BAMC (Candidate), BAMC (Predicted)	Low – no recent records (within the past 20 years) within 10km of the study area. Limited suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Little Lorikeet	Glossopsitta pusilla	V	-	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. In NSW, lorikeets are found westward as far as Dubbo and Albury, and the State provides a large portion of the species core habitat. The Little Lorikeet forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are highly used, due to higher soil fertility and greater productivity. The species targets isolated flowering trees in open country, such as in paddocks or in roadside remnants and street trees, which help sustain viable populations.	22	2020	BioNet, BAMC (Candidate), BAMC (Predicted)	**Recorded** – two individuals observed and heard flying over the study area. Targeted surveys determined that breeding is unlikely to occur within the study area.
Littlejohn's Tree Frog	Litoria littlejohni	V	V	The Littlejohn's Tree Frog is distributed on plateaus and eastern slopes of the Great Diving Range, from Watagan State Forest in NSW, to Buchan in Victoria. Most records are from within the Sydney Basin Bioregion, with only scattered records south to the Victorian border. This species has not been recorded in southern NSW within the last decade. Records are isolated and tend to be at higher altitudes. The species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath-based forests and woodlands where it shelters under leaf litter and low vegetation.	48	2020	BioNet, BAMC (Candidate), PMST	Low – large number (48) of recent records within 10km of the study area. No suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Long-nosed Potoroo	Potorous tridactylus	V	V	The long-nosed potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. In NSW it is generally restricted to coastal heaths and forests east of the Great Dividing Range, with an annual rainfall exceeding 760mm. The species inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature.	1	2001	BioNet, PMST	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area.
Masked Owl	Tyto novaehollandiae	V	-	The Masked Owl is most abundant on the coast but extends to the western plains. About 90% of overall records occur within NSW, excluding the most arid north-western corner. The species occupies dry, eucalypt forests and woodlands up to 1,100m altitude. The Masked Owl typically prefers open forest with low shrub density and requires old trees for roosting and nesting.	26	2017	BioNet, BAMC (Candidate), BAMC (Predicted)	**Moderate** – large number (26) of recent records within 10km of the study area. The study area contains potential foraging and dispersal habitat. Targeted surveys determined that breeding is unlikely to occur within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
New Holland Mouse	Pseudomys novaehollandiae	-	V	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, NSW and Queensland. The species is known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes.	1	2015	BioNet, PMST	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.
Orange-bellied Parrot	Neophema chrysogaster	CE	CE	The Orange-bellied Parrot breeds in the south-west of Tasmania and migrates in autumn to spend the winter on the mainland coast of south-eastern South Australia and southern Victoria. There are occasional reports from NSW, with the most recent records from Shellharbour and Maroubra in May 2003. Typical winter habitat comprises saltmarsh and strandline/foredune vegetation communities either on coastlines or coastal lagoons. Spits and islands are favoured but they will turn up anywhere within these coastal regions, including within weedy areas, pastures, seed crops and golf courses.	-	-	PMST	Low – migratory species. No records and limited suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Oriental Cuckoo	Cuculus optatus	-	-	The Oriental Cuckoo has a large breeding range in northern Eurasia. It breeds across much of Russia west to the Komi Republic with occasional records as far west as Saint Petersburg. It also breeds in northern Kazakhstan, Mongolia, northern China, Korea and Japan. There have been records of birds displaying in Finland in recent years. The exact extent of its wintering range is uncertain due to its secretive habits and the difficulty of separating it from the Himalayan cuckoo and other similar species. It is believed to include the Malay Peninsula, Indonesia, the Philippines, New Guinea, western Micronesia, the Solomon Islands and northern and eastern Australia with occasional birds reaching New Zealand. It has occurred as a vagrant in Ukraine, Israel and Alaska . It mainly inhabits forests, occurring in coniferous, deciduous and mixed forest. It feeds mainly on insects and their larvae, foraging for them in trees and bushes as well as on the ground. It is usually secretive and hard to see.	-	-	PMST	Low – migratory species. No records and limited suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Painted Honeyeater	Grantiella picta	V	V	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of Painted Honeyeater, as well as all breeding events, occur on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter, it is more likely to be found in the north of its range. The species inhabits Boree/Weeping Myall (Acacia pendula), Brigalow (A. harpophylla), Box-Gum Woodlands and Box-Ironbark Forests. The Painted Honeyeater is also a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias; preferring mistletoes of the genus Amyema.	-	-	PMST	Low – no records or suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Pectoral Sandpiper	Calidris melanotos	-	-	In NSW, the Pectoral Sandpiper is widespread, but scattered. Records exist east of the Great Divide, from Casino and Ballina, south to Ulladulla. West of the Great Divide, the species is widespread in the Riverina and Lower Western regions. In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands.	-	-	PMST	Low – migratory species. No records or suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Powerful Owl	Ninox strenua	V	-	The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing. Throughout its eastern range is occurs at low densities and are rare along the Murray River. Former inland populations may never recover. The species inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl typically requires large tracts of forest or woodland habitat with dense wet gullies and creek areas but can also occur in fragmented landscapes. The species breeds and hunts in open or closed sclerophyll forest of woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine (Syncarpia glomulifera), Black She-oak (Allocasuarina littoralis), Blackwood (Acacia melanoxylon), Rough-barked Apple (Angophora floribunda), Cherry Ballart (Exocarpos cupressiformis) and a number of eucalypt species. The Powerful Owl requires large, mature trees with hollows for breeding, and dense areas of vegetation for foraging and roosting.	49	2019	BioNet, BAMC (Candidate), BAMC (Predicted)	**Recorded** – one individual observed foraging within the study area. Targeted surveys determined that breeding is unlikely to occur within the study area.

Regent Honeyeater	Anthochaera phrygia	E	CE	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. The species is also found in drier coastal woodlands and forests. The species range has contracted to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: North-east Victoria (Chiltern – Albury) and the Capertee Valley and Bundarra-Barraba region in NSW. In NSW, the distribution is very patchy and mainly confined to the two listed breeding areas and surrounding fragmented woodlands. In some years, flocks converge on flowering coastal woodlands and forests. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species; these woodlands generally have a large number of mature trees, high canopy cover, and an abundance of mistletoes. Non-breeding flocks are observed foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the Central Coast and occasionally on the upper North Coast. Individuals are occasionally seen on the South Coast. In the last decade, the species has been recorded in urban areas around Albury where Mugga Ironbark and Yellow Box were planted 20 years ago. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important.	3	2013	BioNet, BAMC (Candidate), BAMC (Predicted), PMST	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area and the study area is not within a known breeding area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Rufous Fantail	Rhipidura rufifrons	-	-	The Rufous Fantail is found in northern and eastern coastal Australia, being more common in the north. It is also found in New Guinea, the Solomon Islands, Sulawesi and Guam. The Rufous Fantail is found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas.	-	-	PMST	Low – migratory species. No records or suitable habitat present in the study area.
Satin Flycatcher	Myiagra cyanoleuca	-	-	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. It is also found in New Guinea. The Satin Flycatcher is not a commonly seen species, especially in the far south of its range, where it is a summer breeding migrant. The Satin Flycatcher is found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	-	-	PMST	Low – migratory species. No records or suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Scarlet Robin	Petroica boodang	V	-	The Scarlet Robin is found from south-east Queensland to south-east South Australia and in Tasmania, and south-west Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. The species inhabits dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. The species lives in both mature and regrowth vegetation, occasionally occurring in mallee or wet forest communities, or in wetlands and tea-tree swamps. Abundant logs and fallen timber are key components of the species habitat. In autumn and winter, the Scarlet Robin may occupy open grassy woodlands and grasslands or grazed paddocks with scattered trees.	9	2018	BioNet, BAMC (Predicted)	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Sharp-tailed Sandpiper	Calidris acuminata	-	-	The Sharp-tailed Sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage. They are widespread in most regions of New South Wales (NSW) and Victoria, especially in coastal areas, but they are sparse in the south-central Western Plain and east Lower Western Regions of NSW, and north-east and north-central Victoria. In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms.	-	-	PMST	Low – migratory species. No records or suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Sooty Owl	Tyto tenebricosa	V	-	Occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. Territories are occupied permanently. Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	24	2019	BioNet	Low – large number (24) of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.
Southern Brown Bandicoot (eastern)	Isoodon obesulus obesulus	E	E	The Southern Brown Bandicoot has a patchy distribution. It is found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River, southern coastal Victoria and the Grampian Ranges, south-eastern South Australia, south-west Western Australia and the northern tip of Queensland. Southern Brown Bandicoots are largely crepuscular (active mainly after dusk and/or before dawn). They are generally only found in heath or open forest with a heathy understorey on sandy or friable soils.	8	2017	BioNet, PMST	Low – some (8) recent records within 10km of the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Southern Myotis	Myotis macropus	V	-	The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. The species generally roosts in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.	10	2018	BioNet, BAMC (Candidate)	**Recorded (probable)** – probable (indistinguishable complex) Anabat recording of the species within the study area.
Spectacled Monarch	Monarcha trivirgatus	-	-	The Spectacled Monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. It is also found in Papua New Guinea, the Moluccas and Timor. The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	-	-	PMST	Low – migratory species. No records or suitable habitat present in the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Spotted-tailed Quoll	Dasyurus maculatus	V	E	The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common. The species has been recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den study areas, and have communal latrine study areas; often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks.	12	2018	BioNet, BAMC (Predicted), PMST	Low – some (12) recent records within 10km of the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Square-tailed Kite	Lophoictinia isura	V	-	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the Square-tailed Kite is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. The species is found in a variety of timbered habitats including dry woodlands and open forests and shows a preference for timbered watercourses. In arid north-western NSW, the species has been observed in stony country with a ground cover of chenopods and grasses, open Acacia scrub and patches of low open eucalypt woodland.	23	2017	BioNet, BAMC (Candidate), BAMC (Predicted)	**Moderate** – large number (23) of recent records within 10km of the study area. The study area contains potential foraging and dispersal habitat. Targeted surveys determined that breeding is unlikely to occur within the study area.
Squirrel Glider	Petaurus norfolcensis	V	-	The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey.	1	1998	BioNet, BAMC (Candidate)	Low – no recent records (within the past 20 years) within 10km of the study area. Limited suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Stuttering Frog	Mixophyes balbus	E	V	Stuttering Frogs occur along the east coast of Australia from southern Queensland to north-eastern Victoria. Considered to have disappeared from Victoria and to have undergone considerable range contraction in NSW, particularly in south-east NSW. It is the only Mixophyes species that occurs in south-east NSW and in recent surveys it has only been recorded at three locations south of Sydney. The Dorrigo region, in north-east NSW, appears to be a stronghold for this species. Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range.	-	-	PMST	Low – no records or suitable habitat present in the study area.
Superb Fruit-Dove	Ptilinopus superbus	V	-	The Superb Fruit-dove predominately occurs from north-eastern Queensland to north-eastern NSW. It is much less common further south, where it is largely confined to pockets of suitable habitat as far south as Moruya. There are records of vagrants as far south as eastern Victoria and Tasmania. Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.	1	2017	BioNet	Low – limited number of recent records within 10km of the study area. No suitable habitat present within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Swift Parrot	Lathamus discolor	E	CE	The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW, it mostly occurs on the coast and south west slopes. On the mainland they occur in areas where eucalypts are flowering profusely or where there is abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany (Eucalyptus robusta), Spotted Gum (Corymbia maculata), Red Bloodwood (C. gummifera), Mugga Ironbark (E. sideroxylon), and White Box (E. albens). Commonly used lerp infested trees include Inland Grey Box (E. microcarpa), Grey Box (E. moluccana) and Blackbutt (E. pilularis).	1	2002	BioNet, BAMC (Candidate), BAMC (Predicted), PMST	Low – migratory species. Limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.
Turquoise Parrot	Neophema pulchella	V	-	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. The species lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	16	2017	BioNet, BAMC (Predicted)	Low – some (16) recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Varied Sittella	Daphoenositta chrysoptera	V	-	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades. The species inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, Mallee and Acacia woodland.	3	2019	BioNet, BAMC (Predicted)	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
White-bellied Sea-Eagle	Haliaeetus leucogaster	V	-	The White-bellied Sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In NSW, it is widespread along the east coast, and along all major inland rivers and waterways. Habitats are characterised by the presence of large areas of open water including larger rivers, swamps and lakes, as well as the ocean. The species occurs at study areas near the sea or seashore, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarshes. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland and forests (including rainforest). Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have dead emergent branches or large dead trees nearby which are used as guard roosts.	12	2018	BioNet, BAMC (Candidate), BAMC (Predicted)	**Recorded** – one individual observed flying over the study area. Targeted surveys determined that breeding is unlikely to occur within the study area.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
White-footed Dunnart	Sminthopsis leucopus	V	-	The White-footed Dunnart occurs in Tasmania and along the Victorian and southern NSW coast. The Shoalhaven area is the species' northern-most limit. It has not been recorded west of the coastal escarpment with the western-most record being from Coolangubra State Forest, approximately 10km south-east of Bombala. In NSW, the species favours vegetation communities with an open understorey structure (contrasting with populations in Victoria which apparently prefer dense shrub and ground layers). It is patchily distributed across these habitats and, where present, typically occurs at low densities.	7	2001	BioNet	Low – limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.
White-throated Needletail	Hirundapus caudacutus	-	V	White-throated Needletails are non-breeding migrants in Australia between late spring and early autumn, but most common in summer. The species often occur in large numbers over eastern and northern Australia. White-throated Needletails are aerial birds and for a time it was commonly believed that they did not land while in Australia. It has now been observed that birds will roost in trees, and radio-tracking has since confirmed that this is a regular activity.	7	2016	BioNet, PMST	Low – migratory species. Limited number of recent records within 10km of the study area. Limited suitable habitat present within the study area. Not recorded during targeted surveys.

Common name	Scientific name	Status		Habitat requirements	Number of records	Date	Source	Likelihood of occurrence
		BC Act	EPBC Act					
Yellow-bellied Glider	Petaurus australis	V	-	The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar.	348	2020	BioNet	**Moderate** – large number (348) of recent records within 10km of the study area. The study area contains potential foraging, breeding and dispersal habitat.
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	V	-	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes. The species roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.	4	2016	BioNet, BAMC (Predicted)	Low – some (4) recent records within 10km of the study area. Not recorded during targeted surveys.

Annexure C

Protected Matters Search Tool

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Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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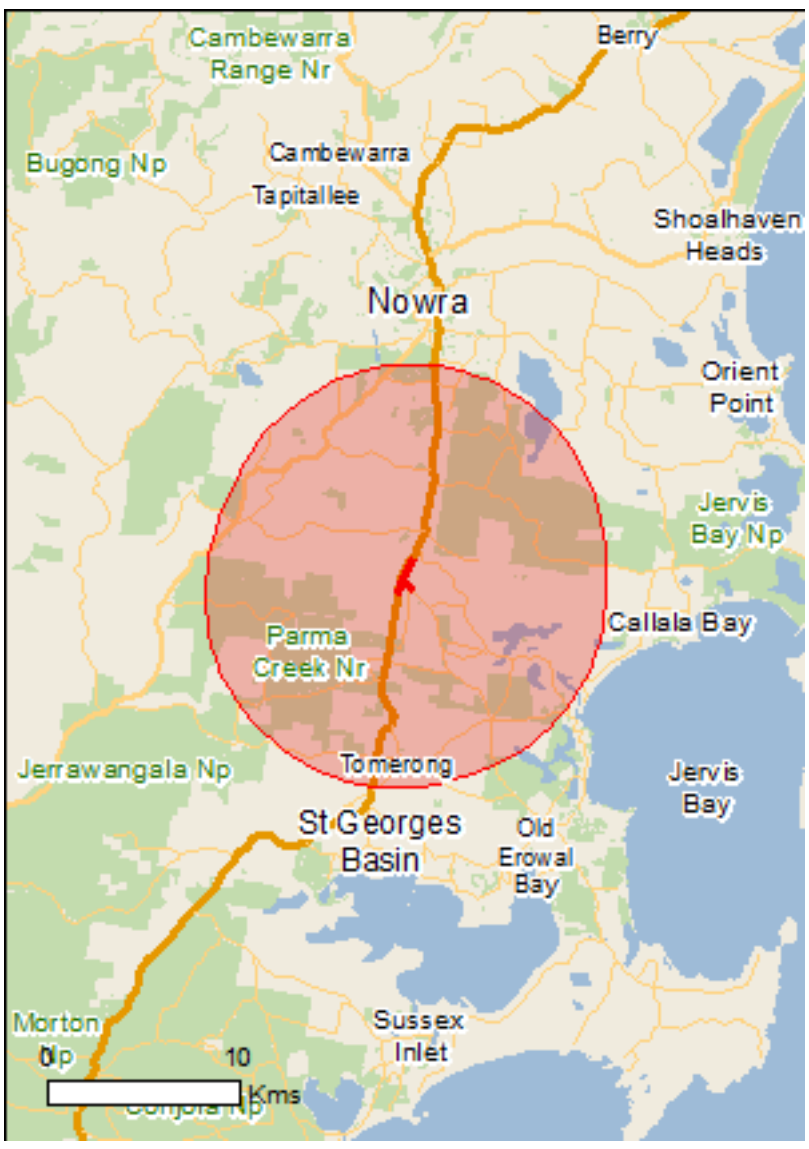

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

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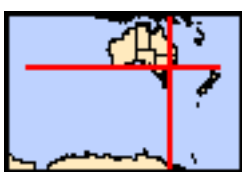

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	86
Listed Migratory Species:	52

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	6
Commonwealth Heritage Places:	None
Listed Marine Species:	74
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	10
Regional Forest Agreements:	1
Invasive Species:	47
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Illawarra and south coast lowland forest and woodland ecological community	Critically Endangered	Community likely to occur within area
Illawarra-Shoalhaven Subtropical Rainforest of the Sydney Basin Bioregion	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Species or species habitat likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Thinornis cucullatus cucullatus Hooded Plover (eastern), Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Heleioporus australiacus Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat known to occur within area
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
Litoria littlejohni Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat known to occur within area
Mixophyes balbus Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE Mainland) [66645]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Plants		
Acacia bynoeana Bynoe's Wattle, Tiny Wattle [8575]	Vulnerable	Species or species habitat likely to occur within area
Banksia vincentia [88276]	Critically Endangered	Species or species habitat likely to occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat known to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat known to occur within area
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Eucalyptus langleyi Albatross Mallee [56224]	Vulnerable	Species or species habitat known to occur within area
Genoplesium baueri Yellow Gnat-orchid [7528]	Endangered	Species or species habitat known to occur within area
Genoplesium vernale East Lynne Midge-orchid [68379]	Vulnerable	Species or species habitat may occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat likely to occur within area
Melaleuca biconvexa Biconvex Paperbark [5583]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
[Melaleuca deanei](#) Deane's Melaleuca [5818]	Vulnerable	Species or species habitat may occur within area
[Persicaria elatior](#) Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat may occur within area
[Pimelea spicata](#) Spiked Rice-flower [20834]	Endangered	Species or species habitat may occur within area
[Pomaderris cotoneaster](#) Cotoneaster Pomaderris [2043]	Endangered	Species or species habitat known to occur within area
[Prasophyllum affine](#) Jervis Bay Leek Orchid, Culburra Leek-orchid, Kinghorn Point Leek-orchid [2210]	Endangered	Species or species habitat may occur within area
[Prostanthera densa](#) Villous Mintbush [12233]	Vulnerable	Species or species habitat likely to occur within area
[Pterostylis gibbosa](#) Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat known to occur within area
[Pterostylis vernalis](#) Halbury Rustyhood [84711]	Critically Endangered	Species or species habitat known to occur within area
[Rhizanthella slateri](#) Eastern Underground Orchid [11768]	Endangered	Species or species habitat known to occur within area
[Syzygium paniculatum](#) Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat known to occur within area
[Thelymitra kangaloonica](#) Kangaloon Sun Orchid [81861]	Critically Endangered	Species or species habitat may occur within area
[Thesium australe](#) Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
[Triplarina nowraensis](#) Nowra Heath-myrtle [64544]	Endangered	Species or species habitat known to occur within area
[Xerochrysum palustre](#) Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat may occur within area
Reptiles		
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Hoplocephalus bungaroides Broad-headed Snake [1182]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Sharks		
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur

Name	Threatened	Type of Presence
		within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Defence - HMAS ALBATROSS

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Cosmocampus howensis Lord Howe Pipefish [66208]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat likely to occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area

Name	Status	Type of Presence
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Brundee Swamp	NSW
Forestry Management Areas in Nowra (FMZ2)	NSW
Jerrawangala	NSW
Jervis Bay	NSW
Parma Creek	NSW
Saltwater Swamp	NSW
South Coast Subregion of Southern Region	NSW
Triplarina	NSW
Woollamia	NSW
Worrigee	NSW

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Southern RFA	New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Jervis Bay	NSW

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-34.97471 150.59278,-34.98317 150.58783,-34.98771 150.59314,-34.98334 150.58774,-34.98912 150.58588

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Annexure D

Assessments of Significance (BC Act)

Scientific name	Common name	Status under BC Act	Potential occurrence
FLORA			
Hibbertia puberula subsp. puberula	-	E	Recorded
FAUNA			
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	Recorded
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	Recorded (Possible)
Glossopsitta pusilla	Little Lorikeet	V	Recorded
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	Recorded
Litoria aurea	Green and Golden Bell Frog	E	Assumed present
Lophoictinia isura	Square-tailed Kite	V	Moderate
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	Recorded (Probable)
Myotis macropus	Southern Myotis	V	Recorded (Probable)
Ninox strenua	Powerful Owl	V	Recorded
Petaurus australis	Yellow-bellied Glider	V	Moderate
Pteropus poliocephalus	Grey-headed Flying-fox	V	Recorded
Scoteanax rueppellii	Greater Broad-nosed Bat	V	Recorded (Possible)
Tyto novaehollandiae	Masked Owl	V	Moderate
ECOLOGICAL COMMUNITIES			
Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion		E	Recorded

Hibbertia puberula subsp. puberula

Potential impacts on the following threatened flora species have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- *Hibbertia puberula subsp. puberula* – Endangered

Hibbertia puberula subsp. puberula was recorded in the site investigation area during field surveys. Approximately 58 individuals were recorded in four clusters across the site investigation area in PCT 1082. Desktop assessment also identified 22 records of *Hibbertia puberula* within 10 kilometres of the site investigation area, the most recent from 2015.

Of the 13.51 hectares of suitable habitat and 58 individuals identified in the site investigation area, 10.51 hectares of suitable habitat and 55 individuals would be removed by the proposal.

As the species is botanically similar to other species within the *Hibbertia* genus, the identification of *Hibbertia puberula subsp. puberula* is complex and subtle. Therefore, samples of the species were sent to the NSW Herbarium for identification confirmation. In January 2021 the NSW Herbarium confirmed that all samples were of *Hibbertia puberula* subsp. *puberula.*

Distribution, habitat and ecology

Hibbertia puberula subsp. puberula is listed as Endangered under the BC Act. Recent work (Toelken & Miller, 2012) on this species has shown that it is widespread, but uncommon. The species is distributed from Wollemi National Park south to Morton National Park and the south coast near Nowra. *Hibbertia puberula subsp. puberula* favours low heath on sandy soils and is often associated with sandstone. It is rarely found in clay and is sometimes associated with rocks underneath (DPIE, 2019).

Hibbertia puberula subsp. puberula typically occupies dry sclerophyll woodland communities but has also been recorded from heaths and one subspecies from upland swamps. Little is known about the lifecycle of the species, but flowering is October to December, occasionally extending into January.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Hibbertia puberula subsp. puberula is a shrublet with few spreading, wiry branches up to 30 centimetres long. The species is widespread, but never common, and has been the subject of recent taxonomic revisions (Toelken & Miller, 2012) which resulted in the identification of three separate subspecies.

There are 22 records of *Hibbertia puberula* within 10 kilometres of the site investigation area, a majority concentrated around Braidwood Road in Parma Creek Nature Reserve, approximately 8 kilometres west of the site investigation area. The species occurs in a wide range of habitats, but typically prefers dry sclerophyll woodland communities and heaths on sandy soils, often associated with sandstone or on clay.

Hibbertia puberula subsp. puberula has been recorded within the site investigation area in PCT 1082, with 33 individuals located in a private property to the south-east of the proposed intersection. Other individuals of the species were recorded in clusters across the site investigation area. While a high number of individuals were recorded in one location, individuals were found throughout the site investigation area, indicating the species is widespread in the locality. Individuals recorded in the site investigation area were all recorded in PCT 1082, in conditions ranging from poor to good. PCT 1082 has a large distribution across the locality, including in adjoining vegetation to the north, east, south and west of the site investigation area. This adjacent vegetation is connected to large intact areas of native vegetation to the west of the site including to

areas of PCT 1082 surrounding Braidwood Road where indiviuals of *Hibbertia puberula* have been recorded. Due to the connecting habitat between these records and the site investigation area it is likely that *Hibbertia puberula* individuals are present between these areas.

Three individuals recorded were within the site investigation area but outside the construction footprint and would not be removed as a result of the proposal.

Little information is available concerning the life cycle of the species. The proposal would impact on the life cycle of the species through the removal of 58 individuals. However, due to the large amount of suitable habitat in the surrounding area, and the comparatively small area of habitat to be directly impacted (a total of 10.51 hectares of PCT 1082), it is unlikely that the proposal would impact on the life cycle of *Hibbertia puberula subsp. puberula* such that a viable local population of the species would be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable. *Hibbertia puberula subsp. puberula* is a threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would require the removal of 10.51 hectares of vegetation containing suitable habitat for *Hibbertia puberula subsp. puberula* in the form of PCT 1082. PCT 1082 has a large distribution across the locality, including in adjoining vegetation to the north, east, south and west of the site investigation area. This adjacent vegetation is connected to large intact areas of native vegetation to the west of the site including to areas of PCT 1082 surrounding Braidwood Road where indiviuals of *Hibbertia puberula* have been recorded. Therefore, the extent of habitat to be removed is considered to be minor given the availability of substantial areas of suitable habitat remaining in nearby areas (eg Parma Creek Nature Reserve).

The removal of 10.51 hectares of habitat from the site investigation area would not result in a significant reduction in habitat connectivity in the region. The habitat to be removed is currently fragmented by existing roads, housing and infrastructure which provide potential barriers to habitat connectivity. Similar habitat surrounding the site investigation area is unlikely to become further isolated or fragmented as a result of clearing for the proposal.

The small area of potential habitat to be removed is not likely to be important to the long-term survival of *Hibbertia puberula subsp. puberula* in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for *Hibbertia puberula subsp. puberula*.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following is relevant to *Hibbertia puberula subsp. puberula*:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. Vegetation proposed for removal contains recorded and/or potential habitat for *Hibbertia puberula subsp. puberula*. However, the extent of vegetation to be removed does not represent a significant area of habitat for *Hibbertia puberula subsp. puberula* in the locality and is considered minor given the availability of suitable habitat in nearby areas.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on *Hibbertia puberula subsp. puberula* in the site investigation area, or wider locality, as a result of the proposed actions as:

- The proposed works would not adversely affect the lifecycle of the species such that viable local populations are likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the species and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for *Hibbertia puberula subsp. puberula*.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Cockatoos

Potential impacts on the following threatened cockatoo species have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*) – Vulnerable

The Glossy Black-Cockatoo was recorded in the site investigation area during field surveys. Small flocks were observed foraging on *Allocasuarina littoralis* in the eastern and southern extents of the site investigation area and chewed seed cones were recorded throughout the site investigation area. Desktop assessment also identified 339 records of the species within 10 kilometres of the site investigation area, the most recent from 2020.

Distribution, habitat and ecology

The Glossy Black-Cockatoo is listed as Vulnerable under the BC Act. The species is uncommon although widespread throughout suitable forest and woodland habitats from along the central Queensland coastline to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW. An isolated population also exists on Kangaroo Island, South Australia. The Glossy Black-Cockatoo inhabits open forest and woodlands of the coast and Great Dividing Range where stands of sheoak occur. In the locality of the site investigation area the Glossy Black-Cockatoo feeds almost exclusively on seeds extracted from the wooden cones of *Allocasuarina*, particularly *Allocasuarina littoralis*. Inland populations may feed on a greater variety of *Allocasuarina* species. The species typically targets mature trees that are 2m – 10m tall. The Glossy Black-Cockatoo is dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The site investigation area offers potential foraging and nesting habitat for the Glossy Black-Cockatoo. *Allocasuarina littoralis* occurs commonly throughout the site investigation area, predominantly within roadside vegetation and isolated patches in private properties. Several trees were identified within the site investigation area with large hollows suitably sized for nesting Glossy Black-Cockatoo. However, targeted surveys did not detect any breeding individuals and as such, the species is considered unlikely to breed within the site investigation area.

Due to the small area of potential foraging habitat to be directly impacted (15.70 hectares), and the low potential of breeding, it is unlikely that the proposal would impact the life cycle of the Glossy Black-Cockatoo. Consequently, it is unlikely that a viable local population of the species would be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable. The Glossy Black-Cockatoo is a threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would require the removal of 16.16 hectares of vegetation containing recorded and/or potential foraging and roosting habitat for the Glossy Black-Cockatoo. In addition, the proposal would require the removal of up to 24 hollow-bearing trees of which a small number are potentially suitable for nesting. However, the extent of habitat to be removed is minor given the availability of substantial areas of suitable habitat in good condition in nearby areas, such as in Parma Creek Nature Reserve, Woollamia Nature Reserve, Jervis Bay National Park and Booderee National Park.

The removal of 16.16 hectares of vegetation would not result in a significant reduction in habitat connectivity in the region. The habitat to be removed is currently fragmented by existing roads, housing and infrastructure which provide potential barriers to habitat connectivity. Further, similar habitat surrounding the site investigation area is unlikely to become further isolated or fragmented as a result of clearing for the proposal.

Given the lack of breeding pairs identified in the potential nest trees to be impacted, the small area of potential habitat to be removed in the site investigation area is not likely to be important to the long-term survival of the Glossy Black-Cockatoo in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for the Glossy Black-Cockatoo.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following are relevant to the Glossy Black-Cockatoo:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. Vegetation proposed for removal contains recorded and/or potential habitat for the Glossy Black-Cockatoo. However, the extent of vegetation to be removed does not represent a significant area of habitat for Glossy Black-Cockatoo in the locality and is considered minor given the availability of suitable habitat in nearby areas.

- Removal of tree hollows

Up to 24 hollow-bearing trees are proposed to be removed as a result of the proposal. A small number of hollow-bearing trees proposed for removal support large tree hollows that may be suitable for nesting Glossy Black-Cockatoo. However, targeted surveys did not detect any breeding individuals and as such, the species is considered unlikely to breed within the site investigation area. Further, the extent of hollow-bearing trees to be removed is minor given the availability of suitable habitat in nearby areas.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on Glossy Black-Cockatoo in the site investigation area, or wider locality, as a result of the proposed actions as:

- The proposed works would not adversely affect the lifecycle of the species such that viable local populations are likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the species and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for the Glossy Black-Cockatoo.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Woodland birds

Potential impacts on the following threatened woodland bird species have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- Little Lorikeet (*Glossopsitta pusilla*) – Vulnerable

The Little Lorikeet was recorded in the site investigation area during field surveys. Two individuals were observed flying overhead in the centre of the site investigation area. Desktop assessment also identified 22 records of the species within 10 kilometres of the site investigation area, the most recent from 2020.

Distribution, habitat and ecology

The Little Lorikeet is listed as Vulnerable under the BC Act. The species is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. There is evidence that the species make nomadic movements, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs. The Little Lorikeet forages on nectar and pollen primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in a range of isolated flowering trees. Riparian habitats are particularly used, due to higher soil fertility and greater productivity. The species nests in hollows within proximity to foraging areas. Hollows generally have small entrances (~3 centimetres) and are 2m – 15m off the ground. The species shows high fidelity to nest sites and

breeds between May and September. In prolific flowering years, the species may breed twice, producing 3 – 4 eggs per attempt.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The site investigation area offers potential foraging and nesting habitat for the Little Lorikeet. Forage trees, including *Eucalyptus* and *Melaleuca*, occur throughout the site investigation area and a large number of trees were identified within the site investigation area with hollows suitable sized for nesting Little Lorikeet. However, targeted surveys did not detect any breeding individuals and there is a low likelihood that the Little Lorikeet may infrequently use small tree hollows within the site investigation area for breeding. As such, it is unlikely that the site investigation area supports breeding habitat for a large proportion of the population of this species.

Due to the small area of potential foraging habitat to be directly impacted (a total of 16.16 hectares of 21.26 hectares), and the low potential of breeding, it is unlikely that the proposal would impact the life cycle of the Little Lorikeet. Consequently, it is unlikely that a viable local population of the species would be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable. The Little Lorikeet is a threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would require the removal of 16.16 hectares of vegetation containing potential foraging and roosting habitat for the Little Lorikeet. In addition, the proposal would require the removal of up to 24 hollow-bearing trees of which some are potentially suitable for nesting. However, the extent of habitat to be removed is minor given the availability of substantial areas of suitable habitat in good condition in nearby areas, such as in Parma Creek Nature Reserve, Woollamia Nature Reserve, Jervis Bay National Park and Booderee National Park.

The removal of 16.16 hectares of potential habitat would not result in a significant reduction in habitat connectivity in the region. The habitat to be removed is currently fragmented by existing roads, housing and infrastructure which provide potential barriers to habitat connectivity. Further, similar habitat surrounding the site investigation area is unlikely to become further isolated or fragmented as a result of clearing for the proposal.

Given the lack of breeding pairs of Little Lorikeet identified in the potential nest trees to be impacted, the small area of potential habitat to be removed in the site investigation area is not likely to be important to the long-term survival of the Little Lorikeet in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for the Little Lorikeet.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following are relevant to the Little Lorikeet:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. Vegetation proposed for removal contains potential habitat for the Little Lorikeet. However, the extent of vegetation to be removed does not represent a significant area of habitat for Little Lorikeet in the locality and is considered minor given the availability of suitable habitat in nearby areas.

- Removal of tree hollows

Up to 24 hollow-bearing trees are proposed to be removed as a result of the proposal. Some hollow-bearing trees proposed for removal support tree hollows that may be suitable for nesting Little Lorikeet. However, targeted surveys did not detect any breeding individuals and as such, the species is considered unlikely to breed within the site investigation area. Further, the extent of hollow-bearing trees to be removed is minor given the availability of suitable habitat in nearby areas.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on Little Lorikeet in the site investigation area, or wider locality, as a result of the proposed actions as:

- The proposed works would not adversely affect the lifecycle of the species such that viable local populations are likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the species and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for the Little Lorikeet.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Diurnal raptors

Potential impacts on the following threatened diurnal raptor species have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- White-bellied Sea-Eagle (*Haliaeetus leucogaster*) – Vulnerable
- Square-tailed Kite (*Lophoictinia isura*) – Vulnerable

One individual White-bellied Sea-Eagle was recorded flying over the site investigation area during field surveys, and desktop assessment also identified 12 records of the species within 10 kilometres of the site investigation area, the most recent from 2020. The Square-tailed Kite was not recorded in the site investigation area during field surveys, however the site investigation area provides suitable habitat for the species, and there are 23 Square-tailed Kite records within 10 kilometres of the site investigation area (the most recent from 2017). As such, the Square-tailed Kite is considered to have a 'moderate' likelihood of occurrence within the site investigation area.

Due to broad similarities in habitat requirements and ecology, impacts to these species have been considered as a single assessment of significance.

Distribution, habitat and ecology

The White-bellied Sea-Eagle is listed as Vulnerable under the BC Act. The species is distributed around the Australian coastline, as well as inland along rivers and wetlands of the Murray Darling Basin. In NSW, it is widespread along the east coast and all major inland rivers and waterways. It inhabits coastal dunes, tidal flats, grassland, heathland, woodland and forest, and occurs at sites near the sea, or within the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Breeding habitat consists of mature tall open forest, woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches. Eggs are laid in late Winter, with young remaining in the nest for 65-70 days. The White-bellied Sea-Eagle preys on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion.

The Square-tailed Kite is listed as Vulnerable under the BC Act. The species ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, there are scattered records although records indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. In the south-east and along the NSW south coast, the species is a summer breeding migrant, arriving in September and leaving by March. The species is found in a variety of timbered habitats including dry woodlands and open forests. In particular, the Square-tailed Kite preference timbered watercourses and appear to occupy hunting ranges of more than 100 square kilometres. Breeding occurs from July to February, with nest sites generally located on or within proximity to watercourses. Nests are usually located in a fork or on large horizontal tree limbs. The Square-tailed Kite is a specialist hunter of passerines, especially honeyeaters. The species will target nestlings in particular, picking most prey items from the outer foliage of the tree canopy.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The site investigation area provides potential foraging and roosting habitat for both diurnal raptor species however no raptor nests were observed in the site investigation area. Vegetation proposed for removal would not be suitable as nesting trees and given the fidelity of all both diurnal raptor species to nest sites, it is unlikely that they would nest within the site investigation area in the future. Due to the small area of potential foraging and roosting habitat to be directly impacted (a total of 16.16 hectares of 21.26 hectares), and the low potential of occurrence of breeding, it is unlikely that the proposal would impact the life cycle of the White-bellied Sea-Eagle and Square-tailed Kite. Consequently, it is unlikely that viable local populations of these species would be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable. The White-bellied Sea-Eagle and Square-tailed Kite are threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would require the removal of 16.16 hectares of vegetation containing potential foraging and roosting habitat for the White-bellied Sea-Eagle and Square-tailed Kite. However, the extent of habitat to be removed is minor given the availability of substantial areas of suitable habitat in good condition in nearby areas, such as in Parma Creek Nature Reserve, Woollamia Nature Reserve, Jervis Bay National Park and Booderee National Park.

The removal of 16.16 hectares of vegetation would not result in a significant reduction in habitat connectivity in the region. The habitat to be removed is currently fragmented by existing roads, housing and infrastructure which provide potential barriers to habitat connectivity. Further, similar habitat surrounding the site investigation area is unlikely to become further isolated or fragmented as a result of clearing for the proposal.

Given the lack of breeding habitat present and the small area of potential foraging and roosting habitat identified, potential habitat to be removed in the site investigation area is not likely to be important to the long-term survival of the White-bellied Sea-Eagle and Square-tailed Kite in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for the White-bellied Sea-Eagle and Square-tailed Kite.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following are relevant to the White-bellied Sea-Eagle and Square-tailed Kite:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. Vegetation proposed for removal contains potential foraging and roosting habitat for the White-bellied Sea-Eagle and Square-tailed Kite. However, the extent of vegetation to be removed does not represent a significant area of habitat for either species in the locality and is considered minor given the availability of suitable habitat in nearby areas.

- Removal of dead wood and dead trees

Dead wood and dead trees may be removed as a result of the proposal. The White-bellied Sea-Eagle and Square-tailed Kite are known to occasionally construct nests in large dead trees. However, no large stick nests were recorded and as such, it is unlikely that dead trees within the site investigation area provide suitable nesting habitat for either diurnal raptor species.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on the White-bellied Sea-Eagle and Square-tailed Kite in the site investigation area, or wider locality, as a result of the proposed actions as:

- The proposed works would not adversely affect the lifecycle of the species such that viable local populations are likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the species and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for any of the three diurnal raptor species.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Large forest owls

Potential impacts on the following threatened large forest owl species have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- Powerful Owl (*Ninox strenua*) – Vulnerable
- Masked Owl (*Tyto novaehollandiae*) – Vulnerable

One individual Powerful Owl was recorded foraging within the site investigation area during field surveys, and desktop assessment also identified 49 records of the species within 10 kilometres of the site investigation area, the most recent from 2019. The Masked Owl was not recorded in the site investigation area during field surveys, however the site investigation area provides suitable habitat for the species, and there are 26 Masked Owl records within 10 kilometres of the site investigation area (the most recent from 2017). As such, the Masked Owl is considered to have a 'moderate' likelihood of occurrence within the site investigation area.

Due to broad similarities in habitat requirements and ecology, impacts to these species have been considered as a single assessment of significance.

Distribution, habitat and ecology

The Powerful Owl (*Ninox strenua*) is listed as Vulnerable under the BC Act. The species is endemic to eastern and south-eastern Australia, predominantly occurring on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout forested habitats, however inland populations have collapsed due to land clearing. The Powerful Owl inhabits a range of vegetation types from woodland and open sclerophyll forest to tall open wet forest and rainforest. Large areas of habitat are required; however, the species can occur in fragmented landscapes. Dense vegetation is used for diurnal roosting, while forests and woodlands are used for foraging and breeding. The Powerful Owl mainly preys on medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. Prey can vary regionally, with Ringtail Possum making up the bulk of diet for Powerful Owls in southern NSW. Breeding pairs demonstrate high fidelity to territories with territory size varying with habitat quality. The species nests in large tree hollows (at least 0.5m deep) and at least 150 years old. Powerful Owls are monogamous and mate for life. Nesting occurs from late Autumn to mid-Winter. Clutches consist of two dull white eggs and incubation lasts approximately 38 days.

The Masked Owl (*Tyto novaehollandiae*) is listed as Vulnerable under the BC Act. Distribution of the Masked Owl throughout Australia is sparse, with 90% of records occurring in NSW. In NSW, the species is widespread within and east of the Great Dividing Range, from Murwillumbah on the north coast to Ben Boyd National Park in the south. Scattered records of the species have been made west of the Great Dividing Range, as far west as Fowlers Gap. The species inhabits dry eucalypt forests and woodlands from sea level up to 1100m that contain tall or dense mature trees that support hollows suitable for nesting and roosting. Although a forest owl, the species will often hunt along forest and roadside edges. The typical diet consists of tree-dwelling and ground mammals, especially rats. Masked Owl roost and breed in moist eucalypt forested gullies, utilising large tree hollows or sometimes caves for nesting.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Several trees were identified within the site investigation area with large hollows suitably sized for nesting large forest owls. Stag-watching surveys were undertaken at these trees and no owls were recorded exiting hollows. In addition, no breeding pairs were observed or heard in the site investigation area. As such, it is unlikely that these species are breeding in the site investigation area. Due to the small area of potential foraging habitat to be directly impacted (a total of 16.16 hectares of 21.26 hectares), and the low potential of occurrence of breeding, it is unlikely that the proposal would impact the life cycle of the Powerful Owl and Masked Owl. Consequently, viable local populations for both species are unlikely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable. The Powerful Owl and Masked Owl are threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would require the removal of 16.16 hectares of potential foraging and roosting habitat for the Powerful Owl and Masked Owl. In addition, the removal of up to 24 hollow-bearing trees would likely reduce prey density in the broader area and may contain hollows suitable for nesting. However, the extent of habitat to be removed is minor given the availability of substantial areas of suitable habitat in good condition in nearby areas, such as in Parma Creek Nature Reserve, Woollamia Nature Reserve, Jervis Bay National Park and Booderee National Park.

The removal of 16.16 hectares of vegetation would not result in a significant reduction in habitat connectivity in the region. The habitat to be removed is currently fragmented by existing roads, housing and infrastructure which provide potential barriers to habitat connectivity. Further, similar habitat surrounding the site investigation area is unlikely to become further isolated or fragmented as a result of clearing for the proposal.

Given the lack of breeding pairs identified in the potential nest trees to be impacted, the small area of potential habitat to be removed in the site investigation area is not likely to be important to the long-term survival of the Powerful Owl and Masked Owl in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for the Powerful Owl or Masked Owl.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following are relevant to the Powerful Owl and Masked Owl:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. Vegetation proposed for removal contains recorded and/or potential habitat for the Powerful Owl and Masked Owl. However, the extent of vegetation to be removed does not represent a significant area of habitat for either species in the locality and is considered minor given the availability of suitable habitat in nearby areas.

- Removal of tree hollows

Up to 24 hollow-bearing trees are proposed to be removed as a result of the proposal. A small number of hollow-bearing trees proposed for removal support large tree hollows that may be suitable for nesting large forest owls. However, targeted surveys did not detect any breeding individuals and as such, the Powerful Owl and Masked Owl are considered unlikely to breed within the site investigation area. Further, the extent of hollow-bearing trees to be removed is minor given the availability of suitable habitat in nearby areas.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on the Powerful Owl and Masked Owl in the site investigation area, or wider locality, as a result of the proposed actions as:

- The proposed works would not adversely affect the lifecycle of the species such that viable local populations are likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the species and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for either of the two large forest owl species.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Large arboreal mammals

Potential impacts on the following threatened large arboreal mammal species have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- Yellow-bellied Glider (*Petaurus australis*) – Vulnerable

The Yellow-bellied Glider was not recorded in the site investigation area during field surveys, however suitable habitat is present in the site investigation area and desktop assessment also identified 348 records of the species within 10 kilometres of the site investigation area, the most recent from 2020. As such, the Yellow-bellied Glider is considered to have a 'moderate' likelihood of occurrence within the site investigation area.

Distribution, habitat and ecology

The Yellow-bellied Glider (*Petaurus australis*) is listed as Vulnerable under the BC Act. In NSW, the Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range. The species is mostly found in tall mature eucalypt forest, generally in areas with high rainfall and nutrient rich soils, however forest type preferences can vary with latitude and elevation. The Yellow-bellied Glider feeds primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. The species typically lives in small family groups and occupies hollows in large trees. They are very mobile and occupy large home ranges between 20 hectares to 85 hectares to encompass dispersed and seasonally variable food resources.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Several trees were identified within the site investigation area with large hollows suitably sized for the Yellow-bellied Glider. Stag-watching surveys were undertaken at these trees and no gliders were recorded exiting hollows. As such, it is unlikely that this species is breeding in the site investigation area. Due to the small area of potential foraging habitat to be directly impacted (a total of 16.16 hectares of 21.26 hectares), and the low potential of occurrence of breeding, it is unlikely that the proposal would impact the life cycle of the Yellow-bellied Glider. Consequently, viable local populations for both species are unlikely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable. The Yellow-bellied Glider is a threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would require the removal of 16.16 hectares of potential foraging and dispersal habitat for the Yellow-bellied Glider. In addition, the removal of up to 24 hollow-bearing trees may contain hollows suitable for breeding. However, the extent of habitat to be removed is minor given the availability of substantial areas of good condition, suitable habitat, such as in Parma Creek Nature Reserve, Woollamia Nature Reserve, Jervis Bay National Park and Booderee National Park, in nearby areas.

The removal of 16.16 hectares of vegetation would not result in a significant reduction in habitat connectivity in the region. The habitat to be removed is currently fragmented by existing roads, housing and infrastructure which provide potential barriers to habitat connectivity. Further, similar habitat surrounding the site investigation area is unlikely to become further isolated or fragmented as a result of clearing for the proposal.

Given the lack of presence and breeding individuals identified in the potential hollow-bearing trees to be impacted, the small area of potential habitat to be removed in the site investigation area is not likely to be important to the long-term survival of the Yellow-bellied Glider in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for the Yellow-bellied Glider.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following are relevant to the Yellow-bellied Glider:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. Vegetation proposed for removal contains potential habitat for the Yellow-bellied Glider. However, the extent of vegetation to be removed does not represent a significant area of habitat for the species in the locality and is considered minor given the availability of suitable habitat in nearby areas.

- Removal of tree hollows

Up to 24 hollow-bearing trees are proposed to be removed as a result of the proposal. A small number of hollow-bearing trees proposed for removal support large tree hollows that may be suitable for the Yellow-bellied Glider. However, targeted surveys did not detect any individuals and as such, the Yellow-bellied Glider is considered unlikely to breed within the site investigation area. Further, the extent of hollow-bearing trees to be removed is minor given the availability of suitable habitat in nearby areas.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on the Yellow-bellied Glider in the site investigation area, or wider locality, as a result of the proposed actions as:

- The proposed works would not adversely affect the lifecycle of the species such that viable local populations are likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the species and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for the Yellow-bellied Glider.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Megachiropteran bats

Potential impacts on the following threatened megachiropteran bats have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- Grey-headed Flying-fox (*Pteropus poliocephalus*) – Vulnerable

The Grey-headed Flying-fox was recorded in the site investigation area during field surveys. Two individuals were observed flying overhead in the centre of the site investigation area. Desktop assessment also identified 145 records of the species within 10 kilometres of the site investigation area, the most recent from 2019.

Distribution, habitat and ecology

Grey-headed Flying-foxes are generally found within 200 kilometres of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. In times of natural resource shortages, they may be found in unusual locations. The species occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 kilometres of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young. Annual mating commences in January and conception occurs in April or May; a single young is born in October or November. Site fidelity to camps is high with some camps having been used for over a century. Grey-headed Flying-fox can travel up to 50 kilometres from the camp to forage; commuting distances are more often up to 20 kilometres. The species feeds on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of

rainforest trees and vines. The species is also known to forage in cultivated gardens and fruit crops.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The site investigation area offers potential foraging habitat for the Grey-headed Flying-fox (a total of 16.16 hectares of 21.26 hectares). A diversity of flowering trees, predominantly *Eucalyptus* sp. and *Melaleuca* were recorded in vegetation within the site investigation area. The site investigation area does not contain any camps (used for roosting and breeding). The nearest Nationally Important Flying-fox camp mapped by National Flying-fox monitoring viewer (DEE, 2020) is at Bomaderry Creek (Camp ID 233; approximately 14 kilometres north of the site investigation area) and Bewong Creek (Camp ID 232; approximately 10 kilometres south-west of the site investigation area), which have typically supported up to approximately 10,000 Flying-foxes in recent years.

Potential foraging resources for the species are available at the site investigation area during critical times of the reproductive cycle. Breeding individuals from any of nearby camps that utilise resources within the site investigation area may be adversely impacted by the removal of foraging habitat. However, vegetation removal, comprising a total of 16.16 hectares of 21.26 hectares, would not significantly diminish the foraging resources elsewhere in the region that would support breeding females. As such, the removal of vegetation as a result of the proposal unlikely to have an adverse effect on the life cycle of the Grey-headed Flying-fox such that a viable local population of the species is likely to be placed at risk of extinction.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable. The Grey-headed Flying-fox is a threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would require the removal of 16.16 hectares of potential foraging and dispersal habitat for the Grey-headed Flying-fox. However, the extent of habitat to be removed is minor given the availability of substantial areas of suitable habitat in good condition in nearby areas, such as in Parma Creek Nature Reserve, Woollamia Nature Reserve, Jervis Bay National Park and Booderee National Park.

The removal of 16.16 hectares of vegetation would not result in a significant reduction in habitat connectivity in the region. The habitat to be removed is currently fragmented by existing roads, housing and infrastructure which provide potential barriers to habitat connectivity. Further, similar habitat surrounding the site investigation area is unlikely to become further isolated or fragmented as a result of clearing for the proposal.

Given the absence of breeding camps in the site investigation area, the small area of potential habitat to be removed in the site investigation area is not likely to be important to the long-term survival of the Grey-headed Flying-fox in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for the Grey-headed Flying-fox.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following are relevant to the Grey-headed Flying-fox:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. Vegetation proposed for removal contains potential habitat for the Grey-headed Flying-fox. However, the extent of vegetation to be removed does not represent a significant area of habitat for the species in the locality and is considered minor given the availability of suitable habitat in nearby areas.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on the Grey-headed Flying-fox in the site investigation area, or wider locality, as a result of the proposed actions as:

- The proposed works would not adversely affect the lifecycle of the species such that viable local populations are likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the species and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for the Grey-headed Flying-fox.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Microchiropteran bats (microbats)

Potential impacts on the following threatened microchiropteran bats (microbats) have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) – Vulnerable
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – Vulnerable
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) – Vulnerable
- Southern Myotis (*Myotis macropus*) – Vulnerable

The Eastern False Pipistrelle and Greater Broad-nosed Bat were recorded as 'Possible' within the site investigation area (see Annexure G of the BAR), and desktop assessment identified seven records (most recent from 2018) and nine records (most recent from 2016) of the species respectively from within 10 kilometres of the site investigation area.

The Large Bent-winged Bat and Southern Myotis were recorded as 'Probable' (see Annexure G of the BAR), and desktop assessment identified 15 records (most recent from 2018) and 10 records (most recent from 2018) of the species respectively from within 10 kilometres of the site investigation area.

Due to broad similarities in habitat requirements and ecology, impacts to these species have been considered as a single assessment of significance.

Distribution, habitat and ecology

The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) is listed as Vulnerable under the BC Act. The species is found on the south-east cost and ranges of Australian from southern Queensland to Victoria and Tasmania, preferring moist habitats with trees taller than 20 metres. The Eastern False Pipistrelle generally roosts in eucalypt hollows but has also been found under loose bark on trees or in buildings. The species hunts a variety of flying insects above or just below the tree canopy. Females are believed to be pregnant in late spring to early summer, and the species undergoes torpor during the winter months.

The Greater Broad-nosed Bat (*Scoteanax rueppellii*) is listed as Vulnerable under the BC Act. The species is predominantly recorded in gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. In NSW, the species is widespread on the New England Tablelands but does not occur at altitudes above 500 metres. The Greater Broad-nosed Bat utilises a variety of habitats, but is most commonly found in tall, wet forest. Although the species typically roosts in tree hollows, it has also been recorded from buildings. The Greater Broad-nosed Bat forages after sunset, flying slowly and directly along riparian corridors at an estimated altitude of three to six metres. Open woodland is also utilised to catch slow flying insects, and sometimes other bat species. Little is known about the reproductive cycle of this species, however females are known to congregate at maternity sites (located in suitable trees) and a single young is born in January.

The Large Bent-winged Bat (*Miniopterus orianae oceanensis*) is listed as Vulnerable under the BC Act. The species occurs along the east and north-west coasts of Australia and primarily roosts in caves, but is also known to use derelict mines, stormwater tunnels, buildings and other man-made structures. The Large Bent-winged Bat hunts in forested areas catching moths and other flying insects above the canopy. The species forms discrete populations centred on a maternity cave that is used in spring and summer for the birth and rearing of young. At other times of the year, populations disperse within about 300 kilometres of maternity caves. The species hibernates in cold caves in southern Australia.

The Southern Myotis (*Myotis macropus*) is listed as Vulnerable under the BC Act. The species is found in the coastal band from north-west Australia, across the top-end and south to western Victoria. It is rarely found more than 100 kilometres inland, except for along major rivers. The species forages over streams and pools catching insects and small fish. Southern Myotis generally roost in groups of 10 to 15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage. In NSW, females have one young each year usually in November or December.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The site investigation area offers potential foraging and breeding habitat for microbat species (a total of 16.16 hectares, and 3.33 hectares of foraging habitat for the Southern Myotis along creeklines). The Large Bent-winged Bat breeds in maternity colonies in caves, and therefore the site investigation area does not contain any suitable breeding habitat for this species. Hollow-bearing trees within the site investigation area could offer potential roosting and/or breeding habitat for the remaining microbat species. The removal of up to 24 hollow-bearing trees could disrupt the breeding cycle of one or more of the listed microbat species. Disturbance of hibernating microbats during winter can result in mortalities due to a lack of foraging resources and limited fat stores during this time (Churchill 2008). Impacts to the breeding cycle could include displacement of females with young or pregnant females. Whether these impacts occur is dependent on the timing of vegetation removal.

Analysis of Anabat data collected during surveys has been analysed to assess activity levels of microbats. Generally, there were very low numbers of passes recorded on the Anabat for each species particularly during and immediately after dusk. Given low activity at this time of night, it is unlikely there is a nearby roost with high numbers of bats. Recordings would be of higher volumes at this time of night when the species is leaving a roost site, if close by. Recordings were not definitive for each species and could also be associated with non-threatened microbats *Nyctophilus sp*. and *Scotorepens orion*.

Southern Myotis uses the habitat surrounding waterways for breeding and roosting. Two hollow bearing trees within the construction footprint are within proximity to a waterway and therefore have potential to be used as breeding or roosting habitat for this species. However, due to the low number of passes at dusk, it is unlikely that this species is roosting within close proximity and using these hollows. The waterways within proximity to the site investigation area are largely surrounded by native vegetation and are likely to contain a large number of suitable hollows for Southern Myotis.

Microbats are wide-ranging, highly mobile animals and any microbats roosting in the site investigation area are likely to be part of local populations that extend beyond the site in connected remnant vegetation. Clearing of up to 24 hollow-bearing trees for the proposal could result in indirect mortalities or interruption to the breeding cycle, reducing the numbers of local populations. The proposal is likely to impact a small proportion, if any, of microbat populations known to occur in the wider locality (ie recorded within 10 kilometres). The proposal is therefore unlikely to lead to the extinction of these populations.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable. The Eastern False Pipistrelle, Greater Broad-nosed Bat, Large Bent-winged Bat and Southern Myotis are threatened species.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would require the removal of 16.16 hectares of potential foraging and breeding habitat for three microbat species, and an additional 3.33 hectares of foraging habitat along creeklines for Southern Myotis. However, the extent of habitat to be removed is minor given the availability of substantial areas of suitable habitat in good condition in nearby areas, such as in Parma Creek Nature Reserve, Woollamia Nature Reserve, Jervis Bay National Park and Booderee National Park.

The removal of 16.16 hectares, and 3.33 hectares of potential foraging habitat for the Southern Myotis along creeklines (and up to 24 hollow-bearing trees) would not result in a significant reduction of habitat connectivity in the region. The habitat to be removed is currently fragmented by existing roads, housing and infrastructure which provide potential barriers to habitat connectivity. Further, similar habitat surrounding

the site investigation area is unlikely to become further isolated or fragmented as a result of clearing for the proposal.

Given the species high mobility, and existing disturbances and fragmentation, the small area of potential habitat to be removed in the site investigation area is not likely to be important to the long-term survival of the Eastern False Pipistrelle, Greater Broad-nosed Bat, Large Bent-winged Bat and Southern Myotis in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for the Eastern False Pipistrelle, Greater Broad-nosed Bat, Large Bent-winged Bat and Southern Myotis.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following are relevant to the Eastern False Pipistrelle, Greater Broad-nosed Bat, Large Bent-winged Bat and Southern Myotis:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. Vegetation proposed for removal contains potential habitat for the Eastern False Pipistrelle, Greater Broad-nosed Bat, Large Bent-winged Bat and Southern Myotis. However, the extent of vegetation to be removed does not represent a significant area of habitat for the species in the locality and is considered minor given the availability of suitable habitat in nearby areas.

- Removal of tree hollows

Up to 24 hollow-bearing trees are proposed to be removed as a result of the proposal. Hollow-bearing trees proposed for removal may support tree hollows suitable for microbat species. However, the extent of hollow-bearing trees to be removed is minor given the availability of suitable habitat in nearby areas.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on the Eastern False Pipistrelle, Greater Broad-nosed Bat, Large Bent-winged Bat and Southern Myotis in the site investigation area, or wider locality, as a result of the proposed actions as:

- The proposed works would not adversely affect the lifecycle of the species such that viable local populations are likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the species and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for the Eastern False Pipistrelle, Greater Broad-nosed Bat, Large Bent-winged Bat and Southern Myotis.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Potential impacts on the following endangered ecological community have been assessed in accordance with the five factors set out in Section 7.3 of the BC Act:

- Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion – Endangered

This TEC occurs in the central section of the site investigation area between Princes Highway and Old Princes Highway as well as in patches along the Princes Highway south of the Jervis Bay Road intersection and in the eastern extent of the site

investigation area. There is a total of 6.28 hectares of this TEC within the site investigation area, 4.18 hectares of which is located in the proposal construction footprint and would be removed as a result of the proposal.

The TEC is present in small patches which are fragmented by the Princes Highway and Jervis Bay Road. The areas of TEC are also subject to ongoing disturbances including edge effects, mowing and grazing. The condition varies across the patches, with some patches experiencing high cover of exotic species and low native species diversity while other patches have high native species cover and diversity.

Distribution, habitat and ecology

Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion is listed as an endangered ecological community under the BC Act. This TEC occurs along the Illawarra coastal plain and escarpment foothills on flats below 100m ASL with sandy loam soils and partially impeded drainage. Characteristic canopy species include *Eucalyptus tereticornis, Eucalyptus eugenioides* (Thin-leaved Stringybark*), Eucalyptus longifolia, Eucalyptus bosistoana* (Coast Grey Box) and *Melaleuca decora*.

PCT 1326 is recognised in the BioNet Vegetation Classification data collection as corresponding to Illawarra Lowlands Grassy Woodland in the Sydney Basin. Section 3.6.1 compares the areas of PCT 1326 in the site investigation area with the final determination for the TEC. The comparison shows the areas are consistent with the TEC.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable. Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion is an endangered ecological community.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

The site investigation area contains 6.24 hectares of Illawarra Lowlands Grassy Woodland of which 4.18 hectares would be removed by the proposal. This represents approximately 1.35% of the area of the TEC mapped within a 10 kilometre radius of the site investigation area (OEH, 2013). The area to be removed is not a significant area of the community in the locality. The removal of 4.18 hectares is therefore unlikely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

(c) in relation to the habitat of a threatened species or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The proposal would result in the clearing of 4.18 hectares of Illawarra Lowlands Grassy Woodland. This community is currently already fragmented by rural dwellings and roads and highways and is therefore present in isolated stands. Many patches of the TEC are heavily grazed or regularly mown and are subject to edge effects. The removal of some of these patches would not further substantially isolate or fragment the TEC.

The patches of Illawarra Lowlands Grassy Woodland within the construction footprint are fragmented and subject to ongoing disturbance, and do not represent a significant or important area for the ecological community. Therefore, their removal would not impact on the long-term survival of the ecological community in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Schedule 4 of the BC Act provides a list of the 'key threatening processes' (KTPs). Of the KTPs listed in Schedule 4 of the BC Act, several are applicable to the proposal. Of those, the following are relevant to Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion:

- Clearing of native vegetation

Native vegetation would be cleared for the proposal. However, the extent of vegetation to be removed does not represent a significant area of habitat for the community in the locality.

- Invasion of native plant communities by exotic perennial grasses

Exotic grasses are abundant in some areas of the site investigation area, including in some areas of Illawarra Lowlands Grassy Woodland and the proposal may exacerbate the KTP by facilitating the spread of seeds or fragments of plant to areas where these grasses are not present, via plant or contaminated topsoil. This could include areas of Illawarra Lowlands Grassy Woodland.

It is unlikely that the continuation and exacerbation of these KTPs would have a significant impact on Illawarra Lowlands Grassy Woodland.

Conclusion

In light of the consideration of the above five factors, the proposal is unlikely to have a significant impact on Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion in the site investigation area, or wider locality, as:

- The proposal would not have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;
- The proposed works would not substantially fragment habitat for the community and;
- The proposed works are unlikely to exacerbate any KTPs, and do not comprise a significant area of habitat for the ecological community.

Consequently, preparation of a Species Impact Statement (SIS) is not required.

Test of Significance for Green and Gold Bell Frog

Princes Highway Upgrade Program: Jervis Bay Road Intersection Upgrade

25/11//21

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Background

1.1 Introduction

This document outlines a Test of Significance (ToS) addressing criteria set out under Section 7.3 of the *Biodiversity Conservation Act 2016* (BC Act). The ToS is based on five broad questions within the BC Act and guidance provided in *Threatened Species Test of Significance Guidelines* (OEH 2018) ("the guidelines"). The ToS is designed to assist Transport for NSW (TfNSW) in determining the risk of a significant impact to the Green and Golden Bell Frog (*Litoria aurea*) (GGBF) as part of the "*Princes Highway Upgrade Program: Jervis Bay Road Intersection Upgrade* ("the proposal") and if further assessment, in the form of a Biodiversity Development Assessment Report (BDAR) or Species Impact Statement is required.

1.2 The proposal

Transport for NSW (TfNSW) proposes to upgrade the intersection of Jervis Bay Road and the Princes Highway north of Falls Creek, NSW, located about 12 kilometres south of Nowra, within the Shoalhaven Local Government Area.

The proposal would provide a grade separated through alignment for the Princes Highway with network access to Jervis Bay Road and the Old Princes Highway provided via dual at grade roundabouts serviced by on and off ramps. The proposal includes a new intersection between Jervis Bay Road and the Princes Highway, an overpass bridge across Jervis Bay Road, a roundabout interchange and connections and tie ins within surrounding properties and businesses along the Old Princes Highway.TfNSW prepared a review of environmental factors (REF) for the Jervis Bay Road Intersection Upgrade to meet the requirements under Division 5.1 of the *Environmental Planning & Assessment Act 1979.* The REF was publicly displayed between Friday 18 June 2021 and Sunday 25 July 2021. A Submissions Report to address community comments from the public display is under preparation

Biodiversity surveys designed to support the approval process for the proposal commenced in August 2020. However, a recent design change has resulted in additional areas of impact which are addressed in this ToS. In August 2021 a site inspection and preliminary vegetation assessment conducted by Arcadis in this additional area identified the potential for the site to constitute GGBF habitat (Arcadis 2021). A follow up survey by GGBF expert Dr Frank Lemckert was carried out on 20 and 21 October 2021 and the results of these surveys, as well as published literature on the GGBF populations of the area have been used to inform this ToS. The site and GGBF records within 10kilometres of the site are shown in Figure 1.

This assessment will be used to determine if the proposal should be further assessed as a BDAR under the Biodiversity Assessment Method, or a Species Impact Statement as per the NSW *Biodiversity Conservation Act 2016.* For this assessment we use the definition of accessible habitat for GGBF developed by Hamer (2016) which includes the subject farm dam and all terrestrial plant communities within 1000 metre radius of the dam centroid (Figure 2).

1.3 Species status, distribution, and habitat

GGBF is listed as endangered in NSW under the *Biodiversity Conservation Act 2016* and as vulnerable under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999.* It is a large, ground-dwelling frog that was once common along the east coast of Australia from eastern Victoria to north-eastern NSW. Its greatly reduced population is now known to be from about 44 metapopulation locations, in isolated parts of north coast NSW, the Sydney Basin, south-eastern highlands, south coast of NSW and north-eastern Victoria (Anstis 2018).

GGBF inhabit a diversity of habitat, from ephemeral drainage lines to large, permanent dams, swamps and lagoons that occur within and adjacent to coastal forests and farmland (Anstis 2018). A review by Pyke and White (2001) showed that habitat most likely to support breeding in this species consists of:

- a water body with a substrate of sand, rock or clay
- still, shallow water, with low to moderate salinity
- unshaded water bodies that are free from predatory fish such as *Gambusia holbrooki* (Plague Minnow)
- Emergent aquatic plants such as *Typha* sp. or *Eleocharis* sp.
- Complexity of terrestrial habitat, including an array of objects (rocks, rotting logs etc) to shelter under outside of breeding periods
- A grassy area adjacent to the water body, and other nearby vegetation of woodland or shrubland with a maximum height of 2m. Although, some researchers dispute this, having found GGBF in forested and unforested areas (discussed in DEC 2005).

GGBF tolerates a wide range of physical and chemical properties of water with tadpoles found in water with varying turbidity, dissolved oxygen, oxidation reduction potential, pH and water temperature (Pyke and White, 2001). Some areas of breeding habitat occur in highly modified landscapes, including established populations at Kooragang Island, Sydney Olympic Park, Port Kembla and Arncliffe, NSW (DEC 2005).

1.4 Ecology and behaviour

Adult GGBF feed on a wide variety of prey items, including invertebrates such as insect larvae, crickets, earthworms, flies and freshwater crayfish (DEC 2005). In addition, GGBF is well known to be highly anurophagous (frog-eating). It is likely that as well as a wide variety of invertebrates in their diet, GGBF are highly opportunistic tackling any vertebrates that are of a size that they can consume, including tadpoles and smaller conspecifics (DEC 2005).

Breeding events for this species have been recorded from late winter to early autumn, but the peak is around January/February, with a narrower window for southerly and high-altitude populations (DEC 2005). GGBF females are highly fecund, with clutch sizes ranging from 2,000 to 11,500 eggs, with 3,700 eggs on average (Pyke and White, 2001). This type of breeding biology is known as R selection (R being for reproduction, where the species produces large numbers of offspring in favourable breeding conditions) which allows for rapid recovery from decline due to environmental conditions and makes them able to swiftly colonise surrounding suitable habitat when environmental conditions are favourable (DEC 2005).

Hatching occurs within five days of fertilisation with tadpole development taking six to 12 weeks, depending on environmental conditions. Overwintering (where tadpoles persist during the cooler months), also occurs (Pyke and White, 2001). Tadpoles consume algae and other aquatic vegetation, especially that which grows on rocks and other submerged substrate.

1.5 Local population

For the purposes of this assessment, the site under investigation is a farm dam at 1 Willowgreen Road, Falls Creek, NSW and potential foraging and overwintering habitat within the vicinity of this dam (considered to be “accessible habitat” as defined by Hamer (2016)). The dam is approximately 377 square metres and located within a cleared area with native vegetation consistent with Plant Community Type (PCT) 1326 *Woolybutt-White Stringybark- Forest Red Gum grassy woodland* nearby. Key species within and immediately surrounding the dam include:

- *Typha orientalis*
- *Imperata cylindrica*
- *Juncus continuus*

- *Carex sp.*

Further detail on the vegetation composition of the dam and surrounds can be found within the Biodiversity Assessment Report for this proposal. There are no records of GGBF at or within the immediate surrounds of the dam, however, the owner of the property has heard GGBF within the dam, up to approximately five years ago (discussed in Lemckert, 2021). Approximately 50 per cent of the dam is open water, with shallow areas, and significant, emergent vegetation.

During surveys in October 2021 the Plague Minnow (*Gambusia holbrook*i) was present within the dam. This species eats GGBF tadpoles, and so successful breeding is difficult when this predatory fish species is present. Complexity of emergent vegetation can assist in breeding success for GGBF when the Plague Minnow is present, but studies have shown that breeding success for GGBF in ponds with this species present is reduced (discussed further in Lemckert 2021). If the dam dries out periodically, that would temporarily eliminate Plague Minnow, but overflow from the creek during flood events is likely to re-introduce this predatory fish species (Lemckert, 2021).

Shading of the dam does occur (to approximately 50 per cent of the waterbody), however, it is not expected that the shading would negatively impact on the suitability of the location for GGBF (Lemckert 2021). GGBF have not been detected at the dam, however the attributes of the dam (emergent vegetation, full sun, shallow water and suitable overwintering sites in the surrounding area), the previous observations by the owner, and assessment by GGBF expert Dr Frank Lemckert confirm that the dam is potential GGBF habitat.

The site occurs in proximity to two established GGBF populations described in the draft recovery plan for the species. These populations are part of the Shoalhaven metapopulation, once a stronghold for the species (DEC 2005). The site is closest to two of the 11 populations that comprise the Shoalhaven metapopulation. The Crookhaven River Floodplain population and the smaller Woollamia Currambene Creek population (DEC 2005). The Crookhaven River Floodplain population is centred around Brundee Swamp, approximately eight kilometres to the north east of the site. The lesser known, Woollamia Currambene Creek population occurs to the east of the site, within the Currambene State Forest, approximately four kilometres to the east. If GGBF does use the site, they are likely to be part of this population (Figure 1), with recent records (2014), three kilometres to the north and north east of the site.

The population ecology of the Crookhaven River floodplain population and Woollamia Currambene Creek population was extensively studied from 1996 to 2014 and reported in Daly (2014). During environmental conditions conducive to GGBF breeding, the population erupted and dispersed from permanent breeding ponds around Brundee Swamp, Worrigee and Terara Swamps across the floodplain and into areas where GGBF had previously not been recorded (2008-2011). However, by 2013/14 the population was declining in known breeding areas, and fewer outlying sites contained GGBFs. This “boom and bust” pattern is a characteristic of GGBF populations, and means that suitable areas of habitat, with or without records still need to be considered as part of the maintenance and recovery of this species (Daly, 2014).

A more recent analysis, carried out for the Save Our Species program of the Crookhaven River floodplain population was undertaken in from 2016 to 2018 and showed a substantial decline in occupancy of GGBF from this area from 2016/17 to 2017/18 (West et. al., 2018). This added further data to a study carried out by Hamer (2018), showing a decline in population size for this area between 2013 and 2018. This metapopulation is under pressure from land clearing, infrastructure and other disturbance (West et. al, 2018).

For the purposes of the ToS, impacts to the local population are crucial to determining impact. Under the guidelines (OEH 2018), “*a local population of resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area*.” Individual frogs have been recorded moving up to five kilometres within the Shoalhaven metapopulation, that encompasses this site (Daly, 2014). Recent GGBF records occur within five kilometres of the site and are likely to be part of the Woollamia Currambene Creek population (Figure 1). Therefore, this ToS considers the local population to be all individuals within the Woollamia Currambene Creek population, including any that occur at the site.

1.6 Mitigation

Under the guidelines “Design features targeted at minimising impacts on threatened species can only be considered if the measure has been used successfully for the target species in similar situations. Studies or literature demonstrating the success of the measure must be referenced if proposing that the measure will minimise impacts” (OEH 2018).

In assessing the potential impacts of the proposal on a threatened fauna species, that requires proof of the continuation of the full life cycle, including successful reproduction, over successive seasons. That is, animals must produce offspring and these offspring must also successfully breed to provide sufficient evidence that a population is likely to persist at the mitigation site. Given this site may not currently support a resident breeding population, but still be important for connectivity and dispersal habitat, it may be sufficient to show occupancy during good conditions. However, compensatory habitat should be designed in such a way that breeding can be accommodated. A well-designed alternative pond, or modifications to the existing dam, to mitigate loss of habitat, is recommended if Green and Golden Bell Frogs are found to occur at the dam and impacts to the dam cannot be avoided.

Compensatory habitat has been built for this species by TfNSW at a number of sites, with detailed monitoring data available for M5 Motorway ponds at Arncliffe and a limited amount of monitoring data for South Nowra. (summarised in Table 1-1). The M5 population has demonstrated successful breeding over multiple seasons (eg 2010/2011 and 2011/12) and there is a self-sustaining population at the artificial two ponds within the M5 Motorway compensatory habitat area (White 2000-2015). Monitoring occurred over a long period at this site which gave enough time to account for the R-selected strategy of reproduction, or “boom and bust” population pattern of this species influencing the determination of successful breeding within the compensatory habitat. GGBF females are not reproductively mature until their second year and when they have obtained a snout-vent length of 65 milimetres (Pyke and White 2001). If this maturity corresponds with poor conditions for breeding it may take three or more years until breeding is demonstrated in new ponds.

The ponds built in this area were able to be drained (to manage for predatory fish such as the Plague Minnow (*Gambusia holbrookii*) and surrounding habitat was managed for weeds (White, 2015).

If compensatory habitat is required for this proposal, TfNSW has acquired the land that includes the site and land further to the west. This would allow for modifications to the current dam if a new design reduced impacts on it, or installation of a similar dam, including access to adjacent grassland and areas for overwintering (logs, rocks etc) within proximity to the impact site. For compensatory habitat, the banks of the new dam would need to be designed to minimise the influx of flow from the nearby creek (reducing the risk of re-introduction of the Plague Minnow during flood events). The inclusion of this compensatory habitat has been considered in determining extent of impact to the species in the ToS in Section 1.7.

Table 1-1 Summary of results of colonisation of artificial habitat for GGBF

Site	Description	Years monitored	Metamorphs?	Breeding?	Successful?	Lessons learnt
M5 Motorway East, Arncliffe	Two constructed ponds at Arncliffe overall population of up to 50 animals, varies, depending on environmental conditions	1999 - 2015 (White 2000 - 2015)	Yes	Yes – most years of monitoring	Yes, but took some time to show breeding success	Monitoring must cover more than three years to show success or otherwise of breeding. Weeds should be removed, and water must be able to be drained regularly to reduce/eliminate predatory fish, but ponds must be full during the spring/summer breeding season
South Nowra	Eight constructed ponds, monitored as part of a GGBF population study (ARCUE 2016)	3 years (2014 - 2017)	No (but one sub-adult detected)	Yes. Tadpoles were located at one constructed pond in February 2015	Yes (3 of the 8 had GGBF present, one had tadpoles	Good water quality and water level is critical in the first year after habitat creation for GGBF to establish (or re-establish) in the area

1.7 Test of Significance

Under Section 7.3 of the *Biodiversity Conservation Act 2016*, the following five questions are to be considered for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats. This assessment is based on desktop data, a preliminary vegetation assessment of the site and an inspection of the site by Dr Frank Lemckert, it excludes data from targeted surveys for GGBF.

Question	Response
a) ***in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,***	The local population, which would include any individuals within the site, is the Woollamia Currambene Creek population, which has most of its records to the east and north of the site. This population has had less attention than the Brundee Swamp population to the north, and is a relatively unknown population of this species (DEC 2005) (Section 1.5). Three sub-populations are currently known, centring around the Currambene Creek and State Forest area (DEC 2005) (Figure 1). If GGBF occurs at the site, it is most likely a fourth sub-population of this population. The closest records of GGBF to the site is 1.74 kilometres north east of the site from 1997. More recent records occur approximately three kilometres to the north and north east from 2013 and 2014 respectively, in artificial ponds and a natural drain (DPIE (EES) (2021)). The closest established site identified in the recovery plan for this species (DEC 2005), is Currambene State Forest (DECC 2007) which is centred around a dam that was constructed a result of quarrying for road base. Records of adult GGBF have been found within and surrounding that area as recently as 2014, with more recent records (2015) at Coomberton, approximately 4.4kilometres to the north of the site. Several locations approximately three kilometres to the south of the site also have records from 2017 (Figure 1). No GGBF have been recorded at the site to date, despite nearby records. If GGBF is present and were to be removed from the site, this would remove this sub-population and potentially reduce the viability of the local population, as this would remove one of four known sub-populations. However, if appropriate compensatory habitat was established in proximity to the site, including retaining access to appropriate accessible habitat then this would minimise the risk to this sub-population, maintaining this location for use by GGBF. There may still be minor changes to access to the area from the intersection upgrade, but access could be maintained across the side road (Willowgreen Road) which would allow use of the compensatory habitat by the local population during periods of favourable environmental conditions.
b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:	Not applicable. GGBF is not an ecological community.

Question	Response
c) in relation to the habitat of a threatened species or ecological community: ***(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and*** ***(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and*** ***(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,***	Accessible habitat for GGBF comprises the dam, the surrounding grassy vegetation and nearby woodland (PCT 1326) from 1000 metre radius the centre of the dam (Hamer 2016). The current design requires removal the removal of potential habitat in the form of a farm dam and impacts to the accessible habitat. It should be noted that accessible habitat only applies if frogs are found within the dam, and this area represents dispersal habitat, so access to this area is important. The project is removing some of this habitat, but not blocking access to the majority of it, and the dam (Figure 2). Design changes may reduce this impact. There are no records of GGBF at the site, but potential habitat occurs, and recent records are within three kilometres. This habitat is likely to provide dispersal and connectivity habitat for the Woolamia Currambene Creek population. This connectivity will be retained via the existing side road, Willowgreen Road, a dirt road that would allow crossing by frogs, and then through current culvert access under the existing Princes Highway and Jervis Bay Road. The proposal would not significantly impact on the current connectivity of the site to other areas of habitat for this species. The dam exhibits many of the requirements of breeding habitat for this species (Section 1.3), including: emergent aquatic fringing vegetation, adjacent grassland, structures and nearby woodland, which would provide fallen logs and other shelter for overwintering. The site does support the Plague Minnow, which is negatively correlated with occurrence of GGBF (discussed in further detail in Lemckert, 2021).The site represents habitat that would support dispersing GGBF during favourable environmental conditions. If GGBF does occur within the site, it is likely to constitute important habitat for the local population of this species.
d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),	A review of the Register of Declared Areas of Outstanding Biodiversity Value (AOBV) found that no AOBV have been declared for GGBF.
e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.	Yes. Potential GGBF habitat removal is part of the *Clearing of Native Vegetation* Key Threatening Process (KTP) listed under the *Biodiversity Conservation Act 2016.* In addition, overwintering habitat may be impacted by the *Removal of Dead Wood and Dead Trees,* also a KTP. Changes to floodplain hydrology as a result of the proposal may also occur, which comes under *Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands* which is also a KTP. While any GGBF within the site is likely to have been exposed to the chytrid fungus, disturbance to remaining habitat may increase the chance of *Infection of Frogs by Amphibian Chytrid Causing the Disease Chytridiomycosis.*

Conclusion

TfNSW currently proposes to remove a dam of 377 square metres of potential habitat for the GGBF and up to 23.48 hectares of surrounding accessible habitat as part of the Jervis Bay Road Intersection upgrade. This ToS was used to conclude that the impact of this removal is unlikely to be significant provided that one of the following criteria are met:

- The design is updated to avoid the dam and connectivity is maintained to accessible habitat adjoining the dam. Construction management actions to be detailed in the Flora and Fauna Management Plan, as part of a Construction Environmental Management Plan for the proposal
- Surveys following appropriate best practice guidelines *NSW Survey Guide for Threatened Frogs: A guide for the survey of threatened frogs and their habitats for the Biodiversity Assessment Method* (DPIE 2020), with reference to the *Commonwealth Survey Guidelines for Australia's Threatened Frogs* (DEWHA, 2010) find no GGBF are present at the site, during the 2021/2022 season and the season is favourable for GGBF activity (ie records are found within at least one nearby reference site)
- If GGBF are found, or surveys are inconclusive due to poor conditions, then compensatory habitat is provided, in such a way as to compensate on a 1:1 basis for any impacts to the dam and to maintain connection to the surrounding accessible habitat (Hamer, 2016) (Figure 2).

The site occurs towards the western perimeter of records for the Woolamia Currumbene State Forest populations of GGBF (described in DEC 2005 & DECC 2007). The closest previous records are 1.7 kilometres to the north-east of the site (record from 1997), with most recent records (less than 10 years old) within four kilometres to the east. If GGBF occurs at the site, it would constitute an additional sub-population to the small, and poorly known Woolamia Currumbene State Forest population. Removal of the dam without mitigation may cause a significant risk to the local population by reducing the areas of habitat available to them, as well as potential injury during construction.

If compensatory habitat is required, the land surrounding the dam has been secured by TfNSW and would be suitable for the construction of compensatory habitat. Compensatory habitat should be constructed as close to the impacted area as possible. If the design was modified to reduce impacts on the dam, then compensatory habitat could comprise modifications to the existing dam to maintain size, depth, shading etc so that there is no net loss of habitat.

TfNSW has successfully installed compensatory habitat for similar projects in Arncliffe and South Nowra that have produced breeding populations of GGBF and this knowledge could be applied to the construction of suitable compensatory habitat for this proposal. Long term monitoring data of artificial habitat at Kooragang Island and Homebush should also be reviewed as part of the design of compensatory habitat. Note that this area is towards the western extent of potential habitat for this species (see Figure 1 for metapopulation records) and therefore compensatory habitat should not be situated more than 500 metres further west than the impact site.

If GGBF are not found within the site during surveys in favourable conditions that detected the species at a reference site, then it would be reasonable to assume that this species does not occur and compensatory habitat will not be required. In the event that GGBF later occupy the site, there is an unexpected finds procedure that would be implemented if a GGBF was found during pre-clearing surveys or construction. This procedure is detailed in Biodiversity Assessment Report and Review of Environmental Factors for the proposal (TfNSW: 21.106, ISBN: 978-1-922549-02-0).

If conditions are not favourable for GGBF during surveys in November to March 2021/22, a precautionary approach should be taken and GGBF should be assumed to occur at the site and compensatory habitat provided.

If GGBF occurs (or is presumed to occur) at the site:

- Compensatory habitat would be constructed as close to the site as possible, noting previous discussion that it should be no more than 500 metres further west. It would need to be of similar size, depth, water quality etc and include access to surrounding grass areas, overwintering (logs, rocks etc) habitat and sheltering habitat. Appropriate fencing, or other barrier, to prevent access to the Princes Highway by frogs should also be installed to avoid or minimise road kill. Access across Willowgreen Road (north of the dam) will be retained.
- GGBF habitat creation guidelines, as per DECC (2008) should be implemented, as well as lessons learnt from previous similar projects (Section 1.6). If the design was altered so that the whole dam would not be removed, but rather there would be only a small area of removal, then compensatory habitat would focus on altering the remaining part of the dam so that water level, area and accessible habitat is maintained or improved
- The creation of compensatory habitat would need to be completed prior to impacts to the dam and frogs given time to colonise the new habitat. In favourable conditions however, GGBF will colonise suitable habitat rapidly (within weeks during suitable environmental conditions). Any tadpoles present would be transferred to the compensatory habitat, and it is recommended that some of the tadpoles are taken to a captive breeding facility for GGBF to prevent overall species loss and provide additional stock for the new dam, if required. A compensatory habitat plan, including monitoring protocols, would need to be developed prior to impact to the dam.

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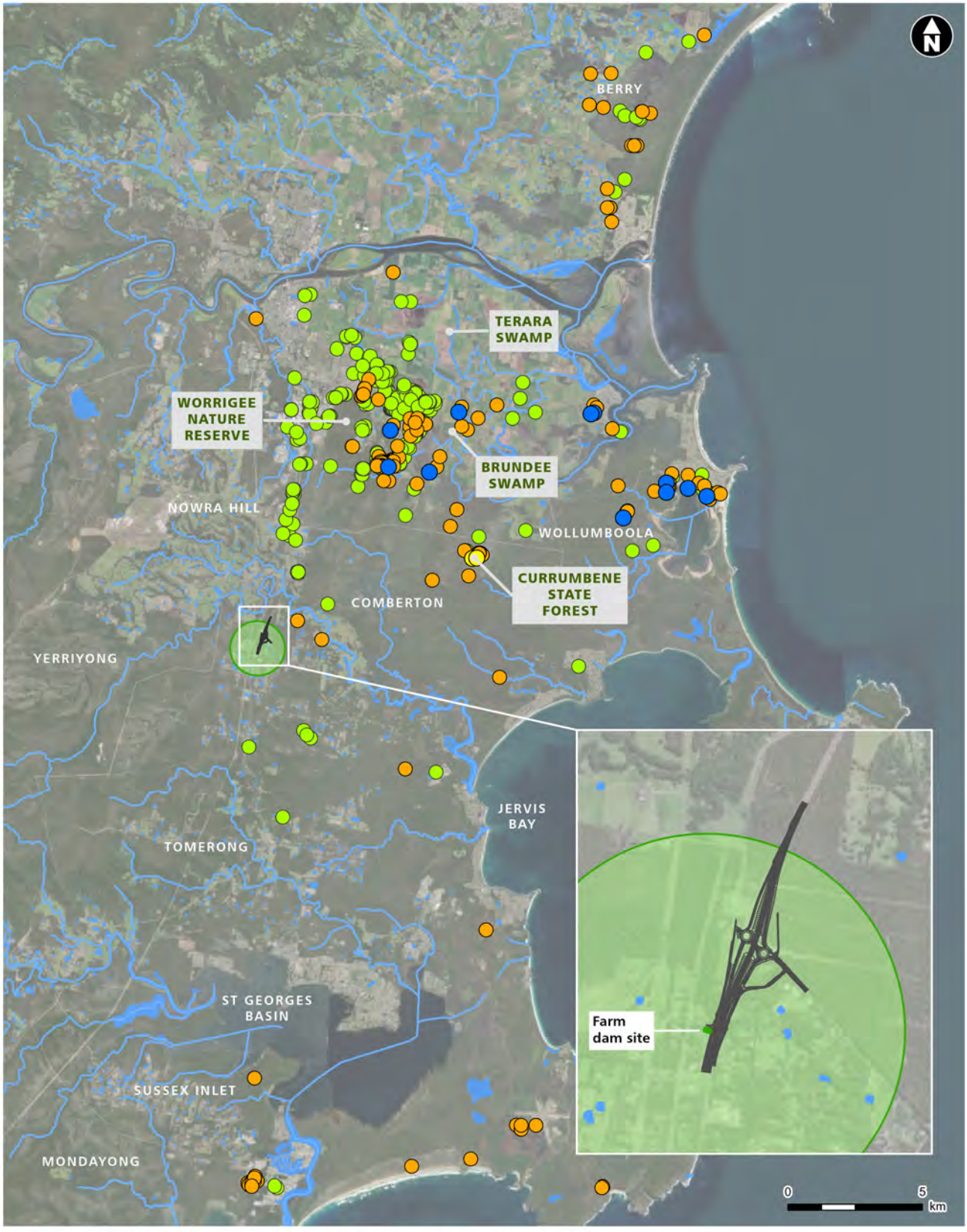

Figure 1: Site location and surrounding areas and GGBF records

Figure 2: Accessible habitat for GGBF and impact area

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Annexure E

Threatened orchid habitat assessment (Towle, 2021)

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ecology | planning | offsets

Jane Rodd
Senior Ecologist
Arcadis
Level 16, 580 George Street
Sydney NSW 2000
Supplied by email

05 May 2021

Re: Orchid habitat assessment, Jervis Bay Road, Falls Creek NSW

Dear Jane,

This letter has been prepared to document the results of habitat assessments for two threatened orchid species in the western portions of Lots 2 and 3 // DP244495, Princes Highway, Falls Creek NSW ('the study area'; **Figure 1**). The two orchid species for which habitat was assessed were *Calochilus pulchellus* (Pretty Beard Orchid) and *Genoplesium baueri* (Bauer's Midge Orchid).

The purpose of these habitat assessments is to identify the likelihood of these threatened orchid species occurring within the study area. The study area forms part of the construction footprint for the proposed upgrade to the intersection of Jervis Bay Rd and Princes Highway. Targeted surveys for these orchid species within the study area were not completed due to restricted access during their respective flowering periods, although targeted surveys have been completed by Arcadis for adjacent areas of the construction footprint.

Methods

An inspection of the study area was completed on the 14 April 2021 by myself and Meredith Leal (Ecologist, Arcadis), although areas inspected were limited to traverses along the northern, western and eastern boundaries of the study area (**Figure 1**). Additionally, discussions were held with Meredith Leal who conducted surveys across the study area including targeted surveys on 20 April 2021, to incorporate her observations into the habitat assessment.

Habitat assessments involved observing and recording habitat features within the study area and comparing these features to known habitat for the threatened orchid species. Habitat features assessed included geology and soil features, topography, vegetation types (Plant Community Types [PCTs] and vegetation communities) and vegetation structure.

The habitat features present within known habitat for the orchid species was determined from as-held records of the species from the BioNet Atlas (DPIE 2021) and from my knowledge of the species within the Jervis IBRA subregion.

Results

Geology and soils

The geology of the study area is mapped as Permian aged sedimentary rocks including sandstones, siltstones and conglomerates (Troedson and Hashimoto 2013). The soils observed around the margins of the study area and across adjacent areas included well-drained sandy to silty loams. The geology and soils of the study area are equivalent to that at known habitat for both *C. pulchellus* and *G. baueri*, with these species known to occur on late Permian to Triassic aged sandstones and Quaternary Alluvium. Additionally, both species have been recorded within well-drained sandy or silty loams.

Plant Community Type

All vegetated areas of the study area, which were observed from the perimeter of Lots 2 and 3 // DP244495, supported vegetation equivalent to PCT 1082[1], consistent with mapping of PCTs by Arcadis. Based upon a review of aerial photography, regional vegetation mapping (Keith et al. 2010; ELA 2015) and discussions with the Arcadis ecologist who surveyed the study area (Meredith Leal), it was concluded that this PCT was consistent throughout the study area.

Known habitat for *C. pulchellus* has previously been described as predominately heathland vegetation (Jones 2006a, Jones 2006b, Stephenson 2011), however, Towle et al. (2020) found that the species also occurs within woodland and forest vegetation types in proximity to wet heathlands. Of relevance to the current study area, Towle et al. (2020) recorded *C. pulchellus* as occurring within the 'Shoalhaven Sandstone Forest' vegetation community (Keith et al. 2010) and the equivalent PCT 1082, the PCT which occurs across the study area.

The habitat of *G. baueri* has been broadly described as including open or heathy forests and woodland with well drained sandy and gravelly soils and in moss beds on sandstone (Harden 1993; Bishop 2000; Jones 2006; Stephenson 2011). This broad habitat description incorporates the 'Shoalhaven Sandstone Forest' vegetation community (Keith et al 2010) and PCT 1082 which occur across the study area. Further, *G. baueri* has been previously recorded from this vegetation community and PCT (BioNet Atlas; DPIE 2021).

Vegetation structure

Vegetation structure across the study area was characterised as an open woodland with a dense mid-storey dominated by *Allocasuarina littoralis* (Black She-Oak) and a relatively sparse understorey (**Plate 1**). Additionally, portions of the study area did not support any understorey vegetation and were characterised as an open woodland with a dense layer of mulch on the ground.

The vegetation structure in which *C. pulchellus* has been recorded include areas with an open canopy and mid-storey allowing for increased solar exposure of the ground-layer. The most extreme example of this habitat preference is the occurrence of the species within slashed powerline easements. Further, habitat for *C. pulchellus* is characterised as having a dense

[1] PCT 1082 Red Bloodwood – Hard-leaved Scribbly Gum – Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion.

understorey of sedges or other species associated with increased moisture availability (Towle et al. 2020).

The specific microhabitat preferences of *G. baueri* vary across the range of the species, however, they are broadly similar to the microhabitat preferences of *C. pulchellus* including occurrences within powerline easements. Personal observations suggest that *G. baueri* prefers microhabitats where there is increased soil moisture. These observations include an association with sedge species that can tolerate frequent inundation, occurring within 'run-on' areas where surface flows from adjacent areas move towards and in more shaded areas.

Observations of the dense mid-storey with a sparse understorey, or an understorey consisting only of dense mulch, do not represent a similar vegetation structure to known habitat for *C. pulchellus* or *G. baueri*.

Summary and conclusions

The study area represents potential habitat for both *Calochilus pulchellus* and *Genoplesium baueri* at the broadest classifications, including the geology and PCT. However, the more specific microhabitat features with which the two species are associated appear to be absent from the study area (i.e. increased moisture availability and open midstorey). Consequently, there is a very low likelihood that either species is present within the study area.

If you have any questions about the information contained within the report, please do not hesitate to contact me.

Yours sincerely,

Brian Towle
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Figure 1: The study area location

Plate 1: Vegetation structure and habitat within the study area as observed on the 14 April 2021.

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Annexure F

Significant Impact Criteria assessments (EPBC Act)

Scientific name	Common name	Status under EPBC Act	Potential occurrence
FAUNA			
Pteropus poliocephalus	Grey-headed Flying-fox	V	Moderate
Litoria aurea	Green and Golden Bell Frog	V	Assumed present
ECOLOGICAL COMMUNITIES			
Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion		E	Recorded

Grey-headed Flying-fox

The Grey-headed Flying-fox was recorded in the site investigation area during field surveys. Two individuals were observed flying overhead in the centre of the site investigation area. Desktop assessment also identified 145 records of the species within 10 kilometres of the site investigation area, the most recent from 2019.

Grey-headed Flying-foxes are generally found within 200 kilometres of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. In times of natural resource shortages, they may be found in unusual locations. The species occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 kilometres of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young. Annual mating commences in January and conception occurs in April or May; a single young is born in October or November. Site fidelity to camps is high with some camps having been used for over a century. Grey-headed Flying-fox can travel up to 50 kilometres from the camp to forage; commuting distances are more often up to 20 kilometres. The species feeds on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines. The species is also known to forage in cultivated gardens and fruit crops.

Grey-headed Flying-foxes roost in large numbers, with up to tens of thousands of flying foxes using individual camps for mating, birth and rearing of young. The site investigation area does not contain a camp (occupied roosting habitat). The nearest Nationally Important Flying-fox camp mapped by National Flying-fox monitoring viewer (DEE, 2020) is at Bomaderry Creek (Camp ID 233; approximately 14 kilometres north of the site investigation area) and Bewong Creek (Camp ID 232; approximately 10 kilometres south-west of the site investigation area), which have typically supported up to approximately 10,000 Flying-foxes in recent years.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

Important populations are those that may be identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal;
- Populations that are necessary for maintaining genetic diversity; and/or
- Populations that are near the limit of the species range.

The Grey-headed Flying-fox has no separate or distinct populations. The species constantly exchanges genetic information between camps throughout its geographic range. The site investigation area does not contain a maternity roost or roosting camp. It is therefore unlikely that the site investigation area contains a population that is a key source of breeding or dispersal or important for maintaining genetic diversity. The site investigation area is not near the limit of the species range. As such, it is not considered to contain an important population. Therefore, the proposal would not lead to a long-term decrease in the size of an important population.

Reduce the area of occupancy of an important population

The site investigation area does not support an important population of the Grey-headed Flying-fox. The proposal would result in the removal of 16.16 hectares of foraging resources. The removal of this potential habitat would have a minimal impact on the area of occupancy of the species.

Fragment an existing important population into two or more populations

The site investigation area does not support an important population of the Grey-headed Flying-fox. The removal of potential foraging habitat from the site investigation area would not fragment the population of the Grey-Headed Flying-fox into two or more populations. As such, potential foraging habitat for the Grey-headed Flying-fox is unlikely to be significantly impacted and would not fragment the population of the Grey-Headed Flying-fox into two or more populations.

Adversely affect habitat critical to the survival of a species

While the proposal would result in the removal of potential foraging habitat, this habitat is not likely to be habitat critical to the survival of this species.

Disrupt the breeding cycle of an important population

There is no known maternity roosting camp of Grey-headed Flying-foxes within the site investigation area. The site investigation area provides a potential foraging resource for the species. The site investigation area is unlikely to contain an important population of the species. As such, the proposal is unlikely to disrupt the breeding cycle of an important population.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposal would involve the removal of potential foraging habitat for the Grey-Headed Flying-fox. This foraging resource does not comprise a significant area of foraging habitat within the site investigation area or the locality. The loss of 16.16 hectares of foraging resources is not likely to be significant to the species such that it is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The action is unlikely to result in the establishment of an invasive species that is harmful to the Grey-Headed Flying-fox. Known predators of the species include native reptiles and birds; no invasive exotic fauna species are known to predate upon Grey-Headed Flying-foxes. As such, the proposal is unlikely to result in the establishment of invasive species that are harmful to the Grey-Headed Flying-fox.

Introduce disease that may cause the species to decline, or

The action is highly unlikely to introduce disease that may cause the Grey-Headed Flying-fox to decline.

Interfere with the recovery of the species

There is currently no approved Recovery Plan in place for the Grey-Headed Flying-fox. A Draft National Recovery Plan for the Grey-headed Flying-fox was prepared in July 2009 (DECCW, 2009). The Draft National Recovery Plan lists 13 specific objectives for the five-year timeframe of the Plan. Of these, two could be considered relevant to the proposal:

- Objective 1: To identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range
- Objective 2: To protect and increase the extent of key winter and spring foraging habitat of Grey-headed Flying-foxes.

While the proposal would result in the removal of potential foraging habitat, this habitat is not likely to be key foraging habitat or habitat critical to the survival of this species.

Conclusion

Under the EPBC Act an action requires approval from the Australian Government Minister for the Environment and Energy (DoEE) if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance such as the Grey-Headed Flying-fox. Based on the above assessment, it is concluded that the action would not have a significant impact on the Grey-Headed Flying-fox as it would result in the removal of a relatively small amount of potential foraging habitat which is not likely to be critical to the survival of the species and as such, potential foraging habitat for the Grey-headed Flying-fox is unlikely to be significantly impacted. Finally, it is unlikely to introduce diseases or invasive species that would impact this species. As such the action does not require referral to DoEE.

Illawarra and south coast lowland grassy woodland ecological community

Illawarra and south coast lowland grassy woodland ecological community is listed as a Critically Endangered ecological community under the EPBC Act. This significant impact criteria assessment considers the Illawarra and south coast lowland grassy woodland ecological community which meets the EPBC criteria for the TEC that is mapped within the proposal construction footprint and is likely to be impacted by the proposal.

This TEC occurs in the central section of the site investigation area between Princes Highway and Old Princes Highway as well as in patches along the Princes Highway south of the Jervis Bay Road intersection and in the eastern extent of the site investigation area. There is a total of 3.98 hectares of this TEC in the site investigation area, 2.29 hectares of which is located within the proposal construction footprint and would be removed as a result of the proposal.

The TEC is present in small patches which are fragmented by the Princes Highway and Jervis Bay Road. The areas of TEC are also subject to ongoing disturbances including edge effects, mowing and grazing. The condition varies across the patches, with some patches experiencing high cover of exotic species and low native species diversity while other patches have high native species cover and diversity.

An action is likely to have a significant impact on an endangered or critically endangered ecological community if there is a real chance or possibility that it will:

Reduce the extent of an ecological community

The proposal would reduce the extent of the Illawarra and south coast lowland grassy woodland ecological community by up to 2.29 hectares. The area to be directly impacted may be smaller than this, however the proposed alignment does intersect the mapped area of TEC and it is likely that most of the 2.29 hectares would be cleared. This represents approximately 0.81% of the area of the TEC mapped within a 10 kilometre radius of the site investigation area (OEH, 2013). However, as the regional vegetation mapping has not been ground-truthed, it is likely that not all areas meet the EPBC condition threshold. Therefore, the area of the TEC to be impacted by the proposal may represent a larger percentage of the total area of TEC within a 10 kilometre radius than 0.81%.

However, it is still considered that the area to be removed is not a significant area of the community in the locality.

Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

The community is currently already fragmented by rural dwellings and roads and highways and is therefore present in isolated stands. Some patches of the TEC are heavily grazed or regularly mown and all are subject to edge effects. While the proposal would increase the distance between some patches of the TEC, and reduce the extent of other patches, the removal of these areas would not substantially further fragment the TEC.

Adversely affect habitat critical to the survival of an ecological community

Under the EPBC Act, the Minister maintains a Register of Critical Habitat. To date, no critical habitat has been declared for Illawarra and south coast lowland grassy woodland.

Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

The proposal would result in modifications to hydrological regimes and likely impacts to soil and water increased sedimentation and runoff during construction. Whilst these changes could impact on the ecological community, they would be on a relatively small scale and would be unlikely to affect its survival.

Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting

The proposed action is unlikely to result in a substantial change to the species composition in the local occurrence of Illawarra and south coast lowland grassy woodland or a decline or loss of functionally important species within this community. The road edges and cleared grasslands in the site investigation area are currently subject to invasion by exotic perennial grasses. The proposal could result in further

spread of these species in retained stands of Illawarra and south coast lowland grassy woodland which could further alter species composition. Weed control measures would be implemented during construction to minimise impacts.

Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: – assisting invasive species, that are harmful to the listed ecological community, to become established, or – causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community?

The proposal could result in further spread of weeds, particularly perennial exotic grasses, in retained stands of Illawarra and south coast lowland grassy woodland. The proposal is not likely to substantially reduce the quality or integrity of the ecological community. Weed control measures would be implemented during construction to minimise impacts.

Fertilisers, herbicides and other chemicals could be used during and post-construction. This would occur within the proposal construction footprint, and any inadvertent usage beyond which could impact the growth of species within the ecological community would be at a minor scale. As such, the quality or integrity of Illawarra and south coast lowland grassy woodland would not be reduced substantially.

Interfere with the recovery of an ecological community?

No recovery plan has been prepared for this community. The draft listing advice for the community outlines the following key approaches in the conservation of the ecological community (DAWE, n.d.)

Protect

- Vegetation clearance and direct habitat damage
- Weeds, disease and feral animals
- Fire
- Grazing

Restore

- Re-vegetation
- Control invasive species and diseases

Communication and Support

- Education, information and local regulation
- Incentives and support

The proposal would interfere with some of the conservation approaches, in particular with vegetation clearance and direct habitat damage through the clearing of some areas of the TEC. However, due to the relatively small amount of TEC to be removed in comparison to the wider locality, this is not expected to substantially interfere with the recovery of the ecological community.

Conclusion

The proposal would have direct impacts on 2.29 hectares of Illawarra and south coast lowland grassy woodland. Given that this represents a small reduction (0.81%) in the extent of the local occurrence of the community, and that the area to be cleared comprises an already fragmented and edge-affected patches, it is considered unlikely that the proposal represents a significant impact to the community. A Referral to the Minister is not required.

ASSESSMENT AGAINST SIGNIFICANT IMPACT CRITERIA: *LITORIA AUREA* (GREEN AND GOLDEN BELL FROG) - DRAFT

Assessment against *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DoE 2013) for Green and Golden Bell Frog on the Princes Highway Upgrade Program: Jervis Bay Road Intersection Upgrade.

Introduction

The proposal

Transport for NSW (TfNSW) proposes to upgrade the intersection of Jervis Bay Road and the Princes Highway north of Falls Creek, NSW, located about 12 kilometres south of Nowra, within the Shoalhaven Local Government Area.

The proposal would provide a grade separated through alignment for the Princes Highway with network access to Jervis Bay Road and the Old Princes Highway provided via dual at grade roundabouts serviced by on and off ramps. The proposal includes a new intersection between Jervis Bay Road and the Princes Highway, an overpass bridge across Jervis Bay Road, a roundabout interchange and connections and tie ins within surrounding properties and businesses along the Old Princes Highway. TfNSW prepared a review of environmental factors (REF) for the Jervis Bay Road Intersection Upgrade to meet the requirements under Division 5.1 of the *Environmental Planning & Assessment Act 1979*. The REF was publicly displayed between Friday 18 June 2021 and Sunday 25 July 2021. A Submissions Report to address community comments from the public display is under preparation.

Biodiversity surveys designed to support the approval process for the proposal commenced in August 2020. However, a recent design change has resulted in additional areas of impact which are addressed in this assessment against EPBC significant impact criteria. In August 2021 a site inspection and preliminary vegetation assessment conducted by Arcadis in this additional area identified the potential for the site to constitute GGBF habitat (Arcadis 2021). A follow up survey by GGBF expert Dr Frank Lemckert was carried out on 20 and 21 October 2021 and the results of these surveys, as well as published literature on the GGBF populations of the area have been used to inform this assessment. The site and GGBF records within 10 kilometres of the site are shown in Figure 1 of Test of Significance (ToS).

Green and Golden Bell Frog

The Green and Golden Bell Frog (*Litoria aurea*) (GGBF) is listed as endangered in NSW under the *Biodiversity Conservation Act 2016* and as vulnerable under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999.*

GGBF is a large, ground-dwelling frog that was once common along the east coast of Australia from eastern Victoria to north-eastern NSW. Its greatly reduced population is now known to be from about 44 metapopulation locations in isolated parts of north coast NSW, the Sydney Basin, south-eastern highlands, south coast of NSW and north-eastern Victoria (Anstis 2018).

GGBF inhabit a diversity of habitat, from ephemeral drainage lines to large, permanent dams, swamps and lagoons that occur within and adjacent to coastal forests and farmland (Anstis 2018). A review by Pyke and White (2001) showed that habitat most likely to support breeding in this species consists of:

- a water body with a substrate of sand, rock or clay
- still, shallow water, with low to moderate salinity
- unshaded water bodies that are free from predatory fish such as *Gambusia holbrooki* (Plague Minnow)

- emergent aquatic plants such as *Typha* sp. or *Eleocharis* sp.
- complexity of terrestrial habitat, including an array of objects (rocks, rotting logs etc) to shelter under outside of breeding periods
- a grassy area adjacent to the water body, and other nearby vegetation of woodland or shrubland with a maximum height of 2m. Although, some researchers dispute this, having found GGBF in forested and unforested areas (discussed in DEC 2005).

GGBF tolerates a wide range of physical and chemical properties of water with tadpoles found in water with varying turbidity, dissolved oxygen, oxidation reduction potential, pH and water temperature (Pyke and White, 2001). Some areas of breeding habitat occur in highly modified landscapes, including established populations at Sydney Olympic Park, Port Kembla and Arncliffe, NSW (DEC 2005).

Any individuals that may occur at the subject site are considered to be part of the Woollamia Currambene Creek local population to the east of the site. This is a relatively unknown population of this species (DEC 2005). Three sub-populations are currently known, centring around the Currambene Creek and State Forest area (DEC 2005). If GGBF occurs at the site, it is most likely a fourth sub-population of this population. The Woollamia Currambene Creek population is identified as an important population in the Green and Golden Bell Frog Draft Recovery Plan (2005). This population forms part of the Shoalhaven metapopulation incorporating 11 populations within the region (DEC 2005).

The site under investigation is a farm dam at 1 Willowgreen Road, Falls Creek, NSW and potential foraging and overwintering habitat within the vicinity of this dam (considered to be “accessible habitat” as defined by Hamer (2016)). Accessible habitat is generally considered to be within a radius of 1000 metres of the centre of the dam (Figure 2 in ToS). Maintaining access to this area will be important if GGBF occur at the dam (Figure 2). The dam is approximately 377 square metres and located within a cleared area with native vegetation consistent with Plant Community Type (PCT) 1326 Woolybutt-White Stringybark- Forest Red Gum grassy woodland nearby. Key species within and immediately surrounding the dam include:

- *Typha orientalis*
- *Imperata cylindrica*
- *Juncus continuus*
- *Carex sp.*

The closest record of GGBF to the site is 1.74 kilometres northeast of the site from 1997. More recent records occur approximately 3 kilometres to the north and northeast from 2013 and 2014 respectively, in artificial ponds and a natural drain (DPIE (EES) (2021)).

The site occurs in proximity to two established populations described in the draft recovery plan for the species (DEC 2005). These populations are part of the Shoalhaven metapopulation which is comprised of 11 populations, including two that are closest to the site. These are the Crookhaven River Floodplain population centred around Brundee Swamp, approximately eight kilometres to the north east of the site and the lesser known, Woollamia Currambene Creek population which occurs approximately 4 kilometres to east of the site, within the Currambene State Forest. If GGBF does use the site, they are likely to be part of this population, with recent records (2014) 3 kilometres to the north and north east of the site.

Mitigation

There is a possibility the proposal design could be modified to avoid impacts on the dam, this would mean the dam and access to surrounding habitat would be retained, and measure to reduce construction impacts would be included in the construction management plan. If GGBF occurs, they also need to be able to access areas surrounding the dam, especially to the north and east.

If impacts to the dam cannot be avoided, mitigation measures can be considered in an assessment against significant impact criteria, provided that the measure has previously been shown to be successful in minimising impacts to the species. Compensatory habitat as a mitigation measure has been provided for this species by TfNSW at a number of sites, with detailed monitoring data available

for M5 Motorway ponds at Arncliffe and a limited amount of monitoring data for South Nowra (summarised in Table 1-1).

Successful breeding has been demonstrated within the M5 compensatory ponds over multiple seasons (for example, 2010/2011 & 2011/12) and there is a self-sustaining population at the two artificial ponds within the M5 Motorway compensatory habitat area (White 2000-2015) (Table 1-1). Monitoring occurred over a long period at this site which gave enough time to allow for the R-selected strategy of reproduction. R-selected strategy of reproduction is described as a “boom and bust” population pattern of this species influencing the determination of successful breeding within the compensatory habitat. GGBF females are not reproductively mature until their second year and when they have obtained a snout-vent length of 65mm (Pyke and White 2001). If this maturity corresponds with poor conditions for breeding it may take three or more years until breeding is demonstrated in new ponds.

The ponds built in this area were able to be drained (to manage for predatory fish such as the Plague Minnow (*Gambusia holbrookii*) and surrounding habitat was managed for weeds (White, 2015).

If compensatory habitat is required for this proposal, TfNSW has acquired the land that includes the site and surrounding habitat. This would allow for modifications to the current dam if a new design reduced impacts on it. This could be done by expanding the current dam to maintain the dam surface area and nearby habitat features. Alternatively, it also allows for a similar dam to be installed, including access to adjacent grassland and areas for overwintering (logs, rocks etc) within proximity to the impact site. For the new compensatory habitat, whether it is a modification to the existing dam, or a new dam, the banks of the dam would need to be designed to minimise the influx of flow from the nearby creek (reducing the risk of re-introduction of the Plague Minnow during flood events).

Table 1-1 Summary of results of colonisation of artificial habitat for GGBF

Site	Description	Years monitored	Metamorphs?	Breeding?	Successful?	Lessons learnt
M5 Motorway East, Arncliffe	Two constructed ponds at Arncliffe with variable overall population of up to 50 animals, depending on environmental conditions	1999- 2015 (White 2000-2015)	Yes	Yes – most years of monitoring	Yes, but took some time to show breeding success	Monitoring must cover more than 3 years to show success or otherwise of breeding. Weeds should be removed, and water must be able to be drained regularly to reduce/eliminate predatory fish, but ponds must be full during the spring/summer breeding season
South Nowra	Eight constructed ponds monitored as part of a GGBF population study (ARCUE 2016)	3 years (2014-2017)	No (but one sub-adult detected)	Yes. Tadpoles were located at one constructed pond in February 2015	Yes (3 of the 8 had GGBF present, one had tadpoles	Good water quality and water level is critical in the first year after habitat creation for GGBF to establish (or re-establish) in the area

Significant Impact Criteria (from DoE 2013).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
a) Lead to a long-term decrease in the size of an important population of a species	No. An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • Key source populations either for breeding or dispersal • Populations that are necessary for maintaining genetic diversity and/or • Populations that are near the limit of the species range. If a sub-population is found to occur on the site, they would form a fourth sub-population of the Woolamia Currambene Creek population to the east of the site, which is identified as a key population within the Green and Golden Bell Frog Draft Recovery Plan (2005). Three sub-populations of the Woolamia Currambene Creek population are currently known and shown on Figure 1. No GGBF have been recorded at the site to date, however, if they occur, they would be considered an additional sub-population of the Woollamia Currambene Creek GGBF population. If GGBF is present and were to be removed from the site, this would remove this sub-population and potentially reduce the viability of the local population. Without appropriate mitigation, this could be a significant impact. Surveys following appropriate best practice guidelines - *NSW Survey Guide for Threatened Frogs: A guide for the survey of threatened frogs and their habitats for the Biodiversity Assessment Method (*DPIE 2020) will be undertaken to determine presence or otherwise of GGBF. If GGBF is found, or surveys are inconclusive, then a precautionary approach would be adopted and appropriate compensatory habitat built in proximity to the site if impacts to the dam couldn't be avoided, with access to appropriate accessible habitat, then this would minimise the risk of a long-term decrease in the size of this sub-population, maintaining this location for use by GGBF. There may still be minor changes to access to the area from the proposal, but access could be maintained across the side road (Willowgreen Road) which would allow use of the compensatory habitat by the local population.
b) Reduce the area of occupancy of an important population	No. There are no records of GGBF at the site, but potential habitat occurs, and recent records are within 3 kilometres. If GGBF occupies this habitat, it would be on the western edge of the local population (Woolamia Currambene Creek population). If the dam was removed from this site, it would represent a reduction in the area of occupancy of approximately one quarter of an important population (since this GGBF at this site would represent a

	fourth sub-population of the Woolamia Currambene Creek population). While this area may not represent key breeding habitat, it provides an area of suitable foraging and sheltering habitat where GGBFs can disperse to during favourable environmental conditions, a reduction in this type of habitat puts the local population at risk, as these areas are important for dispersal events. If appropriate compensatory habitat was built in proximity to the dam, this would minimise the impacts of the reduction in the area of occupancy by the proposal. Compensatory habitat is proposed for the area if GGBF are found, or if surveys are inconclusive with regard to potential occurrence, and impact to the dam cannot be avoided. If the design can be amended to avoid the dam, and measures to maintain or enhance connection to populations to the north and east (ie have the dam still connected to accessible habitat), then no compensatory habitat would be required.
c) Fragment an existing important population into two or more populations	No. There are no records of GGBF at the site, but potential habitat occurs, and recent records are within 3 kilometres. This habitat is likely to provide dispersal and connectivity habitat for the Woolamia Currambene Creek population. This connectivity will be retained via the existing side road, Willowgreen Road, , and then through current culvert access under the existing Princes Highway and Jervis Bay Road. The proposal would not significantly impact on the current connectivity of the site to other areas of habitat for this species.
d) Adversely affect habitat critical to the survival of a species	No. GGBF inhabit a diversity of habitat, from ephemeral drainage lines to large, permanent dams, swamps and lagoons that occur within and adjacent to coastal forests and farmland (Anstis 2018). A review by Pyke and White (2001) showed that habitat most likely to support breeding in this species consists of: • a water body with a substrate of sand, rock or clay • Still, shallow water, with low to moderate salinity • unshaded water bodies that are free from predatory fish such as *Gambusia holbrooki* (Plague Minnow) • Emergent aquatic plants such as *Typha* sp. or *Eleocharis* sp. • Complexity of terrestrial habitat, including an array of objects (rocks, rotting logs etc) to shelter under outside of breeding periods • A grassy area adjacent to the water body, and other nearby vegetation of woodland or shrubland with a maximum height of two metres. Although, some researchers dispute this, having found GGBF in forested and unforested areas (discussed in DEC 2005).

	For the purposes of this assessment, the site under investigation is a farm dam at 1 Willowgreen Road, Falls Creek, NSW and potential foraging and overwintering habitat within the vicinity of this dam (considered to be “accessible habitat” as defined by Hamer (2016)) (Figure 2). The dam is approximately 377 square meters and located within a cleared area with native vegetation consistent with Plant Community Type (PCT) 1326 Woolybutt-White Stringybark- Forest Red Gum grassy woodland nearby. The removal of the whole dam, and up to 23.48 hectares of accessible habitat, without compensatory measures, could adversely affect habitat critical to the survival of this species. However, compensatory habitat, in the form of either the modification of the existing dam (if the footprint were to be reduced so that the dam was only partially impacted) or the construction of a similar dam in a nearby area within the range of accessible habitat (Figure 2) would reduce the potential impact to the local occurrence of GGBF habitat. The accessible habitat is tied to the dam and the GGBF within it, providing overwintering shelter and areas to disperse and connect with northern and eastern populations. It is not habitat for GGBF independent of the dam.
e) Disrupt the breeding cycle of an important population	No. If GGBF occurs at the site, the removal of this habitat is likely to reduce the ability of the local population to disperse. However, it is not a known breeding population, so at least in the short term is unlikely to disrupt breeding. It will however reduce dispersal opportunities during favourable environmental conditions.
f) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Yes. Accessible habitat for GGBF comprises the dam, the surrounding grassy vegetation and nearby woodland (PCT 1326) within 1000m radius of the centre of the dam (Hamer 2016). The current design requires removal of approximately 23.48 hectares of this habitat, including the dam in its entirety (Figure 2). Design changes may reduce this impact. Accessible habitat is tied to GGBF populations that may occur at the dam, and allowing sufficient area and suitable habitat for foraging, overwintering and dispersing. Accessible habitat is not stand alone habitat for the GGBF. There are no records of GGBF at the site, but potential habitat occurs, and recent records are within 3 kilometres. This habitat is likely to provide dispersal and connectivity habitat for the Woolamia Currambene Creek population. This connectivity will be retained via the existing side road, Willowgreen Road. Then, connectivity could continue through current culvert access under the existing Princes Highway and Jervis Bay Road. The proposal would not significantly impact on the current connectivity of the site to other areas of habitat for this species.

	The dam exhibits many of the requirements of breeding habitat for this species, including: emergent aquatic fringing vegetation, adjacent grassland, structures and nearby woodland, which would provide fallen logs and other shelter for overwintering. The site does support the Plague Minnow, which is negatively correlated with occurrence and especially breeding in GGBF (discussed in further detail in Lemckert, 2021). The site represents habitat that could support dispersing GGBF during favourable environmental conditions. If GGBF does utilise the site, it is likely to constitute important habitat for the local population of this species.
g) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No. The most potentially harmful invasive species for the GGBF is the Plague Minnow, which already occurs at the site and is likely to be regularly re-introduced through flooding and overflow from the nearby unnamed creek. The construction or modification of habitat proposed may benefit the species by increasing the bank height and reducing the impacts of this overflow, and the influx of Plague Minnow.
h) introduce disease that may cause the species to decline	No. Amphibian chytridiomycosis, a disease, which is listed as a key threatening process under the EPBC Act, is widespread. Amphibian chytridiomycosis is a fungal disease caused by the amphibian fungus *Batrachochytrium dendrobatidis* which is believed to have been introduced to Australia. Studies revealed that the fungus is water borne and infected individuals exhibit a high mortality rate (90 per cent). Chytrid is already widespread amongst most populations of GGBF, including within the Shoalhaven metapopulation (West et. al, 2018). Conditions that negatively impact chytrid, including increased salinity, greater than 16per cent emergent vegetation and at least 50per cent full sun will assist in reducing the occurrence and impacts of chytrid. Further details would be provided in a compensatory habitat management plan.
i) interfere substantially with the recovery of the species	No. Well-designed compensatory habitat has previously been shown to mitigate for loss of habitat for this species. If GGBF is found then compensatory habitat will be provided such that there will be no net loss of habitat. This will include maintaining connectivity to surrounding accessible habitat so that GGBF can access shelter, foraging resources and be connected to other sub-populations to the east and north of the dam.

Conclusion

TfNSW currently proposes to remove potential habitat for the GGBF as part of the Jervis Bay Road Intersection upgrade. This assessment against EPBC Significant Impact Criteria Guidelines (DoE 2013) was used to inform the conclusion that the impact of this removal is unlikely to be significant provided that one of the following criteria are met:

- The design is updated to avoid the dam and connectivity is maintained to accessible habitat adjoining the dam. Construction management actions to be detailed in the Flora and Fauna Management Plan, as part of a Construction Environmental Management Plan for the proposal
- Surveys following appropriate best practice guidelines NSW Survey Guide for Threatened Frogs: A guide for the survey of threatened frogs and their habitats for the Biodiversity Assessment Method (DPIE 2020), with reference to the Commonwealth Survey Guidelines for Australia's Threatened Frogs (DEWHA, 2010) find no GGBF are present at the site, during the 2021/2022 season and the season is favourable for GGBF activity (ie records are found within at least one nearby reference site)
- If GGBF are found, or surveys are inconclusive due to poor conditions, then compensatory habitat is provided, in such a way as to compensate on a 1:1 basis for any impacts to the dam and to maintain connection to the surrounding accessible habitat (Hamer, 2016) (Figure 2).

The site occurs towards the western perimeter of records for the Woolamia Currumbene State Forest populations of GGBF (described in DEC 2005 & DECC 2007). The closest previous records are 1.7 kilometres to the north-east of the site (record from 1997), with the most recent records (less than 10 years old) within 4 kilometres to the east. If GGBF occurs at the site, it would constitute an additional sub-population to the small, and poorly known Woolamia Currumbene State Forest population. Removal of the dam without mitigation may cause a significant risk to the local population by reducing the areas of habitat available to them, as well as potential injury during construction.

If compensatory habitat is required, the land surrounding the dam has been secured by TfNSW and would be suitable for the construction of compensatory habitat. Compensatory habitat should be constructed as close to the impacted area as possible, and ideally within the area of accessible habitat (Hamer 2016) (Figure 2). If the design was modified to reduce impacts on the dam, then compensatory habitat could comprise modifications to the existing dam to maintain size, depth, shading and so on, so that there is no net loss of habitat.

TfNSW has successfully installed compensatory habitat for similar projects in Arncliffe and South Nowra that have produced breeding populations of GGBF and this knowledge could be applied to the construction of suitable compensatory habitat for this proposal. Long term monitoring data of artificial habitat at sites such as Arncliffe and South Nowra, among others, should also be reviewed as part of the design of compensatory habitat. Note that the site is towards the western extent of potential habitat for this species (see Figure 1 for metapopulation records) and therefore compensatory habitat should not be situated more than 500m further west than the impact site.

If GGBF are not found within the site during surveys in favourable conditions that detected the species at a reference site, then it would be reasonable to assume that this species does not occur and compensatory habitat will not be required. In the event that GGBF later occupy the site, there is an unexpected finds procedure that would be implemented if a GGBF was found during pre-clearing surveys or construction. Compensatory habitat may be required as part of mitigation of potential impact, if that was to occur. This unexpected finds procedure is detailed in Biodiversity Assessment Report and Review of Environmental Factors for the proposal (TfNSW: 21.106, ISBN: 978-1-922549-02-0).

If conditions are not favourable for GGBF during surveys in November – March 2021/22, a precautionary approach should be taken and GGBF should be assumed to occur at the site and compensatory habitat provided.

If GGBF occurs (or is presumed to occur) at the site:

- Compensatory habitat would be constructed as close to the site as possible, noting previous discussion that it should be no more than 500 metres further west. It would need to be of similar size, depth, water quality etc and include access to surrounding grass areas, overwintering (logs, rocks etc) habitat and sheltering habitat. Appropriate fencing, or other barrier, to prevent access to the Princes Highway by frogs should also be installed to avoid or minimise road kill. Access across Willowgreen Road (north of the dam) will be retained.
- GGBF habitat creation guidelines, as per DECC (2008) should be implemented, as well as lessons learnt from previous similar projects (Section 1.6). If the design was altered so that the whole dam would not be removed, but rather there would be only a small area of removal, then compensatory habitat would focus on altering the remaining part of the dam so that water level, area and accessible habitat is maintained or improved

The creation of compensatory habitat would need to be completed prior to impacts to the dam and frogs given time to colonise the new habitat. In favourable conditions however, GGBF will colonise suitable habitat rapidly (within weeks during suitable environmental conditions). Any tadpoles present would be transferred to the compensatory habitat, and it is recommended that some of the tadpoles are taken to a captive breeding facility for GGBF to prevent overall species loss and provide additional stock for the new dam, if required. A compensatory habitat plan, including monitoring protocols, would need to be developed prior to impact to the dam.

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Annexure G

Microbat echolocation call analysis

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MEMO

ARCADIS Design & Consultancy for natural and built assets

Introduction

This memo outlines the methods and results of microbat echolocation call analysis undertaken for the Jervis Bay Road Intersection Upgrade biodiversity assessment. Desktop assessment identified the potential occurrence of eight microbat species listed as threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the NSW *Biodiversity Conservation Act* (BC Act). Threatened species considered from the desktop assessment with the potential to occur within the site investigation area are listed below:

- Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*) (V – BC Act)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (V – BC Act)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (V – BC Act)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) (V – BC Act)
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (V – EPBC Act and BC Act)
- Little Bent-winged bat (*Miniopterus australis*) (V – BC Act)
- Southern Myotis (*Myotis macropus*) (V – BC Act)
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) (V – BC Act)

Methods

Field surveys

Two microbat echolocation call recording devices 'Anabat Express' (Titley Pty Ltd) were deployed at two sites within the site investigation area during field surveys. Call recording sites were selected to sample the diversity of potential microbat habitats within the site investigation area and increase chances of detection (eg woodland edges, riparian or fertile areas, proximity to stag/hollow-bearing trees and other habitat features). Devices were deployed on 3 December 2020 and collected on 17 December 2020 (a total of 14 nights each, or 28 detector nights).

Analysis of data collected during surveys indicated that data was not recorded for every night of survey. Five nights of data were recorded at Site 1 (SN463800) and five nights of data were recorded at Site 2 (SN463821).

A summary of survey effort is outlined in **Table 1** below.

Table 1: Summary of microbat echolocation survey effort

Anabat site	Site description	Device serial no.	Survey dates (intended survey effort)	Data time and date stamps of first and last bat calls (actual survey effort)
1	Anabat set in cleared easement on the edge of woodland habitat, western side of the Princes Highway. In proximity (within 200m) to a	SN463800	3 – 17 December 2020 (14 nights)	08:23 PM 3 December 2020 to 05:54 AM 8 December 2020 (5 nights)

	drainage line, culvert and several hollow-bearing trees			
2	Anabat set in cleared easement on the edge of woodland habitat, eastern side of the Princes Highway. In proximity (within 300m) to a tributary of Parma Creek, culvert and several hollow-bearing trees	SN463821	3 – 17 December 2020 (14 nights)	08:05 PM 3 December 2020 to 05:54 AM 8 December 2020 (5 nights)

Weather conditions during the survey period were consistently warm and clear, with rainfall increasing in the last week. As recordings had stopped prior to increased rainfall (7 December 2020), variations in weather conditions during the survey period are considered unlikely to contribute to the lack of data. Weather records from the Nowra weather station (station 068072) for the surveyed dates, and total rainfall for the week before surveys, are detailed below in **Table 2.**

Table 2: Summary of weather conditions during microbat surveys

Date	Temperature		Rain	Maximum wind gust	
	Min (°C)	Max (°C)	mm	Direction	Speed (km/h)
25 November 2020 – 2 December 2020 (1 week before surveys)	-	-	7.2 (total over 1 week)	-	-
3 December 2020	14.2	23.7	0.6	NE	35
4 December 2020	13.4	33.7	0.0	S	69
5 December 2020	15.3	26.8	0.0	NW	65
6 December 2020	19.2	26.5	0.6	WNW	80
7 December 2020	9.2	27.2	0.0	-	-
8 December 2020	10.8	21.3	0.0	W	39
9 December 2020	10.7	25.8	0.0	ENE	37
10 December 2020	13.2	22.5	0.0	S	46
11 December 2020	11.5	21.2	3.8	S	41
12 December 2020	14.5	22.6	0.0	E	41
13 December 2020	13.7	25.1	3.2	ENE	39
14 December 2020	16.5	25.2	7.6	E	37
15 December 2020	18.0	26.6	0.6	NE	39
16 December 2020	20.3	28.5	18.0	W	39
17 December 2020	20.0	30.5	10.0	SSE	30

Echolocation call analysis

Echolocation calls recorded during surveys were analysed by Arcadis ecologist Jessica Rooke. Jessica has over eight years' experience in biodiversity surveys and has undertaken microbat echolocation call analysis for a large number of projects across eastern Australia.

Calls were extracted, viewed and analysed using 'AnalookW for bat call analysis using ZCA - Version 4.4a 17 September 2018' software (Chris Corben, Copyright © 2018). Calls were identified with reference to 'Bat Calls of NSW' (Pennay *et al*., 2004). This report has been prepared in accordance with the 'Standards for reporting bat detector surveys' (Australasian Bat Society Inc., n.d)

Where possible, calls were identified to species or genus based on the presence/absence of determinate features such as frequency, shape, pulse intervals and other indicative features (eg alternations in frequency within call sequences). Details of identification features used are provided for calls of each species identified in Appendix 1.

Results

Ten species from nine genera were identified from echolocation calls recorded within the site investigation area (**Table 3**). Four species were recorded as 'Definite' and three species as 'Probable'. This level of confidence is considered adequate to assume presence of these taxa within the site investigation area.

An additional three microbat species were identified as 'Possible' from calls recorded during the survey (**Table 3**). These call records did not show the characteristics required to adequately distinguish them from other species with calls at similar frequencies. Identification of 'Possible' calls is not considered adequate to confirm occurrence of these species; however threatened species should be 'Assumed present' when assessing potential impacts.

Species identified from analysis of the call data and levels of confidence are provided in **Table 3**. Example calls recorded, and characteristics used to determine species/genus identity, are provided in Appendix 1.

Table 3: Summary of microbat species/genus identified from the site investigation area

Scientific name*	Common name	BC Act	Confidence
MOLISSIDAE			
Tadarida (Austronomus) australis	White-striped Freetail Bat	-	Definite

Scientific name*	Common name	BC Act	Confidence
VESPERTILIONIDAE			
Nyctophilinae			
Nyctophilus sp.	Unidentified Long-eared Bat	-	Definite
Vespertilioninae			
Chalinolobus gouldii	Gould's Wattled Bat	-	Definite
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	Possible (assumed present)
Myotis macropus	Southern Myotis	V	Probable
Scoteanax rueppellii	Greater Broad-nosed Bat	V	Possible (assumed present)
Scotorepens orion	Eastern Broad-nosed Bat	-	Possible
Vespadelus darlingtoni	Large Forest Bat	-	Probable
Vespadelus vulturnus	Little Forest Bat	-	Definite
MINIOPTERIDAE			
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	Probable

* ABRS, 2009. *Australian Faunal Directory.* Australian Biological Resources Study, Canberra. Viewed 21 January 2021

Conclusion

Seven species of microbat were identified as ‘Definite’ or ‘Probable’ across two locations within the site investigation area (**Table 3**, Appendix 1). This included two species listed as Vulnerable under the BC Act (Southern Myotis, Large Bent-winged Bat). None of these species are listed as threatened under the EPBC Act.

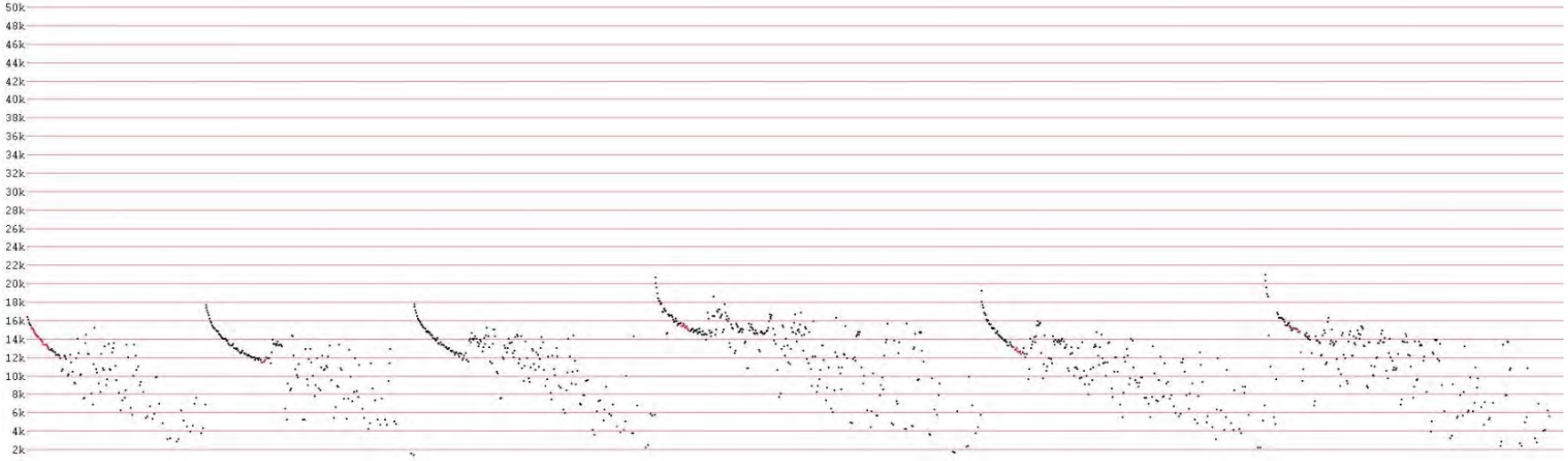
An addition three species were identified as ‘Possible’, including two species listed as Vulnerable under the BC Act (Eastern False Pipistrelle, Greater Broad-nosed Bat). None of these species are listed as threatened under the EPBC Act.

Given the limitations of the survey it is recommended that a precautionary approach should be taken, and threatened species recorded as ‘Possible’ (Eastern False Pipistrelle, Greater Broad-nosed Bat) are assumed to occur where suitable habitat is present within the site investigation area.

Appendix 1: Example call sequences from the site investigation area (December 2020)

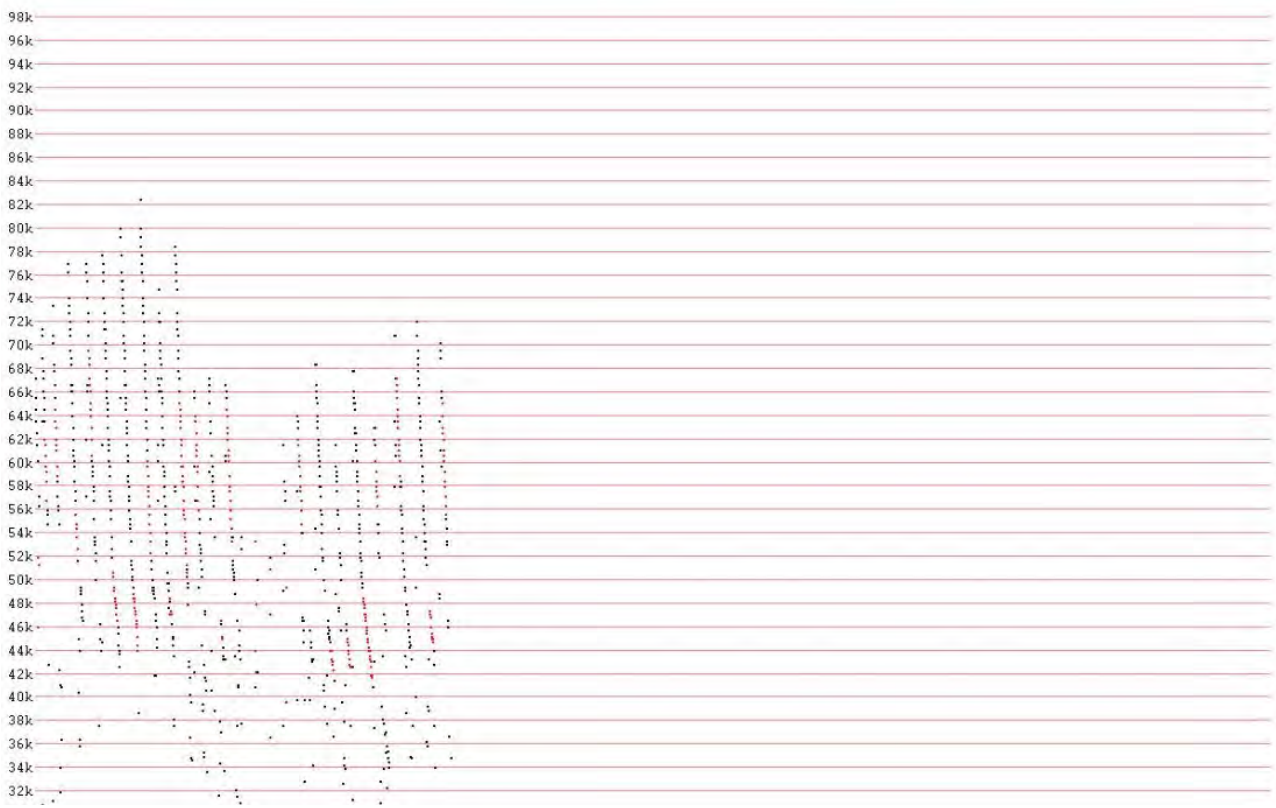
White-striped Freetail-bat (*Tadarida australis*)

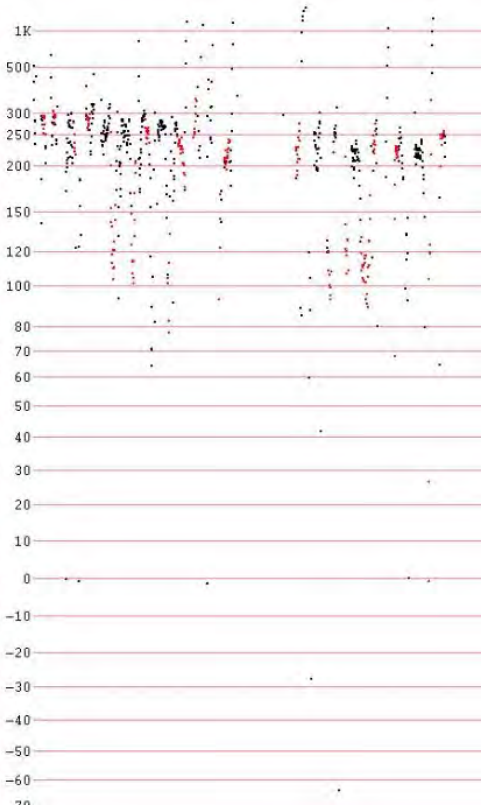
Calls identified based on call shape and characteristic frequency (<14kHz) which do not overlap with any other species known to occur in the region.



Unidentified Long-eared Bat (*Nyctophilus* sp.)

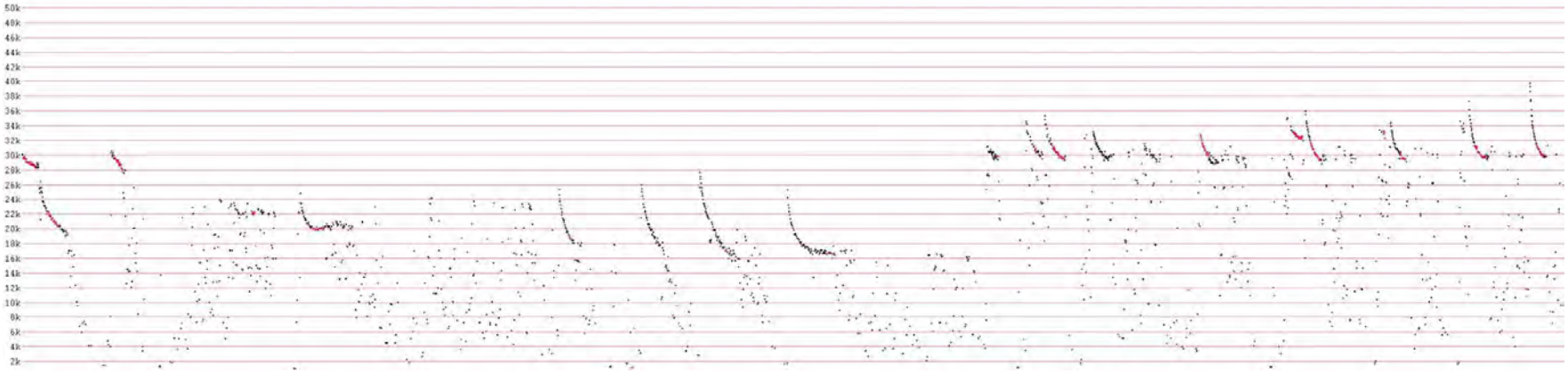
Steep, near vertical call shape for all species in the genus *Nyctophilus* are almost identical and cannot be identified to species. Calls are also similar to those of Southern Myotis (*Myotis macropus*). Calls identified as *Nyctophilus* sp. based on comparatively short length of sequence (due to quieter calls), initial slope less than 300 octaves per second (shown on right), and more uniform call shape (no distinctive ‘kinks’ in pulses around 47kHz – 50kHz).





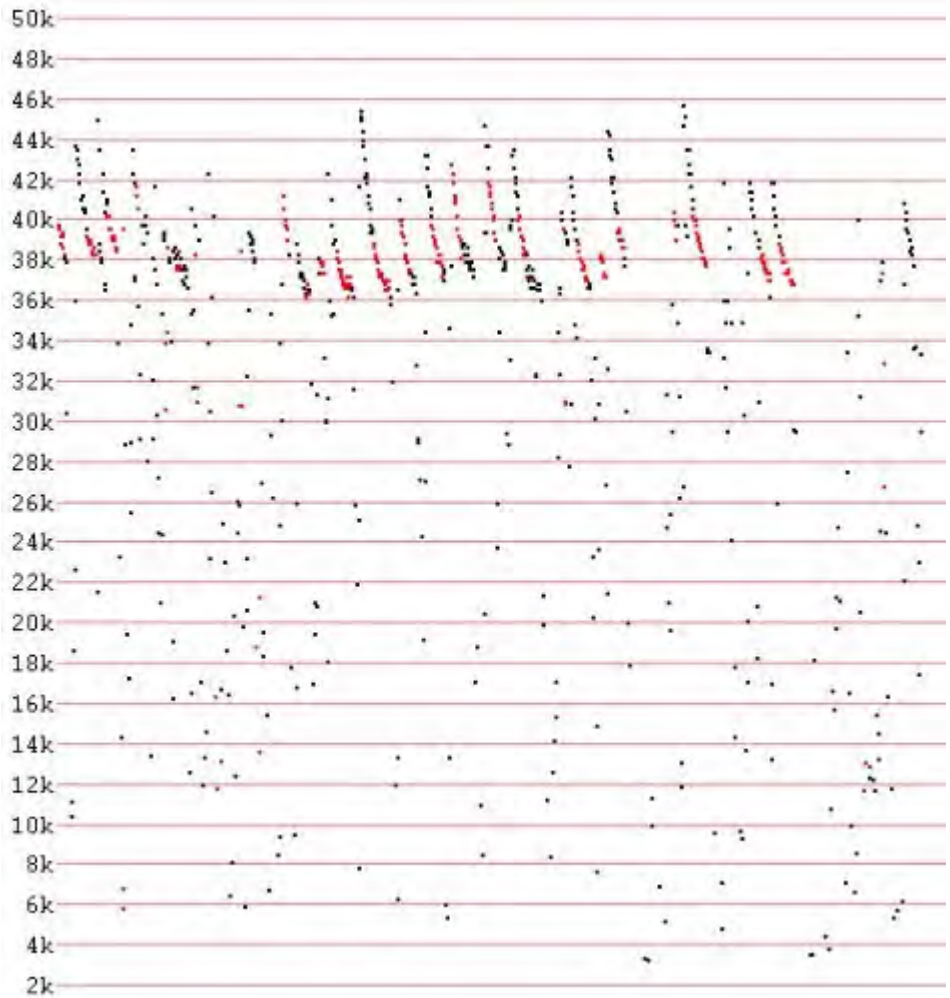
Gould’s Wattled Bat (*Chalinolobus gouldii*)

Calls identified based on call shape (down-sweeping tail), regular alternating pulses, and characteristic frequencies (31kHz for lower pulses, 33kHz for alternating higher pulses). Calls around 16kHz – 20kHz (shown at start of sequence) were determined to be social calls of the same species.



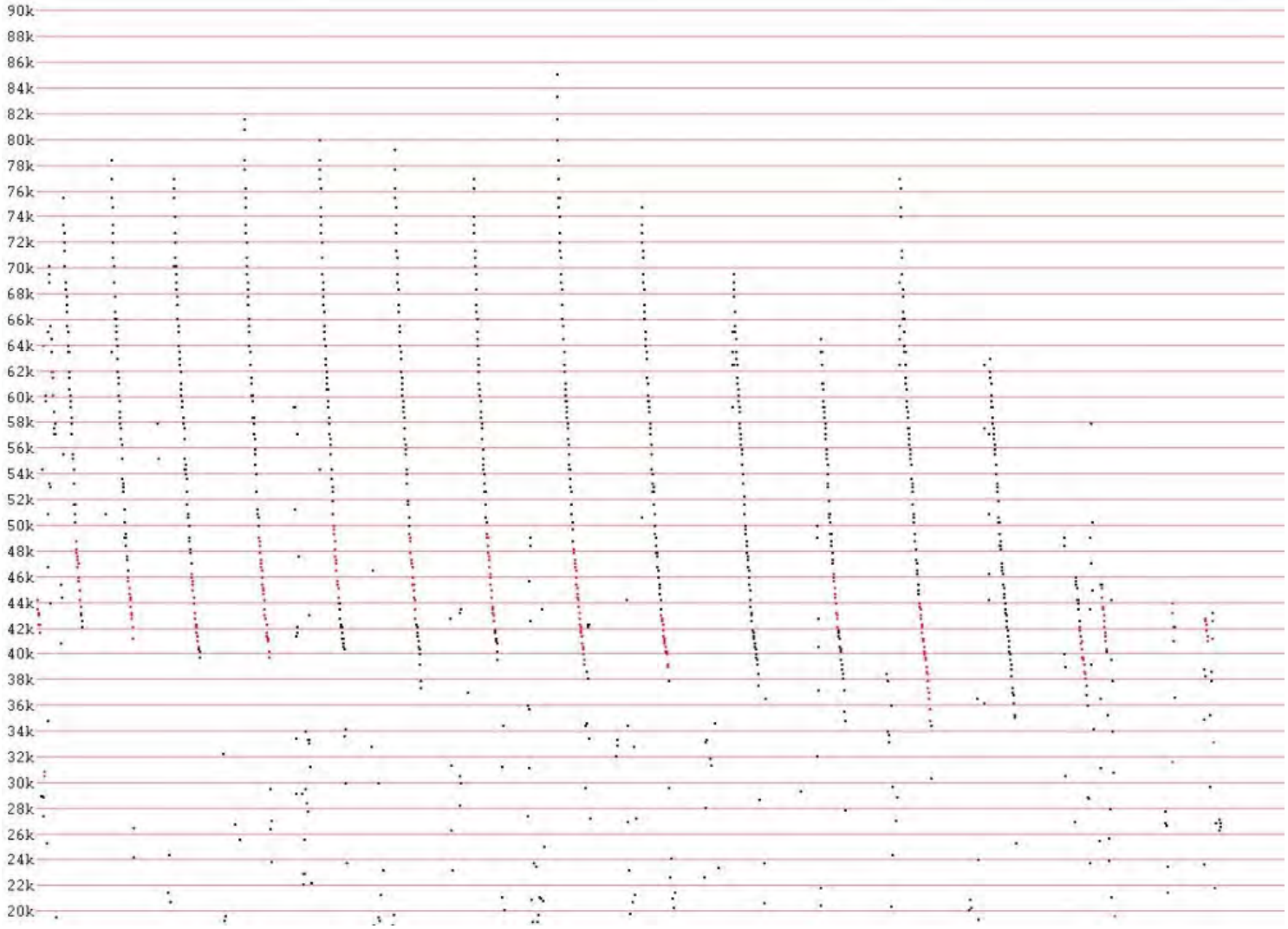
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) / Greater Broad-nosed Bat (*Scoteanax rueppellii*) / Eastern Broad-nosed Bat (*Scotorepens orion*)

Calls considered ‘Possible’ for Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii)* and Eastern Broad-nosed Bat (*Scotorepens orion*). Calls are ‘Possible’ records for any of these three species given overlapping frequency (37kHz) and similar call shape.



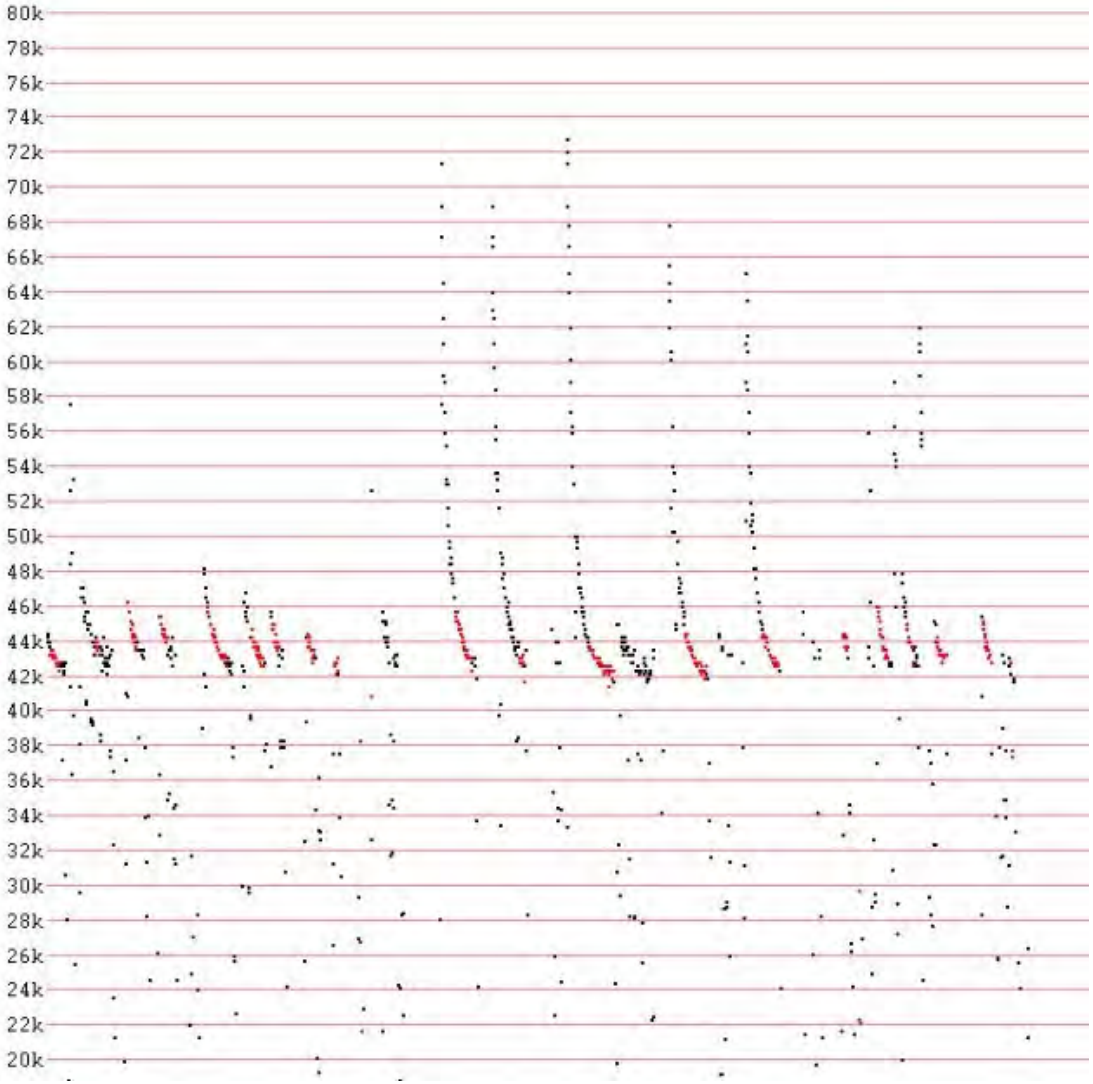
Southern Myotis (*Myotis macropus*)

Calls of Southern Myotis (*Myotis macropus*) are similar to those in the genus *Nyctophilus*. Calls identified as 'Probable' records for Southern Myotis based on call parameters such as length of sequence (typically longer sequences compared to *Nyctophilus* sp.), call frequency range (starting around 80kHz, ending around 35kHz) and call shape (slight 'kink' in some pulses around 47kHz – 50kHz).



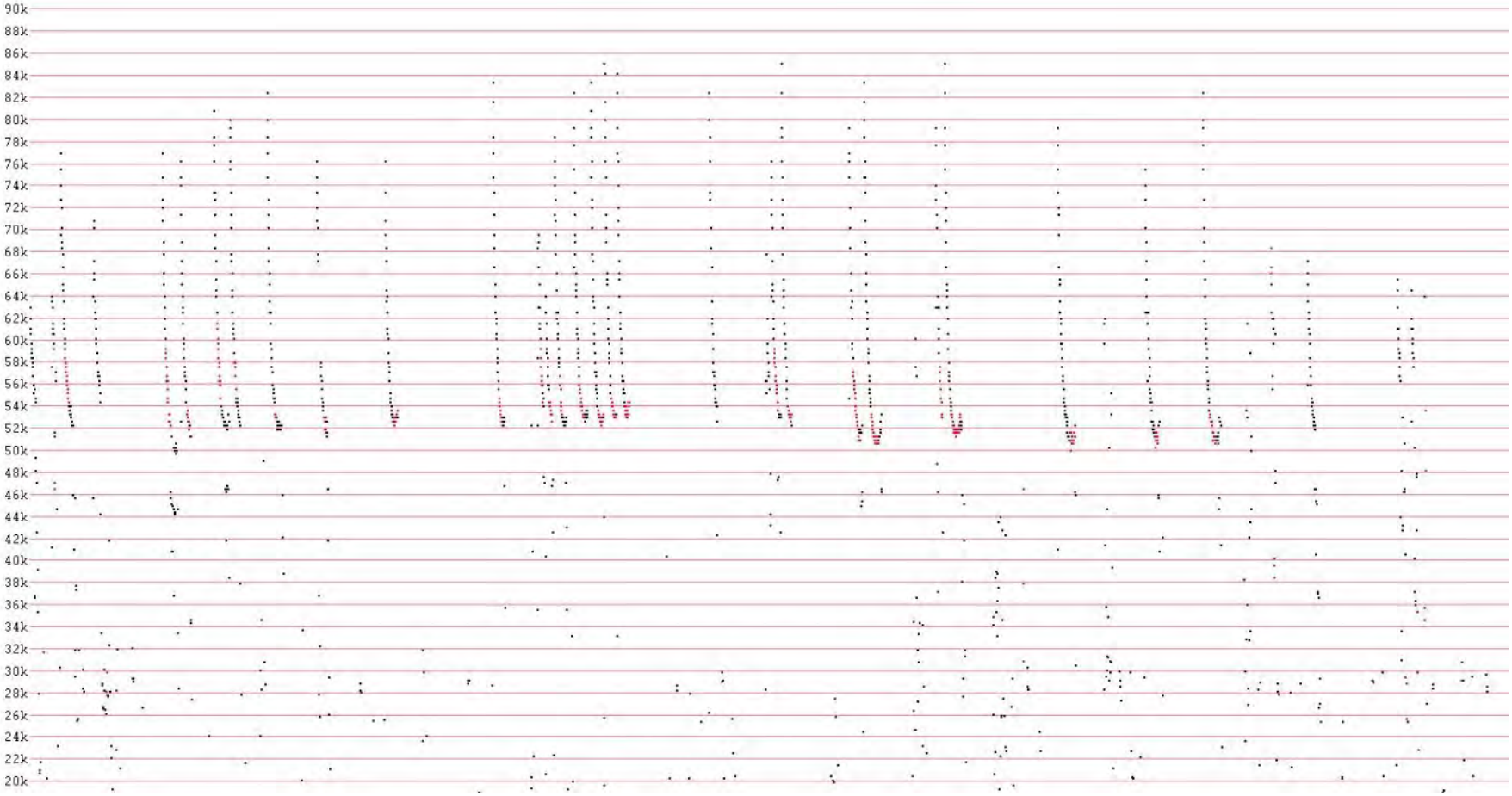
Large Forest Bat (*Vespadelus darlingtoni*)

Calls of Large Forest Bat (*Vespadelus darlingtoni*) overlap in frequency with Large Bent-winged Bat (*Miniopterus orianae oceanensis*). Calls identified as 'Probable' records for Large Forest Bat based on call parameters such as call frequency range (40kHz – 43KhZ), even consecutive pulses, and call shape (lacking prominent down-sweeping tail).



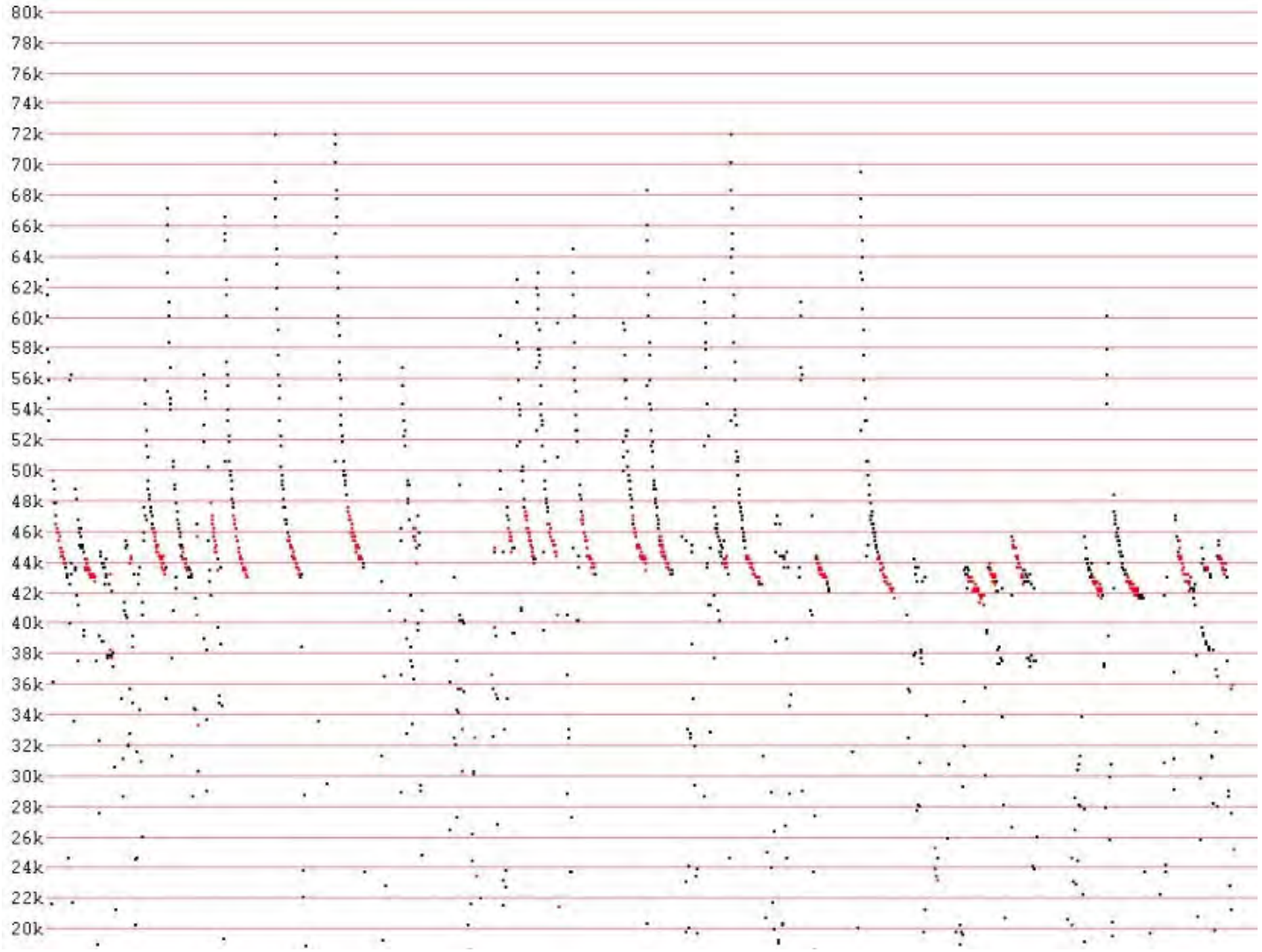
Little Forest Bat (*Vespadelus vulturnus*)

Calls overlap in frequency with Chocolate Wattled-bat (*Chalinolobus morio*). Calls identified as Little Forest Bat (*Vespadelus vulturnus*) based on call shape (up-sweeping tail), variation of frequency within sequence (potentially due to Doppler effect resulting from tight circling behaviour), and characteristic frequency (52kHz).



Large Bent-winged Bat (*Miniopterus orianae oceanensis*)

Calls of Large Bent-winged Bat overlap in frequency with Large Forest Bat. Calls identified as ‘Probable’ records for Large Bent-winged Bat based on call parameters such as characteristic frequency (45kHz), variations in pulses, and call shape (down-sweeping tail).



Annexure H

Green and Golden Bell Frog habitat assessment

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MEMORANDUM			
TO	Nicole Moore		
FROM	Frank Lemckert		
DATE	29 November 2021	PURPOSE	For Information
SUBJECT	Jervis Bay Road Intersection Upgrade Green and Golden Bell Frog site report		

1. Introduction

ELA was engaged to undertake an assessment of the habitats available for the Green and Golden Bell Frog (GGBF), *Litoria aurea* along the route of the proposed Jervis Bay Road Intersection Upgrade (JBRIU) on the 26th of October 2021. This inspection and assessment was undertaken by Dr Frank Lemckert, who is an accredited expert on this species under the NSW Biodiversity Assessment Method (BAM) used in assessments for the *Biodiversity Conservation Act* (2016). The inspection covered the southern extent of the revised proposal construction footprint (study area) provided by Transport for NSW (TfNSW) on the 21st of October 2021 (see Figure 1) and that was listed as available to access. The aim of the inspection was to determine the quality of the water bodies present as potential breeding habitat for the species within the study area and also the potential for water bodies to be suitable as non-breeding habitat, and particularly as connecting habitat. The habitats within the surrounding 50-100 m of the water bodies were also assessed for their potential for foraging and shelter and for migration between water bodies. Attention was paid to the relative connectedness of the available water bodies and habitats and the potential for the upgrade to impact on connectivity.

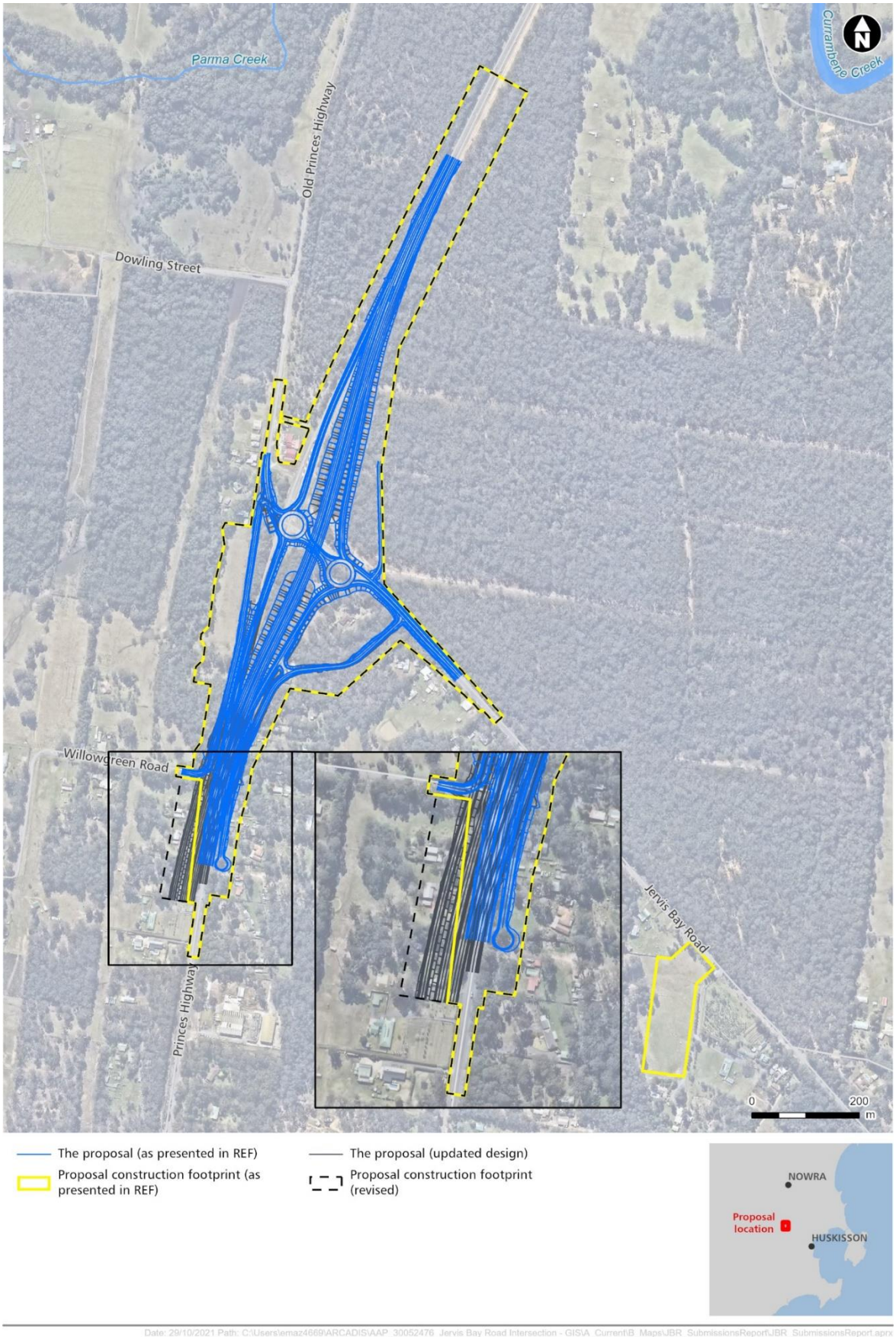

Figure 1. Study area (shown in inset)

2. GGBF Habitat Requirements

Breeding sites for the GGBF include a wide range of natural water bodies and the species has been recorded inhabiting all but fast flowing streams (White and Pyke 1996). It also inhabits many human-created environments, including highly disturbed sites such as abandoned mines and quarries (Pyke et al. 2002), as well as artificial wetlands that have been created at both Kooragang Island (Hamer et al. 2002) and Sydney Olympic Park (Darcovich and O'Meara 2008). White and Pyke (1996) undertook a review of the known breeding habitat of the GGBF and found that they preferred to breed in water bodies that were still, shallow, ephemeral, unshaded, with aquatic plants and free of the Plague Minnow (Gambusia holbrooki) and other predatory fish. This study also found that breeding occurs in a significantly higher proportion of sites with ephemeral (temporary) ponds, rather than sites with fluctuating or permanent ponds. Hamer et al. (2002) found a similar result for the GGBF populations at Kooragang Island where larger males would move to ephemeral water bodies to breed when they were available, although reproduction was also associated with permanent water bodies. The frogs in that study also tended to remain relatively faithful to one water body. The presence of the Plague Minnow does not exclude GGBF from breeding in a water body, but success appears to be dependent on the presence of more complex aquatic vegetation, which allows the GGBF to breed successfully (Hamer et al. 2002). Hence the Plague Minnow does still appear to be a sole determinant of the likely presence of the GGBF in most situations.

The GGBF is unusual for an Australian frog in that the species appears to remain generally associated with water bodies, remaining within the riparian zone unless migrating between water bodies. Most frogs migrate 50-300 m from the breeding site to settle into recognisably different complementary non-breeding habitat in which they spend the majority of the year (Lemckert 2004). Terrestrial habitats immediately adjacent to water bodies (< 50 m) are typically used for foraging and shelter and preferably consist of grassy areas and vegetation no higher than woodlands and contain a range of diurnal shelter sites such as logs, rocks or dense vegetation (White and Pyke 1996). However, there are observations of GGBF moving into taller forests (e.g. dry sclerophyll forest at Nowra; M. Greenlees Pers. Comm. and dense woodlands at Meroo; F. Lemckert Pers. Obs.) and even foraging in suburban backyards (DEC 2005). This again demonstrates the adaptability and lack of habitat specificity of this frog.

Adult frogs show a strong site fidelity in regards to returning to the same ponds over time (Hamer et al. 2008), but their movements around those ponds and immediately adjacent areas are relatively random for most individuals and especially juveniles (F. Lemckert Pers. Obs.). Females though, have been observed to congregate together into specific shelter and foraging sites in areas immediately adjacent to breeding sites (Hamer 1998, Pyke and White 2001).

Another unusual aspect of the GGBF is its well-known habit of basking, typically within areas of aquatic vegetation, in order to increase body temperatures (Pyke and White 2001). Basking in frogs is unusual (being generally nocturnal), but such activities in ectotherms typically allow for periods of greater activity or faster digestion of food items. Whilst the importance of this activity for its physiological requirements is not known, individual GGBF appear to bask regularly. On this basis, it is likely that basking is an important physiological activity for the GGBF. Basking typically occurs within or on the edge of emergent aquatic vegetation, which likely allows individuals the option to make a rapid escape

from diurnal predators. The presence of water bodies that contain emergent vegetation are known important determinants of the presence of GGBF (White and Pyke 1996; Hamer et al. 2002) and form an important resource for the GGBF and in the consideration of their potential presence.

Christy (2001) and Muir (2008) state that terrestrial movements of the GGBF are primarily undertaken through more open environments that contained patches of shelter such as rocks, logs or ponds or areas of thick vegetation. Such habitats provide relatively little impediment to the movements of frogs but allow for individuals to seek shelter as required. Terrestrial movements are typically undertaken at night and are most likely associated with rainfall events (F. Lemckert Pers. Obs.) which would provide protection against desiccation.

Mahony (1999) cautions that the studies that have been carried out since the declines of the GGBF do not necessarily identify the actual preferred requirements of the species. He notes that the changed environment and factors causing the declines may have "altered" the optimal habitats for the species in comparison to their habitat use patterns prior to the declines. This is based on the fact that the use of ephemeral breeding sites was not noted for the bell frog group in earlier habitat descriptions. Such altered habitat use has been noted for other species such as *Litoria lorica* that now is only present in open rocky streams whereas it was once known as a rainforest stream species (Puschendorf et al. 2011). This change is attributed to the impacts of the chytrid fungus, with the frog only surviving in a relatively extreme environment where the fungus is affected by the hotter conditions. Given the chytrid fungus appears also to have been at least a significant contributor (and probably the major one) to the decline of the GGBF, there is a significant potential that the GGBF is now living successfully only in a different set of environments to what it historically did. However, that is unlikely to ever be confirmed.

A critical consideration in the likely presence/absence of the GGBF are metapopulation dynamics. The GGBF is considered to follow a classical metapopulation structure with the "local" population consisting as a series of patchy populations within the larger metapopulation. Individuals move regularly between a mosaic of wetlands across a broad area throughout a single breeding season (Hamer et al. 2008; Hamer & Mahony 2010). There is high site-specific population turnover with local extinctions being balanced by colonisations by regularly dispersing individuals, but with the overall population remaining stable. There are core sites that provide ongoing and regular reproductive success and that maintain long-term populations, but a major part of the population dynamics is driven by inter-year success of breeding at a range of available breeding sites, with years of very good reproductive success leading to opportunities to expand ranges and colonise new sites. On Kooragang Island, GGBF typically reside in permanent waterbodies where they exhibit high site fidelity, but during periods of high rainfall disperse over several hundred metres to breed at ephemeral water bodies that have flooded (Hamer et al. 2008). Reproductive activity (e.g. calling) typically occurs over several nights at these ephemeral waterbodies, with individuals returning to core permanent waterbodies. In times of poor rainfall, the core sites become the refuges for the species and Valdez et al. (2015) found that probability of occupancy of a site increased at large and permanent wetlands.

Following on from this is the identified need for connected sites to allow this population interaction. Hamer (2016) found that the presence of the GGBF at sites at Nowra was dependent on accessibility of ponds, a factor mediated both by the presence of vegetation and the extent of roads in the area, with the presence of roads providing a likely serious barrier to pond use. The presence of vegetation directly

around ponds correlated significantly with the potential for greater species diversity. The type of pond available also was important, with the species avoiding steep sided concrete ponds. The apparent negative impacts of roads was confirmed in follow up work (Hamer 2018) where it was again found that the extent of accessible habitat (habitat close to ponds and not isolated from the pond by a road) positively influenced the likelihood of pond occupancy. Extinctions of GGBF were significantly more likely to occur at ponds in areas with higher densities of roads, but were significantly less likely at ponds with higher aquatic vegetation cover. The spatial arrangement of wetlands and the extent of wetlands measured in a 1 km radius has been found to be an important predictor of pond occupancy by GGBF in studies by Hamer et al. (2002), Hamer and Mahony (2010) and Valdez et al. (2015) with more ponds, ponds in closer proximity and already occupied ponds increasing the potential for the GGBF to be present or occupy a previously unoccupied pond (Puschendorf et al. 2011).

3. Site Inspection

The following properties were inspected on the 26th of October 2021:

- Lot 12 DP1042235
- Lot 1 DP587300
- Lot 1 DP871596
- Lot 62 DP15507
- Lot 63 DP15507
- Lot 64 DP15507
- Lot 2 DP578303.

Each property was inspected to determine the extent and quality of any potential breeding habitat present and to also assess the quality of habitats available for non-breeding activities. All water bodies were checked to determine if they contained any fish of any type and the sites located with a GPS for any future required mapping. Photographs were also taken of any relevant features to provide a record for the inspection. Frogs were opportunistically observed as ponds were inspected as sometimes GGBF can be seen basking during the day.

The weather during the site inspection was mild (23°C) with broken cloud and no rain.

4. Results

No GGBF were observed during the site inspection and no tadpoles seen were GGBF tadpoles.

The results obtained for habitat assessments on the available properties are as follows:

Lot 12 DP1042235 – This property occurs on the western side of the Princes Highway and includes a pond identified as potential low quality breeding habitat for the GGBF (Plate 1). The approximately 20m X 15m pond contains at least 50% emergent vegetation and also has clear areas of open water and does represent potential breeding habitat for the GGBF (Plate 1). However, it is relatively low lying and only slightly higher in elevation than the unnamed creek that runs to the north of this lot (and through Lot 1 DP587300). This likely explains why the pond contains the Plague Minnow (*Gambusia holbrooki*), which is a pest fish species that has a significant negative impact on breeding by the GGBF. In general GGBF avoid breeding in any water body that Plague Minnows are present in because the fish eat their eggs and tadpoles. GGBF do occasionally breed in ponds where the fish occurs and this typically is where there are patches of dense vegetation that provide cover for the eggs and tadpoles, although survivorship of the eggs and tadpoles is likely to be very low. The density of the vegetation in this pond is only moderate and not likely sufficient to expect successful breeding to occur.

The pond does represent potential foraging and shelter habitat given the presence of near permanent water and emergent aquatic vegetation. It is also surrounded by areas of grass that are thought to be favoured by the GGBF as foraging habitat. The landholder reported that he had been at that location for over 30 years and was familiar with the GGBF and that it had called from the dam on the property. However, he had not heard or seen the GGBF over the last few years. No GGBF were evident when the pond was searched during the site inspection.

Lot 1 DP587300 – This property is on the western side of the Princes Highway and includes a section of unnamed tributary flowing through it (Plate 2) that forms potential GGBF shelter habitat and a potential migratory corridor for frogs that may be dispersing through the study area. The creek is not suitable breeding habitat as it contains minimal aquatic vegetation and is infested with the Plague Minnow. The creek is bordered by some patches of native vegetation, but is also immediately adjacent to cleared paddocks that provide clear foraging space. No GGBF or tadpoles were seen during the inspection.

Lot 1 DP 871596 – This property is located on the western side of the Princes Highway and includes sections of the unnamed tributary both upstream and downstream of the above property (Plate 3). As above this stream forms potential GGBF shelter habitat and represents a potential migratory corridor for frogs that may be dispersing through the study area from east to west. The creek is not suitable breeding habitat as it contains minimal aquatic vegetation and is infested with the Plague Minnow. This property does not have any significant clearing on it and the banks and adjacent vegetation are covered in mainly native vegetation with some weed infestation, particularly closer to the Princes Highway and the culvert underneath the Princes Highway. Such habitat still is potential foraging habitat. No GGBF or tadpoles were seen

Lot 62 DP15507, Lot 63 DP15507, Lot 64 DP15507 & Lot 2 DP578303 – All of these lots occur on the eastern side of Princes Highway and provide very similar habitats overall. All are mainly cleared lands

with some mixed native/non-native vegetation patches located on the property and especially lining the stream (Plates 3-7). The stream contains the Plague Minnow and again has very little emergent vegetation in most parts, although some is present in Lot 63 DP15507 within 50 m of the culvert crossing under Princes Highway (Plate 8). As before, this stream and its banks represents potential foraging and migrating habitat for adult and sub-adult frogs, but poor quality breeding habitat for the GGBF. No GGBF or tadpoles were seen in any of the lots available for assessment.

No areas of potential ephemeral breeding habitat were evident in any of the properties searched and no permanent ponds were obviously present in properties within the study area that were not able to be inspected.

5. Discussion

The surveys indicated there is no potential high quality breeding habitat present in the revised proposal construction footprint. The unnamed tributary lacks significant areas of emergent vegetation and contains the Plague Minnow, making breeding unlikely to be attempted by the GGBF in the stream. GGBF typically do not breed in streams as it is.

There is only one isolated pond on the properties investigated, which is a rural pond located at Lot 12 DP1042235. This pond contains a moderate area of emergent vegetation, but also has a population of the Plague Minnow present and so represents only potential marginal breeding habitat and is unlikely to be used on more than an occasional basis. This inspection does not provide absence data and breeding may occur onsite, but the potential for this is assessed to be marginal and the use transient, if at all. This pond was said by the local landholder to have previously contained GGBF, but he had not heard GGBF call in that pond in the last 4-5 years. Based on this, the study area is considered not to contain important breeding habitat. It is unlikely that disturbance to that pond would result in a loss of important breeding opportunities for the local population of the GGBF.

The study area contains potential habitat that is suitable for adult and sub-adult GGBF to use as both shelter and foraging habitat. GGBF use a wide range of vegetation and shelter types and is most prevalent in locations where there are water bodies available that provide retreat sites when conditions dry out and also water bodies that provide stepping stones for migration. The stream provides a corridor that GGBF can move along if they undertake migrations and frogs were seen sheltering in similar streams at South Nowra in 2012/2013 when surveying those upgrade works (Pers. Obs.). The stream banks have fringing vegetation that frogs can shelter in as they move around and the water that can allow them to maintain hydration. The Plague Minnow has minimal impact upon adult and sub-adult GGBF and so would not influence the stream as habitat that frogs would use for migration. Hence the stream provides a long line of potential connectivity across the landscape that may be useful to frogs dispersing across the landscape.

At this time the GGBF records are located mainly to the north and to the east of the study area. Dispersal events are likely to originate from the core population and enable GGBF to colonise newly created areas of breeding habitat. The unnamed tributary provides a potential safe corridor of movement for GGBF, especially given that larger and more heavily trafficked roads provide a significant barrier to movement for the GGBF (Hamer 2016, 2018). Retaining the stream as a corridor and not reducing the level of connectivity available through the open culvert for frogs to move through would ensure that there is no loss of stream based connectivity through this locality.

The pond at Lot 12 DP1042235 also provides a source of potential connecting habitat as it contains extensive emergent vegetation that the GGBF prefers for daytime shelter as it can bask safely in the vegetation. There was not any other such habitat on the properties inspected, although there are human created ponds in the broader landscape. As the presence of isolated water bodies allows for stepping stones of shelter habitat across the landscape where there are no streams present then this pond is considered to be valuable to migratory movements should GGBF be present at any stage. If the GGBF is found to be present at this pond during targeted surveys, impacts to the pond should be avoided, or at least any loss of this pond habitat should be offset, such as by providing compensatory

habitat, to ensure that there is no overall loss of this type of stepping stone connective pond habitat in the locality.

The lots inspected would generally be broadly useful as potential foraging habitat based on the presence of a there being a mosaic of cleared fields mixed in with patches of native and exotic vegetation. The presence of exotic and native vegetation along the stream and around the pond provide for suitable shelter for frogs moving into and through the study area. The presence of adjacent low grasslands provides what is considered to be preferred foraging habitat that the frogs are able to use to visually locate suitable prey items (Muir 2008). This type of habitat is widespread through the locality and is not likely any form of limiting habitat for the GGBF. So the loss of some grassland and other vegetation as part of the upgrade is not considered likely to result in a significant impact to the GGBF in the locality and would not require any form of offset. Works should minimise change to the environment, where possible.

Standard disease protocols should be followed through the duration of the program.

6. Conclusion

- The lots inspected contain only one area of potential breeding habitat in the form of a single farm dam that is considered to be of only low quality due to the presence of the Plague Minnow.
- The lots do contain areas of potential non-breeding foraging and shelter habitat in the form of areas of vegetation.
- The stream that runs through the lots provides a potential movement corridor for the GGBF.
- If the GGBF is located at the pond, impacts to the pond would requires compensation for any loss of pond area, such as by providing compensatory habitat.
- Connectivity is required to be maintained underneath the Princes Highway at the same level as is currently the case and the area of culvert under the Princes Highway should not be reduced and riparian vegetation should be rehabilitated after development to maintain current levels of connectivity.
- The loss of any vegetation outside of the riparian zone is unlikely to be significant for the GGBF given the extent in the broader area and so such a loss does not require any offsetting to compensate for impacts. However, vegetation loss should still be avoided as far as is possible.

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APPENDIX 1: PLATES OF SITES

Plate 1. Lot 12 DP1042235 – pond identified as potential GGBF breeding habitat

Plate 2. Lot 12 DP1042235 – photo demonstrating adjacent cleared foraging habitat

Plate 3. Lot 1 DP587300 – stream running through lot. Note the lack of emergent vegetation in the stream, but streamside has mixed native and non-native vegetation

Plate 4. Lot 1 DP587300 – cleared lands adjacent to riparian zone

Plate 5. Lot 1 DP 871596 – stream running through lot at north-western end

Plate 6. Lot 1 DP 871596 – area of stream adjacent to culvert under Princes Highway. Note the extensive presence of exotic weeds

Plate 7. Culvert under Princes Highway – western side

Plate 8. Culvert under Princes Highway – eastern side

Plate 9. Lot 62 DP15507 – stream running through lot. Note some, but very limited emergent vegetation

Plate 10. Lot 62 DP15507 – area adjacent to stream

Plate 11. Lot 63 DP15507 – vegetation at front of lot and immediately adjacent to Princes Highway

Plate 12. Lot 2 DP578303 – stream at back of lot. Again note disturbance, weeds presence and lack of aquatic vegetation

Plate 12. Lot 2 DP578303 – stream on left of lot and adjacent cleared grass lawn suitable for foraging

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