

Transport
for NSW

Biodiversity assessment report

Hillsborough Road Upgrade

October 2022



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Executive summary

Transport for NSW (Transport) proposes to duplicate a 1.8 kilometre section of Hillsborough Road between the Newcastle Inner City Bypass in the east and the duplicated section of Hillsborough Road about 300 metres west of the intersection with Crocket Street in Warners Bay. The proposal is located within the Lake Macquarie City Council (LMCC) Local Government Area (LGA).

The main land uses surrounding the proposal include the residential area of Hillsborough, Combined Northern Canine Committee Showgrounds (CNCC), Charlestown Golf Club, and Charlestown Recreation Reserve.

Key features of the proposal include:

- Duplication of about 1.8 kilometres of Hillsborough Road from the Newcastle Inner City Bypass roundabout west to a tie in point about 300 metres west of Crockett Street
- Two lanes 3.3 metre wide each way with a central median
- Posted speed of 60 kilometres per hour
- Traffic lights at the Chadwick Street intersection
- Modification of Higham Road intersection
- Traffic lights at the Baker Avenue intersection
- U-turn bay on Barker Avenue
- Traffic lights at the Crockett Street intersection
- On road cycle-lanes in both directions
- Off road shared path on the northern side
- Culvert widening on Winding Creek
- Culvert widening between Crockett Street and Baker Avenue
- New entry and exit for the CNCC Showgrounds
- Left in / left in out only from existing business fronting Hillsborough Road, east of the CNCC Showgrounds

Biosis Pty Ltd (Biosis) was engaged by GHD Pty Ltd (Ltd) on behalf of Transport to prepare a Biodiversity Assessment Report (BAR) to support a Review of Environmental Factors (REF) being prepared for the proposal in accordance with Division 5.1 of the *Environmental Planning and Assessment Act 1979*.

Detailed habitat assessments including a combination of diurnal and nocturnal surveys were undertaken by GHD and Biosis in September and November 2021 as well as June and August 2022 to determine the biodiversity value of the study area (the proposal plus a varying buffer). This included collection of plot data in accordance with the Biodiversity Assessment Methodology (BAM), as well as targeted flora and fauna surveys.

Ecological values within the study area are common and widespread in the surrounding modified landscape including foraging resources, movement corridors and hollow-bearing trees. In addition to these values, entities listed under the *Biodiversity Conservation Act 2016* (BC Act) and/or *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) identified within the study area include:

- 1 hectare of *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (BC Act – Endangered) in moderate condition
- Seventy-seven individuals and/or clumps of Black-eyed Susan *Tetraloche juncea* BC Act and EPBC Act – Vulnerable)

- Up to 14.8 ha of habitat for a range of threatened fauna considered to have a moderate or higher likelihood of occurring including forest owls, woodland birds, microbats and Squirrel Glider *Petaurus norfolcensis*.
- A noted Sydney Red Gum *Angophora costata* due to age and size located west of Barker Avenue
- An important wildlife corridor connecting habitat to the north and south of Hillsborough Road (LMCC 2016) for arboreal species such as Squirrel Glider

Waterways and aquatic habitat values within the study area are limited to Winding Creek in the east, an unnamed tributary of Winding Creek about 200 metres east of Crocket Street, and a shallow artificial wetland. Neither the unnamed tributary or Winding Creek are mapped as Key Fish Habitat or habitat for threatened species listed under the *Fisheries Management Act 1994*. The aquatic habitat value of Winding Creek was assessed by Jacobs (2019) which notes that the waterway has upstream and downstream detention basins as well as large sections of concrete bed in cleared areas. Given these areas devoid of habitat and barriers to passage, habitat quality for fish within these Winding Creek is poor to non-existent.

The unnamed tributary is fed from the south and carries overflow from ponds associated with the Charlestown Golf Club. Given this ephemeral nature, which was noted during June 2022, common amphibious fauna may be supported during suitable conditions, however, habitat for strictly aquatic fauna is absent.

Given the lack of aquatic habitat within the study area, no detailed aquatic surveys were undertaken for this assessment.

The study area forms part of a significant habitat corridor situated north-south in the landscape (LMCC 2016). Canopy distances are anticipated to increase from about 30 metres on average currently to about 50 metres as a result of the proposal, introducing an increased barrier to movement for arboreal fauna such as Squirrel Glider.

Following efforts to avoid and minimise, the proposal would result in the following residual impacts to native vegetation and well as NSW and nationally listed biodiversity values:

- Clearing of up to 4.1 ha of native vegetation including 0.2 ha of Swamp Sclerophyll Forest EEC (BC Act)
- Removal of 2.9 ha of potential habitat for Black-eyed Susan
- Removal of five HBTs (four medium hollows and one small hollow) that may be used by smaller hollow-dependent fauna such as Gliders, microbats and birds
- Increased impacts to an important north-south wildlife corridor for Squirrel Glider and other arboreal fauna by increasing the canopy gap across Hillsborough Road from about 30 metres to about 50 metres

A key impact that requires mitigation is the potential increase in a barrier to movement to Squirrel Glider and other arboreal fauna. The *Wildlife Connectivity Guidelines for Road Projects* (RTA 2011) will need to be enacted and it is recommended that appropriate structures be installed at minimum between Barker Avenue and CNCC. Figure 6.1 and LMCC (2016) should also be used to guide options for consideration.

Significant impact assessments were undertaken for the above and other listed entities considered likely to occur, to determine the severity of impact that may be generated by the proposal. These assessments concluded that, the proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the *Biodiversity Conservation Act 2016* or *Fisheries Management Act 1994* and therefore a Species Impact Statement or Biodiversity Development Assessment Report is not required.

The proposal is also not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*.

The proposal was found to trigger consideration of offsets in accordance with Transport's *No Net Loss Guidelines* (Transport 2022a). Impacts to habitat for Black-eyed Susan and Squirrel Glider, were found to trigger offsets as more than 1 hectare of habitat in 'moderate to good' condition as they would be impacted by the proposal. A Biodiversity Offset strategy would be developed to outline how these impacts would offset and implemented.

Areas of impact not otherwise offset via the above species credits would be subject to the *Tree and Hollow Replacement Guidelines* (Transport 2022b) and a Tree replacement strategy would be developed in detailed design for the proposal to compensate residual loss of native vegetation

Glossary

Definitions

Accredited person or assessor	Means as person accredited under section 6.10 (of the BC Act) to prepare reports in accordance with the BAM.
Biodiversity Assessment Method	The Biodiversity Assessment Method is established under section 6.7 of the BC Act. The BAM 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	The gain in biodiversity values achieved from the implementation of management actions on areas of land, to compensate for losses to biodiversity values from the impacts of development (DPIE 2020a).
Biodiversity Assessment Method Calculator	Biodiversity Assessment Method Calculator (BAM-C) – the online computer program that provides decision support to assessors and proponents by applying the BAM and referred to as the BAM-C. The BAM-C contains biodiversity data from the BioNet Vegetation Classification and the Threatened Biodiversity Data Collection that the assessor is required to use in a BAM assessment. The BAM-C applies the equations used in the BAM, including those to determine the number and class of biodiversity credits required to offset the impacts of a development, or created at a biodiversity stewardship site. It is published by the Department (DPIE 2020a).
Biodiversity credit report	The report produced by the BAM-C that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site, or on land to be biodiversity certified, or that sets out the number and class of biodiversity credits that are created at a biodiversity stewardship site (DPIE 2020a).
Biodiversity Offsets and Agreement Management System	The online system used to administer the Biodiversity Offsets Scheme. The BOAMS is used by accredited assessors (to carry out specific BAM-related tasks involving access to the BAM-C to perform assessments, submit data, generate credits and calculate a credit price), by landholders (to apply for a Biodiversity Stewardship Agreement and manage ongoing reporting obligations for their agreement) and by proponents of developments (to view their credit obligation or the payment required to the Biodiversity Conservation Fund).
Biodiversity Stewardship site	Refers to land which is the subject to a Biodiversity Stewardship Agreement under the BC Act.
BioNet Atlas	The DPIE database of flora and fauna records (formerly known as the NSW Wildlife Atlas). The Atlas contains records of plants, mammals, birds, reptiles, amphibians, some fungi, some invertebrates (such as insects and snails listed under the BC Act) and some fish (DPIE 2020a).
BioNet Vegetation classification	Refers to the vegetation community-level classification for use in vegetation mapping programs and regulatory biodiversity impact assessment frameworks in NSW. The BioNet Vegetation Classification is published by the Department and available at www.environment.nsw.gov.au/research/Visclassification.htm (DPIE 2020a).
Construction footprint	The area to be directly impacted by the proposal during construction activities. See also definition for subject land.

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 EP&A 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) (DPIE 2020a).
Ecosystem credit species	Threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for ecosystem credits. This is analogous with the definition of 'predicted species'.
Ecosystem credits	A measurement of the value of threatened ecological communities, threatened species habitat for species that can be reliably predicted to occur with a PCT, and PCTs generally. Ecosystem credits measure the loss in biodiversity values at a development, activity, clearing or biodiversity certification site and the gain in biodiversity values at a biodiversity stewardship site (DPIE 2020a).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (DPIE 2020a).
Indirect impact	Impacts that occur when the proposal affects native vegetation and threatened species habitat beyond the development footprint or within retained areas (e.g. transporting weeds or pathogens, dumping rubbish). This includes impacts from activities related to the construction or operational phase of the proposal and prescribed impacts (DPIE 2020a).
Local population	The population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions: <ul style="list-style-type: none"> • The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the study area that could reasonably be expected to be cross-pollinating with those in the study area. • The 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. • The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the study area from time to time or return year to year (OEH 2018).
Matter of national environmental significance	A matter of national environmental significance (MNES) is any of the nine defined components protected by a provision of Part 3 of the EPBC Act (Commonwealth).
NSW (Mitchell) landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (DPIE 2020a).
Mitigation	Action to reduce the severity of an impact.
Native vegetation	Has the same meaning as in section 1.6 of the BC Act and section 60B of the LLS Act. In summary, <p>(a) trees (including any sapling or shrub or any scrub),</p>

	<p>(b) understorey plants,</p> <p>(c) groundcover (being any type of herbaceous vegetation),</p> <p>(d) plants occurring in a wetland.</p> <p>A plant is native to New South Wales if it was established in New South Wales before European settlement (BC Act).</p> <p>Native vegetation does not extend to marine vegetation (being mangroves, seagrasses or any other species of plant that at any time in its life cycle must inhabit water other than fresh water). Marine vegetation is covered by the provisions of the FM Act.</p>
Operational footprint	The area that will be subject to ongoing operational impacts from the proposal. This includes the road, surrounding safety verges and infrastructure, fauna connectivity structures and maintenance access tracks and compounds.
Patch size	<p>An area of native vegetation that:</p> <ul style="list-style-type: none"> • occurs on the development site or biodiversity stewardship site • includes native vegetation that has a gap of less than 100 m from the next area of native vegetation (or ≤ 30 m for non-woody ecosystems). <p>Patch size may extend onto adjoining land that is not part of the development site or biodiversity stewardship site (DPIE 2020a).</p>
PlantNET	An online database of the flora of New South Wales which contains currently accepted taxonomy for plants found in the State, both native and exotic.
Population	A group of organisms, all of the same species, occupying a particular area (DPIE 2020a).
Spatial datasets	<p>Spatial databases required to prepare a BDAR</p> <ul style="list-style-type: none"> • BioNet NSW (Mitchell) Landscapes – Version 3.1 • NSW Interim Biogeographic Regions of Australia (IBRA region and sub-regions) – Version 7 • NSW soil profiles • hydrogeological landscapes • acid sulfate soils risk • digital cadastral database • Vegetation Information Systems maps • Geological sites of NSW.
Species credit species	Threatened species or components of species habitat that are identified in the Threatened Species Data Collection as requiring assessment for species credits (DPIE 2020a). This is analogous with the definition of ‘candidate species’.
Species credits	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Biodiversity Data Collection (DPIE 2020a).
Species polygon	An area of land identified in Chapter 5 (of the BAM) that contains habitat or is occupied by a threatened species (DPIE 2020a).
Subject land	Land subject to a development, activity, clearing, biodiversity certification or a biodiversity stewardship proposal. It excludes the landscape assessment area which surrounds the subject land (ie the area of land in the 1500 m buffer zone around the subject land or 500m buffer zone for linear proposals). In the case of a biodiversity certification proposal, subject land includes the biodiversity certification assessment area (DPIE 2020a). See also definition for construction footprint.

Study area	The area directly affected by the proposal (subject land or construction footprint) and any additional areas likely to be affected by the proposal, either directly or indirectly.
Threatened Biodiversity Data Collection	A publicly assessable online database (registration required) which contains information for listed threatened species, populations and ecological communities (DPIE 2020a). Part of the BioNet database, published by EESG and accessible from the BioNet website at www.bionet.nsw.gov.au .
Vegetation integrity (score)	The condition of native vegetation assessed for each vegetation zone against the benchmark for the PCT. The vegetation integrity score is the quantitative measure of vegetation condition calculated by the BAM-C (DPIE 2020a).
Vegetation zone	A relatively homogeneous area of native vegetation on a development site, clearing site, land to be biodiversity certified or biodiversity stewardship site that is the same PCT and has the same broad condition state (DPIE 2020a).

Abbreviations

AOBV	Area of Outstanding Biodiversity Value
BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Assessment Method Calculator
BC Act	<i>Biodiversity Conservation Act 2016 (NSW)</i>
BC Regulation	Biodiversity Conservation Regulation 2017 (NSW)
BDAR	Biodiversity Development Assessment Report
BOAMS	Biodiversity Offsets and Agreement Management System
BOS	Biodiversity Offset Scheme
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
DAWE	Department of Agriculture, Water and the Environment
DCCEEW	Department of Climate Change, Energy, the Environment and Water (formerly DAWE)
DIWA	Directory of Important Wetlands in Australia
DPI	Department of Primary Industries
DPE	Department of Planning and Environment
EEC	Endangered ecological community
EESG	NSW Environment Energy and Science Group within the Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EP&A Act	<i>Environment Planning and Assessment Act 1979 (NSW)</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i>
Fisheries NSW Policy and Guidelines	Fisheries NSW Policy and guidelines for fish habitat conservation and management (Update 2013)
FM Act	<i>Fisheries Management Act 1994 (NSW)</i>
GDE	Groundwater dependent ecosystems
IBRA	Interim Biogeographically Regionalisation of Australia

KTP	Key threatening process
LGA	Local Government Area
MNES	Matters of national environmental significance
PCT	Plant community type
PMST	Protected Matters Search Tool
REF	Review of Environmental Factors
SAII	Serious and Irreversible Impacts
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
SSI	State Significant Infrastructure
TBDC	Threatened Biodiversity Data Collection
TECs	Threatened ecological communities (VECs, EECs and CEECs)
Transport	Transport for NSW
VEC	Vulnerable Ecological Community

1 Introduction

1.1 Proposal background

Transport for NSW (Transport) proposes to duplicate a 1.8 kilometre section of Hillsborough Road between the Newcastle Inner City Bypass in the east and the duplicated section of Hillsborough Road, about 300 metres west of the intersection with Crockett Street in Warners Bay (the proposal) (Figure 1-1 and Figure 1-2). The proposal is located within the Lake Macquarie City Council (LMCC) Local Government Area (LGA).

The proposal is located within the 'B57 road corridor', which is a sub-arterial road that extends from Speers Point in the south-west to Charlestown and services west-east journeys for freight and general traffic.

This section of Hillsborough Road also currently serves as the main connection for the residential and commercial areas travelling between Warners Bay and Charlestown. The proposal is required to improve safety, congestion, and reduce delays that are currently experienced along this section of Hillsborough Road and associated connecting roads.

The main land uses surrounding the proposal include the residential area of Hillsborough, Combined Northern Canine Committee Showgrounds (CNCC), Charlestown Golf Club, and Charlestown Recreation Reserve.

1.2 The proposal

Key features of the proposal include:

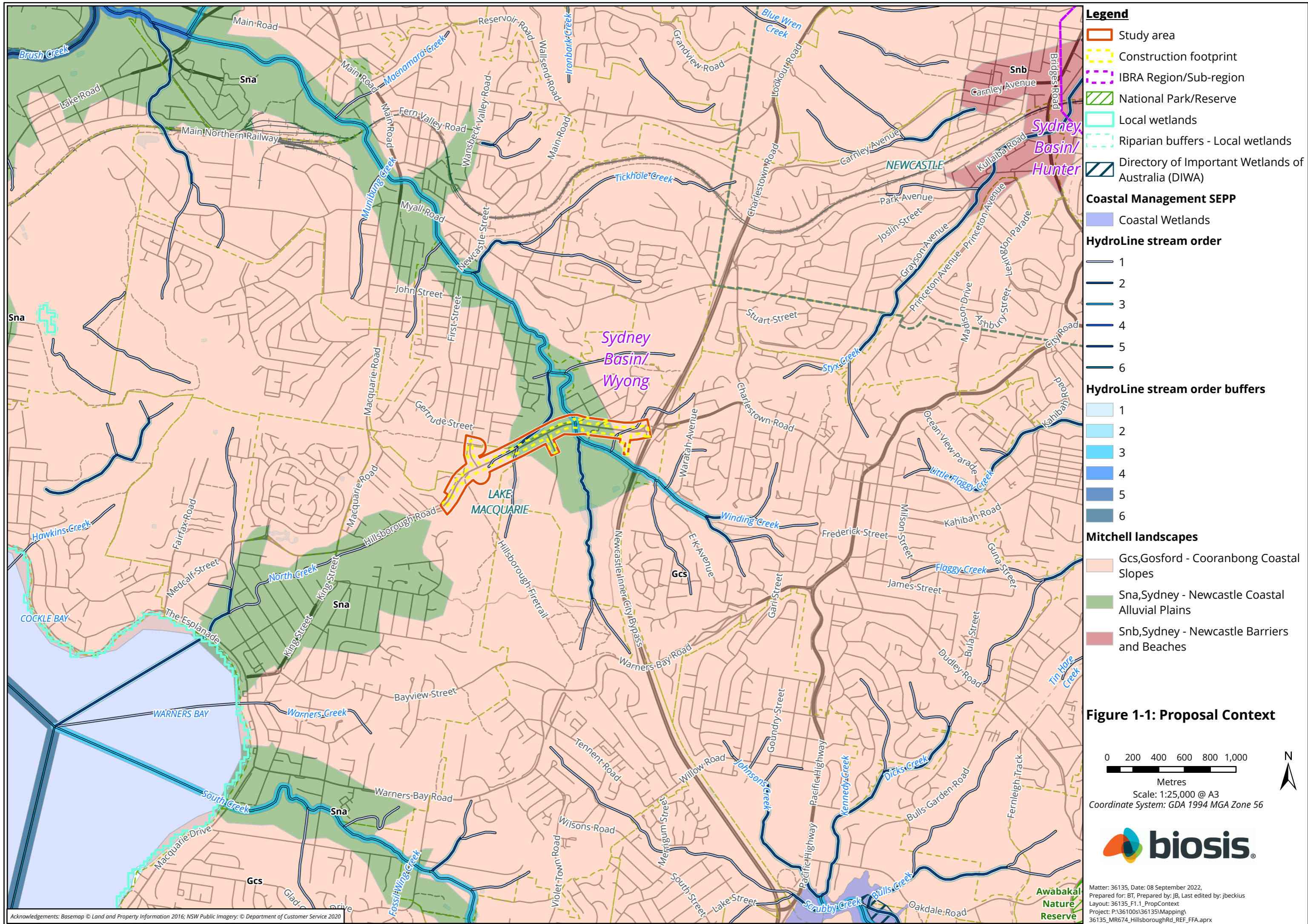
- Duplication of about 1.8 kilometres of Hillsborough Road from the Newcastle Inner City Bypass roundabout west to a tie in point about 300 metres west of Crockett Street
- Two lanes 3.3 metre wide each way with a central median
- Posted speed of 60 kilometres per hour
- Traffic lights at the Chadwick Street intersection
- Modification of Higham Road intersection
- Traffic lights at the Baker Avenue intersection
- U-turn bay on Barker Avenue
- Traffic lights at the Crockett Street intersection
- On road cycle-lanes in both directions
- Off road shared path on the northern side
- Culvert widening on Winding Creek
- Culvert widening between Crockett Street and Baker Avenue
- New entry and exit for the CNCC Showgrounds
- Left in / left in out only from existing business fronting Hillsborough Road, east of the CNCC Showgrounds

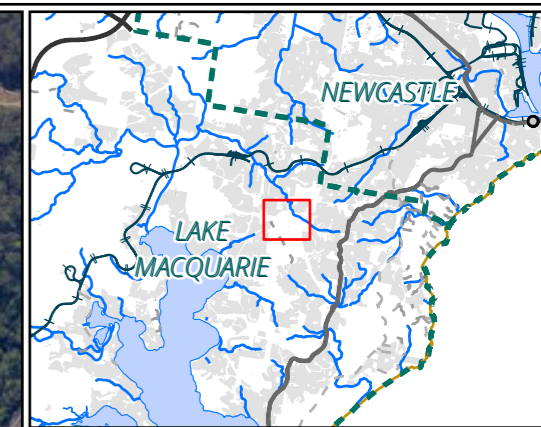
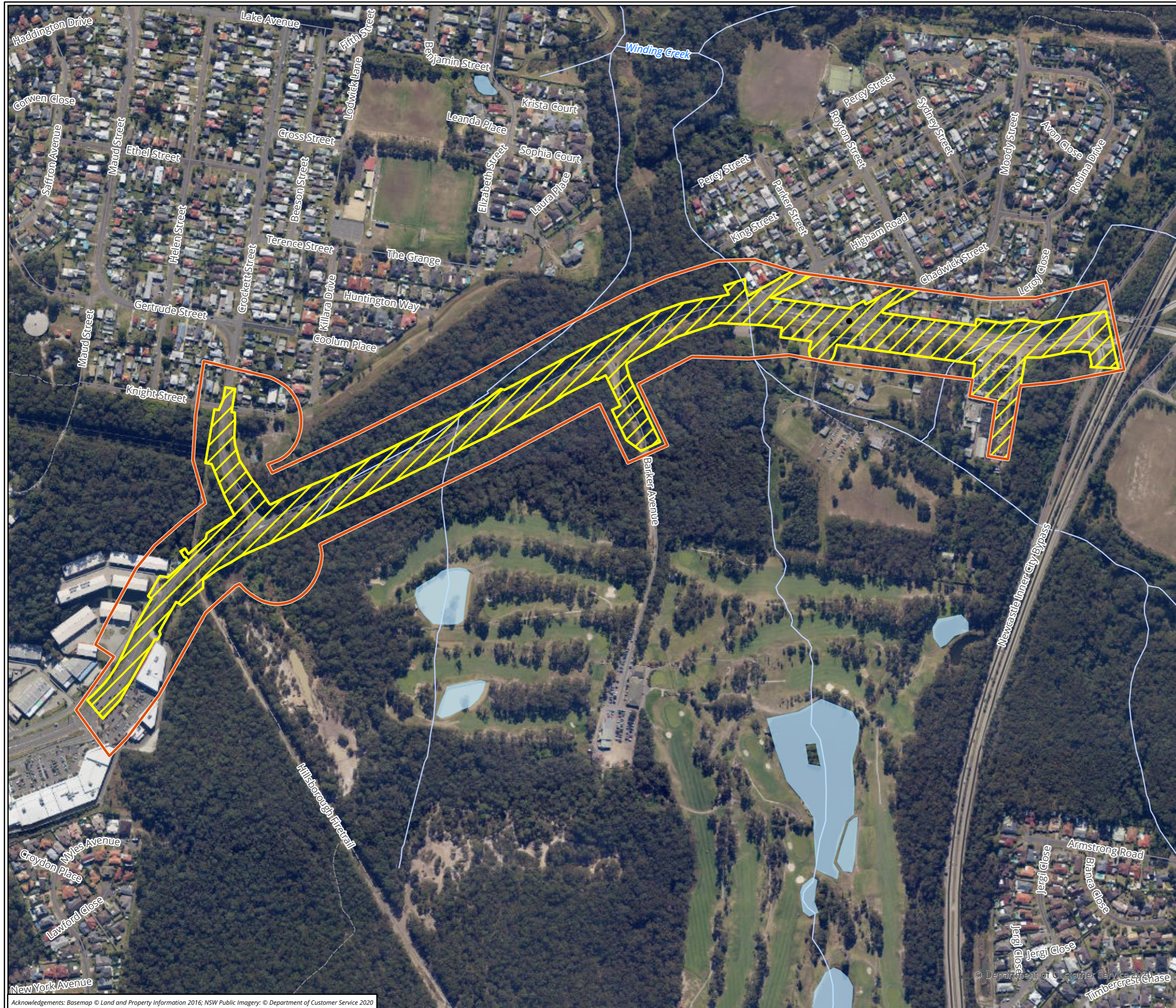
Construction of the proposal is expected to start in 2024 and take about 18 months to complete. Staging of the proposal into 3 prioritised and distinct stages, due to availability of proposal funding, is yet to be determined.

1.2.1 Key terms

The following key terms are used throughout this BAR:

- The proposal, as described in Section 1.2 above
- Construction footprint, or limit of works, the physical area equivalent to the proposal including compounds and disturbance footprint, as shown on Figure 1-2. This is the boundary used to calculate direct impacts
- Operational footprint, the finished design boundary, which sits inside the construction footprint
- Study area, the construction footprint plus a varying buffer to capture land which may be indirectly impacted. The area surveyed for the purposes of the biodiversity assessment as shown on Figure 1-2
- Locality, the area covered by a 10 kilometre buffer of the study area





Legend

- Study area
- Construction footprint

Figure 1-2: The Proposal

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



Matter: 36135, Date: 05 September 2022,
 Prepared for: BT, Prepared by: JB, Last edited by: jbeckius
 Layout: 36135_F1.2_Proposal
 Project: P:\36100s\36135\Mapping\
 36135_MR674_HillsboroughRd_REF_FFA.aprx

1.3 Legislative context

A Review of Environmental Factors (REF) is prepared to satisfy Transport duties under Section 5.5 of the EP&A Act 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 s.5.5 in making decisions on the likely significance of any environmental impacts. This BAR forms part of the REF being prepared for the proposal and assesses the biodiversity impacts of the proposal to meet the requirements of the EP&A Act.

Part 7 of the BC Act requires that the significance of the impact on threatened species, populations and threatened ecological communities is assessed using a five-part test listed in Section 7.3 of the BC Act. Similarly, and Part 7A of the FM Act requires that significance assessments are undertaken in accordance with Division 12 of the FM Act. Where a significant impact is likely to occur, a species impact statement (SIS) must be prepared in accordance with the Environment Agency Head’s requirements, or a Biodiversity Development Assessment Report (BDAR) must be prepared by an accredited assessor in accordance with the Biodiversity Assessment Method (BAM) (DPIE 2020a).

In September 2015, a “strategic assessment” approval was granted by the Federal Minister in accordance with the EPBC Act. The approval applies to Transport 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, proposals assessed via an REF:

- Must address and consider potential impacts on EPBC Act 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 Climate Change, Energy, the Environment and Water (DCCEEW) for these matters, even if the activity is likely to have a significant impact
- Must use the Biodiversity Offset Scheme (BOS) to offset impacts.

To assist with this, assessments of impact significance are required for all relevant biodiversity values in accordance with the *Matters of National Environmental Significance: Significant impact guidelines 1.1. Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2013).

2 Methods

2.1 Personnel

The personnel involved in the preparation of this BAR are detailed in Table 2-1. Note, there was collaboration between Biosis and GHD staff for aspects of the fieldwork.

Table 2-1: Personnel

Name	Role	Qualifications
Mitchell Palmer	Principle Ecologist	BSc, Accredited BAM Assessor (BAAS17051)
Brendon True	Senior Botanist	BSC, M.Con.Bio, Accredited BAM Assessor (BAAS18155)
Brooke Corrigan	Senior Restoration Ecologist	B.Env.Sci, Dip.P.M, Accredited BAM Assessor (BAAS19061)
Felicity Williams	Zoologist	BSc (Hons)
Zoe Goold	Zoologist	BSc
Luke O'Brien (GHD)	Ecologist	BSc

2.2 Background research

The background research conducted for the preparation of this BAR is summarised in this section with the online database and tools utilised detailed in Table 2-2 below.

Table 2-2: Summary of online background research databases and tools conducted

Database / Tool	Search area	Date
Atlas of NSW Wildlife (BioNet)	Locality	29/03/2022
Threatened Biodiversity Data Collection (TBDC)	Locality	Ongoing during BAR preparation
BioNet Vegetation Classification Database	Wyong IBRA sub-region	Ongoing during BAR preparation
Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool	Locality	29/03/2022
Department of Climate Change, Energy, the Environment and Water (DCCEEW) Species Profile and Threats Database (SPRAT)	Locality	Ongoing during BAR preparation
Seed Layer Intersection Tool	Study area	29/03/2022
NSW DPI Fisheries Spatial Data Portal	Study area	29/03/2022

Database / Tool	Search area	Date
Commonwealth Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE)	Study area	29/03/2022
DCCEEW National Flying-fox monitoring viewer	Locality	29/03/2022
State Environmental Planning Policy (SEPP) Resilience and Hazards 2021 Chapter 2 (Coastal Management)	Study area	29/03/2022

In addition to the above, the following sources of background information were used to inform this BAR:

- Regional vegetation mapping obtained via SEED, namely Lower Hunter Vegetation Mapping 2013, VIS_ID 4513 (Parsons Brinckerhoff 2013)
- NSW State Vegetation Type Mapping (DPE 2022)
- The preliminary biodiversity assessment for the proposal: Hillsborough Road Warners Bay to Newcastle Inner City Bypass: Preliminary Biodiversity Assessment (Jacobs 2019)

The preliminary and provisional determinations to list species and ecological communities as threatened under the BC Act were viewed on the EESG NSW Threatened Species Scientific Committee website on 29 August 2022.

The annual Final Priority Assessment List of nominated species and ecological communities that have been approved for assessment by the Minister responsible for the EPBC Act were viewed on the Commonwealth DCCEEW website on 29 August 2022.

2.3 Vegetation assessment

2.3.1 Vegetation mapping

For the purposes of this BAR, native vegetation is defined in accordance with section 1.6 of the BC Act and Part 5A 60B of the Local Land Services Act 2013, repeated here:

(1) For the purposes of this Part, native vegetation means any of the following types of plants native to New South Wales:

- (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.*

(2) A plant is native to New South Wales if it was established in New South Wales before European settlement. The regulations may authorise conclusive presumptions to be made of the species of plants native to New South Wales by adopting any relevant classification in an official database of plants that is publicly accessible.

(3) For the purposes of this Part, native vegetation extends to a plant that is dead or that is not native to New South Wales if:

- (a) the plant is situated on land that is shown on the native vegetation regulatory map as category 2-vulnerable regulated land, and*
- (b) it would be native vegetation for the purposes of this Part if it were native to New South Wales.*

(4) For the purposes of this Part, native vegetation does not extend to marine vegetation (being mangroves, seagrasses or any other species of plant that at any time in its life cycle

must inhabit water other than fresh water). A declaration under Section 14.7 of the BC Act that specified vegetation is or is not marine vegetation also has effect for the purposes of this Part.

In this BAR, native vegetation has been mapped and classified in accordance with the Plant Community Type (PCT) classification system which is described in the BioNet Vegetation Classification (Veg-C). Areas of non-native vegetation have also been mapped and are described as containing vegetation that could not confidently be assigned a PCT due to past disturbance.

Vegetation mapping of the study area was initially undertaken by Jacobs (2019) for the purposes of a Preliminary Biodiversity Assessment (PBA) encompassing the proposal. The PBA vegetation mapping was reviewed by Biosis and ground-truthed in the field on 30 September 2021. Ground-truthing involved collection of Rapid Data Points (RDPs), whereby the dominant flora species across all three strata (upper, middle and ground) were recorded, as well as verifying PCT boundaries. A most likely PCT, in accordance with the Veg-C, was allocated to each point based on species dominance, soil substrate and landscape position. The PCTs allocated at each point were then compared to the mapping of Jacobs (2019). Small refinements to the boundaries of PCTs were made and incorporated into this BAR.

Prior to field work being undertaken by Biosis in September 2021, review of the vegetation of the Lower Hunter region (Parsons Brinckerhoff 2013) was conducted to inform the PCT classification process described above.

Finally, plot-based data was collected across 8 and 9 June 2022. Analysis of this detailed data further refined the vegetation mapping of the study area as described in Section 2.3.2 below.

In total, four PCTs were mapped within the study area for this BAR.

2.3.2 Vegetation survey and classification

2.3.2.1 Vegetation zones

Each of the four PCTs mapped within the study area were stratified into vegetation zones reflecting variation in condition. Generally, the PCTs within the study area are relatively intact, containing developed upper, middle and ground strata. The only incidence of a PCT being in a markedly different condition state is the area of canopy only and maintained understory associated with the CNCC Showgrounds. Remaining vegetated areas do show variation in condition relating to extent of exotics and cover and abundance of native species. However, this is more subtle than the CNCC Showgrounds and the BAM-C was used to stratify these areas where it was reasonable to do so. This process involved entering collected plot data into the BAM-C per PCT and then grouping areas that returned commensurate vegetation integrity scores into a vegetation zone. Consideration was then given to whether the extent of exotics in areas of a zone warranted further stratification as the presence of non-high threat species aren't reflected in vegetation integrity scores.

Following the process described above, the study area was deemed to contain eight vegetation zones across four PCTs as detailed in Table 2-4.

In addition to native vegetation zones, one non-native vegetation zone has been mapped, named Disturbed/Urban Vegetation. This zone accounts for the weedy roadside verge and those cleared and disturbed areas that are predominantly weedy and/or have few native species to confidently assign a PCT.

2.3.2.2 Plot-based vegetation survey

Plot-based full floristic survey was completed in accordance with subsection 4.3.4 of the BAM (DPIE 2020a) where possible. The number of plots completed within each vegetation zone adhered to the minimum requirements of the BAM (Table 2-3) with one exception. PCT 1736 was not accessible during the time of survey due to inundation. RDP data was collected for this PCT to aid with identifying the appropriate PCT.

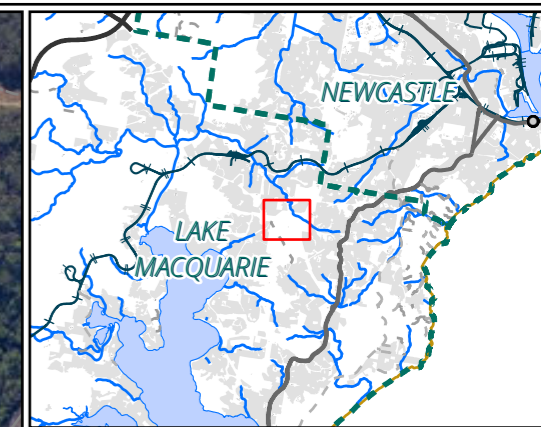
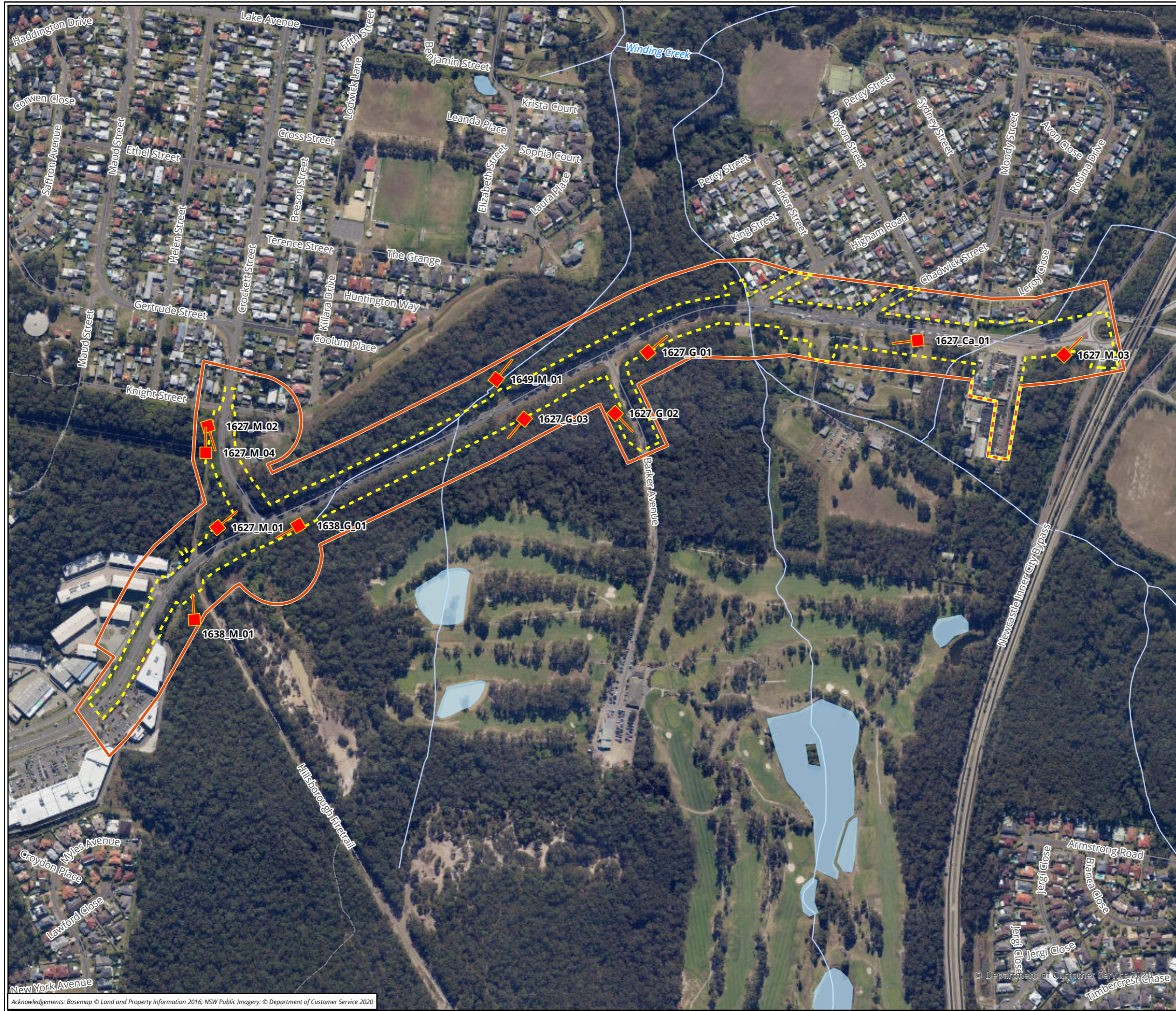
Table 2-4 summarises the number of plots required as per the BAM and the number of plots undertaken for each vegetation zone.

Table 2-3: Minimum number of plots required per zone area

Vegetation zone area (ha)	Minimum number of plots/mid-lines
<2	1 plot/mid-lines
>2-5	2 plots/mid-lines
>5-20	3 plots/mid-lines
>20-50	4 plots/mid-lines
> 50–100	5 plots/mid-lines
> 100–250	6 plots/mid-lines
> 250–1000	7 plots/mid-lines; more plots may be needed if the condition of the vegetation is variable across the zone
> 1000	8 plots/mid-lines; more plots may be needed if the condition of the vegetation is variable across the zone

Table 2-4: Minimum number of plots required and completed per vegetation zone

Veg. zone	PCT	Vegetation zone area (ha)	No. plots required	No. plots completed (plot IDs)
Zone 1	PCT 1627_Good	7.8	3	3 - 1627_G_01, 1627_G_02, 1627_G_03
Zone 2	PCT 1627_Moderate	1.7	1	3 – 1627_M_01, 1627_M_02, 1627_M_03, 1627-M_04
Zone 3	PCT 1627_Canopy	1.6	1	1 – 1627_Ca_01
Zone 4	PCT 1638_Good	1	1	1 – 1627_G_01
Zone 5	PCT 1638_Moderate	1.7	1	1 – 1627_M_01
Zone 6	PCT 1649_Moderate	1	1	1 – 1627_M_01
Zone 7	PCT 1736_Moderate	0.1	1	0 Rapid assessment only and outside of construction footprint



Legend

- Study area
- Development footprint
- BAM Plot

Figure 2-1: Vegetation plot-based survey locations

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



Matter: 36135, Date: 06 September 2022,
 Prepared for: BR, Prepared by: JB, Last edited by: jbeckius
 Layout: 36135_F2.1_Plots
 Project: P:\36100s\36135\Mapping\
 36135_MR674_HillsboroughRd_REF_FFA_F2-3.aprx

2.4 Threatened species assessment

2.4.1 Habitat assessment

A habitat assessment was undertaken and is included in Appendix B – Habitat assessment table. Note, that the likelihood of occurrence ratings for each threatened entity reflect the results of on-ground habitat assessment and targeted flora and fauna surveys undertaken for this BAR in addition to that undertaken by Jacobs (2019).

Databases searches (BioNet and PMST) of the locality were the primary means of generating the list of threatened entities that should be considered for assessment. However, consideration was also given to any species credit species (BAM) associated with the PCTs within the study area that were not returned from said databases searches. In this instance, no such species were added to the habitat assessment.

In addition to the knowledge and experience of personnel, information utilised in the habitat assessment includes habitat feature mapping undertaken for this BAR, as well as ecological information contained within BioNet, the TBDC and SPRAT as appropriate. Where background information or targeted survey is lacking, the precautionary principle has been applied and a 'Moderate' rating given to ensure that all threatened entities at risk of being impacted by the proposal have been adequately assessed.

2.4.2 Targeted flora surveys

Targeted surveys were undertaken for all threatened flora species considered as having a moderate or higher likelihood of occurring following review of background information an initial habitat assessment. These surveys are summarised in Table 2-5 and shown on

Figure 2-2. Surveys were undertaken across 30 September 2021, 24 November 2021 and 19 August 2022 for a total of 26 person hours.

For those species targeted in September 2021, conditions were suitable for detection (22.8 °C, with light to moderate ESE winds and 10.4 mm rainfall in the preceding 5 days).

Similarly, survey's targeting Leafless tongue Orchid *Cryptostylis hunteriana* in November 2021 were conducted during suitable conditions for detection.

Survey methods and effort adhered to those described in *Surveying threatened plants and their habitats. NSW survey guide for the Biodiversity Assessment Method* (DPIE 2020b). Namely, parallel field traverses ranging from 5-10m separation were walked by two ecologists in areas of suitable habitat. A random meander style (Cropper 1993) survey was utilised to first identify areas of suitable habitat that would be targeted.

References populations of Sand Doubletail *Diuris praecox* (Nelson Bay) and Leafless Tongue Orchid (Central Coast) were confirmed to be flowering prior to targeted surveys being undertaken.

The methods used to determine peak flowering of Black-eyed Susan *Tetratheca juncea* were those outlined in the EPBC Act referral guidelines (Commonwealth of Australia 2011) for the species, whereby the numbers of buds, flowers and seed capsules (including flowers after all petals have fallen) were counted or estimated for a number of different clumps across the study area. A total of 25 clumps were selected for assessment of peak flowering. However, as the distribution of Black-eyed Susan across the study area occurs in two relatively dense clusters, with additional two small more isolated outliers, most of those counted were below the minimum 10 m from other counted clumps as stipulated in the EPBC Act referral guidelines (Commonwealth of Australia 2011).

Limitations of the targeted flora surveys undertaken, such as sub-optimal timing, are discussed in Section 2.6.

Table 2-5: Targeted threatened flora survey details

Species name	Common name	Required survey period	Associated PCTs in the study area	Minimum survey requirements ¹	Survey completed
<i>Caladenia tessletata</i>	Thick Lip Spider Orchid	September to October	PCT 1627 – 11.1 ha	5-10 m wide parallel traverses in suitable habitat (DPIE 2020b)	Survey undertaken in September 2021. Suitable habitat in associated PCTs surveyed via 5-10 m wide parallel traverses. 10 person hours total.
<i>Callistemon linearifolius</i>	Netted Bottlebrush	October to January	PCT 1627 – 11.1 ha	5-10 m wide parallel traverses in suitable habitat (DPIE 2020b)	Survey undertaken on 29 September 2021. Suitable habitat in associated PCTs surveyed via 5-10 m wide parallel traverses. 10 person hours total.
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	November to January	PCT 1627 – 11.2 ha PCT 1638 – 2.7 ha PCT 1649 – 1 ha	5-10 m wide parallel traverses in suitable habitat (DPIE 2020b)	Survey undertaken in late November 2021. Suitable habitat in associated PCTs surveyed via 5-10 m wide parallel traverses. 10 person hours total.

Species name	Common name	Required survey period	Associated PCTs in the study area	Minimum survey requirements ¹	Survey completed
<i>Diuris praecox</i>	Sand Doubletail	August	PCT 1627 - 11.1 ha	5-10 m wide parallel traverses in suitable habitat (DPIE 2020b)	Survey undertaken in September 2021 and August 2022. Suitable habitat in associated PCTs surveyed via 5-10 m wide parallel traverses. 16 person hours total. A reference population was confirmed in flower prior to undertaking both surveys.
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small Flower Grevillea	August to November	PCT 1649 – 1 ha	5-10 m wide parallel traverses in suitable habitat (DPIE 2020b)	Survey undertaken in September 2021. Suitable habitat in associated PCTs surveyed via 5-10 m wide parallel traverses. 10 person hours total.
		September to October	PCT 1627 – 11.1 ha	5-10 m wide parallel traverses in suitable habitat (DPIE 2020b)	Survey undertaken in September 2021. Suitable habitat in associated PCTs surveyed via 5-10 m wide parallel traverses. 10 person hours total.

2.4.3 Targeted fauna surveys

The targeted fauna surveys undertaken for this BAR are summarised in Table 2-6 below. Forest Owls, Squirrel Glider and microbats were targeted. Many of the species below, particularly microbats, are ecosystem credit species under the BAM and do not strictly require survey. The minimum requirements quoted in Table 2-6 are those required under the BAM.

Limitations of the targeted fauna surveys conducted are discussed in Section 2.6.3.

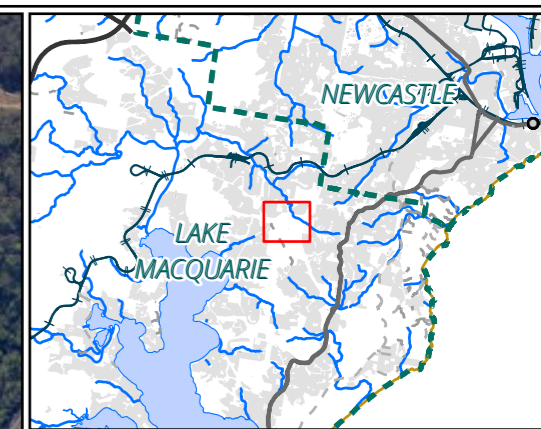
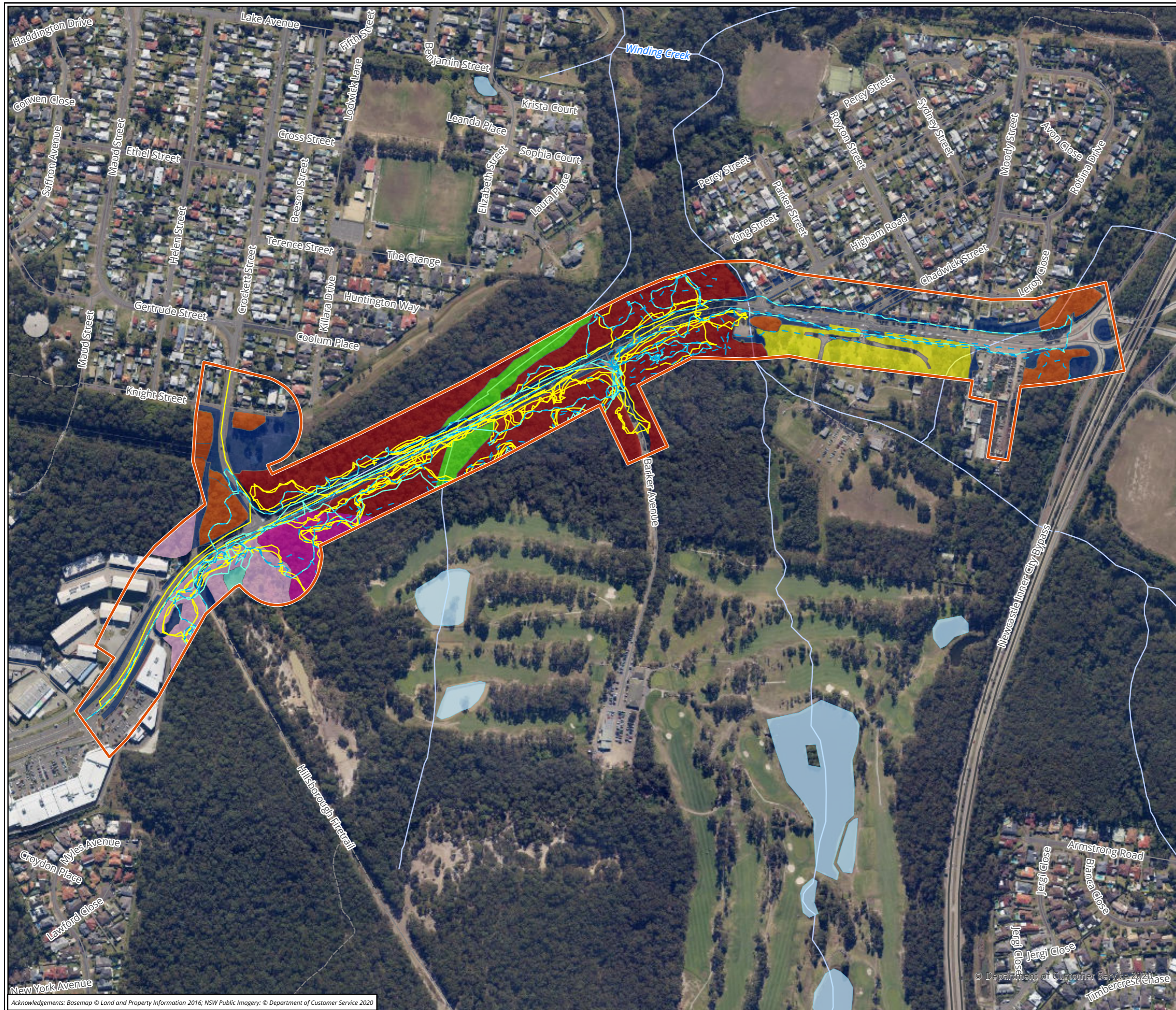
Table 2-6: Targeted threatened fauna survey details

Species name	Common name	Required survey period	Associated PCTs in the study area	Minimum survey requirements ¹	Survey completed
<i>Calyptrorhynchus lathamii</i>	Glossy Black-Cockatoo	January - September	PCT 1627 PCT 1638 PCT 1649	Determine if potential nest trees are present. Targeted and opportunistic bird survey for evidence of breeding	Habitat assessment to determine if foraging and breeding habitat is present. Targeted and opportunistic surveys in September 2021 and August 2022.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	November - January	PCT 1627 PCT 1638 PCT 1649	Survey not required under the BAM unless suspected or known breeding habitat is identified	Habitat assessment to determine if breeding habitat is present. 2 acoustic detector nights over 2 nights in September to determine if species is present for foraging.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	N/A	PCT 1627 PCT 1638 PCT 1649	Survey not required for ecosystem credit species	2 acoustic detector nights over 2 nights in September.
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	N/A	PCT 1627 PCT 1638 PCT 1649	Survey not required for ecosystem credit species	2 acoustic detector nights over 2 nights in September.
<i>Miniopterus australis</i>	Little Bent-winged Bat	December – January (breeding)	PCT 1627	Survey not required under the BAM unless suspected or known breeding habitat is identified.	Habitat assessment undertaken in Spring 2021 and 2022 to determine if breeding/roosting habitat is present. 2 acoustic detector nights over 2 nights in September to determine if species is present for foraging.
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	December – January (breeding)	PCT 1627	Survey not required under the BAM unless suspected or known breeding habitat is identified.	Habitat assessment undertaken in Spring 2021 and 2022 to determine if breeding/roosting habitat is present. 2 acoustic detector nights over 2 nights in September to determine if species is present for foraging.

Species name	Common name	Required survey period	Associated PCTs in the study area	Minimum survey requirements ¹	Survey completed
<i>Myotis macropus</i>	<i>Southern Myotis</i>	October - March (breeding)	PCT 1627 PCT1649	16 acoustic detector nights over a minimum 4 nights.	Habitat assessment to determine if breeding/roosting habitat is present. 2 acoustic detector nights over 2 nights in September to determine if species is present for foraging. Visual inspections of culverts.
<i>Petaurus norfolcensis</i>	<i>Squirrel Glider</i>	January - December	PCT 1627 PCT 1638	There is no recognised minimum survey requirement as a variety of techniques can be used. For spotlighting, two 1 hr, 1 km transects on separate nights per 200 ha.	Six 1 hr, 1 km transects on six separate nights.
<i>Pteropus poliocephalus</i>	<i>Grey-headed Flying-fox</i>	October - December	PCT 1627 PCT 1649	Sufficient on ground survey coverage to determine if camps are present.	Habitat assessment across the study area to determine presence/absence of camps.
<i>Saccolaimus flaviventris</i>	<i>Yellow-bellied Sheath-tail-bat</i>	N/A	PCT 1627 PCT 1638 PCT 1649	Survey not required for ecosystem credit species	2 acoustic detector nights over 2 nights in September.
<i>Scoteanax rueppellii</i>	<i>Greater Broad-nosed Bat</i>	N/A	PCT 1627 PCT 1638 PCT 1649	Survey not required for ecosystem credit species	2 acoustic detector nights over 2 nights in September.

Species name	Common name	Required survey period	Associated PCTs in the study area	Minimum survey requirements ¹	Survey completed
<i>Vespadelus troughtoni</i>	<i>Eastern Cave Bat</i>	November - January	PCT 1627 PCT 1638 PCT 1649	Survey not required under the BAM unless suspected or known breeding habitat is identified.	Habitat assessment to determine if breeding habitat is present. 2 acoustic detector nights over 2 nights in September to determine if species is present for foraging. Visual inspections of culverts. .
<i>Ninox connivens</i>	<i>Barking Owl</i>	May-December (if breeding habitat present)	PCT 1627 PCT 1638 PCT 1649	Determine if potential nest trees are present, monitor potential nest trees for a minimum four nights. Call playback across 4 nights.	2021: Call playback and spotlighting on two nights in September. 2022: Monitoring of two potential nest trees over four nights in August. Call playback and spotlighting over four nights in August.
<i>Ninox strenua</i>	<i>Powerful Owl</i>	May-August (if breeding habitat present)	PCT 1627 PCT 1638 PCT 1649	Determine if potential nest trees are present, monitor potential nest trees for a minimum four nights. Call playback across 4 nights.	2021: Call playback and spotlighting on two nights in September. 2022: Monitoring of two potential nest trees over four nights in August. Call playback and spotlighting over four nights in August.
<i>Tyto novaehollandiae</i>	<i>Masked Owl</i>	May-August (if breeding habitat present)	PCT 1627 PCT 1638 PCT1649	Determine if potential nest trees are present, monitor potential nest trees for a minimum four nights. Call playback across 8 nights.	2021: Call playback and spotlighting on two nights in September. 2022: Monitoring of two potential nest trees over four nights in August. Call playback and spotlighting over four nights in August.

Species that have N/A noted for their required survey period are ecosystem credit species for the purposes of the BAM and do not have a required survey period noted within the TBDC.



Legend

- Study area
- November 2021
- September 2021
- August 2022
- Plant Community Type**
- 1627_Good
- 1627_Moderate
- PCT 1627_Canopy
- PCT 1638_Good
- PCT 1638_Moderate
- PCT 1649_Moderate
- PCT 3959_Moderate
- Disturbed/Urban Vegetation

Figure 2-2: Threatened Flora Survey Locations

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



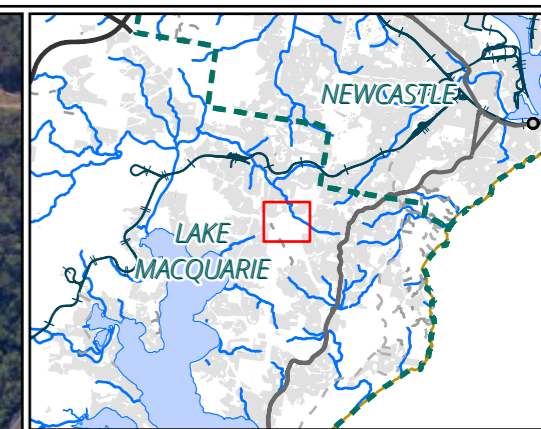
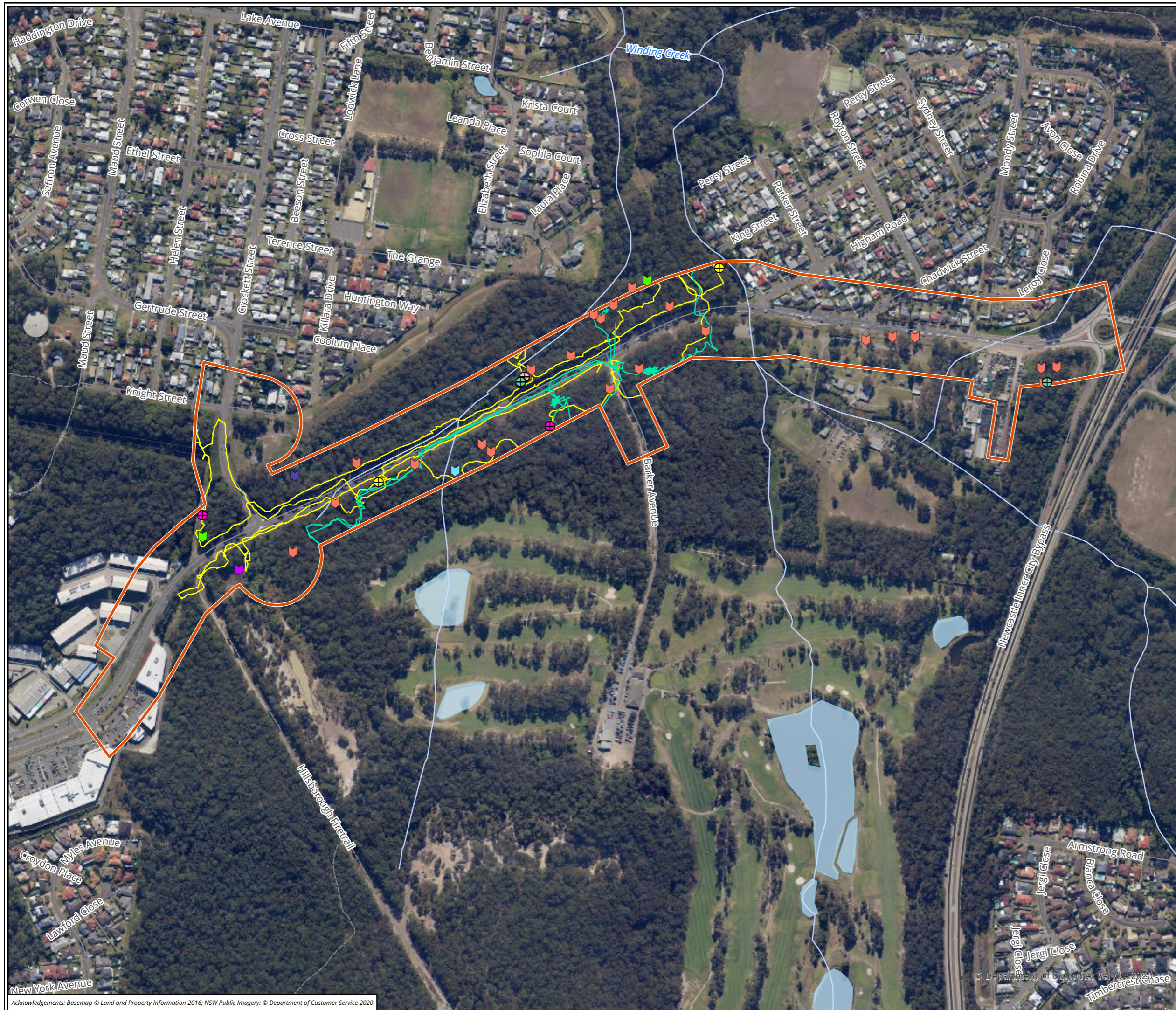
2.5 Aquatic surveys

Waterways and aquatic habitat values within the study area are limited to Winding Creek in the east, an unnamed tributary of Winding Creek about 200 metres east of Crocket Street, and a shallow artificial wetland (mapped as PCT 1736, Figure 3-1). The artificial wetland has formed from previous disturbance and excavation and is highly ephemeral and rainwater dependent. During dry times, it may more resemble a cleared version of the woodland that surrounds it. Therefore, the potential of this area to sustain aquatic fauna is negligible.

Neither the unnamed tributary nor Winding Creek are mapped as Key Fish Habitat or habitat for threatened species listed under the FM Act (DPI 2019). The aquatic habitat value of Winding Creek was assessed by Jacobs (2019) which notes that the waterway has upstream and downstream detention basins as well as large sections of concrete bed in cleared areas. Given these areas devoid of habitat and barriers to passage, habitat quality for fish within these Winding Creek is poor to non-existent.

The unnamed tributary is fed from the south and carries overflow from ponds associated with the Charlestown Golf Club. Given this ephemeral nature, which was noted during June 2022, common amphibious fauna may be supported during suitable conditions, however, habitat for strictly aquatic fauna is absent.

Given the lack of aquatic habitat within the study area, no detailed aquatic surveys were undertaken for this BAR.



- Legend**
- Study area
 - 2021
 - 2022
- Habitat features**
- Dam
 - Drain
 - Hollow bearing tree
 - Termite nest
 - Wetland
- Targeted fauna survey points**
- ⊕ Anabat (2021)
 - ⊕ Owl call playback (2021)
 - ⊕ Owl call playback (2022)
 - ⊕ Stag watch (2022)

Figure 2-3: Threatened Fauna Survey Locations

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



2.6 Limitations

2.6.1 General flora survey

The random meander and plot-based (DPIE 2020a) survey undertaken has provided a list of flora species for a point in time. As the plot-based survey was undertaken in winter, cryptic species that are typically detectable in limited timeframes in the warmer months, such as orchids, are unlikely to have been recorded, however is supplemented by rapid searches in more optimal seasonal periods. Therefore, the cover and abundance of native species recorded within each plot is almost assuredly less than what is truly present. Repeated survey over several seasons or years during ranging weather conditions would be required to detect all the species present, which is not feasible for this BAR.

2.6.2 Targeted flora survey

Of the threatened flora species that were subject to targeted surveys, Nettle Bottlebrush *Callistemon linearifolius*, was surveyed for outside the timing stipulated by the TBDC. However, this was only by one day. Furthermore, as a shrub typically 3-4 m high with long and narrow leaves, 'potential' individuals of this species are detectable all year round.

It is a recognised limitation that not all species present within an area are detectable at any one time or year over year. While the conditions during the targeted flora surveys are considered favourable for detecting those species targeted, differing emergence rates in orchid species for example, mean that the presence of such species varies temporally.

2.6.3 Targeted fauna survey

General Limitations

It is an unavoidable limitation that not all species that utilise a study area will be detected, and therefore a precautionary habitat-based assessment has been undertaken in conjunction with results obtained during targeted surveys. This is generally due to their mobility and unpredictable movement throughout their habitat. Furthermore, climatic conditions may influence the species present at any one time. The habitat assessment approach and resulting Test of Significance (ToS) and EPBC Act Significant Impact Criteria (SIC) assessments have been used to alleviate this limitation and those limitations discussed below.

Microbats

Ecosystem credit microbat species (those with an N/A survey period in Table 2-6) are not required to be surveyed for under the BAM and are assumed to be associated with the habitat present. Nor is survey required for Large-eared Pied Bat, Eastern Cave Bat, Large Bent-winged Bat and Little Bent-winged Bat, as the study area is not known or suspected to contain suitable optimal breeding habitat (i.e. caves) following on-ground habitat assessment. The targeted surveys undertaken for the remaining threatened microbats deviate from the requirements of the BAM and are generally lacking in scope, timing and intensity to adequately determine the presence/absence of the targeted species. To negate this limitation, habitat assessment has taken precedence and a 'Moderate' likelihood of occurrence rating has been applied to all threatened microbats surveyed for (Appendix B – Habitat assessment table), not just those requiring survey under the BAM. Additionally, visual inspections of sub-optimal opportunistic overwintering roost sites, such as culverts were undertaken. Further surveys during warmer months (December to February) would be undertaken as part of detailed design, and prior to construction, that would review assumptions made in this assessment to date and the application of the 'Moderate' likelihood finding of this BAR.

Forest Owls

The Forest Owl species targeted (Table 2-6) are dual credit species under the BAM, thus they are assumed to be present for foraging purposes if suitable foraging habitat is present. Surveys to determine breeding (habitat feature mapping and monitoring, stag watching, call playback and spotlighting) were undertaken during the prescribed survey periods for all

species. While the combination of all these methods is satisfactory to determine if any of the targeted species are breeding within the study area, the efficacy of call playback as a detection method was significantly reduced due to noise pollution from Hillsborough Road. No suitable hollow bearing trees for forest owls will be directly impacted by the proposal. Section 3.4 discusses in further detail the level of habitat present within the study area and Section 5.1.2 discusses associated impacts from the proposal.

3 Existing environment

The study area is situated either side of a 1.8 km stretch of Hillsborough Road within the LMCC LGA. The IBRA bioregion is the Sydney Basin and the IBRA subregion is Wyong. The underlying geology is a combination of the Gosford - Cooranbong Coastal Slopes and Sydney - Newcastle Coastal Alluvial Plains (central areas). Significant areas of bushland are present to the north and south of the study area.

The main land uses surrounding the study area include the residential area of Hillsborough, CNCC, Charlestown Golf Club, and Charlestown Recreation Reserve.

Outside common edge effects, primarily weed incursion and exposure, the native PCTs present within the study area are generally in good to moderate condition, with structure and diversity, more resembling a 'natural' state, improving as distance from Hillsborough Road increases. Mature trees, predominantly Eucalypts, are present throughout, with diversity in the mid and understorey present. Evidence of past disturbances include increased exotic shrub (*Lantana camara* and *Ligustrum spp*) and grass incursion as well as the dominance of early successional natives such as *Acacia spp.* in a few locations. However, these areas are small in relation to the size of the study area as a whole. Further, the construction of Hillsborough Road, surrounded by a mix of other land uses, has altered the natural hydrology in some places, meaning that species that tend to colonise wetter soils, such as Sweet Pittosporum *undunlatum* and Cheese Tree *Glochidion ferdinandi* have colonised traditionally drier/heathier PCTs.

The study area intersects two waterways, one named (Winding Creek) at the eastern end and one (unnamed) tributary of Winding Creek about 500 metres to the west. These waterways are carried under Hillsborough Road in a south-north direction by one double box culvert and one triple box culvert respectively. These culverts are heavily overgrown with vegetation, primarily exotic.

3.1 Plant community types and vegetation zones

A candidate list of potential PCTs, including reference to the revised but to yet to be applied Eastern PCTS, was generated by inputting the dominant native flora species present across the study area into the BioNet Vegetation Classification. The Wyong IBRA subregion was used as a filter for potential candidates.

Subsequently, the plot data collected, and other factors such as landscape position, were compared to the descriptions of each candidate PCT. Most weight was given to what canopy species were present over mid and understorey species which can be more widespread and distributed across several related PCTs. This process revealed that four PCTs were present across the study area, summarised.

Table 3-1: Plant community types and vegetation zones

Veg. zone	Plant community type (PCT)	Threatened ecological community	Area (ha)	
			Study area	Impact area
1	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast (Good) (3621 Sydney Hinterland Turpentine-Apple Gully Forest)	Not a TEC	7.8	2.1

Veg. zone	Plant community type (PCT)	Threatened ecological community	Area (ha)	
			Study area	Impact area
2	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast (Moderate) (3621 Sydney Hinterland Turpentine-Apple Gully Forest)	Not a TEC	1.7	0.4
3	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast (Canopy) (3621 Sydney Hinterland Turpentine-Apple Gully Forest)	Not a TEC	1.6	0.8
4	PCT 1638: Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast (Good) (3582 Hunter Coast Lowland Apple-Bloodwood Forest)	Not a TEC	1	0.2
5	PCT 1638: Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast (Moderate) (3582 Hunter Coast Lowland Apple-Bloodwood Forest)	Not a TEC	1.7	0.4
6	PCT 1649: Smooth-barked Apple - Red Mahogany - Swamp Mahogany - Melaleuca sieberi heathy swamp woodland of coastal lowlands (Moderate) (3998 Lower North Creekflat Mahogany Swamp Forest)	Endangered (BC Act), does not satisfy EPBC Act listing minimum condition thresholds	1	0.2
7	PCT 1736: Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter (Moderate) (3975 Southern Lower Floodplain Freshwater Wetland)	Not a TEC due to man-made nature	0.1	-
8	Disturbed/Urban vegetation	Not a TEC	3.9	2.5
Total			18.8	6.6

3.1.1 Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast

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

Vegetation class: Sydney Coastal Dry Sclerophyll Forest

PCT ID: 1627 (3621)

Conservation status: Not a TEC

Estimate of percent cleared: 9 %

Vegetation zones (condition) and plots:

- Zone 1 1627 Good – 7.8 ha, three plots
- Zone 2 1627 Moderate – 1.7 ha, four plots
- Zone 3 1627 Canopy – 1.6 ha, one plot

Description:

Generally, this PCT occurs open forests to woodland with a generally well developed and distinctly two-layered mid-stratum. The ground cover is characterized by graminoids, sub-shrubs and forbs. Sandstone ranges of the Central Coast hinterland from Wisemans Ferry to Pearl Beach and north to within Wyong sub region and Lower Hunter. Commonly found at elevation between 50 to 300m.

Within the study area, this PCT is widespread and occurs as open forest with a canopy dominated by Smooth-Barked Apple *Angophora costata*, with other varying co dominants including Sydney Peppermint *Eucalyptus piperita*, and occasional Red Bloodwood *Corymbia gummifera*, Scribbly Gum *Eucalyptus haemastoma*, Broad-leaved Mahogany *Eucalyptus umbra* and Turpentine *Syncarpia glomulifera*. The mid-storey consists of a diverse moist open mesic and heathy shrub layer such as *Allocasuarina* spp, *Denhamia silvestris*, *Leptospermum* spp, *Melaleuca* spp, *Banksia marginata*, Hopbush *Dodonaea triquetra*, Cheese tree *Glochidion ferdinandi* and Christmas Bush *Ceratopetalum gummiferum* along with various small climbers. The ground layer is characteristically grassy with a mix of forbs; small ferns and other graminoids such as *Lepidosperma laterale*, *Entolasia stricta* and *Lomandra obliqua*.

Good and moderate condition zones are predominantly native with low levels of weed ingress of common environmental weed species, however low condition areas contain high abundance and cover of exotic flora such as Privet *Ligustrum sinense*, Camphor Laurel *Cinnamomum camphora*, Lantana *camara* and *Megathyrsus maximus*. Canopy zone relates to areas within the CNCC, and is largely restricted to canopy species only, with an understory and ground stratum dominated by Kikuyu *Cenchrus clandestinus* and Buffalo grass *Stenotaphrum secundatum*.

The PCT also contains a noted tree, one Sydney Red Gum *Angophora costata*, due to age and size located west of Barker Avenue.

Floristic and structural summary of PCT 1627 within the study area

Growth form	Typical species
Trees	<i>Angophora costata</i> , <i>Eucalyptus piperita</i> , <i>Syncarpia glomulifera</i> , <i>Corymbia gummifera</i> , <i>Eucalyptus umbra</i>
Shrubs	<i>Allocasuarina littoralis</i> , <i>Monotoca elliptica</i> , <i>Denhamia silvestris</i> , <i>Ceratopetalum gummiferum</i> , <i>Dodonaea triquetra</i> , <i>Banksia marginata</i> , <i>Glochidion ferdinandi</i>
Grass and grass-like	<i>Lepidosperma laterale</i> , <i>Entolasia stricta</i> , <i>Lomandra obliqua</i> , <i>Imperata cylindrical</i> , <i>Themeda triandra</i> , <i>Cynodon dactylon</i>

Growth form	Typical species
Forb	<i>Dampiera stricta</i>
Fern	<i>Pteridium esculentum</i> , <i>Lindsaea linearis</i>
Other	<i>Eustrephus latifolius</i> , <i>Xanthorrhoea</i> spp, <i>Parsonsia straminea</i>
Exotic	<i>Plantago lanceolata</i> , <i>Richardia brasiliensis</i> , <i>Trifolium repens</i>
High Threat Exotic	<i>Ligustrum sinense</i> , <i>Asparagus africanus</i> , <i>Cinnamomum camphora</i> , <i>Lantana camara</i> , <i>Cenchrus clandestinus</i> , <i>Stenotaphrum secundatum</i>



Photo 3-1: Plot 1627_G_03 showing vegetation zone One (PCT 1627 - Good)

3.1.2 Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast

Vegetation formation:

Vegetation class:

PCT ID: 1638 (3582)

Conservation status: Not a TEC

Estimate of percent cleared: 24%

Vegetation zones (condition) and plots:

- Zone 4 1638 Good – 1 ha, one plot
- Zone 5 1638 Moderate – 1.7 ha, one plot

Description:

Generally, this PCT occurs as a tall open forest dominated by Angophoras and Corymbia species on drier clay soils, with a generally well developed low shrub and predominantly grassy ground stratum. This PCT is extensively distributed at low elevations throughout the Lake Macquarie region.

Within the study area, this PCT is an open forest with a canopy dominated by Smooth-Barked Apple *Angophora costata*, with co dominants including Red Bloodwood, *Corymbia gummifera* Scribbly Gum *Eucalyptus haemastoma* and Brown Stringybark *Eucalyptus capitellata*. The mid-storey consists of a diverse but sparse to moderately dense mid shrub stratum including *Allocasuarina littoralis*, *Lambertia formosa*, *Exocarpus stictus*, *Leptospermum* spp, and *Pultenaea daphnoides* along with various climbers such as *Billardiera scandens* and *Parsonsia straminea*. The ground layer is characteristically grassy with a mix of forbs including Weeping Grass *Microlaena stipoides*, *Panicum smile*, *Lepyrodia scariosa* and Bracken Fern *Pteridium esculentum*.

Good and moderate condition zones are predominantly native with low levels of weed ingress of common environmental weed species, however, contain a low to moderate abundance and cover of exotic flora such as Camphor Laurel *Cinnamomum camphora*, Lantana *Lantana camara* and *Ipomoea indica*.

Floristic and structural summary of PCT 1638 within the study area.

Growth form	Typical species
Trees	<i>Angophora costata</i> , <i>Eucalyptus haemastoma</i> , <i>Corymbia gummifera</i> , <i>Eucalyptus capitellata</i>
Shrubs	<i>Allocasuarina littoralis</i> , <i>Exocarpus stictus</i> , <i>Lambertia Formosa</i> , <i>Callistemon salignus</i> , <i>Acacia longifolia</i> , <i>Pultenaea daphnoides</i> , <i>Polyscias sambucifolia</i> , <i>Leptospermum polygalifolium</i> , <i>Leptospermum trinervium</i> ,
Grass and grass-like	<i>Xanthorrhoea spp</i> , <i>Microlaena stipoides</i> , <i>Entolasia stricta</i> , <i>Imperata cylindrical</i> , <i>Lomandra obliqua</i> , <i>Gahnia aspera</i> , <i>Panicum simile</i>
Forb	<i>Dianella caerulea</i> , <i>Cryptostylis erecta</i> , <i>Lobelia purpurascens</i> ,
Fern	<i>Pteridium esculentum</i>
Other	<i>Billardiera scandens</i> , <i>Parsonsia straminea</i>
Exotic	<i>Syagrus romanzoffiana</i> , <i>Senna pendula var. glabrata</i> , <i>Setaria parviflora</i>

Growth form

Typical species

High Threat Exotic

Cinnamomum camphora, *Lantana camara*, *Cardiospermum grandiflorum*, *Ipomoea indica*



Photo 3-2: Plot 1638_G_01 showing vegetation zone five (PCT 1627 - Good)

3.1.3 Smooth-barked Apple - Red Mahogany - Swamp Mahogany - *Melaleuca sieberi* heathy swamp woodland of coastal lowlands

Vegetation formation: Forested Wetlands

Vegetation class: Coastal Swamp Forests

PCT ID: 1649 (3998)

Conservation status: Listed as Endangered “Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions” NSW BC Act. Does not meet the EPBC Act minimum condition thresholds for listing.

Estimate of percent cleared: 50 %

Vegetation zones (condition) and plots:

- Zone 6 1649 Low – 1 ha, one plot

Description:

Generally, this PCT occurs as a tall to very tall sclerophyll open forest or woodland with a sub-canopy of *Melaleuca* trees and a ground layer of sedges found on poorly drained clay alluvium on low-lying creek flats.

Within the study area, this PCT is restricted to riparian areas in poor condition and occurs as open forest with a canopy dominated by Smooth-Barked Apple *Angophora costata* and Swamp Mahogany *Eucalyptus robusta* with occasional Sydney Peppermint *Eucalyptus piperita*. The mid-storey contains sporadic *Melaleuca sieberi* and *Gahnia clarkei* individuals however is dominated and highly modified by Privet *Ligustrum sinense* and Lantana *Lantana camara*.

Floristic and structural summary of PCT 1649 within the study area

Growth form	Typical species
Trees	<i>Eucalyptus robusta</i> , <i>Angophora costata</i> , <i>Eucalyptus piperita</i>
Shrubs	<i>Melaleuca sieberi</i> , <i>Pittosporum undulatum</i> , <i>Glochidion ferdinandi</i>
Grass and grass-like	<i>Gahnia clarkei</i>
Forb	N/A
Fern	<i>Pteridium esculentum</i>
Other	N/A
Exotic	<i>Hydrocotyle bonariensis</i> , <i>Cyperus brevifolius</i>
High Threat Exotic	<i>Ligustrum sinense</i> , <i>Lantana camara</i> ,



Photo 3-3: Plot 1649_M_01 showing vegetation zone seven (PCT 1649 - Low)

3.1.4 Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter

Vegetation formation: Freshwater Wetlands

Vegetation class: Coastal Freshwater Wetlands

PCT ID: 1736 (3975)

Conservation status: Listed as in part as Endangered “*Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*” NSW BC Act. However, due to the artificial nature of this PCT, it does not represent the associated TEC.

Estimate of percent cleared: 92 %

Vegetation zones (condition) and plots:

- Zone 7 1736 Moderate – No plots. Within the study area but outside of construction footprint. Could not be surveyed due to water level.

Description:

Generally, this PCT occurs as freshwater sedgeland or forbland occurring in depressions on Quaternary alluvial deposits, primarily backswamps with organic-rich mud, silt or clay soils on coastal floodplains. A very sparse emergent tree layer is present on occasion with community often occurring in disturbed environments and may potentially include derived states.

Within the study area, this PCT occurs at the western end, and is likely to be a derived or artificial wetland within a low lying depression and as a function of previous disturbance, and colonised and dominated by *Baumea articulata*.

Floristic and structural summary of PCT 1736 within the study area

Growth form	Typical species
Trees	N/A
Shrubs	N/A
Grass and grass-like	<i>Baumea articulata</i> , <i>Cynodon dactylon</i> , <i>Typha orientalis</i>
Forb	<i>Persicaria decipiens</i> , <i>Alternanthera denticulata</i> ,
Fern	N/A
Other	N/A
Exotic	N/A
High Threat Exotic	N/A



Photo 3-4: showing vegetation zone eight (PCT 1736 - Moderate)

3.2 Threatened ecological communities

One PCT present within the study area, PCT 1649, is associated with TECs listed under the BC Act and EPBC Act, these being:

- Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (Swamp Sclerophyll Forest) (Endangered, BC Act), and
- Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland (Swamp Sclerophyll Forest EPBC Act) (Endangered, EPBC Act)

In this instance, PCT 1649 is considered to represent Swamp Sclerophyll Forest (Endangered, BC Act) as:

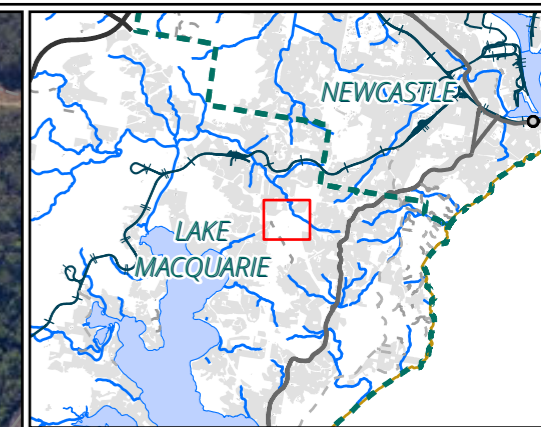
- 75% (6 of 8) of the native flora species recorded within PCT 1649 are characteristic of this TEC, most notably Swamp Mahogany which is the dominant tree
- The study area is within the Sydney Basin IBRA subregion and Lake Macquarie LGA
- The TEC occurs up to 50 metres elevation, where PCT 1649 occurs is about 30 metres elevation

The distribution of Swamp Sclerophyll Forest within the study area is that of PCT 1649 and is shown on Figure 3-2.

In contrast to the BC Act listings of TECs, the EPBC Act listings require that more stringent key diagnostics and condition criteria be satisfied. That is, a patch of potential EPBC Act TEC must meet the minimum condition and size thresholds. In this case, non-native

species must comprise no more than 80% of the total ground layer vegetation cover. Due to the high level (87.5%) of non-native cover, particularly Small-leaf Privet, recorded within PCT 1649, the minimum condition threshold is not met. Accordingly, PCT 1649 is not considered consistent with Swamp Sclerophyll Forest EPBC Act.

While PCT 1736 is listed as Endangered *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (BC Act), as it is artificial, it's not considered to represent this TEC in accordance with paragraph 4 of the final determination for the TEC.



Legend

- Study area

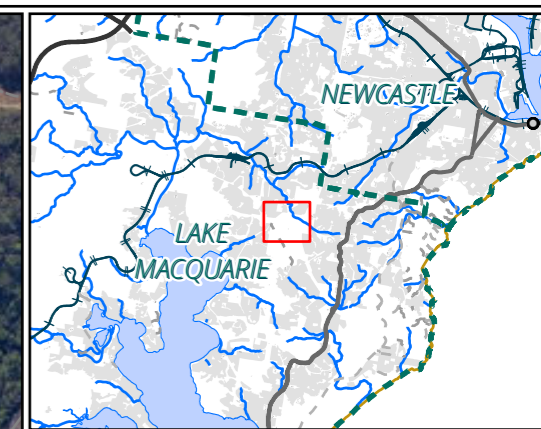
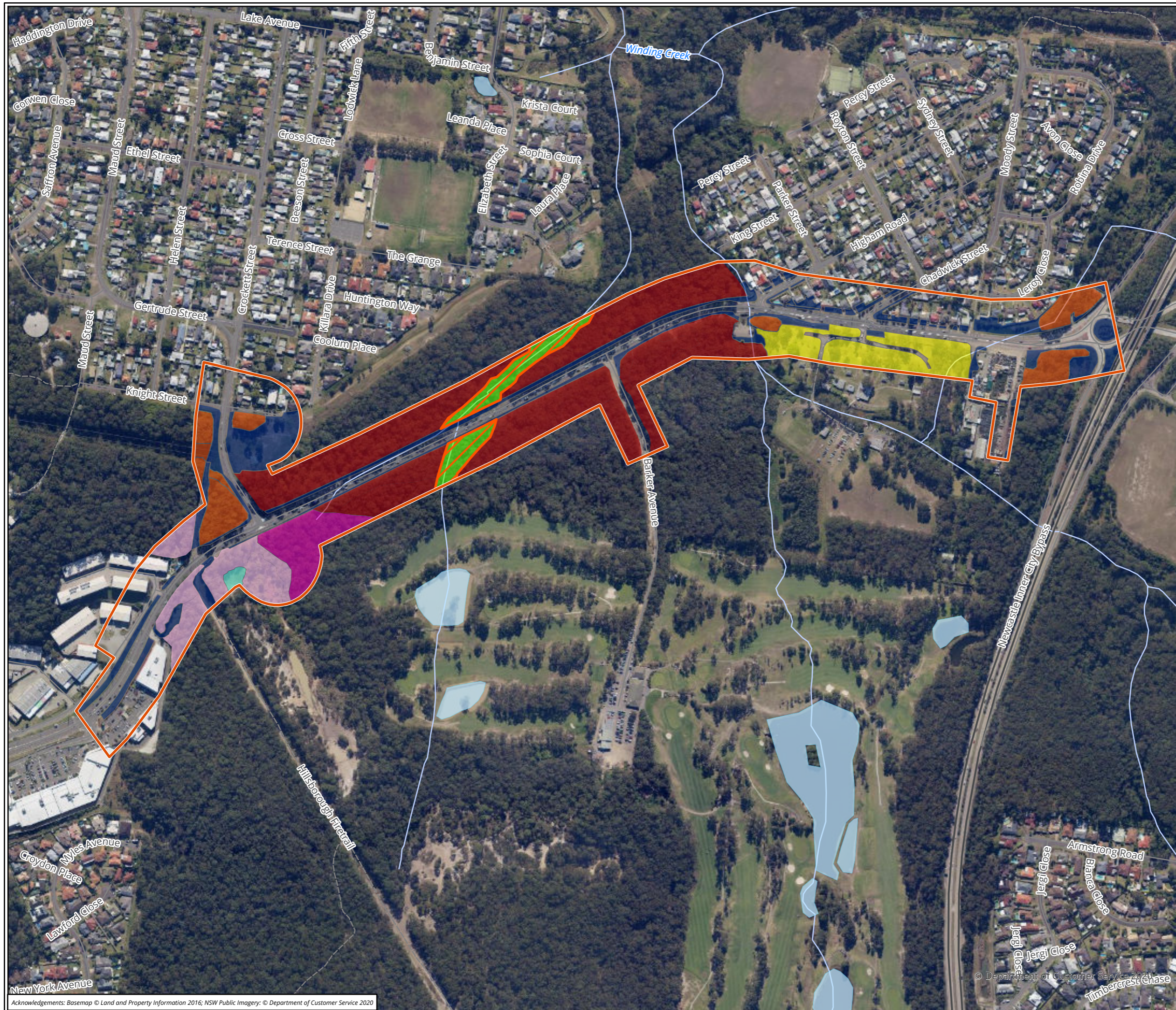
Zone, Plant Community Type and Management Zone

- Zone 1, PCT 1627_Good
- Zone 2, PCT 1627_Moderate
- Zone 3, PCT 1627_Canopy
- Zone 4, PCT 1638_Good
- Zone 5, PCT 1638_Moderate
- Zone 6, PCT 1649_Moderate
- Zone 7, PCT 1736_Moderate
- Disturbed/Urban Vegetation

Figure 3-1: Plant Community Types and vegetation zones

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56





Legend

- Study area
- Threatened Ecological Community**
- Swamp Sclerophyll Forest
- Plant Community Type**
- 1627_Good
- 1627_Moderate
- PCT 1627_Canopy
- PCT 1638_Good
- PCT 1638_Moderate
- PCT 1649_Moderate
- PCT 3959_Moderate
- Disturbed/Urban Vegetation

Figure 3-2: Threatened Ecological Communities

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56

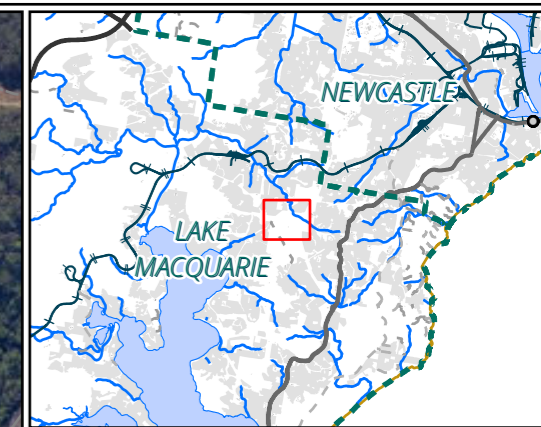
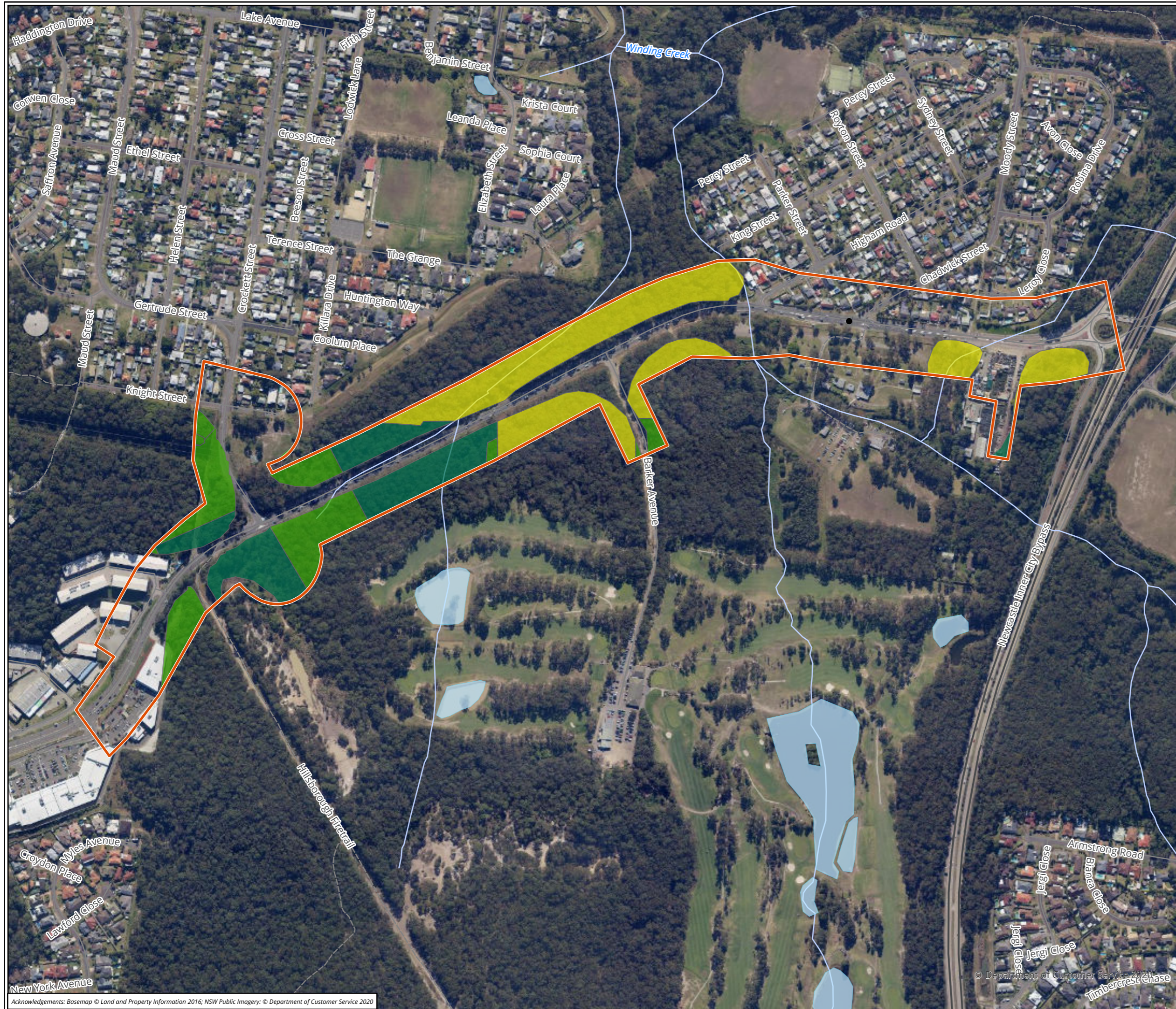


3.3 Groundwater dependent ecosystems

The likely degree of groundwater dependence of the PCTs within the study area has been assessed using the Atlas of GDEs (BOM 2022). The Atlas of GDEs (Figure 3-3) identifies areas of the study area associated with Winding Creek and adjoining tributary to the west as high potential GDE's. The study area does not contain any aquatic GDEs and is not located within a floodplain alluvial groundwater source (Jacobs 2019).

While PCT 1649 is considered a high likelihood to be a GDE, this PCT is not obligate, that is entirely dependent on groundwater. PCT 1649 is not restricted to locations of groundwater discharge or located within aquifers. PCT 1649 is likely to be an opportunistic facultative GDE that depends on the subsurface presence of groundwater in some locations but not in others, particularly where an alternative source of water (i.e. rainfall) cannot be accessed to maintain ecological function (Kuginis et al., 2012)

PCT 1736 only occurs in the study area due to previous disturbance (clearing and excavation) and is not a naturally occurring wetland. This wetland is man-made and exists due to ponding of stormwater. A freshwater wetland would not have naturally occurred in this location, rather PCT 1638 would have. The occurrence of PCT 1736 in the study area is rain fed and is not likely to be a GDE.



Legend

- Study area

Terrestrial GDEs (BOM 2022)

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies

Figure 3-3: Groundwater dependent ecosystem

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



3.4 Threatened species

3.4.1 Threatened flora

Targeted flora surveys were conducted for all those threatened flora considered to species to have a moderate or higher likelihood of occurring prior to targeted survey (Table 2-5). All but one, Black-eyed Susan (Vulnerable, BC Act and EPBC Act), were not detected and are considered a low likelihood of occurring (Table 3-2).

The growth form of Black-eyed Susan within the study area was a diffuse scrambler as is typical for the species where growing under larger shrubs and dense grassy undergrowth, however occasionally occurred as small, dense, multi-stemmed sub-shrubs. Owing to this rhizomatous nature of Black-eyed Susan, individuals were determined as clumps arising from the ground at a distance of >30 cm from any other clump, following the methods developed by Payne et al (2002). The location of all clumps were marked using ArcGIS field maps (Samsung tablet). Where more than one individual clump was located within an approximate 2 m radius of the observer, all clumps were recorded under a single GPS point.

The methods used to determine peak flowering of Black-eyed Susan were those outlined in the EPBC Act referral guidelines (Commonwealth of Australia 2011). Clumps of Black-eyed Susan were considered readily detectable using the parallel field traverse method, supported by random meanders searches. In areas of optimal habitat, there is a high likelihood that all, or at least the vast majority of individuals occurring in the study area, were detected during the survey. A total of 77 clumps of Black-eyed Susan were recorded within the study area and immediate surrounds (Figure 3-4). As the unit of measurement for this species is area, the species polygon has been formulated for Black-eyed Susan includes PCTs where the species was recorded (PCTs 1627 and 1638) in moderate to good condition (Zones 1, 2, 4 and 5) (Figure 3-4).

A summary of the targeted threatened flora survey results is provided in Table 3-2.

Table 3-2: Threatened flora surveys results

Species	EPBC Act	BC Act	Identification method (not recorded, assumed, recorded, expert report)	Survey effort compliant? ¹	Results
<i>Caladenia tessletata</i>	VU	EN	Not recorded	Yes	Habitat present but species not recorded after adequate survey.
<i>Callistemon linearifolius</i>	VU		Not recorded	Yes	Habitat present but species not recorded after adequate survey.
<i>Cryptostylis hunteriana</i>	VU	VU	Not recorded	Yes	Habitat present but species not recorded after adequate survey.
<i>Diuris praecox</i>	VU	VU	Not recorded	Yes	Habitat present but species not recorded after adequate survey.
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	VU	VU	Not recorded	Yes	Habitat present but species not recorded after adequate survey.

Species	EPBC Act	BC Act	Identification method (not recorded, assumed, recorded, expert report)	Survey effort compliant? ¹	Results
<i>Tetratheca juncea</i>	VU	VU	Recorded	Yes	77 clumps recorded within 2.9 ha of habitat (moderate-good condition zones of PCTs 1627 and 1638).

Note: 1. As identified in Section 2.4 of this BAR.

3.4.2 Threatened fauna

Incidental surveys and habitat assessment was undertaken to determine the likelihood of occurrence for a range of woodland birds, nectivorous birds and for the Grey-headed Flying-fox. These incidental surveys did not indicate the presence of a Grey-headed Flying-fox camp within the study area. All species of woodland birds and nectivorous birds were assessed as having a moderate likelihood of occurrence based on the availability of suitable foraging habitat associated with PCT 1627, PCT 1638 and PCT 1649. While mapping of hollows was undertaken, no targeted diurnal bird surveys were undertaken. Targeted surveys for Dusky Woodswallow, Varied Sittella, Brown Tree-creeper, Scarlet Robin or the Little Lorikeet, are not required under the BAM as they are ecosystem credits only, and therefore assumed to present.

Mapping of suitable hollows for breeding and targeted surveys for the Barking Owl, Masked Owl and Powerful Owl were undertaken within the study area. This revealed two potential nest trees within the study area. Call playback and spotlighting was undertaken in September 2021 and again in August 2022 broadly across the study area, across 6 sampling sessions in total, and 4 within optimal breeding periods. Additionally, monitoring of the two potential nest trees (Stag/hollow watching) and other areas were undertaken within the study area for evidence of activity (whitewash/pellets) in August 2022 over 4 evenings/nights.

Although differing from the amount of call playback survey required as stated in the relevant guidelines for the Masked Owl, similar variations to survey effort in August utilising a combination of methods employed in this assessment have been approved and undertaken previously in other BAM assessments and give a high likelihood of detection than call playback alone. Additionally, it is also less than ideal to undertake call playback in August from an ethical perspective, which can cause nest disturbance if a tree hollow is in use. It is preferred by owl subject matter experts that less intrusive survey, such as stag/hollow watching and targeted activity searches be prioritised later in the optimal breeding season. Given the location of the study area, and the identified potential suitable hollow bearing trees, the combination of methods employed ensure a very high probability of detection of forest owls species if they were to be present for breeding/roosting. No owl species were seen or heard during surveys and no evidence of breeding/roosting of the target owl species was observed, however foraging habitat is present.

Mapping of suitable hollows for Squirrel Glider and spotlighting was also undertaken over six nights. While Sugar Gliders *Petaurus breviceps* and Brush-tailed Possums *Trichosurus vulpecula* were detected commonly, no Squirrel Glider individuals were detected. However, a high likelihood of occurrence has been precautionarily assumed based on the ranking of the habitat present as highest quality by the Draft Lake Macquarie Squirrel Glider Planning and Management Guidelines 2015 (LMCC 2015) and nearby BioNet records, as well as more optimal habitat present to the south and north of Hillsborough Road.

Two acoustic detectors were deployed over two nights throughout the study area in September. No threatened microbat species were recorded during the survey period. No

breeding habitat for Large-eared Pied Bat, Large Bent-winged Bat, Little Bent-winged Bat and Eastern Cave Bat is present within the study area. However, there is only foraging habitat for these species present. The two box culverts within the study area are both of modern construction with very limited potential of use for microbats species. One central seam is evident in both culverts; however, no obvious gaps or crevices were observed that might serve as potential habitat for microbats (Photo 3-5:).

Under the BAM, habitat within two kilometres of known or perceived breeding habitat for Large-eared Pied Bat and Eastern Cave Bat is included in the species polygon for these species. Review of aerial imagery, BioNet records and field survey does not suggest that the study area falls within such parameters, therefore a species polygon for Large-eared Pied Bat and Eastern Cave Bat has not been prepared. As no breeding habitat for Large Bent-winged Bat or Little Bent-winged Bat is present and therefore a species polygon for these species has also not been prepared.

Foraging habitat for Southern Myotis is not present within the study area, however, it is present nearby including the ponds within Charlestown Golf Course to the south. Eastern False Pipistrelle, Eastern Coastal Free-tailed Bat, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat are ecosystem credits and are therefore assumed present based on foraging habitat available.

The targeted surveys undertaken for threatened microbats deviate from the requirements of the BAM and are generally lacking in scope, timing and intensity to adequately determine the presence/absence of the targeted species. To negate this limitation, habitat assessment has taken precedence and a 'Moderate' likelihood of occurrence rating has been applied to all threatened microbats surveyed for (Appendix B – Habitat assessment table), not just those requiring survey under the BAM.

Species polygons have been prepared for Squirrel Glider and Southern Myotis (Figure 3-4). For Squirrel Glider, the species polygon includes all applicable vegetation zones in 'moderate to good' condition. While no aquatic foraging habitat (dams, suitable pooling and widths of creeks) is present within the study area for Southern Myotis, there is at the golf course to the south in the form of damming. Portions of the study area within 200 metres of this foraging habitat have been included in the species polygon for Southern Myotis in accordance with *Species credit' threatened bats and their habitats* (OEH 2018).

Note that as species polygons were not prepared for the other species credit bat species (Large-eared Pied Bat, Large Bent-winged Bat, Little Bent-winged Bat and Eastern Cave Bat), These species are also not considered in offset calculations (Section 7).



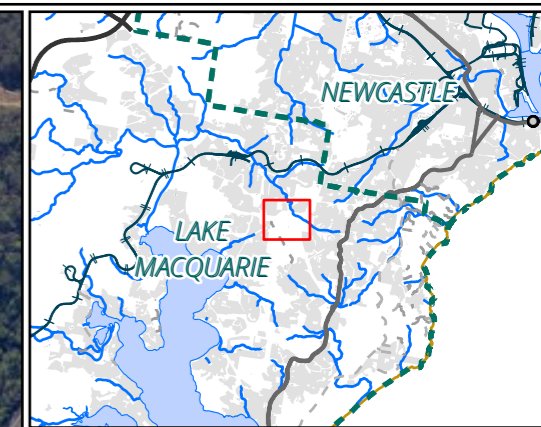
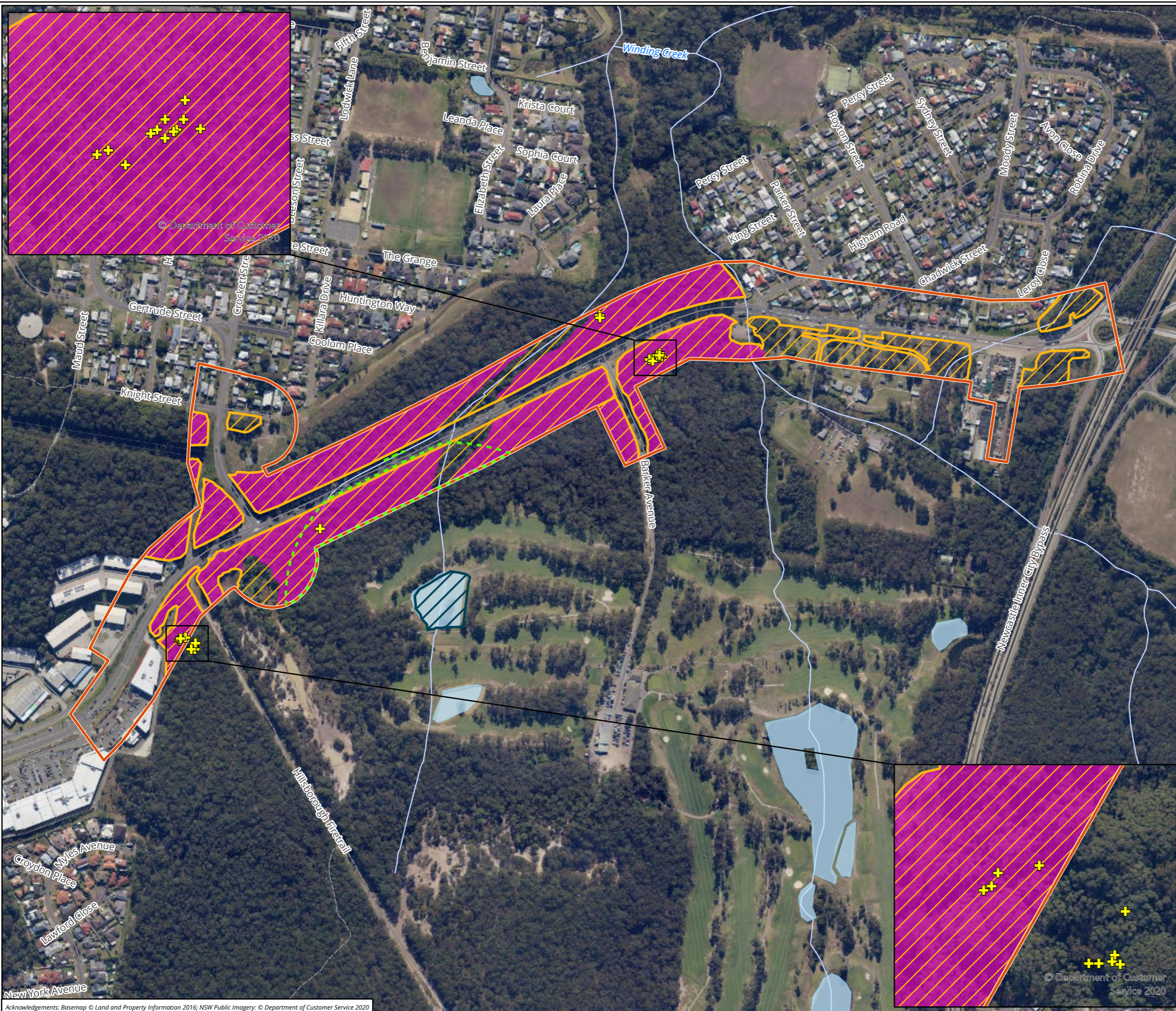
Photo 3-5: Example of culvert condition at Winding Creek

Table 3-3: Threatened fauna surveys results

Species	EPBC Act	BC Act	Identification method (not recorded, assumed, recorded, expert report)	Survey effort compliant? ¹	Results
Barking Owl <i>Ninox connivens</i>	N/A	V	Not Recorded	Yes	<p>Species/ Ecosystem Credit.</p> <p>The study area contains 14.8 hectares of suitable foraging habitat (PCT 1627, 1638 and 1649). Two potential nest trees were recorded within the study area which provide suitable breeding habitat for the species. These trees were monitored over four nights in August 2022. No sign of usage by owls was observed, with other arboreal fauna utilising one of the hollows</p>
Masked Owl <i>Tyto novaehollandiae</i>	N/A	V	Not Recorded	Yes - Varied methodology	<p>Species/ Ecosystem Credit.</p> <p>The study area contains 14.8 hectares of suitable foraging habitat (PCT 1627, 1638 and 1649). Two potential nest trees were recorded within the study area which provide suitable breeding habitat for the species. These trees were monitored over four nights in August 2022. No sign of usage by owls was observed, with other arboreal fauna utilising one of the hollows</p>

Species	EPBC Act	BC Act	Identification method (not recorded, assumed, recorded, expert report)	Survey effort compliant? ¹	Results
Powerful Owl <i>Ninox strenua</i>	N/A	V	Not Recorded	Yes	<p>Species/ Ecosystem Credit.</p> <p>The study area contains 14.8 hectares of suitable foraging habitat (PCT 1627, 1638 and 1649). Two potential nest trees were recorded within the study area which provide suitable breeding habitat for the species. These trees were monitored over four nights in August 2022. No sign of usage by owls was observed, with other arboreal fauna utilising one of the hollows</p>
Swift Parrot <i>Lathamus discolor</i>	CE	E	Not Recorded	Yes	<p>Species/Ecosystem Credit.</p> <p>The study area contains 14.8 hectares of suitable foraging habitat (PCT 1627, 1638 and 1649). Breeding occurs in Tasmania. Species not detected within the study area. The study area does not fall within known areas of important habitat mapping</p>
Regent honeyeater <i>Anthochaera phrygia</i>	CE	CE	Not Recorded	Yes	<p>Species/Ecosystem Credit.</p> <p>The study area contains 14.8 hectares of sub optimal foraging habitat (PCT 1627, 1638 and 1649). Species not detected within the study area. The study area does not fall within known areas of important habitat mapping</p>

Species	EPBC Act	BC Act	Identification method (not recorded, assumed, recorded, expert report)	Survey effort compliant? ¹	Results
Squirrel Glider <i>Petaurus norfolcensis</i>	N/A	V	Not Recorded – assumed present	Yes	Species Credit. The study area contains 14.8 hectares of suitable foraging habitat (PCT 1627, 1638 and 1649) suitable hollows for nesting. Species was not detected within the study area, however there is a high likelihood of occurrence based on background research and known records in the broader locality
Glossy Black-Cockatoo <i>Calyptorhynchus lathami</i>	V	V	Not Recorded	Yes	Species/Ecosystem Credit. The study area contains 14.8 hectares of suitable foraging habitat (PCT 1627, 1638 and 1649). No hollows suitable for breeding are expected to be impacted as a result of the works.
Large-eared Pied Bat <i>Chalinolobus dwyeri</i>	N/A	V	Not Recorded	NA	Species Credit. The study area contains 14.8 hectares of suitable foraging habitat (PCT 1627, 1638 and 1649). No breeding habitat is present. There is a moderate likelihood of occurrence for foraging.
Southern Myotis <i>Myotis Macropus</i>	N/A	V	Not Recorded – assumed present within species polygon	No	Species Credit. 2 hectares of native vegetation within the study area is contained within the species polygon for Southern Myotis. 5 suitable hollows for roosting/breeding area expected to be removed as a result of the works. Species was not detected within the study area, however there is a moderate likelihood of occurrence.



Legend

- Study area
- Southern Myotis foraging habitat
- + Black-eyed Susan

Species polygon

- Black-eyed Susan
- Squirrel Glider
- Southern Myotis

Figure 3-4: Recorded threatened species

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



Matter: 36135, Date: 07 September 2022,
 Prepared for: BR, Prepared by: JB, Last edited by: jbeckius
 Layout: 36135_F3.4_ThrSpec
 Project: P:\36100s\36135\Mapping\
 36135_MR674_HillsboroughRd_REF_FFA_F2-3.aprx

3.5 Aquatic results

As mentioned in Section 2.5, the habitat quality for aquatic species within Winding Creek and its unnamed tributary has been assessed by this BAR and Jacobs (2019) as being poor.

No KFH or habitat for threatened aquatic species, populations or ecological communities listed under the FM Act is present. No such threatened entities are considered to have a moderate or higher likelihood of occurring.

The location of Winding Creek and its unnamed tributary can be seen on Figure 1-2.

3.6 Areas of outstanding biodiversity value

No areas of outstanding biodiversity value occur within the study area.

3.7 Wildlife connectivity corridors

The study area comprises roadside vegetation that sits within a much larger tract of native vegetation that extends north to Cardiff South and Garden Suburb, west to Warners Bay and south to Mount Hutton. Connectivity in an eastward direction is hindered significantly by the Newcastle Inner City Bypass.

Presently, the current Hillsborough Road serves as an impediment to movement and a mortality risk to movement for ground dwelling fauna. The current tree canopy gap across Hillsborough Road is about 30 metres on average (Jacobs 2019) which is within the capabilities of gliding marsupials such as Squirrel Glider. As discussed in Section 3.4.2, the habitat present within the study area is high quality for Squirrel Glider and LMCC (2016) with mapped important crossing points at four locations between the CNGG Showground in the east and the power easement in the west near Crockett Street. The central crossing point, about where the unnamed tributary crosses Hillsborough Road is considered a Category 6 crossing which is defined as:

Wide interface of bushland (>500 metres) at each side of a crossing point & less than 70 metres in crossing distance. Important areas for fauna movement (LMCC 2016).

3.8 SEPPs

The State Environmental Planning Policy (SEPP) (Resilience and Hazards) 2021 commenced on 1 March 2022 and includes coastal planning provisions that were enacted by the SEPP (Coastal Management) 2018. No coastal management areas identified under the new SEPP are present within the study area, therefore the proposal need not consider, SEPP (Resilience and Hazards) 2021.

The proposal does not require assessment in accordance with the SEPP as it is an activity being considered under Division 5.1 of the EP&A Act, however the SEPP provides guidance for the identification of koala habitat which was used to inform the assessment for the proposal.

3.9 Matters of national environmental significance

One Matter of National Environmental Significance (MNES), Black-eyed Susan (Vulnerable, EPBC Act) was recorded within the study area. No other flora species listed under the EPBC Act were assessed as having a moderate or higher likelihood of occurrence within the study area.

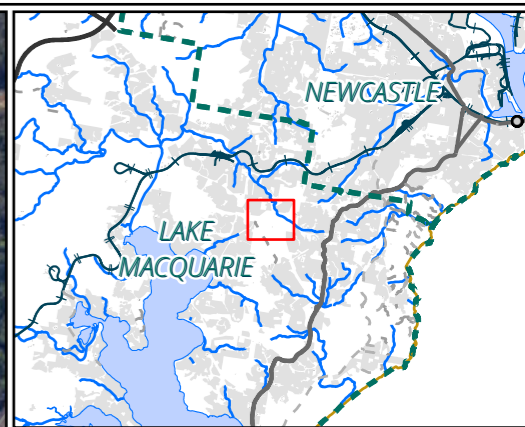
As discussed in Section 3.2, although PCT 1649 is associated with the EPBC Act listed TEC Swamp Sclerophyll Forest (Endangered), PCT 1649 within the study area does not meet the minimum condition threshold for listing.

Three threatened fauna species listed under the EPBC Act were assessed as having a moderate or higher likelihood of occurrence within the study area, these include Regent

Honeyeater (Critically Endangered), Swift Parrot (Critically Endangered) and Large-eared Pied Bat (Vulnerable).

The nearest wetland of international importance is Hunter Estuary Wetlands, which occurs within 10 km to the north. There is no apparent interaction between the waterways within the study area and Hunter Estuary Wetlands. Winding Creek flows north and east to Cockle Creek, which then flows south into Lake Macquarie.

No migratory species are considered likely to occur within the study area with any regularity.



- Legend**
- Study area
 - + Black-eyed Susan

Figure 3-6: Matters of National Environmental Significance

0 50 100 150 200
 Metres
 Scale: 1:5,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



Matter: 36135, Date: 06 September 2022,
 Prepared for: BR, Prepared by: JB, Last edited by: jbeckius
 Layout: 36135_F3.6_MONES
 Project: P:\36100s\36135\Mapping\
 36135_MR674_HillsboroughRd_REF_FFA_F2-3.aprx

4 Avoidance and minimisation

A key part of management of biodiversity for this proposal is the application of the 'avoid, minimise, mitigate and offset' hierarchy as follows:

1. Avoid and minimise impacts
2. Mitigate impacts
3. Offset impacts in accordance with relevant Transport guidelines.

This chapter of the BAR demonstrates the efforts taken to avoid and minimise impacts on biodiversity values.

The key biodiversity constraints within the study area recommended for avoidance were discussed in the PBA for the proposal prepared by Jacobs (2019). These included:

- Swamp Sclerophyll Forest located along the central riparian corridor which traverses north and south of Hillsborough Road.
- The population of Black-eyed Susan, which at the time was thought to only occur on the southern side of Hillsborough Road, east of the golf course entry.
- Targeted surveys conducted for this BAR confirmed the species to be present at a further three locations (Figure 3-4). All known occurrences of Black-eyed Susan within the study area are outside the construction footprint considered by Jacobs (2019) and this BAR.
- Predicted habitat for several threatened fauna species, particularly Squirrel Glider, Powerful Owl, Masked Owl, and Grey-headed Flying-fox. Jacobs (2019) notes *Hillsborough Road currently dissects large areas of remnant vegetation and habitat to the north and south, and the proposed duplication of the road has potential to increase the barrier effect of the road and will require consideration of the introduction of appropriate fauna crossing structures. Hollow-bearing trees have been mapped in proximity to the road edge, and these represent important features where impact could be avoided or minimised.*
- The importance of the north-south corridor for fauna recognised by LMCC (2016).

Review of the strategic design considered by the Jacobs (2019) in comparison to the proposal assessed for this BAR has revealed that there have been limited opportunities to avoid the biodiversity constraints listed above. Moreover, required design refinements, such as the inclusion of a U-turn facility at Barker Avenue, have resulted in a slight increase to the overall clearing footprint from that included in the strategic design.

However, in acknowledgement of the proposal's objectives and that the 'do nothing' option is not feasible, this is not considered an unexpected outcome. The footprint of the proposal is considered the minimum required to provide for a more functional and safer carriageway.

It should be noted that no Black-eyed Susan are known to be present within the proposal area, therefore, there was no opportunity to demonstrate avoidance of this threatened species. Furthermore, elements of the proposal where this is more flexibility, such as the temporary compounds, are proposed to be located in areas that have low environmental sensitivity, ensuring biodiversity impacts have been minimised wherever possible. The noted Sydney Red Gum *Angophora costata* tree has also been avoided during design.

Given that there are impacts to biodiversity from the proposal that are not avoidable, standard and site-specific mitigation measures and safeguards would be applied to ameliorate or minimise these expected impacts, as well as the implementation of the No Net Loss Guidelines (Transport 2020a). These are detailed in Section 6 and Section 7.

5 Impact assessment

5.1 Direct impacts

5.1.1 Removal of native vegetation

The proposal would result in the direct loss of native vegetation, including one BC Act listed TEC, as summarised in Table 5-1. Impacts were calculated using GIS and the construction footprint (limit of works) provided to Biosis by GHD.

Table 5-1: Summary of direct impacts on native vegetation

Veg zone	PCT	Broad condition class	TEC	Area to be impacted (ha) ¹
1	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Good	Not a TEC	2.1
2	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Moderate	Not a TEC	0.4
3	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Canopy	Not a TEC	0.8
4	PCT 1638: Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast	Good	Not a TEC	0.2
5	PCT 1638: Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast	Moderate	Not a TEC	0.4
6	PCT 1649: Smooth-barked Apple - Red Mahogany - Swamp Mahogany - Melaleuca sieberi heathy swamp woodland of coastal lowland	Moderate	Endangered, BC Act	0.2
Total				4.1

NOTE 1: Area to be cleared based on ground-truthed vegetation mapping within the subject land.

5.1.2 Removal of threatened fauna habitat

The proposal would result in the removal of approximately 4.1 ha of native vegetation, 3.3 ha (80%) of which is in good to moderate condition. Foraging resources, for a range of threatened fauna, would be removed. Additionally, five HBTs, containing one small hollow (0-9 cm) and four medium hollows (10-15 cm), suitable for hollow-dependent small birds, microbats and gliders would be directly impacted. No evidence of any current use of these hollows by any species was observed during field surveys and based on the location and current level of disturbance from the existing road, it is likely only common mobile

disturbance tolerant species would be considered likely to utilise these hollows at any time. The loss of hollow-bearing trees is a KTP listed under Schedule 2 of the BC Act. No HBTs that are suitable habitat for dual credit species such as Powerful Owl (living or dead trees with hollow greater than 20 cm diameter) and Glossy-Black Cockatoo (living or dead trees with hollows greater than 15 cm diameter and greater than 8m above ground) would be removed.

Works to widen both culverts will impact the associated waterways and surrounding vegetation directly. Both culverts are considered unsuitable for roosting microbats given no potential habitat was observed and that they are heavily overgrown which would limit fly-in and fly-out.

A summary of impacts to potential habitat for those species assessed as having a moderate or higher likelihood of occurrence within the study area are presented below.

Table 5-2: Summary of direct impacts on threatened fauna and habitat

Species	Credit type	BC Act	EPBC Act	Potential occurrence (Moderate, High, Recorded)	Associated habitat in subject land	Impact (ha)
Regent Honeyeater <i>Anthochaera phrygia</i>	Ecosystem/ Species	CR	CR	Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only). Note – there are no impacts to important mapped areas.
Dusky Woodswallow <i>Artamus cyanopterus cyanopterus</i>	Ecosystem	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1
Glossy Black-Cockatoo <i>Calyptorhynchus lathami</i>	Ecosystem/ Species	VU	VU	Moderate	PCT 1627, 1638	3.1 (foraging only)
Large-eared Pied Bat <i>Chalinolobus dwyeri</i>	Ecosystem/ Species	VU	VU	Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only)
Brown Tree Creeper (eastern subspecies) <i>Climacteris picumnus victoriae</i>	Ecosystem	VU		Moderate	PCT 1627, 1638	3.1
Speckled Warbler <i>Daphoenositta chrysoptera</i>	Ecosystem	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1
Eastern False Pipistrelle <i>Falsistrellus tasmaniensis</i>	Ecosystem	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1

Species	Credit type	BC Act	EPBC Act	Potential occurrence (Moderate, High, Recorded)	Associated habitat in subject land	Impact (ha)
Little Lorikeet <i>Glossopsitta pusilla</i>	Ecosystem	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1
Swift Parrot <i>Lathamus discolor</i>	Ecosystem/ Species	EN	CR	Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only). Note – there are no impacts to important mapped areas.
Square-tailed Kite <i>Lophoictinia isura</i>	Ecosystem/ Species	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only)
Eastern Coastal Free-tailed Bat <i>Micronomus norfolkensis</i>	Ecosystem	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1
Little Bent-winged Bat <i>Miniopterus australis</i>	Ecosystem/ Species	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only)
Large Bent-winged Bat <i>Miniopterus orianae oceanensis</i>	Ecosystem/ Species	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only)
Southern Myotis <i>Myotis macropus</i>	Species	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	0.5 within species polygon
Barking Owl <i>Ninox connivens</i>	Ecosystem/ Species	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only)
Powerful Owl <i>Ninox strenua</i>	Ecosystem/ Species	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only)
Squirrel Glider <i>Petaurus norfolcensis</i>	Species	VU		High	PCT 1627, 1638 and 1649 (all zones)	4.1 within species polygon
Scarlet Robin <i>Petroica boodang</i>	Ecosystem	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1
Grey-headed Flying-fox <i>Pteropus poliocephalus</i>	Ecosystem/ Species	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only)

Species	Credit type	BC Act	EPBC Act	Potential occurrence (Moderate, High, Recorded)	Associated habitat in subject land	Impact (ha)
Yellow-bellied Sheath-tail-Bat <i>Saccolaimus flaviventris</i>	Ecosystem	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1
Greater Broad-nosed Bat <i>Scoteanax rueppellii</i>	Ecosystem	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1
Eastern Cave Bat <i>Vespadelus troughtoni</i>	Species	VU		Moderate	PCT 1627, 1638 and 1649 (all zones)	4.1 (foraging only)

5.1.3 Removal of threatened flora

The proposal would not lead to the direct loss of any individuals of threatened flora species as the only threatened flora species recorded, Black-eyed Susan, was recorded outside the construction footprint. However, there would be the removal of up to 2.9 ha of potential habitat (PCTs 1627 and 1638) defined by the species polygon for the species.

The viable local population of Black-eyed Susan present is unlikely to depend on the habitat that would be removed for its long-term survival as expanses of high quality habitat occur contiguous with the study area to the north and south of Hillsborough Road.

Table 5-3: Summary of direct impacts on threatened flora

Species	BC Act	EPBC Act	Potential occurrence (Moderate, High, Recorded)	Associated habitat in subject land	Impact (ha or individuals)
Black-eyed Susan <i>Tetradlea juncea</i>	VU	VU	Recorded	PCT 1627 (Zone 1 and 2), PCT 1638 (Zones 5 and 6)	2.9 ha within species polygon

5.1.4 Aquatic impacts

The most likely aquatic impact from the proposal is introduction of sedimentation downstream from construction, potential erosion of stream banks from physical disturbance and potential bed erosion if the culvert extensions do not have sufficient scour protection. The extensions will also impact upon bed area at Winding Creek and the unnamed waterway.

The hydrology of Winding Creek would be altered to facilitate the flow of water into the culvert at an angle in line with the skew of the existing culvert proposed extension. This is not considered likely to have any lasting detrimental effects on Winding Creek. The culvert works, in conjunction with rehabilitation works, may improve flow and improve aquatic fauna movements above the present condition.

There is unlikely to be the loss of riparian and/or aquatic habitat such as relocation or removal of snags. Fish passage, as discussed in Section 2.5, is unlikely to be occurring due to the nature of Winding Creek. Therefore, the proposal would not introduce a new barrier to fish passage. Any obstruction to fish passage would be during construction only and minor.

Discernible change in the hydrology and depth of the unnamed creek is not anticipated.

No threatened aquatic species, populations and communities have been identified within the study area or are considered likely to occur, therefore, would not be impacted

5.1.5 Injury and mortality

The potential for wildlife injury or death could occur during the construction phase of the proposal. The clearing of vegetation may result in injury or death to resident fauna. Species at risk include nocturnal species such as possums, glider and microbats which shelter during the day, and ground dwelling species such as snakes, lizards, and small mammals. There is also the risk of displaced fauna succumbing to predation, or stress induced by competing with existing resident populations for resources, particularly shelter / refuge habitat.

In summary, injury and mortality of fauna could occur during construction activities, including:

- During construction, when vegetation and habitat are being cleared.
- Collision/strike by machinery and plant.
- Collision with construction traffic.

5.1.6 Groundwater dependent ecosystems

As discussed in Section 3.3, The Atlas of GDEs (BOM 2022) (Figure 3-3) identifies areas of the study area associated with Winding Creek and adjoining tributary to the west as high potential GDE's. The study area does not contain any aquatic GDEs and is not located within a floodplain alluvial groundwater source (Jacobs 2019).

Direct impacts to these GDEs include the clearing of native vegetation and the construction and disturbance footprint required to facilitate the extension of existing culverts. There is not anticipated to be any appreciable change in groundwater flow or depth during construction of the proposal. It should also be noted that these GDEs are not entirely groundwater dependent and are more reliant on the collection of rainwater in these locations.

5.2 Indirect impacts

5.2.1 Edge effects on adjacent native vegetation and habitat

The proposal is likely to create new edge effects in previously undisturbed native vegetation in good-moderate condition, including that adjacent to known locations of Black-eyed Susan. Considering the present edge effects, such as increased opportunity for weed encroachment and exposure within the study area, widening of Hillsborough Road would 'push back' these edge effected areas in the long-term as weeds colonise previously undisturbed areas.

5.2.2 Wildlife connectivity and habitat fragmentation

The study area forms part of an important wildlife corridor as described in Section 3.7 (LMCC 2016). Hillsborough Road and adjacent existing transmission line already presents a barrier to movement in a north-south direction, particularly for ground dwelling and less mobile fauna. Use of GIS software has revealed that the proposal would increase the present canopy gap from about 30 metres average to about 50 metres on average at the location of this corridor (Jacobs 2019). Gap distance allowing regular crossing is thought to be up to 35 metres depending on the height of the existing trees present, whereas a road

canopy gap of at least 50 metres is thought to be an almost complete barrier to glide crossings (Van Der Ree et al. 2010). Therefore, the increase in a canopy gap proposed is likely to create a barrier to movement for arboreal fauna such as Squirrel Glider. Individuals would be deterred from making the crossing and those that do have an increased chance of vehicle strike. Furthermore, the relocation of overhead power lines on the northern side of Hillsborough Road would also pose an injury/mortality risk as they may obstruct the vegetation that traversing individuals are trying to reach.

The proposal would increase localised habitat fragmentation by 20 metres, primarily in a north-south direction. Based on the literature reviewed for this BAR, there is a high likelihood that a barrier to movement for arboreal fauna such as Squirrel Glider and other arboreal fauna would be introduced. Accordingly, mitigation measures are proposed (Section 6) with the aim of reducing any potential long-term impacts to a non-significant level by maintaining the present level of connectivity.

It is proposed that a re-directive barrier in the centre of the road be implemented as part of the proposal, however it is not anticipated that the installation of a re-directive barrier between eastbound and westbound lanes would introduce a barrier to movement for any fauna species due to the height and width of the structure once installed. Additionally, the installation of safety barriers on the edge line of the road upon operation will not significantly impact upon the movement of fauna above what is currently existing.

5.2.3 Injury and mortality

Given the widening of Hillsborough Road proposed, and potential for increased development in the broader locality, it is anticipated that traffic volumes may increase upon operation. The proposal will introduce improvements in traffic safety, management and flow, however coupled with an approximate doubling in crossing distance, it is considered possible that an increase to the risk of injury and mortality to susceptible fauna via vehicle strike would occur upon operation.

5.2.4 Invasion and spread of weeds

The proposal has the potential to spread weeds during vegetation removal and through the movement of vehicles and machinery into or out of the proposal area. Weeds are easily transported as seeds and propagules on machinery brought to the proposal area. Equally, they can be carried away to other areas from the site or spread within it. If weeds are not controlled prior to work commencing, then there is the potential for spread throughout the site during and following construction.

Rehabilitation of disturbed areas and ongoing weed management after the completion of construction activities would limit the establishment and spread of weed species during operation.

Several High Threat Weeds (under the BAM) were recorded. These are:

- Whiskey Grass *Andropogon virginicus*
- Asparagus Fern *Asparagus aethiopicus*
- Climbing Asparagus Fern *Asparagus africanus*
- Balloon Vine *Cardiospermum grandiflora*
- Kikuyu *Cenchrus clandestina*
- Camphor laurel *Cinnamomum camphora*
- African Love Grass *Eragrostis curvula*
- Coolatai Grass *Hyparrhenia hirta*
- Morning Glory *Ipomoea indica*
- Lantana *Lantana camara*
- Large-leaf Privet *Ligustrum lucidum*

- Small-leaf Privet *Ligustrum sinense*
- Japanese Honeysuckle *Lonicera japonica*
- Guinea Grass *Megathyrsus maximus*
- Mickey Mouse Plant *Ochna serrulata*
- *Paspalum dilatatum*
- Buffalo Grass *Stenotaphrum secundatum*

Many of the above species occur as incidental of low coverages within vegetation categorised as good to moderate condition. Within certain zones (PCT 1627 Moderate and PCT 1649 Moderate), woody weeds such as Lantana and Small-leaf Privet are prevalent in disturbed areas such as edges.

5.2.5 Invasion and spread of pests, pathogens and disease

During construction, the proposal has the potential to cause both the spread of pathogens and diseases currently occurring in the study area and surrounds, and to introduce new biodiversity risks. This is particularly the case for fungus and diseases spread through the introduction and movement of soil. Standard pest hygiene management measures during construction would minimise this risk.

5.2.6 Changes to hydrology

There will be some alteration to the existing surface hydrological conditions, however, this alteration is anticipated to be minor (surface level changes) such that the processes that are currently in place would largely remain.

Additionally, the nature of Winding Creek and the unnamed waterway to the west would be altered as the culverts associated with each waterway would be extended. Ultimately, the condition of each waterway post-construction will differ little from their current state.

Any small change to hydrology is unlikely to be cause a substantial impact to the native vegetation and habitat present in the study area or surrounds post construction

5.2.7 Noise, light, dust and vibration

Temporary disturbance to wildlife from noise emissions and light spill during construction and night works are likely to be localised to within 50-100 m of the construction footprint and are not likely to have a significant long-term impact on wildlife that may occur within the study area or surrounding environment.

Noise, light and vibration may disturb any fauna, including threatened microbats that may be inhabiting nearby HBTs. Night works may be sufficient enough of a deterrent to arboreal fauna, such as Squirrel Glider, from crossing Hillsborough Road as they would normally do.

Given Hillsborough Road would be duplicated, an increase in operational noise is anticipated, particularly at the intersection with Chadwick Street. Traffic noise can reduce the distance over which acoustic signals such as song can be detected, an effect known as acoustic interference or masking. Traffic noise could hamper detection of acoustic signals by members of the same species or predator species that use these signals to locate prey. Traffic noise is makes it more difficult for fauna to establish and maintain territories, attract mates and maintain pair bonds, and possibly leading to reduced breeding success in noisy roadside habitats.

5.3 Cumulative impacts

Table 5-4 demonstrates known projects in the broader locality that will impact upon similar native vegetation, habitat and threatened species.

Table 5-4: Present and future project/proposals

Project/proposal	Biodiversity value impacted	Construction impacts	Operational impacts
Newcastle Inner City Bypass (Rankin Park to Jesmond)	Black-eyed Susan	Removal of 846 clumps	None
	Native vegetation and associated habitat for threatened flora and fauna including Squirrel Glider and Black-eyed Susan	39.2 ha	Indirect impacts such as noise, lighting and vibration within 20 m of the construction footprint.
	Squirrel Glider	Removal of 320 hollow-bearing trees	Reduction of a wildlife corridor and potential impediment to movement
John Hunter Health and Innovation Precinct (SSD - 9351535)	Native vegetation and associated habitat for threatened flora and fauna including Squirrel Glider and Black-eyed Susan	7.2 ha vegetation removal	Indirect impacts such as noise and lighting

5.4 Assessments of significance

BC Act Tests of Significance (ToS) and EPBC Act Significant Impact Criteria (SIC) assessments were undertaken for all relevant threatened entities recorded or considered to have a moderate or higher likelihood of occurrence within the construction footprint. These assessments are summarised in Table 5-5 and Table 5-6 respectively.

No FM Act 7-part tests were undertaken as no threatened entities protected under the FM Act are considered likely to occur and are subsequently at no risk of impact.

A significant impact to any threatened entity is not considered likely, however this finding is underpinned by the effective implementation of the mitigation measures detailed in Section 6. This is particularly true for Squirrel Glider as the level of impact the proposal would cause to the local population without connectivity mitigation is uncertain without further, in-depth study. Accordingly, the precautionary principle has been applied and the potential for a significant identified.

Table 5-5: Summary of BC Act significance assessments findings

Threatened species, or communities	<i>Significance assessment question*</i>					Likely significant impact?
	a	b	c	d	e	
<i>Barking Owl</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>Unlikely</i>
<i>Masked Owl</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>Unlikely</i>
<i>Powerful Owl</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>Unlikely</i>

Significance assessment question*						
Threatened species, or communities	a	b	c	d	e	Likely significant impact?
<i>Grey-headed Flying-fox</i>	N	N	N	N	N	Unlikely
<i>Dusky Woodswallow</i>	N	N	N	N	N	Unlikely
<i>Varied Sittella</i>	N	N	N	N	N	Unlikely
<i>Brown Tree Creeper</i>	N	N	N	N	N	Unlikely
<i>Scarlet Robin</i>	N	N	N	N	N	Unlikely
<i>Swift Parrot</i>	N	N	N	N	N	Unlikely
<i>Regent Honeyeater</i>	N	N	N	N	N	Unlikely
<i>Little Lorikeet</i>	N	N	N	N	N	Unlikely
<i>Squirrel Glider</i>	N	N	N	N	N	Unlikely
<i>Glossy Black-Cockatoo</i>	N	N	N	N	N	Unlikely
<i>Large-eared Pied Bat</i>	N	N	N	N	N	Unlikely
<i>Large Bent-winged Bat</i>	N	N	N	N	N	Unlikely
<i>Little Bent-winged Bat</i>	N	N	N	N	N	Unlikely
<i>Eastern Cave Bat</i>	N	N	N	N	N	Unlikely
<i>Eastern Coastal Free-tailed Bat</i>	N	N	N	N	N	Unlikely
<i>Eastern False Pipistrelle</i>	N	N	N	N	N	Unlikely
<i>Greater Broad-nosed Bat</i>	N	N	N	N	N	Unlikely
<i>Southern Myotis Myotis</i>	N	N	N	N	N	Unlikely
<i>Yellow-bellied Sheath-tail-bat</i>	N	N	N	N	N	Unlikely
<i>Black-eyed Susan</i>	N	N	N	N	N	Unlikely
<i>Swamp Sclerophyll Forest</i>	N	N	N	N	N	Unlikely

Notes: Y = Yes (negative impact), N = No (no or positive impact), X = yes/no answer not applicable, ? = unknown impact.

* Section 7.2 of the BC Act and Threatened Species Test of Significance Guidelines (OEH 2018)

Table 5-6: Summary of EPBC Act significance assessments findings

Threatened species, or communities	Important population*	Likely significant impact?
<i>Black-eyed Susan</i>	N	N
<i>Swift Parrot</i>	X	N
<i>Regent Honeyeater</i>	X	N
<i>Glossy-black Cockatoo</i>	N	N

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

* Significant Impact Guidelines 1.1 (DoE 2013)

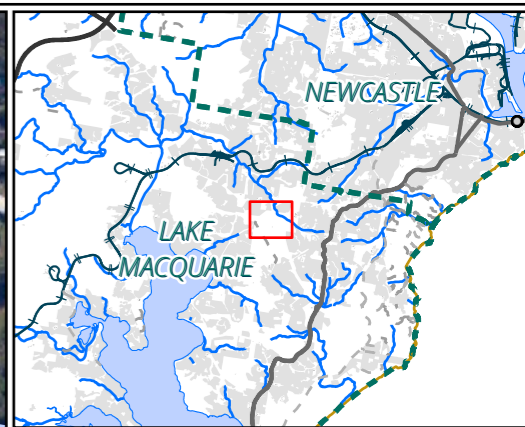
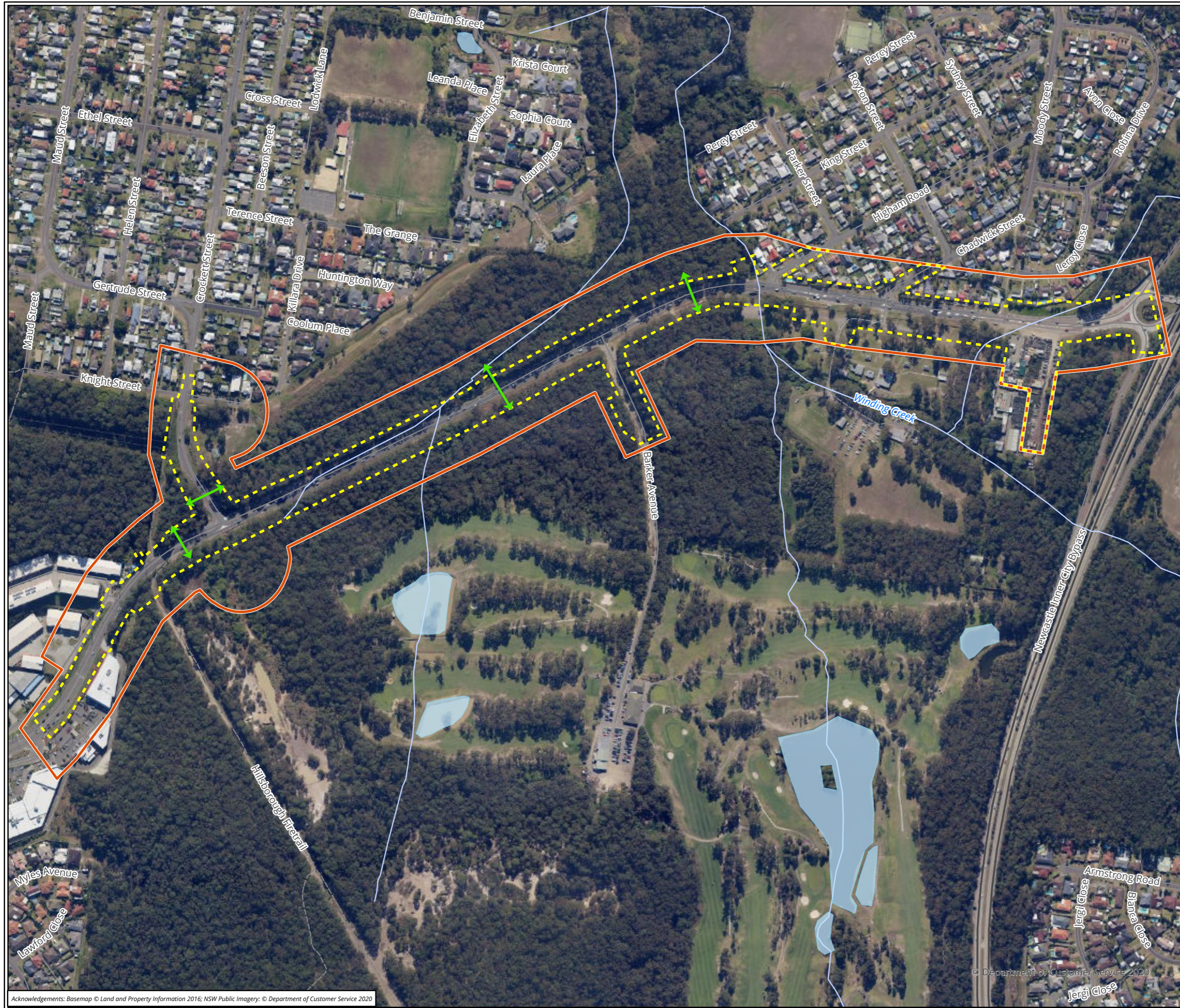
6 Mitigation

Mitigation measures recommended for the proposal are detailed in Table 6-1.

Table 6-1: Mitigation measures

Impact	Mitigation measure	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated?	Responsibility
Impacts to native flora and fauna	A Flora and Fauna Management Plan will be prepared and implemented as part of the Construction Environmental Management Plan (CEMP). It will address impacts to flora and fauna and include, but not necessarily be limited to:	Prior to construction	Effective	The residual impact on native vegetation is the 4.1 ha or removal proposed, including 0.2 ha of BC Act listed TEC.	Transport/Contract or
	(a) plans for the construction site and adjoining area showing native vegetation, flora and fauna habitat, threatened species and ecological communities;				
	(b) plans showing areas to be cleared and areas to be protected, including exclusion zones and protected habitat features (eg. hollow-bearing trees), and areas for rehabilitation or re-establishment of native vegetation;				
	(c) requirements set out in the RTA Landscape Guideline;				
	(d) procedures addressing relevant matters specified in the <i>Biodiversity Guidelines - Protecting and managing biodiversity on RTA projects</i> (RTA 2011)				
	Development and implementation of a Biodiversity Offset Strategy to facilitate offsetting of impacts that exceed the thresholds within the <i>No Net Loss Guidelines</i> (Transport 2022a) (see Section 7.3)	Prior to construction	Effective	None	Transport
	Calculate the requirement to replace trees and hollows in accordance with the <i>Tree and Hollow Replacement Guidelines</i> (Transport 2022b). Prepare a Tree and Hollow Replacement Plan if onsite replacement is sought (see Section 7.3) and/or make equivalent payment to the Transport Conservation Fund.	Prior to construction	Effective	None	Transport
Biodiversity impacts	Impacts to biodiversity will be minimised through detailed design, where practical and demonstrated within the Detailed Design report.	Detailed design	Effective	Identify the loss of biodiversity	Transport

Impact	Mitigation measure	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated?	Responsibility
Fragmentation of identified habitat corridors	<p>A Fauna Connectivity strategy would be developed and implemented in accordance with the draft Roads and Maritime Wildlife Connectivity Guidelines (Roads and Maritime 2011c). The strategy is to focus on maintaining connectivity through the proposal and is to include, but not be limited to:</p> <p>(a) Assessment of tree heights at identified locations on Figure 6-1, and other areas in the study area, for suitability of crossing points.</p> <p>(b) provision of fauna crossings and locations, particularly where canopy gaps are greater than 50 metres, between Barker Avenue and CNCC Showgrounds</p> <p>(c) identification of trees suitable for retention and recommendations for suitable landscaping or fauna features in design</p> <p>(d) consideration of further minimising impact area where practical</p> <p>(e) consideration of traffic noise and artificial lighting impacts at crossing points</p> <p>(f) Consideration of undergrounding utilities to reduce clearing</p>	Detailed design, during construction and post construction	Proven	May introduce a barrier to movement for arboreal fauna if mitigation measures aren't effective.	Transport/Contractor
Edge effects on adjacent native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with <i>Guide 2: Exclusion zones</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	Minimal if exclusion zones and weed species controlled effectively	Transport/Contractor
Injury and mortality of fauna	Installation of appropriate warning signage of potential fauna crossing and slow speed. Fauna will be managed in accordance with <i>Guide 9: Fauna handling</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	During construction	Effective	Uncertain and should be monitored long-term.	Transport/Contractor



- Legend**
- Study area
 - Construction footprint
 - ↔ Recommended Crossing Locations

Figure 6-1: Arboreal Fauna Crossing Locations

0 50 100 150 200
 Metres
 Scale: 1:5,000 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



7 Offsets and other measures

This section considers whether any residual impacts from the proposal require the provision of biodiversity offsets, in accordance with the following:

- Not Net Loss Guidelines (Transport 2022a) and supporting resources, and
- Tree and Hollow Replacement Guidelines (Transport 2022b) and supporting resources.

7.1 Thresholds

Detail the thresholds set out by the No Net Loss Guidelines are demonstrated in Table 7-1.

Table 7-1: Offset Thresholds (Transport No Net Loss Guidelines)

Category	Impact	Threshold
A – Threatened Ecological Communities		
A1	Works involving clearing of a CEEC	Where there is any clearing of an CEEC in 'moderate to good' condition
A2	Works involving clearing of an EEC	Where clearing of an EEC \geq 2 ha in 'moderate to good' condition
A3	Works involving clearing of a VEC	Where clearing of a VEC \geq 5 ha in 'moderate to good' condition
B – Threatened fauna habitat		
B1	Works involving clearing of threatened fauna habitat that is also a TEC identified in Category A	No –covered by Category A TEC thresholds
B2	Works involving clearing of any habitat for a known species credit fauna species or clearing of breeding habitat (as defined by the TBDC) for dual-credit fauna species (excluding exotic and planted vegetation that cannot be assigned to a plant community type)	Where clearing \geq 1 ha in 'moderate to good' condition
C – Threatened flora and habitat		
C1	Works involving removal of known threatened flora species and their habitat	Where loss of individuals is \geq 10 (species that have a 'count of individuals' as the unit of measure) or where clearing of habitat (calculated by a species polygon in accordance with the BAM) is \geq 1 ha
D – Key Fish Habitat		
B	Type 1 or Type 2 key fish habitats	Where there is a net loss of habitat
Tree and hollow replacement		

Category	Impact	Threshold
	Any residual biodiversity impact that doesn't require offsets in accordance with the No Net Loss Guideline is to be assessed against the requirements of the Tree and Hollow Replacement Guideline.	Any clearing of hollows and/or trees $\geq 5\text{cm}$ DBH

Table 7-2 details the assessment of direct impacts to native vegetation and habitat against the above thresholds. The category of each threshold that has been triggered is quoted as well as the applicable threatened entity.

Note that while a species polygon for Southern Myotis was prepared, impact within this polygon of 0.4 hectares does not exceed the applicable threshold of one hectare in category (B2).

Table 7-2: Assessment of vegetation impacts against thresholds

Veg. zone	PCT	Condition	TEC	Impact area (ha)	Threshold triggered?
1	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Good	Not a TEC	2.1	Yes (B2 – Squirrel Glider, C1 – Black-eyed Susan)
2	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Moderate	Not a TEC	0.4	Yes (B2 – Squirrel Glider, C1 – Black-eyed Susan)
3	PCT 1627: Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	Canopy	Not a TEC	0.8	Yes (B2 – Squirrel Glider)
4	PCT 1638: Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast	Good	Not a TEC	0.2	Yes (B2 – Squirrel Glider, C1 – Black-eyed Susan)

Veg. zone	PCT	Condition	TEC	Impact area (ha)	Threshold triggered?
5	PCT 1638: Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast	Moderate	Not a TEC	0.4	Yes (B2 – Squirrel Glider, C1 – Black- eyed Susan)
6	PCT 1649: Smooth-barked Apple - Red Mahogany - Swamp Mahogany - Melaleuca sieberi heathy swamp woodland of coastal lowland	Moderate	Endangered, BC Act	0.2	Yes (B2 – Squirrel Glider)
Urban Native/Exotic	NA	NA	NA	2.5	No (Tree and Hollow Replacement Guidelines apply)

7.2 Preliminary Offset Calculations

Preliminary calculations of offsets for each threshold category triggered above are provided in Table 7-3. As there is no threshold triggered relating to TECs, no ecosystem credits are required. Calculations for impacts to species credit species have been calculated using the BAM Calculator.

Table 7-3: Preliminary credit calculations

Species name	EPBC Act	BC Act	Impact area (ha)	Species credits
Squirrel Glider <i>Petaurus norfolcensis</i>	Not listed	Vulnerable	4.1	105
Black-eyed Susan <i>Tetratheca juncea</i>	Vulnerable	Vulnerable	2.9	88
Total species credits				193

7.3 Biodiversity offset strategy/tree and hollow replacement plan

As biodiversity offsetting thresholds have been reached under the Not Net Loss Guidelines, offsets or conservation measures are required (refer Table 7-3). In accordance with the No Net Loss Guidelines, a detailed Biodiversity Offset strategy is to be developed to outline how the proposal would address the offsetting requirements of these residual impacts.

For impacts to vegetation that would not be otherwise offset via the Biodiversity Offset Strategy, the Tree and Hollow Replacement Guidelines would apply. A Tree and Hollow Replacement Plan would be prepared to address the impacts prior to the commencement of works. Where tree and

hollow replacement cannot be accommodated locally or can only be partially accommodated, payment must be made to the Transport of NSW Conservation Fund prior to the commencement of works in accordance with the Transport for NSW (2022b) Tree and hollow replacement guidelines.

8 Conclusion

Through a combination of diurnal and nocturnal survey, the study area was found to contain a range of biodiversity values including:

- Four PCTs covering 14.8 ha in moderate-good condition
- 1 ha of Swamp Sclerophyll Forest (Endangered, BC Act)
- 77 individuals and/or clumps of Black-eyed Susan (Vulnerable, BC Act and EPBC Act)
- 10.8 ha of potential habitat for Black-eyed Susan
- 23 HBTs containing a range of small to large hollows, decorticating bark and fissuring
- Two waterways, which provide habitat for common amphibian but do not provide habitat for aquatic fauna
- Up to 14.8 ha of habitat for a range of threatened fauna considered to have a moderate or higher likelihood of occurring including forest owls, woodland birds, microbats and Squirrel Glider
- An important wildlife corridor connecting habitat to the north and south of Hillsborough Road (LMCC 2016)
- A noted Sydney Red Gum *Angophora costata*, identified as significant due to age and size, located west of Barker Avenue.

Following efforts to avoid and minimise, the proposal would result in the following residual impacts to native vegetation and well as NSW and nationally listed biodiversity values:

- Clearing of up to 4.1 ha of native vegetation including 0.2 ha of Swamp Sclerophyll Forest EEC (BC Act)
- Removal of 2.9 ha of potential habitat for Black-eyed Susan
- Removal of five HBTs (four medium hollows and one small hollow) that may be used by smaller hollow-dependent fauna such as Gliders, microbats and birds
- Increased impacts to an important north-south wildlife corridor for Squirrel Glider and other arboreal fauna by increasing the canopy gap across Hillsborough Road from about 30 metres to about 50 metres

A key impact that requires mitigation is the potential increase in a barrier to movement to Squirrel Glider and other arboreal fauna. The *Wildlife Connectivity Guidelines for Road Projects* (RTA 2011) will need to be enacted and it is recommended that appropriate structures be installed at minimum between Barker Avenue and CNCC. Figure 6.1 and LMCC (2016) should also be used to guide options for consideration.

In accordance with Transport's *No Net Loss Policy* (Transport 2022a), the proposal triggers the consideration of offsets or conservation measures to offset impacts to Black-eyed Susan and Squirrel Glider. Outside of the areas that would be otherwise offset via these species credit species, the *Tree and Hollow Replacement Guidelines* (Transport 2022b) apply. A Tree and Hollow Replacement Plan would be developed for the proposal.

Appropriate significant impact assessments were undertaken for threatened species and ecological communities either recorded or considered as having a moderate or higher likelihood of occurring. These assessments concluded that the proposal is unlikely to have a significant impact on any NSW or nationally listed entity. Through the application of specific and measurable mitigation measures proven effective on similar proposals, it is anticipated that the level of impact to threatened fauna and flora will continue to be negligible. Therefore, Transport is not required to prepare a Species Impact Statement (SIS) or Biodiversity Development Assessment Report (BDAR).

With the effective implementation of safeguards and mitigation measures identified in this BAR, risk of impacts to biodiversity can be mitigated to an acceptable level.

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Appendix A – Species recorded

Recorded flora

See Appendix C.

Recorded fauna

Class	Scientific name	Common name	Status	
			BC Act	EPBC Act
Aves	<i>Psophodes olivaceus</i>	Eastern Whipbird		
Aves	<i>Malurus cyaneus</i>	Superb Fairy-wren		
Aves	<i>Corvus coronoides</i>	Australian Raven		
Aves	<i>Cacatua sanguinea</i>	Little Corella		
Aves	<i>Dacelo novaeguineae</i>	Laughing Kookaburra		
Aves	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet		
Aves	<i>Eopsaltria australis</i>	Eastern Yellow Robin		
Aves	<i>Eudynamys orientalis</i>	Eastern Koel		
Aves	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo		
Aves	<i>Rhipidura albiscapa</i>	Grey Fantail		
Aves	<i>Nechmia temporalis</i>	Red-browed Finch		
Aves	<i>Acanthiza nana</i>	Yellow Thornbill		
Aves	<i>Cracticus tibicen</i>	Australian Magpie		

Class	Scientific name	Common name	Status	
			BC Act	EPBC Act
<i>Aves</i>	<i>Manorina melancephala</i>	Noisy Miner		
<i>Aves</i>	<i>Platycerus eximius</i>	Eastern Rosella		
<i>Aves</i>	<i>Cracticus torquatus</i>	Grey Butcherbird		
<i>Aves</i>	<i>Meliphaga lewinii</i>	Lewin's Honeyeater		
<i>Aves</i>	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo Shrike		
<i>Mammalia</i>	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum		
<i>Mammalia</i>	<i>Trichosurus vulpecula</i>	Brush-tail Possum		
<i>Mammalia</i>	<i>Petaurus breviceps</i>	Sugar Glider		

Appendix B – Habitat assessment table

Use the below criteria to determine the likelihood that a threatened species could occur in the study area. This criteria is designed for use in a BAR only, and is not applicable for use in a BDAR (i.e. where the BAM-C is being used). Only recorded sightings from BioNet are valid in this criteria.

Likelihood of occurrence criteria

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey or has been recorded within the past five years (known from a reputable source).
High	<p>A species is considered highly likely to occur in the study area if:</p> <ul style="list-style-type: none"> There are previous credible records on BioNet within the study area from the last 10 years and suitable habitat is present. <p><u>OR</u></p> <ul style="list-style-type: none"> The species is highly mobile, dependent on identified suitable habitat within the study area (i.e. for breeding or important life cycle periods such as winter flowering resources) and has been recorded recently (within five years) on BioNet in the locality. This also includes species known or likely to visit the study area during regular seasonal movements or migration.
Moderate	<p>A species is considered moderately likely to occur in the study area if:</p> <ul style="list-style-type: none"> Any suitable habitat (eg foraging) is present in the study area, the species is highly mobile and has been recorded in the locality in the last 10 years on BioNet. The species may be 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. <p><u>OR</u></p> <ul style="list-style-type: none"> The species is not highly-mobile, dependent on identified suitable habitat features (eg hollows, rocky outcrops) within the study area and has been recorded in the locality in the last 10 years on BioNet. <p><u>OR</u></p> <ul style="list-style-type: none"> For flora species that are associated with PCTs in the study area (see TBDC) or have been recorded in the locality in the last 10 years on BioNet – the associated PCT/habitat present in the study area is not degraded and the species was not targeted by surveys in accordance with the BAM and relevant survey guidelines. In

Likelihood**Criteria**

addition, for flora species known to occur in disturbed areas (eg orchids), records from any time within the locality may warrant inclusion in this category.

Low

A species is considered to have a low likelihood of occurring in the study area if:

- For highly mobile species, the species may be an occasional visitor, but habitat similar to the study area is widely distributed in the locality, meaning that the species is not dependent (ie for breeding or important life cycle periods such as winter flowering resources) on habitats in the study area and the species has not been recorded in the locality in the last 10 years on BioNet.

OR

- The species is not highly-mobile, dependent on identified suitable habitat features (eg hollows, rocky outcrops) within the study area and has not been recorded in the locality in the last 10 years on BioNet.

OR

- For flora species that are associated with PCTs in the study area (see TBDC) and the species was not identified following targeted surveys in accordance with the BAM and relevant survey guidelines. Flora species that have been recorded in the locality on BioNet at any time, associated suitable habitat (see the TBDC) is not present in the study area, though similar habitats of the same vegetation formation is present in the study area.

Unlikely

Suitable habitat for the species is absent from the study area.

Habitat assessment table – threatened flora and ecological communities

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Angophora inopina</i>	Charmhaven Apple	VU	VU	Species	N/A	Small to large tree endemic to the Central Coast region from Karuah to the Charmhaven - Morisset area. Grows in woodland with a dense shrubby understorey in a variety of communities including Sydney Coastal Dry Sclerophyll Forests, Coastal Floodplain Wetlands, Eastern Riverine Forests and Sydney Coastal Heaths. Grows on sandstone substrates in deep, white sandy soils.	616 – BioNet, PMST	Low – species not recorded incidentally within the study area. Not detected from targeted surveys by Jacobs (2019). Study area is outside the species known distribution.
<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	VU	EN	Species	N/A	Small orchid recorded from the Wyong, Ulladulla and Braidwood regions with the Kiama and Queanbeyan populations believed to be extinct. Found in a wide variety of communities including Central Gorge Dry Sclerophyll Forests, Cumberland Dry Sclerophyll Forests, Coastal Floodplain Woodlands and Subalpine Woodlands. Grows on clay loam or sandy soils.	PMST	Low – species not detected during targeted surveys.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Callistemon linearifolius</i>	Netted Bottle Brush		VU	Species	N/A	Shrub recorded from the Georges River to the Hawkesbury River, north of the Nelson Bay area and south at Coalcliff in the Illawarra region. Grows on the coast and adjacent ranges in a variety of communities including Cumberland Dry Sclerophyll Forests, Coastal Floodplain Wetlands, Sydney Coastal Heaths and North Coast Wet Sclerophyll Forests.	116 – BioNet	Low – species not detected during targeted surveys.
<i>Chamaesyce psammogeton</i>	Sand Spurge		EN	Species	N/A	Mat forming herb with a sparse distribution along the coast spanning from the south of Jervis Bay to Queensland. Grows on exposed headlands, fore dunes or pebbly strand-lines near the sea in a variety of communities including South Coast Sands Dry Sclerophyll Forests, Sydney Coastal Heaths, and Maritime Grasslands. Grows in sand soils.	1 - BioNet	Unlikely, no associated PCTS present.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	VU	VU	Species	N/A	Orchid with a distribution spanning from Gibraltar Range National Park southwards to the coastal area near Orbost in Victoria. Grows in a variety of communities including Sydney Coastal Dry Sclerophyll Forests, Coastal Heath Swamps, New England Dry Sclerophyll Forests and Sydney Coastal Heaths. Grows in sandy soils.	1 – BioNet, PMST	Low – species not detected during targeted surveys.
<i>Cynanchum elegans</i>	White-flowered Wax Plant	EN	EN	Species	N/A	Climbing vine restricted to eastern NSW from Brunswick Heads to Gerroa in the Illawarra region. Grows in rainforest gully scrub and scree slope on the edge of dry rainforests in a variety of communities including Coastal Floodplain Wetlands, Maritime Grasslands, Coastal Valley Grassy Woodlands and Northern Hinterland Wet Sclerophyll Forests.	2 - BioNet	Low
<i>Diuris praecox</i>	Rough Doubletail	VU	VU	Species	N/A	Terrestrial orchid growing between Bateau Bay and Smiths Lake. Grows on hills and slopes of near-coastal districts in a variety of communities including Sydney Coastal Dry Sclerophyll Forests, Sydney Hinterland Dry Sclerophyll Forests, Coastal Floodplain Wetlands and North Coast Wet Sclerophyll Forests.	2330 – BioNet, PMST	Low – study area is outside known range. Not detected during targeted surveys.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Epacris purpurascens</i> var. <i>purpurascens</i>			VU	Species	N/A	<i>Erect shrub distributed from Gosford in the north, Silverdale to the west, Narrabeen in the east and Avon Dam in the south. Grows in scrubs and swamps in a variety of communities including Cumberland Dry, Sydney Hinterland Dry, Northern Hinterland Wet, and Southern Tableland Wet Sclerophyll Forests, Eastern Riverine Forests, and Coastal Valley Grassy Woodlands. Grows in soils with a strong shale influence on sandstone substrates.</i>	1 - BioNet	Unlikely
<i>Eucalyptus camfieldii</i>	Camfield's Stringybark	VU	VU	Species	N/A	<i>Mallee tree restricted to a narrow band stretching from Raymond Terrace to the north and Waterfall in the south. Grows in scattered, localised distributions including sites at Norah Head, Terrey Hills, North Head, Menai, Mt Colah, Peats Ridge and Elvina Bay Trail. Grows in scattered stands near the boundaries of tall coastal heath and low open woodland in a variety of communities including Sydney Coastal Dry Sclerophyll Forests, Eastern Riverine Forests, Sydney Coastal Heaths and Wallum Sand Heaths. Grows in sandy soils on Hawkesbury sandstone.</i>	2 – BioNet, PMST	<i>Low – study area is outside known range. Not detected incidentally by Biosis. Not detected during targeted surveys by Jacobs (2019).</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	VU	VU	Species	N/A	Low spreading to erect shrub sporadically distributed throughout the Sydney Basin, most notably in the Picton, Appin and Bargo regions, in the Cessnock - Kurri Kurri area and isolated populations from Putty to Wyong and Lake Macquarie. Grows in Shale Sandstone Transition Forest, Kurri Sand Swamp Woodland, <i>Corymbia maculata</i> - <i>Angophora costata</i> Open Forest in the Dooralong Area, Sydney Sandstone Ridgetop Woodland at Wedderburn and Cooks River/Castlereagh Ironbark Forest at Kemps Creek. Grows in sandy or light clay soils including tertiary alluviums over thin shales and lateritic ironstone gravels.	98 – BioNet, PMST	Low – not detected during targeted surveys.
<i>Grevillea shiressii</i>		VU	VU	Species	N/A	Tall shrub confined to two populations growing near Gosford on Mooney Mooney Creek and Mullet Creek, both tributaries of the lower Hawkesbury River. Grows adjacent to creek banks in Sydney Coastal Dry Sclerophyll Forests, Eastern Riverine Forests and North Coast Wet Sclerophyll Forests. Grows on Hawkesbury Sandstone in alluvial or sandy soils.	1 – BioNet, PMST	Unlikely

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Melaleuca biconvexa</i>	<i>Biconvex Paperbark</i>	VU	VU	Species	N/A	Large shrub or small tree confined to NSW with scattered, widely dispersed populations around the Jervis Bay area in the south and the Gosford-Wyong area to the north. Grows in damp places, often near streams or low lying areas on low slopes or sheltered aspects in a variety of communities including Hunter-Macleay Dry Sclerophyll Forests, Coastal Swamp Forests, Coastal Floodplain Wetlands, Coastal Freshwater Lagoon and North Coast Wet Sclerophyll Forests. Grows in alluvial soils.	9 – BioNet, PMST	Low – no associated PCTs present within the study area.
<i>Muehlenbeckia</i> sp. Mt Norman	<i>Scrambling Lignum</i>		VU	Species	Rocky areas; or within 50m or rocky areas	Scrambling Lignum is a scrambling climber. The low straggling stems are up to 5 m long and have turned up ends. Scattered distribution from Queensland to the Blue Mountains in NSW. Records on the New England Tablelands and North West Slopes include Bald Rock north of Tenterfield, Warra and Butterleaf National Parks near Glen Innes and Mt Kaputar. Grows in coarse sandy soils and peat in heath, mallee and open eucalypt woodland on granite or acid volcanic outcrops at higher altitudes.	1 - BioNet	Unlikely

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Persicaria elatior</i>	Tall Knotweed	VU	VU	Species	Semi-permanent/ephemeral wet areas; or within 50 m Swamps; or within 50 m Waterbodies ; including Wetlands, or within 50 m	Erect herb found growing in south-eastern NSW at Mount Dromedary, Moruya State Forest near Turlinjah, Upper Avon River catchment north of Robertson, Bermagui and Picton Lakes. Also grows in northern NSW around Raymond Terrace near Newcastle and Cherry Tree and Gibberagee State Forests in the Grafton area. Grows in damp places usually on the margins of waterbodies and in swamp forests in a variety of communities including Coastal Floodplain Wetlands, Coastal Swamp Forests, Eastern Riverine Forests, Coastal Freshwater Lagoons and Coastal Heath Swamps.	PMST	Unlikely

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Prasophyllum</i> <i>sp. Wybong</i>		CR		Species	N/A	<p><i>Terrestrial orchid restricted to five sites within NSW at Boorowa, Captains Flat, Ilford, a Travelling Stock Route at Delegate and 10 kilometres south-east of Muswellbrook. Found growing in open sites and patchy forest in Natural Temperate Grassland, Box-Gum Woodlands, Temperate Montane Grasslands, Southern Tableland Grassy Woodlands, Subalpine Woodlands, Tableland Clay Grassy Woodlands, Western Slopes Grassy Woodlands. This species is cryptic and most visible when flowering between October and December. Grows in fertile soils.</i></p>	PMST	Unlikely

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	EN	EN	Species	N/A	Deciduous terrestrial orchid with a disjunct distribution from the Milbrodale in the Hunter Region, Albion Park and Yallah in the Illawarra Region and Nowra in the Shoalhaven Region. Found growing amongst grasses on flat or gently sloping land with poor drainage in woodland dominated by Forest Red Gum <i>Eucalyptus tereticornis</i> , Woollybutt <i>E. longifolia</i> , and White Feather Honey-myrtle <i>Melaleuca decora</i> . In Nowra, the orchid can be found growing in association with Spotted Gum <i>Corymbia maculata</i> , Forest Red Gum and Grey Ironbark <i>E. paniculata</i> . In the Hunter Region, the orchid is associated with Narrow-leaved Ironbark <i>E. crebra</i> , Forest Red Gum and Black Cypress Pine <i>Callitris endlicheri</i> . Grows in red brown loam soils.	PMST	Unlikely

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Pultenaea maritima</i>	Coast Headland Pea		VU	Species	N/A	Small prostrate, mat forming shrub with a distribution spanning 16 headlands from Newcastle north to Byron Bay. Found growing in grasslands on exposed coastal headlands and adjoining low coastal heath at elevations between 5 and 30 metres in Maritime Grasslands including Kangaroo Grass Headland, Coastal headland Heaths, Northern Montane Heaths and Wallum Sand Heaths. Grows in sandy loam or clay loam soils on sandstone substrates.	4 - BioNet	Unlikely
<i>Rhodamnia rubescens</i>	Scrub Turpentine		CR	Species	N/A	Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	23 - BioNet	Unlikely
<i>Rhodomyrtus psidioides</i>	Native Guava		CR	Species	N/A	Pioneer species found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines.	1 - BioNet	Unlikely

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Rutidosis heterogama</i>	Heath Wrinklewort	VU	VU	Species	N/A	Small perennial herb with populations located in the Cessnock to Kurri Kurri area with outlying occurrences at Howes Valley, from Wyong to Newcastle on the Central Coast and Woolli to Evans Head in Yuraygir and Bundjalung National Parks and in New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes. Grows mostly in heath and along roadsides in coastal districts in a variety of communities including North-west Slopes Dry Sclerophyll Woodlands, Western Slopes Dry Sclerophyll Forests, Northern Tableland Wet Sclerophyll Forests, Maritime Grasslands, Coastal Headland Heaths and Wallum Sand Heaths. Grows in sandy soils.	13 - BioNet	Low – study area is outside known range. Not detected by Biosis or Jacobs (2019).

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Senecio spathulatus</i>	Coast Groundsel		EN	Species	Other; Headlands within 500 m of the coast	Low growing perennial herb or shrub with populations occurring in Nadgee Nature Reserve and between Kurnell in Sydney and Myall Lakes National Park with additional populations occurring between Wilsons Promontory in Victoria to the NSW border. Found growing in coastal areas mostly on frontal dunes and forming low, broad clumps in Maritime Grasslands and Sydney Coastal Heaths. Grows in soils ranging from clay to loamy sands.	1 - BioNet	Low – no associated PCTs present.
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	VU	EN	Species	N/A	Small to medium sized rainforest tree restricted to a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. Found growing on stabilized dunes near the sea in South Coast Sands Dry Sclerophyll Forests, Coastal Swamp Forests, Coastal Headland Heaths, Littoral Rainforests, Northern Hinterland Wet Sclerophyll Forests and Southern Lowland Wet Sclerophyll Forests. Grows on grey sandy, gravelly, silty or clay soils over sandstone substrates.	9 – BioNet, PMST	Low – not detected incidentally by Biosis or during targeted surveys by Jacobs (2019).

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Tetratheca glandulosa</i>			VU	Species	N/A	<p><i>Small, spreading shrub with 150 populations confined to the Baulkham Hills, Gosford, Hawkesbury, Ku-ring-gai, Pittwater, Ryde and Wyong Local Government Areas. Found growing in a variety of communities including Sydney Sandstone Ridgetop Woodland, Sydney Coastal Dry Sclerophyll Forests, Eastern Riverine Forests, Coastal Valley Grassy Woodlands, Sydney Montane Heaths and North Coast Wet Sclerophyll Forests. Grows in the shallow, yellow clay/sandy loams that are typical of shale/sandstone transition soils where shale caps occur over sandstone substrates such as the Lucas Heights, Gynea, Lambert and Faulconbridge soil landscapes.</i></p>	1 - BioNet	<p><i>Low – not detected incidentally or during targeted surveys by Biosis or Jacobs (2019).</i></p>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Tetratheca juncea</i>	Black-eyed Susan	VU	VU	Species	N/A	Small shrub confined to the northern area of the Sydney Basin bioregion and the southern area of the North Coast bioregion in the Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock Local Government Areas. Found growing at well drained sites which experience annual rainfall levels between 1000 and 1200 mm at elevations below 200 metres in swampy heath and moist forests. Usually found growing in soils from the Awaba soil landscape comprising of low nutrient sandy, skeletal soils, sandy loam soils and clay soils on sandstone or conglomerate substrates.	5693 – BioNet, PMST	Recorded – detected within the study area by Biosis and Jacobs (2019). Seventy-seven clumps mapped by Biosis.
<i>Zannichellia palustris</i>			EN	Species	Waterbodies; Freshwater or slightly brackish estuarine areas (10%)	Submerged aquatic plant confined to the Hunter Valley as well as Sydney Olympic Park. Found growing in fresh or slightly saline stationary or flowing water in Coastal Freshwater Lagoons and Saltmarshes.	8 - BioNet	Unlikely
Threatened Ecological Communities								

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Central Hunter Valley eucalypt forest and woodland</i>		CR						<i>Unlikely – study area is outside the distribution of this TEC. No associated PCTs present within the study area</i>
<i>Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>		VU	EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community</i>		EN						<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Coastal Upland Swamp in the Sydney Basin Bioregion</i>		EN	EN					<i>Unlikely – no associated PCTs present within the study area.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Kincumber Scribbly Gum Forest in the Sydney Basin Bioregion</i>			CR					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>		CR	EN					<i>Unlikely – no associated PCTs present within the study area.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Low woodland with heathland on indurated sand at Norah Head</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Lower Hunter Spotted Gum—Ironbark Forest in the Sydney Basin Bioregion</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions</i>		CR	EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>		EN	EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>		EN	EN					<i>Recorded within the study area (PCT 1649).</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Sydney Freshwater Wetlands in the Sydney Basin Bioregion</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>
<i>Umina Coastal Sandplain Woodland in the Sydney Basin Bioregion</i>			EN					<i>Unlikely – no associated PCTs present within the study area.</i>

Habitat assessment table – threatened fauna

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Birds</i>								
<i>Anseranas semipalmata</i>	Magpie Goose		VU	Ecosystem	N/A	Mainly found in shallow wetlands (less than 1 m deep) with dense growth of rushes or sedges. They are often seen walking and grazing on land; feeds on grasses, bulbs and rhizomes. Breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level. Nests are formed in trees over deep water; breeding is unlikely in south-eastern NSW. Often seen in trios or flocks on shallow wetlands, dry ephemeral swamps, wet grasslands and floodplains; roosts in tall vegetation.	125 - BioNet	Low. Habitat not suitable.
<i>Anthochaera phrygia</i>	Regent Honeyeater	CR	CR	Dual	As per mapped areas.	Regent Honeyeaters are semi-nomadic, occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests. Nectar and fruit from mistletoes are also eaten. This species usually nest in tall mature eucalypts and sheoaks.	7 – BioNet, PMST	Moderate. Marginal habitat associated with the PCTs in the study area.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow		VU	Ecosystem	N/A	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 ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.	4 - BioNet	Moderate. Marginal habitat associated with the PCTs in the study area.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	EN	Ecosystem	Waterbodies; Brackish or freshwater wetlands	The Australasian Bittern is distributed across south-eastern Australia. Often found in terrestrial and estuarine wetlands, generally where there is permanent water with tall, dense vegetation including <i>Typha</i> spp. and <i>Eleocharis</i> spp.. Typically this bird forages at night on frogs, fish and invertebrates, and remains inconspicuous during the day. The breeding season extends from October to January with nests being built amongst dense vegetation on a flattened platform of reeds.	5 - BioNet, PMST	Low. Habitat not suitable.
<i>Calidris canutus</i>	Red Knot	EN		Dual	As per mapped areas	Typically located within intertidal mudflats, sandflats and sandy beaches of	2 - BioNet, PMST	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>sheltered coasts. Occasionally found on sandy open beaches or shallow pools, or in saline wetlands close to the coast.</i>		
<i>Calidris ferruginea</i>	<i>Curlew Sandpiper</i>	CR	EN	Dual	As per mapped areas	<i>Inhabits sheltered intertidal mudflats. Also non-tidal swamps, lagoons and lakes near the coast. Infrequently recorded inland.</i>	6 - BioNet, PMST	Low. <i>Habitat not suitable.</i>
<i>Calidris tenuirostris</i>	<i>Great Knot</i>	CR	VU	Dual	As per mapped areas	<i>Mainly found on intertidal mudflats, sandflats and sandy beaches.</i>	2 - BioNet	Low. <i>Habitat not suitable.</i>
<i>Callocephalon fimbriatum</i>	<i>Gang-gang Cockatoo</i>	EN	VU	Dual	<i>Hollow bearing trees; Eucalypt tree species with hollows greater than 9 cm diameter</i>	<i>In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest. In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. It requires tree hollows in which to breed.</i>	4 - BioNet	Low. <i>Marginal foraging habitat associated with PCT 1627. Not recorded within last ten years in proximity to the study area.</i>
<i>Calyptorhynchus lathami</i>	<i>Glossy Black-Cockatoo</i>	VU	VU	Dual	<i>Hollow bearing trees; Living or dead tree with hollows greater than 15cm diameter</i>	<i>Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier</i>	14 - BioNet	Moderate. <i>Minor foraging habitat available.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
					<i>and greater than 8m above ground.</i>	<i>forest types. Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead.</i>		
<i>Charadrius mongolus</i>	<i>Lesser Sand-plover</i>	EN	VU	Dual	N/A	<i>In Australia, the species is known to favour coastal environs including beaches, mudflats and mangroves. Within NSW, individuals have been observed on intertidal sand and mudflats in estuaries or roosting on sandy beaches or rocky shores at high tide.</i>	1 - BioNet	Low. <i>Habitat not suitable.</i>
<i>Chthonicola sagittata</i>	<i>Speckled Warbler</i>		VU	Ecosystem	N/A	<i>Chthonicola sagittata occurs on the hills and tablelands of the Great Dividing Range. Found in eucalypt and cypress woodlands with a grassy understorey, often on ridges or gullies. The species nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground for arthropods and seeds.</i>	2 - BioNet	Low. <i>Habitat not suitable.</i>
<i>Circus assimilis</i>	<i>Spotted Harrier</i>		VU	Ecosystem	N/A	<i>The Spotted Harrier is found throughout Australia but rarely in densely forested and wooded habitat of the escarpment and coast. Preferred habitat consists of open and wooded country</i>	4 - BioNet	Low. <i>Habitat not suitable.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						with grassland nearby for hunting. Habitat types include open grasslands, acacia and mallee remnants, spinifex, open shrublands, saltbush, very open woodlands, crops and similar low vegetation. The Spotted Harrier is more common in drier inland areas, nomadic part migratory and dispersive, with movements linked to the abundance of prey species. Nesting occurs in open or remnant woodland and unlike other harriers, the Spotted Harrier nests in trees.		
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)		VU	Ecosystem	N/A	Lives in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present.	1 - BioNet	Moderate. Marginal habitat associated with the PCTs present in the study area.
<i>Daphoenositta chrysoptera</i>	Varied Sittella		VU	Ecosystem	N/A	The Varied Sittella is a sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in mallee	20 - BioNet	Moderate. Marginal habitat associated with the PCTs present in the study area.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>and acacia woodlands, paperbarks or mature Eucalypts. The Varied Sittella feeds on arthropods gleaned from bark, small branches and twigs. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.</i>		
<i>Dasyornis brachypterus</i>	<i>Eastern Bristlebird</i>	EN	EN	Ecosystem	N/A	<i>Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands.</i>	PMST	<i>Low. Highly restricted distribution.</i>
<i>Diomedea exulans</i>	<i>Wandering Albatross</i>	EN	EN	-	N/A	<i>A marine, pelagic and aerial species. Versatile feeders in pelagic and shelf waters. Breed on subantarctic and antarctic islands.</i>	3 - BioNet	<i>Low. Habitat not suitable.</i>
<i>Ephippiorhynchus asiaticus</i>	<i>Black-necked Stork</i>		EN	Ecosystem	<i>Swamps; Shallow, open freshwater or saline wetlands or shallow edges of deeper wetlands within 300m of these swamps.] Waterbodies; Shallow lakes, lake margins and estuaries within 300m of these waterbodies</i>	<i>Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water.</i>	13 - BioNet	<i>Low. Habitat not suitable.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Epthianura albifrons</i>	White-fronted Chat		VU	Ecosystem	N/A	<p>Sydney Metropolitan CMA: The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level. In NSW it occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state.</p> <p>The White-fronted Chat is found in damp open habitats, particularly wetlands containing saltmarsh areas that are bordered by open grasslands or lightly timbered lands. Along the coastline, they are found in estuarine and marshy grounds with vegetation less than 1 m tall. The species is also observed in open grasslands and sometimes in low shrubs bordering wetland areas. Inland, the species is often observed in open grassy plains, saltlakes and salt pans that are along the margins of rivers and waterways.</p> <p>In Victoria White-fronted Chats have been observed breeding from late July through to early March. Nests are built in low vegetation and in the Sydney region nests have also been</p>	17 - BioNet	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<p>observed in low isolated mangroves.</p> <p><i>An Endangered Population occurs in the Sydney Metropolitan CMA area, at Newington Nature Reserve near Homebush and at Towra Point Nature Reserve.</i></p>		
<i>Erythrotriorchis radiatus</i>	Red Goshawk	VU	CR	Species	N/A	<p>Occur in forest and woodland habitat near permanent water. In NSW prefer <i>Melaleuca</i> swamp forest and open eucalypt woodland. Require greater than 20 m tall trees for nesting.</p>	PMST	<p>Low.</p> <p>Habitat not suitable.</p>
<i>Esacus magnirostris</i>	Beach Stone-curlew		CR	Dual	N/A	<p>In Australia, the Beach Stone-curlew occupies coastlines from about Point Cloates in Western Australia, across northern and north-eastern Australia south to north-eastern NSW, with occasional vagrants to south-eastern NSW and Victoria. In NSW, the species occurs regularly to about the Manning River, and the small population of north-eastern NSW is at the limit of the normal range of the species in Australia. Beach Stone-curlews are found exclusively along the coast, on a wide range of beaches, islands, reefs and in</p>	1 - BioNet	<p>Low.</p> <p>Habitat not suitable.</p>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>estuaries, and may often be seen at the edges of or near mangroves. They forage in the intertidal zone of beaches and estuaries, on islands, flats, banks and spits of sand, mud, gravel or rock, and among mangroves. Beach Stone-curlews breed above the littoral zone, at the backs of beaches, or on sandbanks and islands, among low vegetation of grass, scattered shrubs or low trees; also among open mangroves.</i>		
<i>Falco subniger</i>	<i>Black Falcon</i>		VU	Ecosystem	N/A	<i>Mainly occur in woodlands and open country where can hunt. Often associated with swamps, rivers and wetlands. Nest in tall trees along watercourses.</i>	1 - BioNet	<i>Low. Habitat not suitable.</i>
<i>Glossopsitta pusilla</i>	<i>Little Lorikeet</i>		VU	Ecosystem	N/A	<i>Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-</i>	35 - BioNet	<i>Moderate. Foraging habitat associated with PCTs in the study area.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>barked eucalypts. Most breeding records come from the western slopes.</i>		
<i>Grantiella picta</i>	<i>Painted Honeyeater</i>	VU	VU	Ecosystem	<i>Other; Mistletoes present at a density of greater than five mistletoes per hectare</i>	<i>Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe. Often found on plains with scattered eucalypts and remnant trees on farmlands.</i>	PMST	<i>Low. Habitat not suitable.</i>
<i>Haematopus fuliginosus</i>	<i>Sooty Oystercatcher</i>		VU	Species	<i>Other; Within 100m of estuarine areas and the ocean</i>	<i>The Sooty Oystercatcher is found on undisturbed tidal rocks on ocean shores and islands. Occasionally it is observed on sandspits and mudflats. It forages on exposed rock or coral at low tide for limpets and mussels. The Sooty Oystercatcher breeds in spring and summer almost exclusively offshore or on isolated promontories</i>	9 - BioNet	<i>Low. Habitat not suitable.</i>
<i>Haematopus longirostris</i>	<i>Pied Oystercatcher</i>		EN	Species	<i>Other; Within 100m of estuarine areas and the ocean</i>	<i>An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Its food supply (beach macroinvertebrates) have been negatively affected by human impacts. The Pied Oystercatcher is restricted to the littoral zone of beaches and estuaries, nesting on the ground above the tideline. A pair will re-nest in the same</i>	11 - BioNet	<i>Low. Habitat not suitable.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>spot each year, rarely shifting their territory. Occasionally the Pied Oystercatcher is found in paddocks near the coast.</i>		
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle		VU	Dual	N/A	<i>A migratory species that is generally sedentary in Australia, although immature individuals and some adults are dispersive. Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes. It hunts over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roosts and makes nest in trees.</i>	104 - BioNet	<i>Low. Habitat not suitable.</i>
<i>Hieraaetus morphnoides</i>	Little Eagle		VU	Dual	N/A	<i>The Little Eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species. It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests.</i>	13 - BioNet	<i>Low. Habitat not suitable.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Hirundapus caudacutus</i>	White-throated Needletail	VU		Ecosystem	N/A	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breeds in Asia.	35 - BioNet, PMST	Low. Exclusively aerial species that may occasionally fly over the study area but would not rely on ground-level habitats.
<i>Irediparra gallinacea</i>	Comb-crested Jacana		VU	Ecosystem	Waterbodies; Freshwater wetlands with a good surface cover of floating aquatic vegetation	Occurs in freshwater wetlands, lagoons, Billabongs, swamps, lakes, rivers and reservoirs, generally with abundant floating aquatic vegetation.	10 - BioNet	Low. Habitat not suitable.
<i>Ixobrychus flavicollis</i>	Black Bittern		VU	Ecosystem	Waterbodies; Land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation	The Black Bittern is found along the coastal plains within NSW, although individuals have rarely being recorded south of Sydney or inland. It inhabits terrestrial and estuarine wetlands such as flooded grasslands, forests, woodlands, rainforests and mangroves with permanent water and dense waterside vegetation. The Black Bittern typically roosts on the ground or in trees during the day and forages at night on frogs, reptiles, fish and invertebrates. The breeding season extends from December to March. Nests are constructed of reeds and sticks in branches overhanging the water.	7 - BioNet	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Lathamus discolor</i>	Swift Parrot	CR	EN	Dual	As per mapped areas	<p>The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. Favoured feed trees include winter flowering species such as Swamp Mahogany <i>Eucalyptus robusta</i>, Spotted Gum <i>Corymbia maculata</i>, Red Bloodwood <i>C. gummifera</i>, Mugga Ironbark <i>E. sideroxylon</i>, and White Box <i>E. albens</i>. Commonly used lerp infested trees include Grey Box <i>E. microcarpa</i>, Grey Box <i>E. moluccana</i> and Blackbutt <i>E. pilularis</i>. This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability.</p>	28 - BioNet, PMST	<p>Moderate.</p> <p>Potential foraging habitat associated with the PCTs present in the study area.</p>
<i>Limosa lapponica baueri</i>	Bar-tailed Godwit (<i>baueri</i>)	VU		Dual	As per mapped areas	<p>The bar-tailed godwit (western Alaskan) occurs mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It has also been recorded in coastal sewage farms and saltworks, saltlakes</p>	PMST	<p>Low.</p> <p>Habitat not suitable.</p>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef flats.</i>		
<i>Limosa lapponica menzbieri</i>	Northern Siberian Bar-tailed Godwit	CR		-	N/A	<i>The bar-tailed godwit (northern Siberian) occurs mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It has also been recorded in coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef flats.</i>	PMST	<i>Low. Habitat not suitable.</i>
<i>Limosa limosa</i>	Black-tailed Godwit		VU	Dual	As per mapped areas	<i>The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes</i>	6 - BioNet	<i>Low. Habitat not suitable.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>in the western areas during summer, when the muddy shores are exposed. The species has been recorded within the Murray-Darling Basin, on the western slopes of the Northern Tablelands and in the far north-western corner of the state.</i>		
<i>Lophoictinia isura</i>	Square-tailed Kite		VU	Dual	N/A	<i>Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by Eucalyptus longifolia, Corymbia maculata, E. elata, or E. smithii. Individuals appear to occupy large hunting ranges of more than 100 km². They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs.</i>	9 - BioNet	<i>Moderate. Potential foraging habitat associated with PCTs found in the study area.</i>
<i>Macronectes giganteus</i>	Southern Giant Petrel	EN	EN	-	N/A	<i>The Southern Giant-Petrel is a marine species found throughout the Antarctic to subtropical waters occasionally venturing to inshore waters.</i>	4 - BioNet	<i>Low. Habitat not suitable.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)		VU	Ecosystem	N/A	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas.	1 - BioNet	Low. Habitat not suitable.
<i>Neophema pulchella</i>	Turquoise Parrot		VU	Ecosystem	N/A	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs. Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies. Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist.	4 - BioNet	Low. Habitat not suitable.
<i>Nettapus coromandelianus</i>	Cotton Pygmy-Goose		EN	Ecosystem	Waterbodies; Deep permanent fresh waters on floodplains with floating and submergent vegetation.	The Cotton Pygmy-goose is found along the coast from Northern Queensland extending south into Victoria. It is considered a vagrant throughout the southern extent of its range. The Cotton Pygmy-goose is rarely seen on land, preferring deep permanent water including freshwater swamps, lagoons, dams, with water lilies and other semi-emergent water plants. In the north it will move onto the floodplains following the wet season rain.	1 - BioNet	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Ninox connivens</i>	<i>Barking Owl</i>		VU	Dual	N/A	Generally found in open forests, woodlands, swamp woodlands, farmlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country. Territories are typically 2000 ha in NSW habitats. Hunts small arboreal mammals or birds and terrestrial mammals when tree hollows are absent.	7 - BioNet	Moderate. Marginal habitat associated with the PCTs present in the study area.
<i>Ninox strenua</i>	<i>Powerful Owl</i>		VU	Dual	N/A	The Powerful Owl occupies wet and dry eucalypt forests and rainforests. It may inhabit both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm. It has a large home range of between 450 and 1450 ha.	267 - BioNet	Moderate. Marginal habitat associated with the PCTs present in the study area.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Numenius madagascariensis</i>	Eastern Curlew	CR		Dual	As per mapped areas	Occurs in sheltered coasts, especially estuaries, embayments, harbours, inlets and coastal lagoons with large intertidal mudflats or sandflats often with beds of seagrass.	9 - BioNet, PMST	Low. Habitat not suitable.
<i>Onychoprion fuscata</i>	Sooty Tern		VU	Species	N/A	The Sooty Tern is a pelagic species found over tropical waters where it feeds offshore far away from land. It breeds off the coast of WA and QLD rarely venturing to the south-east of Australia.	2 - BioNet	Low. Habitat not suitable.
<i>Oxyura australis</i>	Blue-billed Duck		VU	Ecosystem	N/A	The Blue-billed Duck is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 km away. It is generally only seen in coastal areas during summer. Prefers large permanent wetlands, feeding on the bottom of swamps.	4 - BioNet	Low. Habitat not suitable.
<i>Pachyptila turtur subantarctica</i>	Fairy Prion (southern)	VU		-	N/A	Fairy Prions (including other subspecies) are often beachcast on the south-eastern coast of Australia, and are commonly seen offshore over the continental shelf and over pelagic waters. Observations are less common off Western Australia	PMST	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<p>and Queensland than in south-eastern Australia. Beachcast birds are found along the whole coast of NSW, and the species is common offshore along the entire Victorian coast, where thousands are sometimes seen. In Tasmania, the Fairy Prion is an abundant visitor to all offshore waters. In South Australia, this species is regularly seen and often beachcast.</p>		
<i>Pandion cristatus</i>	Eastern Osprey		VU	Dual	<p>Other; Presence of stick-nests in living and dead trees (>15m) or artificial structures within 100m of a floodplain for nesting</p>	<p>Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 km inland along larger rivers. It is water-dependent, hunting for fish in clear, open water. The Osprey occurs in terrestrial wetlands, coastal lands and offshore islands. It is a predominantly coastal species, generally using marine cliffs as nesting and roosting sites. Nests can also be made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.</p>	34 - BioNet, PMST	<p>Low. Habitat not suitable.</p>
<i>Petroica boodang</i>	Scarlet Robin		VU	Ecosystem	N/A	<p>The Scarlet Robin inhabits dry eucalypt forests and woodlands. The understorey is usually open and grassy</p>	8 - BioNet	Moderate.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<p>with few scattered shrubs. During autumn and winter it moves to more open and cleared areas. The Scarlet Robin forages amongst logs and woody debris for insects. The nest is an open cup of plant fibres and cobwebs, sited in the fork of a tree.</p>		<p>Marginal habitat associated with PCTs found in the study area.</p>
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)		VU	Ecosystem	N/A	<p>The eastern sub-species occurs on the western slopes of the Great Dividing Range, the western plains, woodlands in the Hunter Valley and locations on the north coast of NSW. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine, open Box Woodlands on alluvial plains and woodlands on fertile soils in coastal regions. Feeds on invertebrates and builds dome-shaped nests.</p>	1 - BioNet	<p>Low. Habitat not suitable.</p>
<i>Pterodroma solandri</i>	Providence Petrel		VU	-	N/A	<p>The Providence Petrel is a pelagic marine species which rarely comes closer to the Australian mainland than the continental shelf. It breeds exclusively on Lord Howe and Phillip Islands since suffering extinction in 1800 on the larger Norfolk Island.</p>	1 - BioNet	<p>Low. Habitat not suitable.</p>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove		VU	Ecosystem	N/A	Mainly occurs in large undisturbed patches of tall tropical or subtropical rainforest. Occasionally occurs in patches of monsoon forest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest.	4 - BioNet	Low. Habitat not suitable.
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove		VU	Ecosystem	N/A	Occurs in tall tropical and subtropical, evergreen or semi-deciduous rainforest, especially with dense growth of vines. Prefers large patches of rainforest, but sometimes occurs in remnant patches surrounded by suboptimal habitat including farmlands.	6 - BioNet	Low. Habitat not suitable.
<i>Ptilinopus superbus</i>	Superb Fruit-Dove		VU	Ecosystem	N/A	The Superb Fruit Dove ranges from northern NSW to as far south as Moruya. It is found in rainforests, closed forests (including mesophyll vine forests) and sometimes in eucalypt and acacia woodlands with fruit-bearing trees. It forages in the canopy of fruiting trees such as figs and palms.	6 - BioNet	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Rostratula australis</i>	Australian Painted Snipe	EN	EN	Ecosystem	N/A	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, but have been recorded in brackish waters. Forages on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter.	5 - BioNet, PMST	Low. Habitat not suitable.
<i>Sternula nereis nereis</i>	Fairy Tern	VU		Species	N/A	The Fairy Tern nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. This species will also frequent embayments, estuarine habitats, wetlands and mainland coastlines.	PMST	Low. Habitat not suitable.
<i>Stictonetta naevosa</i>	Freckled Duck		VU	Ecosystem	N/A	The Freckled Duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits.	10 - BioNet	Low. Habitat not suitable.
<i>Sula dactylatra</i>	Masked Booby		VU	-	N/A	This species breeds on Lord Howe Island, where it remains year around but can range widely for food and some juveniles wander before returning to breed.	1 - BioNet	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Thalassarche melanophris</i>	Black-browed Albatross	VU	VU	-	N/A	Inhabits Antarctic, subantarctic and subtropical waters. Although generally pelagic the species also occurs on the continental shelf and can be seen from land.	2 - BioNet	Low. Habitat not suitable.
<i>Thinornis rubricollis rubricollis</i>	Eastern Hooded Plover	VU		-	N/A	In south-eastern Australia Hooded Plovers prefer sandy ocean beaches, especially those that are broad and flat, with a wide wave-wash zone for feeding, much beachcast seaweed, and backed by sparsely vegetated sand-dunes for shelter and nesting. Occasionally Hooded Plovers are found on tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, and small beaches in lines of cliffs. They regularly use near-coastal saline and freshwater lakes and lagoons, often with saltmarsh. They forage in sand at all levels of the zone of wave-wash during low and mid-tide or among seaweed at high-tide, and occasionally in dune blowouts after rain. At night they favour the upper zones of beaches for roosting. When on rocks they forage in crevices in the wave-wash or spray zone, avoiding elevated	PMST	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>rocky areas and boulder fields. In coastal lagoons they forage in damp or dry substrates and in shallow water, depending on the season and water levels.</i>		
<i>Tyto novaehollandiae</i>	<i>Masked Owl</i>		VU	Dual	<i>Hollow bearing trees; Living or dead trees with hollows greater than 20cm diameter.</i>	<i>The Masked Owl is found in range of wooded habitats that provide tall or dense mature trees with hollows suitable for nesting and roosting. It is mostly seen in open forests and woodlands adjacent to cleared lands. Prey includes hollow-dependent arboreal marsupials and terrestrial mammals.</i>	32 - BioNet	<i>Moderate. Habitat associated with the PCTs in the study area.</i>
<i>Tyto tenebricosa</i>	<i>Sooty Owl</i>		VU	Dual	<i>Caves; Caves or cliffines/ledges. Hollow bearing trees; Living or dead trees with hollows greater than 20cm diameter.</i>	<i>The Sooty Owl is often found in tall old-growth forests, including temperate and subtropical rainforests. It is mostly found on escarpments with a mean altitude <500 m. This species nests and roosts in hollows of emergent trees, mainly eucalypts often located in gullies.</i>	12 - BioNet	<i>Low. Habitat not suitable.</i>
<i>Xenus cinereus</i>	<i>Terek Sandpiper</i>		VU	Dual	<i>As per mapped areas</i>	<i>Mainly found on saline intertidal mudflats in sheltered estuaries, embayments, harbours and lagoons.</i>	7 - BioNet	<i>Low. Habitat not suitable.</i>

Mammals

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Cercartetus nanus</i>	Eastern Pygmy-possum		VU	Species	N/A	<i>Patchily distributed from the coast to the Great Dividing Range, and as far as Pillaga, Dubbo, Parkes and Wagga Wagga on the western slopes. Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Soft fruits are eaten when flowers are unavailable and it also feeds on insects. Will often nest in tree hollows, but can also construct its own nest. Because of its small size it is able to utilise a range of hollow sizes including very small hollows. Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5 ha area over a 5 month period.</i>	3 - BioNet	<i>Low. Habitat not suitable.</i>
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	VU	VU	Species	<i>Cliffs; Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels.</i>	<i>Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley. Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands. Forages on small, flying insects below the forest</i>	14 – BioNet, PMST	<i>Moderate. Marginal habitat associated with the PCTs present in the study area.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<p>canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals. Likely that it hibernates during the cooler months. The only known existing maternity roost is in a sandstone cave near Coonabarabran.</p>		
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	EN	VU	Ecosystem	N/A	<p>Occurs along the east coast of Australia and the Great Dividing Range. Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests. Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas. Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage. Seventy per cent of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage. The home range of a female is between 180 and 1000 ha,</p>	8 - BioNet	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>while males have larger home ranges of between 2000 and 5000 ha. Breeding occurs from May to August.</i>		
<i>Falsistrellus tasmaniensis</i>	<i>Eastern False Pipistrelle</i>		VU	Ecosystem	N/A	<i>Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet high-altitude sclerophyll and coastal mallee habitat, preferring wet forests with a dense understorey but being found in open forests at lower altitudes. Apparently hibernates in winter. Roosts in tree hollows and sometimes in buildings in colonies of between 3 and 80 individuals. Often change roosts every night. Forages for beetles, bugs and moths below or near the canopy in forests with an open structure, or along trails. Has a large foraging range, up to 136 ha. Records show movements of up to 12 km between roosting and foraging sites.</i>	6 - BioNet	<i>Moderate. Marginal habitat associated with the PCTs present in the study area.</i>
<i>Micronomus norfolkensis</i>	<i>Eastern Coastal Free-tailed Bat</i>		VU	Ecosystem	N/A	<i>Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney. Most records are from dry eucalypt forests and woodland.</i>	26 - BioNet	<i>Moderate. Marginal habitat associated with the PCTs present in the study area.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<p>Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites.</p>		
<i>Miniopterus australis</i>	Little Bent-winged Bat		VU	Dual	<p>Caves: Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature.</p>	<p>Occurs from Northern Queensland to the Hawkesbury River near Sydney. Roost sites encompass a range of structures including caves, tunnels and stormwater drains. Young are raised by the females in large maternity colonies in caves in summer. Shows a preference for well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. The Little Bentwing bat forages for small insects (such as moths, wasps and</p>	199 - BioNet	<p>Moderate. Marginal habitat associated with the PCTs present in the study area.</p>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>ants) beneath the canopy of densely vegetated habitats.</i>		
<i>Miniopterus orianae oceanensis</i>	<i>Large Bent-winged Bat</i>		VU	Dual	<i>Caves: Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records with microhabitat code "IC - in cave;" observation type code "E nest-roost;" with numbers of individuals >500</i>	<i>Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways.</i>	123 - BioNet	<i>Moderate. Marginal habitat associated with the PCTs present in the study area.</i>
<i>Myotis macropus</i>	<i>Southern Myotis</i>		VU	Species	<i>Hollow bearing trees; Within 200 m of riparian zone. Other; Bridges, caves or artificial structures within 200 m of riparian zone. Waterbodies: This includes rivers, creeks, billabongs, lagoons, dams and other waterbodies on</i>	<i>Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind</i>	12 - BioNet	<i>Moderate. Marginal habitat associated with the PCTs present in the study area.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
					<i>or within 200m of the site</i>	<i>claws, and also catch flying insects.</i>		
<i>Petauroides volans</i>	<i>Greater Glider</i>	VU		Species	<i>Hollow bearing trees.</i>	<i>The distribution of the Greater Glider includes the ranges and coastal plain of eastern Australia, where it inhabits a variety of eucalypt forests and woodlands. Presence and density of Greater Gliders is related to soil fertility, eucalypt tree species, disturbance history and density of suitable tree hollows. Feeds exclusively on eucalypt leaves, buds, flowers and mistletoe.</i>	1 – BioNet, PMST	Low. <i>Habitat not suitable.</i>
<i>Petaurus australis</i>	<i>Yellow-bellied Glider</i>		VU	Species	<i>Hollow bearing trees; Hollows > 25cm diameter</i>	<i>Restricted to tall native forests in regions of high rainfall along the coast of NSW. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types.</i>	2 - BioNet	Low. <i>Habitat not suitable.</i>
<i>Petaurus norfolcensis</i>	<i>Squirrel Glider</i>		VU	Species	N/A	<i>Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the</i>	167 - BioNet	High.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						southern part of its range. Requires abundant hollow-bearing trees and a mix of eucalypts, banksias and acacias. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked.		Suitable habitat present within the study area and recent records close by.
<i>Phascolarctos cinereus</i>	Koala	EN	VU	Dual	Areas identified via survey as important habitat	In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region. Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally. Primary feed trees include <i>Eucalyptus robusta</i> , <i>E. tereticornis</i> , <i>E. punctata</i> , <i>E. haemostoma</i> and <i>E. signata</i> . They are solitary with varying home ranges.	17 - BioNet, PMST	Low. Marginal habitat associated with the PCTs present in the study area however, no known populations in this location and no recent records.
<i>Potorous tridactylus</i>	Long-nosed Potoroo	VU	VU	Species	Other; Dense shrub layer or alternatively high canopy cover exceeding 70% (i.e. to capture populations inhabiting wet sclerophyll and rainforest)	Usually found within 50 km of the coast. Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy. Known to eat fungi, arthropods, fleshy fruit, seeds and plant tissue.	1 - BioNet	Low. Habitat not suitable.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	VU		Species	N/A	<i>The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. The home range of the New Holland Mouse can range from 0.44 ha to 1.4 ha. The New Holland Mouse is a social animal, living predominantly in burrows shared with other individuals. The species is nocturnal and omnivorous, feeding on seeds, insects, leaves, flowers and fungi, and is therefore likely to play an important role in seed dispersal and fungal spore dispersal. It is likely that the species spends considerable time foraging above-ground for food, predisposing it to predation by native predators and introduced species. Breeding typically occurs between August and January, but can extend into autumn.</i>	7 - BioNet, PMST	Low. Habitat not suitable.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	VU	VU	Dual	Other; Breeding Camps	Occurs along the NSW coast, extending further inland in the	529 - BioNet	Moderate.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
						<i>north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies, commonly in dense riparian vegetation.</i>		<i>Foraging habitat associated with PCTs present in the study area.</i>
<i>Saccolaimus flaviventris</i>	<i>Yellow-bellied Sheath-tail-bat</i>		VU	Ecosystem	N/A	<i>Found throughout NSW in habitats including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert. They roost in tree hollows in colonies and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. Forages for insects above the canopy in forests.</i>	3 - BioNet	<i>Moderate. Marginal habitat associated with the PCTs present in the study area.</i>
<i>Scoteanax rueppellii</i>	<i>Greater Broad-nosed Bat</i>		VU	Ecosystem	N/A	<i>Occurs along the Great Dividing Range and in coastal areas. Occurs in woodland and rainforest, preferring open habitats or openings in wetter forests. Often hunts along creeks or river corridors. Preys upon beetles and other large, flying insects, other bats and spiders. Roosts in hollow tree trunks and branches.</i>	29 - BioNet	<i>Moderate. Marginal habitat associated with the PCTs present in the study area.</i>

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
<i>Vespadelus troughtoni</i>	Eastern Cave Bat		VU	Species	Caves; Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds."	Found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. It roosts in small groups, often in well-lit overhangs and caves, mine tunnels, road culverts, and occasionally in buildings.	14 - BioNet	Moderate. Marginal habitat associated with the PCTs present in the study area.
Amphibians								
<i>Crinia tinnula</i>	Wallum Froglet		VU	Species	N/A		9	Low. Habitat not suitable.
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	VU	VU	Species	N/A		PMST	Low. Habitat not suitable.
<i>Litoria aurea</i>	Green and Golden Bell Frog	VU	EN	Species	Semi-permanent/ephemeral wet areas; Within 1km of wet areas. Swamps; Within 1km of swamp. Waterbodies; Within 1km of waterbody		4 – BioNet, PMST	Low. Habitat not suitable.
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	VU	VU	Species	N/A		PMST	Low.

Scientific name	Common name	Status		BAM credit type	BAM Habitat Constraint	Distribution and habitat	Number of records (source)	Likelihood of occurrence
		EPBC Act	BC Act					
								<i>Habitat not suitable.</i>
<i>Pseudophryne australis</i>	<i>Red-crowned Toadlet</i>		VU	Species	N/A		1	Low. <i>Habitat not suitable.</i>
<i>Invertebrates</i>								
<i>Petalura gigantea</i>	<i>Giant Dragonfly</i>		EN		<i>Swamps; Within 500 m of swamps</i>	<i>Live in permanent swamps and bogs with some free water and open vegetation. Adults spend most of their time settled on low vegetation on or adjacent to the swamp.</i>	1 - BioNet	Low. <i>Habitat not suitable.</i>

Appendix C – Plot-based field data sheets

Appendix D – Test of Significance

Owls

The following species of owl have previously been recorded within a 10 kilometre radius of the study area and have a moderate or greater likelihood of occurrence within the study area:

- Barking Owl *Ninox connivens* (Vulnerable, BC Act).
- Masked Owl *Tyto novaehollandiae* (Vulnerable, BC Act).
- Powerful Owl *Ninox strenua* (Vulnerable, BC Act).

Species background

The Barking Owl is known to occur throughout continental Australia except for the central arid regions. Commonly inhabiting woodlands, open forests and fragmented remnant vegetation surrounding farmland or along timbered watercourses. Usually occurring in monogamous pairs, this species typically hunts small arboreal mammals including Squirrel Gliders and Common Ringtail possum. The Barking Owl usually inhabits a territory of greater than 100 hectares, with nesting occurring in large tree hollows in mid-winter and spring (DPE 2018).

The Masked Owl is medium sized owl which is broadly distributed across south-eastern Australia, with approximately 90% of records occurring within NSW. The mask owl primarily inhabits the dry eucalypt forest of the tablelands and western slopes or the undulating wet-dry forest of the coast, with optimal habitat consisting of an open understory and dense ground cover. Usually occurring in breeding pairs the Masked Owl will largely use the same hollows for breeding through its lifetime. This species will utilise hollows with an entrance of greater than 40 centimetres, which occurring in trees with a diameter of at least 90 centimetres, with an entrance height of at least 3 metres (DEC 2006).

The Powerful Owl is widely distributed over eastern and southern-eastern Australia, primarily residing on the eastern side of the Great Dividing Range within a range of vegetation communities. The Powerful Owl requires large tracts of forest or woodland habitat and is therefore susceptible to largescale fragmentation of habitat (DPE 2017a). The Powerful Owl feeds on a range of medium-sized marsupials nocturnally and roosts by day in dense vegetation. Usually occurring in breeding pairs within territories, with the size of the territory of the Powerful Owl is dependent on quality of habitat. Nest within large old growth trees which contain hollows 15-20 metres high, with an entrance of 30-50 centimetres wide (Lake Macquarie City Council 2014).

(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,

Impacts likely to have an adverse effect on the life cycle of Barking Owl, Masked Owl and Powerful Owl include; direct mortality, disturbance to nesting sites, loss of nesting/sheltering habitat and loss and fragmentation of foraging habitat.

The proposal will remove up to 4.1 linear hectares of native vegetation across three PCTs (PCT 1627, PCT 1638 and PCT 1649), representing potential foraging habitat for these species. Field survey including call playback, stag watching and whitewash/pellet searches, did not detect the use of habitat for breeding or roosting in the study area. No large hollow (>20 centimetre diameter)

are expected to be removed as a result of the proposed works. However, some indirect impact, including an increase in sound and light pollution is expected to occur. This will likely reduce the quality of habitat available within the broader study area, which contains four large sized (>20 centimetre diameter) hollows.

Foraging habitat to be removed is occurs within a large size patch (>100 hectares) of good quality bushland, extending from Hillsborough Road to Bayview Street to the south of the study area. Based on the number of records within the immediate area and known owl populations within the Lake Macquarie Council area (Lake Macquarie City Council 2014), it is likely that some or all of the three owl species are utilising the vegetation within both the study area and broader landscape. Given that the study area occurs along a portion of bushland which would be heavily influenced by edge effects, it is likely that if the species uses the study area for foraging then the local population would use the entire patch of bushland, which extends to the north (approximately 1.6km) and the south (approximately 1.6km) of the study area. Owls are highly mobile creatures and are known to hunt over hundreds of hectares and as such the removal of a relatively small linear edge effected patch of vegetation is unlikely to significantly impact the life cycle of the species, given the availability of resources in the surrounding landscape.

The removal of the four medium and one small sized hollow would not have a significant impact on any prey species such that they would be subject to population reduction and therefore a reduction in food availability to the Barking Owl, Masked Owl or Powerful Owl.

The removal of a relatively small linear patch of vegetation which does not contain suitable breeding habitat is unlikely to significantly impact a viable local population of Barking Owl, Masked Owl or Powerful Owl such that it 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.

(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 proposed action will result in the removal of up to 4.1 linear hectares of native vegetation (PCT 1627, PCT 1638 and PCT 1649), which may provide potential foraging habitat for the subject owl species. While this vegetation does contain a total of five tree hollows, all hollows are <15 centimetres, and it is therefore highly unlikely that any of these hollows would be utilised by either the Barking Owl, Masked Owl or Powerful Owl for breeding. The widening of the existing Hillsborough Road will likely have indirect impacts on four large hollows (>20 centimetres diameter) within the study area, which have the potential to provide marginal nesting habitat for

these species. Indirect impacts may include an increased vehicle strike risk, adverse effects associated with the edge effect and increased noise and light pollution.

The proposed works will alter a relatively small linear area of vegetation within a large patch of good quality bushland. Due to the highly mobile nature of these species, the proposed widening of the existing roadway and the associated vegetation clearing is unlikely to pose a barrier in terms of movement for the species. The proposed works are not expected to lead to an increase of habitat fragmentation as impacts will be limited to the edge of an already fragmented area, which occurs along the roadway.

The proposed works will require the removal of 4.1 linear hectares of edge effected native vegetation within a large patch of good quality bushland. The removal of a relatively small linear strip of habitat running parallel with previous linear disturbance associated with the road corridor is unlikely to increase fragmentation or isolation of foraging habitat. The small area of potential foraging habitat proposed for removal would represent a small proportion of available foraging habitat for these species in the local area. The site is located within a larger area of bushland which would provide better habitat potential than the area to be impacted by the proposed works.

(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),

The proposed works will not have an adverse effect on an area of outstanding biodiversity value.

(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.

Key threatening processes of relevance to the Barking Owl, Masked Owl and Powerful Owl include loss of large hollow-bearing trees and clearing of native vegetation (DEC 2006).

No suitable hollows for nesting are expected to be removed as a result of the proposed works. However, the proposed works may reduce the vegetated buffer between the road and some medium hollows. As there is no evidence that these hollows are utilised for nesting currently, it is unlikely that any indirect impacts associated with the proposed works, would lead to nest disturbance. A total of 4.1 linear hectares of native vegetation is expected to be removed as a result of the proposed works. Vegetation clearing will be undertaken along either side of the road corridor, which represents sub optimal foraging habitat, particularly given the availability of habitat in the broader landscape and away from the existing road. Impacts associated with the widening of the road are also not expected to increase habitat fragmentation for the species, due to their highly mobile nature.

As such, while some sub optimal foraging habitat will be required to be removed, it is unlikely that the proposal will increase the impact of a key threatening process for either the Barking Owl, Masked Owl and Powerful Owl in any significant manner.

Conclusion

In light of the consideration of the above five factors (a-e), the proposed activity is not likely to significantly impact Barking Owl, Masked Owl or Powerful Owl within the study area or wider locality, as:

- No hollows of suitable size for breeding are expected to be significantly impacted.
- Vegetation to be removed represents sub optimal foraging habitat only, located adjacent to an existing busy road.

- Increased fragmentation of habitat is not expected to occur due to the availability of higher quality resources for these highly mobile species in the broader locality.
- The habitat to be removed is not considered important to the survival of the species.
- The proposal does not significantly contribute to a KTP for these species.

As such further assessment of impact in the form of a SIS or BDAR is not required.

Grey-headed Flying Fox

Grey-headed Flying-fox *Pteropus poliocephalus* is listed as Vulnerable under the BC Act. Grey-headed Flying-fox population movements trend with the distribution of plants with similar flowering and fruiting times, support regular annual cycles of migration (Eby & Law 2008). Therefore, population dispersal is often associated with flowering Myrtaceae species dependant on seasonality.

The species feeds on a variety of preferred Eucalypt and non-Eucalypt species depending on a number of factors including location, vegetation type, and vegetation condition. The vegetation within the study area provides potential habitat foraging resources for the Grey-headed Flying-fox.

No Grey-headed Flying-foxes were recorded during the field investigation, however there are known foraging records of the species within 86 metres of the study area and broadly in the region. The closest Grey-headed Flying-fox camp is located in Blackbutt Reserve in Newcastle (2.5 kilometres north east of the study area) (DoE 2015).

(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,

Impacts likely to have an adverse effect on Grey-headed Flying-fox resulting from the proposal include loss, modification and fragmentation of habitat, increased light pollution and an increase in collision risks. Grey-headed Flying-fox habitat to be removed is located in an area broadly surrounded by highly urbanised areas of Newcastle and is limited to linear removal of vegetation either side of Hillsborough Road. As such, vegetation to be impacted is unlikely to be important to the life cycle of the species given it is located on the fringe of a larger patch of disturbed vegetation. However, it may provide occasional foraging habitat.

Works will result in the removal of 4.1 linear hectares of native vegetation consisting of; PCT 1627, 1638 and 1649, which is likely to provide foraging habitat for Grey-headed Flying-fox. The removal of this vegetation will reduce the availability of resources within the immediate area; however large tracts of high quality foraging habitat occur within the immediate locality and within the 50 kilometre feeding radius of this species.

The species is highly mobile and relatively widespread in the region, however roosting and maternity sites are well documented and conspicuous. Roosting or breeding habitat within the study area or in adjacent vegetation is sub optimal. No camps have previously been recorded within the study area and no roosting flying-foxes were observed during field investigation. The closest Grey-headed Flying-fox camp is located at Blackbutt Reserve in Newcastle (2.5 kilometres north east of the study area) (DoE 2015). Given the vegetation removal is confined to the edge of a patch and the majority of habitat within the interior of the patch will be retained, habitat is unlikely to become fragmented or isolated from other areas of habitat as a result of the proposed activity. Foraging opportunities for the species will remain within retained habitat.

Given the scale of impact in the context of available resources within the immediate vicinity and region more broadly, the distance of the Newcastle camp (2.5 kilometres), the highly mobile nature of the species (known to travel up to 50 kilometres whilst foraging) (Eby 1991), and relatively small area of potential foraging habitat to be removed (4.1 hectares), it is unlikely that the proposal will have an adverse effect on the life cycle of 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.

(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

The proposal will remove up to 4.1 linear hectares of native vegetation across three PCTs (PCT 1627, PCT 1638 and PCT 1649), which may provide potential foraging habitat for Grey-headed Flying-fox. The small area of potential foraging habitat proposed for removal would represent a small proportion of available habitat for these species in the local area. There are larger, intact forested areas connected to the study area in virtually all directions. Habitat to be removed occurs along the edge of a patch of vegetation and is likely impacted by noise and light pollution from the road. Therefore, the habitat to be removed would not be considered of high importance to the survival of the species in the locality.

(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

Given the removal of vegetation is located on the edge of a patch and the majority of habitat will be retained, Grey-headed Flying-fox habitat is unlikely to become further fragmented or isolated from other areas of habitat as a result of the proposed activity.

The vegetation to be impacted is located on the fringe of an intact patch of vegetation. The vegetation is contiguous with a large patch of good condition vegetation to the east and south-east, providing connectivity throughout the broader landscape. The clearing of 4.1 hectares of Grey-headed Flying-fox foraging habitat is considered unlikely to significantly contribute to any fragmentation of habitat given the high mobility of the species and the study areas locality within close proximity of large patches of remnant vegetation.

(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 national population of the Grey-headed Flying-fox is considered a single population as it is a highly mobile species (DoEE 2020). The works are expected to remove up to 4.1 linear hectares of native vegetation which occurs along a narrow band either side of Hillsborough road. Vegetation expected to be removed includes spring and winter foraging resources notably, Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *Corymbia gummifera*, Mugga Ironbark *Eucalyptus sideroxylon*, and White Box *Eucalyptus albens* (Eby & Law 2008). Given that the vegetation to be removed occurs within a narrow band, in close proximity to a busy roadway. It is unlikely that this vegetation would constitute an important foraging resource for this species. Given the proximity of the roadway to impact area and the mobile nature of this species, the removal of vegetation from the study area is unlikely to significantly impact the species, such that the long-term survival of the species within the locality is placed at risk.

(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),

The proposal will not impact on an area declared as of outstanding biodiversity value.

(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.

Key threatening processes relevant to Grey-headed Flying-fox including the clearing of native vegetation.

The clearing of 4.1 linear hectares of habitat for the species inclusive of spring and winter foraging resources will result in a reduction of foraging resources within the immediate vicinity of the study area. However, an abundance of high quality dispersal and foraging habitat occurs within the vicinity, with Glenrock conservation area located 3.5km to the west and Sugarloaf state Conservation area located 11 kilometres to the west, in addition to remnant vegetation located in the immediate vicinity. Therefore, given the contiguous nature of the vegetation with a variety of suitable Grey-headed Flying-fox foraging resources nearby, the proposal is not considered to significantly contribute to the key threatening process of loss of foraging sites for the species.

As such, it is unlikely that the proposal will increase the impact of a key threatening process for Grey-headed Flying-fox outside of temporary impacts which would be considered to be of minimal risk.

Conclusion

In consideration of the above five factors (a-e), the proposed activity is not likely to significantly impact Grey-headed Flying-fox within the study area or wider locality, as:

- The proposed road expansion will result in the clearing of 4.1 hectares of foraging habitat for Grey-headed Flying-fox.
- Given the high availability of foraging resources in the broader landscape and the proximity of impacted vegetation to a busy roadway, it is unlikely that the 4.1 hectares of vegetation to be removed would provide a significant foraging resource for this species.
- The proposal does not significantly contribute to a KTP for Grey-headed Flying-fox.

As such further assessment of impact in the form of a SIS or BDAR is not required.

Woodland bird species

The following woodland bird species have previously been recorded within a 10 kilometre radius of the study area and have a moderate or greater likelihood of occurrence within the study area:

- Dusky Woodswallow *Artamus cyanopterus cyanopterus* (Vulnerable, BC Act).
- Varied Sittella *Daphoenositta chrysoptera* (Vulnerable, BC Act).
- Brown Tree Creeper *Climacteris picumnus victoriae* (Vulnerable, BC Act).
- Scarlet Robin *Petroica boodang* (Vulnerable, BC Act).

Species background

Dusky Woodswallow are found over a broad range of habitats, primarily inhabiting dry open Eucalypt forests and woodland, yet can be found in moist forest or rainforest. The species can be resident or migratory birds depending on location. Populations in NSW migrate to south-eastern Queensland after breeding in Spring. Dusky Woodswallow nest in open cup shaped nests, generally occurring in shrubs or low trees. Dusky Woodswallow primarily eat insects whilst flying high but can also forage under canopy over leaf litter or dead timber (DPE 2017b).

The Varied Sittella is a sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. The species usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in mallee and acacia woodlands, paperbarks or mature Eucalypts. The Varied Sittella feeds on arthropods gleaned from bark, small branches and twigs. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.

The Brown Treecreeper is Australia's largest treecreeper and is found across the east coast of Australia. This species inhabits dry open woodlands dominated by Stringybark's or other rough-barked eucalypts. Normally observed in small pairs or groups of up to 12 birds, the Brown Treecreeper will feed on a range of insects; predominantly ants, and nectar. This species nest in hollows and tends to have a territory of approximately 4.4ha.

Scarlet Robin is found from south east Queensland to south east South Australia and also in Tasmania and south west Western Australia. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. The species lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation that usually contains abundant logs and fallen timber, which are important components of its habitat. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps.

- 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 proposed works are expected to result in the removal of 4.1 linear hectares of native vegetation along either side of Hillsborough Road in order to allow for the widening of the current roadway. The vegetation may provide potential foraging and possibly breeding resources for a number of woodland birds which may be utilising the study area including Dusky Woodswallow, Varied Sittella, Brown Treecreeper and Scarlet Robin. While, locally occurring threatened woodland bird population may occasionally be using the study area, given the proximity of the

study area to Hillsborough Road and the availability of higher quality resources throughout the broader landscape it is unlikely that this vegetation would be utilised with any frequency. Woodland birds are able to move freely between the study area and adjacent woodland habitats. Potential impacts associated with the proposed works include the; loss of nesting, perching, foraging and sheltering habitat. Indirect impacts including clutch failure due to noise disturbance, mortality through vehicle strikes and increased in light disturbance.

There are no known records of any of the species assessed occurring within one kilometre of the area. The Dusky Woodswallow has been recorded closest to the study area (1.17 kilometres), however the density of records is very low, with only four records. The Varied Sittella, Brown Treecreeper and Scarlet Robin have not been recorded within three kilometres of the study area. As such, if any of the assessed species are utilising the study area it would be assumed it would be irregularly and at low density.

It is likely that if these species use the study area for nesting and breeding then the local populations would be reasonably expected to use the entire patches of contiguous habitat available either side of the study area. Removal of vegetation in the context of the available habitat adjacent to the development will not adversely affect the life cycle of threatened woodland bird species such that local populations would be placed at risk of extinction given the quantity of suitable breeding and nesting habitat immediately adjacent to the development, and the dispersal ability of these mobile avian species.

(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.

(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 will remove 4.1 linear hectares of potential foraging and breeding habitat for; Dusky Woodswallow, Varied Sittella, Brown Tree Creeper and Scarlet Robin. Vegetation to be removed occurs along an existing roadway, which is already fragmenting two patches of vegetation within the broader landscape. Given the mobile nature of these species, it is unlikely that the removal of this vegetation would create an increased barrier for these species which would lead to the isolation or fragmentation of a local population.

In a broader sense, the potential habitat to be removed within the study area would be considered to be marginal habitat for these species, given its proximity of to an existing roadway. As such, it is

unlikely that the removal/disturbance of 4.1 linear hectares of native vegetation required for the development, will jeopardise the long term survival of these species in the locality, given the quantity of higher quality contiguous habitat immediately adjacent to the development. The cumulative impacts of incremental habitat loss are a key concern for woodland bird species but given the type of impact in the context of the available habitat at the location, this is not seen as a significant issue in this case. Habitat removal of this type and extent will not adversely influence the long term survival of any threatened woodland birds given the quantity of similar habitat immediately adjacent to the development.

(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),

The proposed works will not impact on an area declared as of outstanding biodiversity value.

(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.

Key threatening processes relevant to the woodland bird species identified on the Schedule 4 of the BC Act that may be exacerbated by the proposed slope works include:

- Clearing of native vegetation.
- Aggressive exclusion from forest and woodland habitat by Noisy Miners.

The current proposal will result in the clearing of 3.8 hectares of relatively low quality native vegetation along the side of Hillsborough Road within the study area. This vegetation forms part of a larger connective corridor throughout the landscape, which extends to the north (approximately 1.6km) and the south (approximately 1.6km) of the study area. Due to the small size of edge effected vegetation to be cleared, which is confined to the edge of Hillsborough Road the proposed works would not be considered to significant impact the habitat available for Dusky Woodswallow, Varied Sittella, Brown Treecreeper or Scarlet Robin.

The works are unlikely to lead to an increase in competition from other more aggressive bird species, or from Noisy Miners as the widening of Hillsborough Road will not result in significantly different impact to retained vegetation that what is currently being experienced.

Conclusion

In consideration of the above five factors (a-e), the proposed activity is not likely to significantly impact threatened woodland birds within the study area or broader locality, as:

- The extent of the vegetation removal in the context of the broader area will not significantly disrupt the lifecycle of threatened woodland birds as large areas of similar habitat will still be available for critical activities to occur post construction in adjacent areas to the study area.
- The species considered readily move through the landscape and are capable of short distance dispersal. As such, fragmentation is unlikely to occur as a result of the widening of the roadway.
- Vegetation to be removed would not be considered to be high quality foraging or breeding habitat, due to edge effects.
- The proposal does not significantly increase the impact of a KTP for these species.

As such further assessment of impact in the form of a SIS or BDAR is not required.

Nectivorous bird species

The following Nectivorous bird species have previously been recorded within a 10 kilometre radius of the study area and have a moderate or greater likelihood of occurrence within the study area:

- Swift Parrot *Lathamus discolor* (Endangered BC Act).
- Regent Honeyeater *Anthochaera phrygia* (Critically endangered BC Act).
- Little Lorikeet *Glossopsitta pusilla* (Vulnerable, BC Act).

Swift Parrot is listed as Endangered under the BC Act and Critically Endangered under the EPBC Act. It breeds in Tasmania during spring and summer, migrating in the autumn and winter months (March to October) to south-eastern Australia from Victoria and eastern parts of South Australia up to south-east Queensland. In NSW it occurs mostly on the coast and south west slopes (OEH 2017). Whilst on the mainland they are typically found in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Their favoured trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *Corymbia gummifera*, Mugga Ironbark *Eucalyptus sideroxylon*, and White Box *Eucalyptus albens*. Commonly used lerp infested trees include Inland Grey Box *Eucalyptus microcarpa*, Grey Box *Eucalyptus moluccana* and Blackbutt *Eucalyptus pilularis*. Individuals are known to return to some foraging sites on a cyclic basis depending on food availability (OEH 2017).

Regent Honeyeater is listed as critically endangered under the BC and EPBC Act. It is a striking and distinctive, medium-sized, black and yellow honeyeater with a sturdy, curved bill. The Regent Honeyeater is a generalist forager, although it feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. The species mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands (OEH 2022).

Little Lorikeet is distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 metres and 15 metres, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.

Neither Swift Parrot, Regent Honeyeater nor the Little Lorikeet were recorded during the field surveys (no targeted survey was undertaken). However, there are known records of the species within 10 kilometres of the study area (DPE 2022a), and there is potential for the study area to be used occasionally by this species for foraging, although it is unlikely that individuals rely upon resources in the study area.

(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,

Impacts likely to have an adverse effect on the life cycle of Swift Parrot, Regent Honeyeater or Little Lorikeet include loss of winter flowering foraging habitat, roosting habitat loss from forest harvesting and development, competition from introduced species, unsuitable fire regimes, predation, and further habitat fragmentation.

The proposal will remove up to 4.1 linear hectares of native vegetation consisting of PCT 1627, PCT 1638 and PCT 1649. The removal of this native vegetation may be potential foraging and roosting habitat for Swift Parrot, Regent Honeyeater and Little Lorikeet. Preferred winter flowering tree within the study area include Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, and Red Bloodwood *Corymbia gummifera*. Potential habitat to be removed is located close to Hillsborough Road and is likely impacted by impacts associated with this road and edge effects. The broad patches of vegetation within the locality form a relatively large connectivity corridor throughout the broader landscape. As such, it is likely that if these species use the study area for foraging, they also utilise the entire vegetated corridor; to the south, north and west of the study area, which represent higher quality vegetation. Similarly with roosting habitat the species are more likely to use the larger intact forested areas nearby and further from the major roadway. Removal of a relatively small patch of lower quality edge effected foraging resources is unlikely to significantly reduce the availability of foraging resources available, particularly given the highly mobile nature of these species. The study area is not mapped as important habitat for any of these species under the BAM (DPE 2022b).

The Swift Parrot breeds in Tasmania (DPE 2022c) and the Regent Honeyeater breeds in a number of locations including Capertee Valley and Bundarra-Barraba regions (OEH 2022), therefore there would be no nesting habitat within the study area for these two species. One small hollow (<90mm) is expected to be impacted as a result of the proposed works, which may provide marginal breeding habitat for the Little Lorikeet. However, no signs of use were observed and in general the hollow to be removed would be considered to be poor quality due to the proximity to the roadway.

The study area does not include areas mapped as significance habitat for either the Swift Parrot or the Regent Honeyeater (DPE 2022a), although they are known to occur within the Lake Macquarie area (Birdlife Australia 2014). In an assessment undertaken on behalf of Lake Macquarie Council the study area was mapped as low value for Regent Honeyeaters and moderate to low value for the Swift Parrots (Birdlife Australia 2014). Vegetation within the study area is not considered to be of high ecological importance for either of these species (Birdlife Australia 2014).

As minimal to no breeding habitat is to be removed and as impact to potential foraging is limited to a narrow band of vegetation along the road verge it is unlikely that the removal of 4.1 linear hectares of potential habitat would adversely affect the life cycle of a viable local population of the species such that it could 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.

(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 proposed action will result in the removal of up to 4.1 hectares of potential foraging and roosting habitat, either side of Hillsborough Road. One small hollow which may provide suitable breeding habitat for the Little Lorikeet is expected to be removed as a result of the proposed works.

Vegetation within the study area is connected to the; south, north and west to relatively large tracks of native vegetation. Connectivity corridors throughout the study area are already intersected by a number of roads including Hillsborough Road. The proposed widening of Hillsborough Road is therefore unlikely to significantly increase fragmentation as impacts will be limited to the edge of the roadway in already impacted and fragmented areas. The Swift Parrot, Regent Honeyeater and Little Lorikeet are highly mobile species capable of traveling hundreds of kilometres (DPE 2022c), as such it is highly unlikely that the widening of Hillsborough Road would constitute a barrier to the movement of these species thereby increasing fragmentation.

The small area of potential foraging habitat proposed for removal would represent a small proportion of available habitat for these species in the local area. There are larger, intact forested areas connected to the study area in virtually all directions. Habitat to be removed occurs along the edge of a patch of vegetation and is likely impacted by noise and light pollution from the road. Therefore, the habitat to be removed would not be considered of high importance to the survival of the species 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),

The proposed works will not have an adverse effect on an area of outstanding biodiversity value.

(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.

Key threatening processes of relevance to Swift Parrot, Regent Honeyeater and Little Lorikeet include;

- Clearing of Native vegetation.
- Loss of hollow-bearing trees.
- Aggressive exclusion from forest and woodland habitat by Noisy Miners.

The current proposal will result in the clearing of 4.1 hectares of relatively low quality native vegetation along the side of Hillsborough Road within the study area. This vegetation forms part of a larger connective corridor throughout the landscape, which extends to the north (approximately

1.6km) and the south (approximately 1.6km) of the study area. Due to the small size of edge effected vegetation to be cleared, which is confined to the edge of Hillsborough Road the proposed works would not be considered to significant impact the habitat available for Swift Parrot, Regent Honeyeater or Little Lorikeet.

The proposed works will result in the removal of one small hollow (<90mm), which may provide sub optimal breeding habitat for the Little Lorikeet. Given this hollow's proximity to the road, it is considered of a lower likelihood that this hollow would be utilised for breeding. Surrounding vegetation is assumed to be relatively dense in higher quality hollows. Mitigation measures including the installation of nest boxes have also been recommended, in order to minimise impacts.

The works are unlikely to lead to an increase in competition from other more aggressive bird species, such as Noisy Miners that are already in moderate abundance, as the widening of Hillsborough Road will not result in significantly different impact to retained vegetation that what is currently being experienced.

As such the works are unlikely to significantly increase the impact of the key threatening process.

Conclusion

In light of the consideration of the above five factors (a-e), the proposed activity is not likely to significantly impact Swift Parrot, Regent Honeyeater or Little Lorikeet within the study area or wider locality, as:

- The proposal will remove a relatively small area (up to 4.1linear hectares) of sub optimal foraging and roosting habitat, from an area containing large tracts of more suitable habitat.
- Only one hollow suitable for breeding for the Little Lorikeet will be removed as a result of the proposed works, although the likelihood of the species utilising the hollow for breeding habitat is considered low. Given the expected availability of hollows within the broader landscape and the mitigation measures implemented this impact would be considered minimal.
- The habitat to be removed is not considered important to the survival of the species.
- The proposal does not significantly contribute to any KTP for this species.

Therefore, no further assessment is required and a SIS or BDAR is not required.

Squirrel Glider

Squirrel Glider *Petaurus norfolcensis*, listed as Vulnerable under the BC Act, is a small arboreal mammal with a head and body length of approximately 20 centimetres. The species is nocturnal and has a wide, although sparse, distribution throughout eastern Australia extending from northern Queensland to western Victoria.

Squirrel Glider inhabits mature to old growth Box, Box-Ironbark woodlands, and River Red Gum Forest west of the Great Dividing Range, as well as Blackbutt-Bloodwood Forest with a heath understorey in coastal areas. The species feeds on the gum produced by *Acacia* shrubs, as well as Eucalyptus sap and nectar, honeydew and manna, as well as some invertebrates and pollen. The species shelters and breeds in tree hollows (DPE 2017c, Smith & Murray 2003) and is known to occur in groups of two to nine individuals. Home range for Squirrel Gliders within the Lake Macquarie area was calculated to be between 6-7 hectares, depending on habitat available, with a night range of 300-500 metres (Lake Macquarie City Council 2015).

The study area includes *Eucalyptus* spp., *Banksia spinulosa* and Red Bloodwood *Corymbia gummifera*, which provide foraging resources for the Squirrel Glider. Five hollow-bearing trees including one small hollow (<90 mm) and four medium hollows (90 – 150 mm) to be impacted by the proposed works also represent potential sheltering and breeding habitat for the species.

(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,

Impacts likely to have an adverse effect on the life cycle of Squirrel Glider include loss, modification and fragmentation of habitat through clearing of vegetation, loss of understorey food resources, and loss of hollow-bearing tree nest sites.

The proposed works will result in the removal of up to 4.1 linear hectares of potential habitat for this species, associated with PCT 1627, PCT 1638 and PCT 1649. Vegetation to be removed includes canopy and understorey feed trees, such as *Banksia spinulosa* and Red Bloodwood *Corymbia gummifera*, which are listed as key feed trees for the Squirrel Glider in the Lake Macquarie Area (Lake Macquarie City Council 2015). The removal of this vegetation will reduce the availability of potential resources within the immediate area. However, as this vegetation occurs along a pre-disturbed road corridor and is of a lower quality compared to the surrounding resources within the broader locality, it is unlikely that it would represent a significant foraging resource for the species.

While the removal of 4.1 hectares of native vegetation will reduce the availability of foraging resources within the area, given that the southern portion of the study area occurs within a patch of vegetation greater than 100 hectares (Smith 2002), the removal of 4.1 linear hectares of would not reduce the overall patch size to a level in which the local population would be considered at risk of significant decline. Mitigation measures including a Wildlife Connectivity Strategy will prevent further fragmentation occurring in the northern section of the study area by providing a connective corridor. If mitigation measures were not implemented, connectivity between the north and the south of the study area may be substantially disrupted by the proposal, and it is likely that the northern population would be considered at risk of long term extinction due to diminished patch size and connectivity (Lake Macquarie City Council 2015).

The proposed works also include impacts to five hollow-bearing trees containing one small hollow (<90 mm) and four medium (90 – 150mm) which may provide sheltering and breeding habitat for

the species. The Squirrel Glider as known to inhabit several hollows across its home range, with Squirrel Glider population density often linked to the availability of hollows (Smith & Murray 2003). While a small number of hollows will be required to be removed as a result of the proposed works, given the nocturnal nature of the species and its sensitivity to light it is unlikely that these hollows would be utilised for dens with any frequency, based on their close proximity to the roadway. Additionally, given the expected density of hollows available within surrounding vegetation, it is unlikely that the proposed removal of five tree hollows along a narrow band of edge effected vegetation would significantly reduce the density of available den locations within the locality. In the event that these hollows are being utilised by the local population of Squirrel Gliders, mitigation measures including the installation of nest boxes and a pre-clearance survey will be implemented prior to works commencing.

The proposed works are likely to increase fragmentation of available habitat for this species as the widening of Hillsborough Road will result in an increase in glide distance from about 30 metres to about 50 metres, which would represent the upper limit of (and likely greater than) canopy gaps that the species is able to traverse (Van Der Ree et al. 2010). Vegetation on either side of Hillsborough Road has been identified as an important connectivity corridor by Lake Macquarie Council (Economos 2018) and as such, impacts to connectivity should be minimised. While it is likely that the current road already represents a significant barrier to movement for this species, the proposed works will further limit movement, potentially isolation populations. As such, mitigation measures including a Wildlife Connectivity Strategy would be implemented to maintain connectivity and reduce the risk of population isolation occurring as a result of the proposed works. If glider poles are unable to be installed at an appropriate distance to maintain connectivity, then further analysis of population dynamic will need to be undertaken to determine if the widening of Hillsborough Road would result in the fragmentation of the local population placing it at risk of extinction though isolation due to the future patch of vegetation o the north of the study area being surrounded on all side by urban development and/or major roadways.

Given that impacts associated with the proposed works will be confined to edge effected vegetation which occurs along Hillsborough Road and base on the implementation of the recommendations outlined in this report relating to the maintenance of habitat connectivity, it is unlikely that the proposed works will have an adverse effect on the life cycle this species 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.

(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 proposed works include clearing of 4.1 linear hectares of native vegetation either side of Hillsborough Road, in order to allow for the widening of the road corridor. Five tree hollows comprising; one small hollow (<90 mm) and four medium (90 – 150mm) which may provide sheltering and breeding habitat for the species, will be removed. Although Sugar Gliders, Common Ringtail Possums and Common Brush-tailed possums were observed, no Squirrel gliders were observed during field surveys, however they are known to occur more broadly in the locality.

Vegetation to be removed occurs along an existing roadway, which is already fragmenting two patches of vegetation within the broader landscape. Connectivity between vegetation within each patch will remain high through retention of vegetation, however the proposed works will widen the road corridor to at about 50 m, which would reduce connectivity between the patches as it will represent the upper limit of (and likely greater than) canopy gaps that the species is able to traverse (Van Der Ree et al. 2010). This increased separation may represent a complete barrier in movement between the northern and southern patches of vegetation contiguous with the study area. While the current road and transmission line would already represent a limiting barrier to movement for this species, it is likely the additional two lanes could prevent crossing almost entirely. Considering this, mitigation measures outlined in the BAR including glider poles, which will minimise the severity of the direct and indirect impacts generated by the proposed works, including potential isolation or mortality caused by a reduction in connectivity and vehicle strike. If mitigation measures cannot be implemented, then further analysis of population dynamics will need to be undertaken in order to assess the potential risks of isolating the current population into two distinct groups.

Given the wide availability of suitable high-quality resources providing similar foraging and roosting habitat immediately adjacent to the proposed works, the mitigation methods in place to ensure connectivity is maintained, and given that habitat fragmentation (Hillsborough Road) already present within the study area will be mitigated, the proposed works are not considered likely to constitute a significant impact to the long term survival of the Squirrel Glider within 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),

The proposed works will not have an adverse effect on any declared areas of outstanding biodiversity value.

(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.

Key threatening processes relevant to Squirrel Glider include:

- Clearing of native vegetation.
- Loss of hollow-bearing trees.
- Predation by European Red Fox *Vulpes vulpes* and Feral Cat *Felis catus*.

The proposed works will result in the removal of 4.1 linear hectares of native vegetation containing five tree hollows. Vegetation clearing will occur along a narrow band along Hillsborough Road, in areas of vegetation already impacted by edge effects associated with the current road.

Clearing of up to 4.1 linear hectares of PCT's 1627, 1638 and 1649, including feed trees and hollow-bearing trees, will reduce the potential availability of both foraging and sheltering/breeding resources within the immediate study area. Of this vegetation to be removed; 0.51 ha is considered to be of low quality due to its position along a pre-disturbed road corridor subject to edge effects. Additionally, mitigation measures to maintain connectivity along the north south corridor are implemented, vegetation removal will not reduce the overall patch size of vegetation to <100 hectares, which would place the local population a risk of decline (Smith 2002). Given the contiguous nature of the vegetation with a large tract of good quality bushland with abundant nearby resources, the small-scale removal is not considered to significantly exacerbate key threatening processes to this species, as these areas are likely used as marginal foraging and sheltering habitat only.

The proposed works are not likely to result in an increase in predation or an increase in occupancy of hollow by exotic species. Collision risk is not expected to be significantly higher than what is already observed under current conditions.

With the exception of an increased risk of fragmentation from vegetation clearing, the works are not expected to significantly increase the risk of any of the threatening process listed.

Conclusion

In consideration of the above five factors (a-e), the proposed activity is not likely to significantly impact the Squirrel Glider within the study area or wider locality, as:

- The proposed works will result in the removal of up to 4.1 linear hectares of PCT's 1627, 1638 and 1649, all of which occurs along a pre-disturbed road corridor. Given the high availability of high quality resources within the study area and surrounding connected areas, the removal of this native vegetation is unlikely to constitute a significant impact.
- Mitigation measures will be implemented to ensure connectivity is maintained between the two patches of vegetation that are currently fragmented to the north and south of the study area. This will ensure that broader patch size will remain greater than 100 hectares, which is considered a significant enough patch to support a local population without significant risk of decline (Smith 2002). As such, the proposed works will not cause a significant impact to the long term survival of the Squirrel Glider within the locality, or further isolate viable populations.
- The proposed works do not significantly contribute to a KTP for Squirrel Glider.

As long as appropriate measures can be undertaken to maintain connectivity, no further assessment of impact in the form of a SIS or BDAR is not required.

Glossy-Black Cockatoo

Glossy Black-Cockatoo *Calyptorhynchus lathami*, listed as vulnerable under the BC Act, is a medium-sized cockatoo with a diagnostic combination of black-brown head, neck and underbody, red or orange-red panel in tail, and otherwise black plumage. Adult females also exhibit extensive patches of yellow feathering on head and neck. The species is closely associated with *Allocasuarina* spp. and *Casuarina* spp. dominated woodlands, or open sclerophyll forest where the middle stratum is *Allocasuarina* spp. They feed almost exclusively on the seed of *Allocasuarina* spp. but occasionally also take wood-boring insect larvae. The species is dependent on hollow-bearing trees for breeding habitat as they nest in the hollows formed in the trunk, stump, spout or limbs of eucalypt trees, living or dead (Higgins 1999, DPE 2022d).

The study area includes five tree hollows including one small hollow (<90 mm) and four medium hollows (90 – 150 mm), however these do not provide suitable nesting habitat for Glossy Black-Cockatoo as the species requires hollow greater than 150 mm in size and above 8 metres in height (DPE 2022d). *Allocasuarina* spp. were present within the study area, representing potential foraging resources for the species. The proposed works include the removal of hollow-bearing trees as well as the removal of a proportion of *Allocasuarina* spp. from the broader vegetation community that along the road corridor of Hillsborough Road.

No Glossy Black-Cockatoo individuals were recorded during the field investigation, however there are known records of the species within 10 kilometres of the study area (OEH 2019a). Due to the presence of potential foraging habitat within the study area, a test for determining whether the proposed works are likely to significantly affect the species in accordance with Section 7.3 of the BC Act has been undertaken below.

(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,

Impacts associated with the proposed works will be limited to the removal of up to 4.1 linear hectares of potential foraging habitat which contains *Allocasuarina littoralis* and *Allocasuarina torulosa*, which are both preferred feed tree for this species. No hollows of suitable size for nesting area are expected to be removed as a result of the works.

While the works will require the removal of 4.1 linear hectares of native vegetation (PCT 1627, PCT1638 and PCT 1649), given the contiguous nature of the vegetation to both the north and the south of the study area; representing an approximate size of greater than 100 hectares, the removal is not considered significant.

Indirect impacts resulting from the proposed works that have the potential to impact Glossy Black-Cockatoo include the introduction and spread of invasive weeds that would result in degradation of their foraging habitat. As the vegetation impacts are restricted to the fringes of vegetation patches, adjacent to an already disturbed corridor associated with Hillsborough Road, the spread of invasive weeds into unaffected areas is expected to be minimal. Recommendations have been provided to ensure good soil transportation practices during the proposed works to minimise the risk of introduction and proliferation of weed species.

Given the small scale of impact associated with the proposed works, the recommendations provided within this assessment report for the mitigation of these impacts, and the wide availability of suitable high-quality resources within the locality, it is unlikely that the proposed works will have

an adverse effect on the life cycle of Glossy Black-Cockatoo 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.

(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 proposed widening of Hillsborough Road is not expected to result in the removal of any hollow bearing trees suitable as nesting habitat for Glossy Black-Cockatoo. As such, impacts associated with the proposed works will be limited to the removal of 4.1 hectares of sub optimal foraging habitat.

Habitat connectivity within the locality is high as the study area is located within relatively large tracts of native bushland. The vegetation with the study area is located directly adjacent to Hillsborough Road which is the main source of fragmentation within the area. Glossy Black-Cockatoo is a highly mobile species and is known to forage across a range of 4.1 hectares. Given that vegetation clearing is being undertaken along an already disturbed road corridor and that impacts to nesting habitat would constitute indirect impacts only it is considered unlikely to significantly contribute to any fragmentation of habitat.

Given the wide availability of higher quality resources within the locality, the removal of vegetation from the study area is unlikely to significantly impact the species, such that the long-term survival of the species within the locality is placed at risk. Recommendations are included to protect trees to be retained which will further ensure any impact to foraging habitat for the species is minimalised.

(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),

The proposed works will not impact on an area declared as of outstanding biodiversity value.

(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.

Key threatening processes relevant to the Glossy Black-Cockatoo that may be exacerbated by the proposed works include:

- Clearing of native vegetation.

- Hollow-bearing trees

No hollow bearing trees suitable for nesting are expected to be removed as a result of the proposed works. The 4.1 linear hectares of sub optimal foraging habitat to be removed is located along a cleared disturbed corridor associated with Hillsborough Road. The study area is also located within a large contiguous patch of good quality bushland, with an abundance of similar habitat nearby. As such the proposed removal of vegetation is not considered to significantly contribute to any of the key threatening process for the species.

Conclusion

In consideration of the above five factors (a-e), the proposed activity is not likely to significantly impact Glossy Black-Cockatoo individuals within the study area or wider locality, as:

- The Hillsborough Road upgrade will not result in the removal of any hollow-bearing trees which would be deemed suitable for nesting. Impacts associated with the proposed are limited to the removal of up to 4.1 linear hectares of edge effected foraging habitat and potential indirect impacts associated with increased light and noise pollution. As such the removal of these habitats is unlikely to constitute a significant impact.
- The proposed works do not significantly contribute to a KTP for Glossy Black-Cockatoo.

As such further assessment of impact in the form of a SIS or BDAR is not required.

Cave-dwelling microbat species

The following Cave-dwelling microbat species have previously been recorded within a 10 kilometre radius of the study area and have a moderate or greater likelihood of occurrence within the study area:

- Large-eared Pied Bat *Chalinolobus dwyeri* (Vulnerable, BC Act).
- Large Bent-winged Bat *Miniopterus orianae oceanensis* (Vulnerable, BC Act).
- Little Bent-winged Bat *Miniopterus australis* (Vulnerable, BC Act).
- Eastern Cave Bat *Vespadelus troughtoni* (Vulnerable, BC Act).

Species background

Large-eared Pied Bat, listed as Vulnerable under the BC Act, is a small to medium-sized bat with long, prominent ears and glossy black fur. It is found mainly in areas with extensive cliffs and caves and ranges from Rockhampton in Queensland down to Bungonia in the NSW Southern Highlands. Within NSW it is generally rare with a very patchy distribution. The species is cave-dependent and roosts near the entrance of caves and crevices in cliffs. It is also known to utilise old mine workings as well as disused Fairy Martin *Petrochelidon ariel* mud nests. The species forages for small, flying insects below the forest canopy (DPE 2017d).

Large Bent-winged Bat, listed as Vulnerable under the BC Act, is similar in appearance with the Little Bent-winged Bat with dark reddish brown to dark brown fur on its back tending to slightly light on the belly. It also has a distinctly short muzzle and domed head but can be told from the Little Bent-winged Bat by its larger forearm length (45.2 – 50.0 millimetres compared to 37.3 – 40.8 millimetres). The species is cave-dwelling but will also roost in man-made structures such as abandoned mines and road culverts. They are insectivorous feeding primarily on moths as well as flies, cockroaches and beetles. In forested areas they hunt just above the canopy level. They can forage long distances, with individuals recorded traveling up to 65 kilometres in one night. The species occurs along the eastern coast of Australia from Cape York in northern Queensland to Castlemaine in Victoria, including coastal areas of NSW (Churchill 2008).

Little Bent-winged Bat, listed as Vulnerable under the BC Act, is the smallest of the bent-winged bats with uniform dark chocolate-brown fur on its back tending to slightly lighter on the belly. It has a distinctly short muzzle and domed head. The species is a cave-dwelling bat however it is known to roost in caves, abandoned mines, tunnels, stormwater drains, and occasionally buildings. It is insectivorous, feeding primarily on beetles, moths and flies, but is also known to frequently consume spiders. They hunt their prey by flying rapidly with considerable manoeuvrability between the shrub and canopy layers of densely wooded forests (Churchill 2008). The species occurs on the east coast of Australia, ranging from Cape York in Queensland to Wollongong in NSW (DPE 2019a).

The Eastern Cave Bat is a small chestnut coloured bat with small conical ears and a short up-tipped nose. Found across both side of the great diving range this bat inhabits caves in dry open woodlands near cliffs and has been known to occur in colonies of up to 500 individuals. Little is known about the feeding habits of this bat species however it is likely that they feed upon small flying insects.

(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,

Impacts likely to have an adverse effect on the life cycle of cave dependent threatened microbat species include direct mortality, disturbance of cave sites, degradation or removal of breeding and foraging habitat, introduction of exotic pathogens particularly white-nose fungus, and blocking of cave entrances for human health and safety or by vegetation encroachment (DPE 2019a, 2019b)

The proposed works include widening two existing culverts under Hillsborough Road which are unlikely to provide optimal roosting habitat (not breeding habitat) for threatened cave-dwelling microbats. The current construction of the culvert provides marginal roosting habitat for microbats due to the cracks and crevices formed which allow for microbats to take hold when roosting. While the marginal amounts of cracking may provide some roosting habitat, no evidence of bats utilising these structures was observed. Culverts present within the study area are also subject to light spill and noise impacts from the overhead Hillsborough Road. The proposed works would only cause short-term disturbance to this habitat during the upgrade process. There is a range of other higher quality roosting resources available in the broader locality.

No suitable cliffs or cave habitat which would support breeding habitat for these species was observed within the study area or in the immediate vicinity of the works. Given the low quality roosting resources the culverts represent, impacts associated with the proposed works will largely be limited to impacts associated with the removal of 4.1 linear hectares of potential foraging habitat, which would be impacted by light and noise spill from Hillsborough Road. No impact is expected to occur to any potential breeding habitat, such as caves.

The proposed works will only result in the removal of foraging habitat and temporary disturbance to marginal roosting habitat, in the form of two culverts. The mitigation measures outlined in the BAR, including pre-clearing surveys, will minimise the severity of the direct and indirect impacts generated by the proposal, such as potential mortality caused during clearing and construction phases. Given the relatively minimal impacts associated with the proposed works along with the mitigation measures recommended, the works are unlikely 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 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.

(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 proposed road upgrade will remove marginal roosting and foraging habitat for cave-dwelling microbats within the immediate study area. This habitat is considered of lower quality due to the construction of the culvert, lack of cracking and the light spill and noise disturbances from Hillsborough Road.

Habitat connectivity within the locality is high as the study area is located within large tracts of native bushland. Microbats are also highly mobile species and the proposed road upgrades would not serve as barrier to the movement of individuals across the area.

Due to the low quality marginal roosting habitat afforded by culverts present within the roadway, the lack of breeding habitat, and the highly mobile nature of microbat species, the proposed road upgrade works are considered unlikely to result in significant reduction in important habitat for the subject species, such that the long-term survival of either species within the locality is placed at risk.

(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),

The proposed works will not impact on an area declared as of outstanding biodiversity value.

(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.

Key threatening processes relevant to microbats include clearing of native vegetation.

The widening and temporary disturbance to two culverts and removal of up to 4.1 linear hectares of native vegetation will reduce the availability of foraging and roosting resources within the immediate proposal area. However, given the extent of habitat in the surrounding landscape, the habitat being removed it is unlikely to be heavily relied upon as a foraging resource by Large-eared Pied Bat, Large Bent-wing Bat, Little Bent-winged Bat or Eastern Cave Bat, particularly given their mobile nature.

Conclusion

In consideration of the above five factors (a-e), the proposed activity is not likely to significantly impact Large-eared Pied Bat, Large Bent-wing Bat, Little Bent-winged Bat or Eastern Cave Bat within the study area or wider locality, as:

- The proposed road upgrade will result in temporary disturbance to marginal low-quality roosting and removal of linear forage habitat only. Given the availability of similar resources within the locality, the removal of these habitats is considered unlikely to constitute a significant impact to these microbat species.
- The proposed works are unlikely to significantly contribute to a key threatening process for microbats.

As such further assessment of impact in the form of a SIS or BDAR is not required.

Tree-roosting microbat species

The following cave roosting microbat species have previously been recorded within a 10 kilometre radius of the study area and have a moderate or greater likelihood of occurrence within the study area:

- Eastern Coastal Free-tailed Bat *Micronomus norfolkensis oceanensis* (Vulnerable, BC Act).
- Eastern False Pipistrelle *Falsistrellus tasmaniensis* (Vulnerable, BC Act).
- Greater Broad-nosed Bat *Scoteanax rueppellii* (Vulnerable, BC Act).
- Southern Myotis *Myotis Macropus* (Vulnerable, BC Act).
- Yellow-bellied Sheath-tail-bat *Saccolaimus flaviventris* (Vulnerable, BC Act).

Species background

The Eastern Coastal Free-tailed Bat is a microbat listed as Vulnerable under the BC Act. It is found along the east coast from south Queensland to southern NSW (DPE 2022e). This species is identifiable by its hairless faces with wrinkled lips and triangular ears. It occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. The species mainly roosts in tree hollows but will also roost under bark or in man-made structures. The Eastern Coastal Free-tailed Bat is usually solitary but also recorded roosting communally. The species is most likely insectivorous (DPE 2022e). Threats to the Eastern Coastal Free-tailed Bat include; loss or disturbance of roosting and breeding sites; loss of hollow-bearing trees; application of pesticides into foraging areas; artificial light sources spilling onto foraging or roosting habitat; and large scale wildfires resulting in loss of key habitat.

The Eastern False Pipistrelle is a microbat listed as Vulnerable under the BC Act. It is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania (DPE 2017e). The Eastern False Pipistrelle is relatively large (65 millimetres) and has long slender ears set well back on the head and some sparse hair on the nose. It prefers moist habitats, with trees taller than 20 metres, and generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. It hibernates in winter, with females often pregnant in late spring to early summer (DPE 2017e). Threats to the Eastern False Pipistrelle include, loss or disturbance of roosting and breeding sites, loss of hollow-bearing trees and the loss or fragmentation of foraging habitat, particularly extensive areas of continuous forest and areas of high productivity.

The Greater Broad-nosed Bat is a microbat listed as Vulnerable under the BC Act. It is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 metres (DPE 2022f). The Greater Broad-nosed Bat is a large powerful bat with a broad head and a short square muzzle and is distinguished from other broad-nosed bats by its greater size. It 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 this species usually roosts in tree hollows, it has also been found in buildings. This species forages after sunset in open woodland habitat and dry open forest flying slowly and directly along waterways at an altitude of 3-6 metres. The species forages for beetles and other large, slow-flying insects. Threats to the Greater Broad-nosed Bat include, loss or disturbance of roosting and summer breeding sites, vegetation clearing for

agricultural purposes, loss of hollow bearing trees and hydrological disturbance. Artificial light sources spilling onto foraging and/or roosting habitat also impacts the species.

The Southern Myotis is a microbat listed as Vulnerable under the BC Act. It 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 kilometres inland, except along major rivers (DPE 2020). The Southern Myotis has disproportionately large feet and has previously been called the Large-footed Myotis. It generally roosts in groups of 10-15 individuals close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. It forages over streams and pools catching insects and small fish by raking their feet across the water surface. The Southern Myotis is dependent on waterways with pools of 3 metres wide or greater for foraging, habitat surrounding waterways is used for breeding and roosting (DPE 2020). Threats to the Southern Myotis include, loss or disturbance of roosting sites, vegetation clearing for agricultural purposes, poisoning through pesticide application and hydrological disturbance.

Yellow-bellied Sheathtail-bat, listed as Vulnerable under the BC Act, is a large species of microbat with rich shiny black fur on the back and contrasting bright white, cream or yellow fur on the belly. It roosts in large tree hollows in mixed-sex groups of two to six and occasionally up to 30 individuals. They are insectivorous, feeding primarily on beetles but also grasshoppers, crickets, leafhoppers, shield bugs, wasps, and flying ants. They usually forage above the canopy but will forage lower over open spaces at the forest edge. (Churchill 2008). The species is wide-ranging, present across northern and eastern Australia, including coastal and inland NSW (DPE 2022g).

(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,

Impacts likely to have an adverse effect on the life cycle of threatened microbat species resulting from the proposed works include the degradation or removal of potential breeding and foraging habitat. The proposed upgrade of Hillsborough Road includes the potential removal five tree hollows, representing potential breeding and roosting habitat for subject bat species. The works also include removal of up to 4.1 linear hectares of PCT 1627, PCT 1638 and PCT 1648, which provides foraging habitat to insectivorous microbat species including within the locality.

The condition of the vegetation to be removed is largely edge effected due to the previous disturbance history associated with the construction and maintenance of Hillsborough Road. Given the study area is located within a larger patch of bushland (>100 hectares), there is a wide availability of resources directly adjacent to the study area which would provide higher quality breeding and foraging habitat for these species. While vegetation to be retained within the study area may experience a degree of degradation which may limit microbat roosting and foraging in the area, given the highly mobile nature of the species and the broad range of hollows available in the locality, it is unlikely that these affects would be significant. In order to minimise indirect impact to vegetation to be retained, which may provide habitat for a range of threatened microbats, it is recommended that any lighting installed be positioned in a manner that minimises light shine into the surrounding bushland. As such, it is unlikely that the impact necessary to undertake would have an adverse effect on the life cycle of any of the five microbat species such that a viable local population 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.

(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 remove 4.1 linear hectares of potential foraging habitat and 5 tree hollows to accommodate the current proposal. Due to the historical impacts surrounding the study area and the associated edge effects, the potential habitat for the five microbat species is of limited value for foraging and roosting purposes.

The vegetation to be cleared is only a small portion of the total native vegetation mapped within a 10 km locality. The proposed works are unlikely to result in the fragmentation or isolation of other areas of habitat for these highly mobile species, as only a small amount of already disturbed native vegetation removal is required to accommodate the current proposal, and large contiguous bushland in the surrounding area provides better quality resources.

It is less likely that these species use the study area as more than marginal foraging and roosting habitat, given the larger tracts of less disturbed habitat in the immediate vicinity. Therefore the importance of the habitat to be removed for the long-term survival of the five species is considered low.

(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),

The proposed works will not impact on an area declared as of outstanding biodiversity value).

(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.

The proposed works have the potential to result in the following KTPs which are considered relevant to threatened microbat species:

- Clearing of native vegetation.
- Loss of hollow-bearing trees.

The five hollows to be removed would be considered to constitute sub optimal nesting or roosting habitat due the proximity of the habitat to Hillsborough Road. It is likely that adjacent high quality vegetation would provide more suitable hollows for roosting/nesting. As such, it is unlikely that the relatively small number of hollows to be removed within the study area would represent significant habitat for these species. The 4.1 linear hectares of foraging habitat to be removed is located along a cleared disturbed corridor associated with Hillsborough Road. The study area is also located within a large contiguous patch of good quality bushland, with an abundance of similar

habitat nearby. As such the proposed removal of vegetation is not considered to significantly contribute to any of the key threatening process for the species.

Conclusion

In consideration of the above, the proposed activity is not likely to significantly affect the Eastern Coastal Free-tailed Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat, Southern Myotis or Yellow-bellied Sheath-tail-bat within the study area, as:

- A small amount of potential marginal foraging and roosting habitat is proposed for removal.
- Functional habitat for foraging and roosting will remain in the study area and wider locality. Pre-clearance surveys will be undertaken to ensure mitigation of mortality associated with the removal of five tree hollows.
- The proposed works are localised, and the vegetation within the study area exists along a road corridor which has already been exposed to a number of disturbances which are unlikely to be further exacerbated by the proposed works.
- The habitat to be removed is not considered important for the long-term survival of these species in the locality.
- The localised nature of the proposed works will not significantly trigger or exacerbate any key threatening processes.

Therefore further assessment in the form of a SIS or BDAR is not required.

Black-eyed Susan *Tetraloeca juncea*

Tetraloeca juncea is listed as Vulnerable under the BC Act. It is a low shrub that grows in clumps of single or multiple stems with downward facing flowers that usually have 4 petals and range from white to pink to dark purple in colour. This species is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape, and generally prefers well-drained sites below 200m elevation and annual rainfall between 1000 - 1200mm. The distribution of this species is confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock (DPE 2022h).

***Tetraloeca juncea* within the study area**

Approximately 77 clumps of *Tetraloeca juncea* were recorded within the study area during field investigations. The proposal will result in the removal of up to 2.9 hectares of PCT 1627, PCT 1638 and PCT 1649, which may provide potential habitat for the species. The proposed works will not result in the direct removal of known clumps.

(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,

This species reproduces both through asexual rhizomal spread and sexual pollination, seed development and germination. Sexual reproduction is aided by insect pollinators and dispersers, with seed germination occurring during hot, fast medium intensity fires. Asexual reproduction occurs through propagation from rootstock, with underground stems growing up to 50 cm long, forming plant clumps of up to 0.5 metres squared. As a consequence of clonality and plant clumping, at any location a group of plants will be comprised of clonal and non-clonal individuals, making it difficult to differentiate individual plants. This species is slow growing.

The proposed works will remove up to 2.9 hectares of potential habitat for *Tetraloeca juncea*. While 77 clumps of *Tetraloeca juncea* were recorded within the study area, mitigation measures including exclusion fencing around known recorded of *Tetraloeca juncea* will be implemented.

The removal of this vegetation has the potential to reduce habitat for *Tetraloeca juncea*. However, given that no individuals will be directly removed, the individuals recorded within the study area are part of a larger population of known individuals extending south of the study area, 5,693 individuals of the species have been recorded within a 10 km radius of the study area (DPE 2022a), and the removal is small-scale; consisting of roadside vegetation, the proposal is considered unlikely to have an adverse effect on the life cycle of the species. Due to the localised scale of the impacts and the area of occupancy of the local population of the species, the level of impact will not lead to the extinction of the viable local population.

(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.

(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 proposed works will remove up to 2.9 ha of potential habitat for *Tetradlea juncea* through clearing of native vegetation for the widening of Hillsborough Road.

Approximately 77 clumps of *Tetradlea juncea* were recorded within the study area, however, none will be directly removed by the proposal. The extent of habitat removal is not considered to be substantial when assessed in the context of the local population of the species, which occurs throughout the Hillsborough area more broadly.

The proposed works will not result in increases to fragmentation, or isolation of *Tetradlea juncea* habitat as, vegetation is already fragmented by Hillsborough Road and as vegetation to be cleared exists in a contiguous manner with large continuous patches of good condition vegetation to the north and south of the study area, and clearing is limited to removal of linear roadside strips of vegetation that are currently subject to edge effects. The extent to which habitat will be impacted when considered in the context of that which is available to the entire local populations is small, and as such the impacts are not considered substantial.

In light of the above, the proposed works are not considered likely to impact upon *Tetradlea juncea* habitat at a level likely to lead to the extinction of the species 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),

The proposed works will not impact on an area declared as of outstanding biodiversity value.

(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.

The proposed works have the potential to result in the following key threatening processes which are listed under the Schedule 4 of the BC Act, and which are considered relevant to *Tetradlea juncea*:

- Clearing of native vegetation.

Up to 2.9 ha of native vegetation that provides potential habitat for *Tetradlea juncea* will be impacted by the proposed works.

Conclusion

In consideration of the above five factors, the proposed works are not likely to significantly impact *Tetradlea juncea* within the study area or wider locality, as:

- The proposed works will not remove any individual plants of *Tetradlea juncea* within the study area and will be limited to the removal of linear strips of vegetation that are currently subjected to disturbance along the road corridor within potential habitat.

- The localised nature of the proposed works will not significantly trigger or exacerbate any key threatening processes.
- The habitat to be removed is not considered important to the survival of the species.
- Therefore, no further assessment is required and a SIS or BDAR is not required.

Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Swamp Sclerophyll Forest) is listed as an Endangered Ecological Community Under the BC Act. It is a swamp community characterised by an open to dense canopy layer of *Eucalypt* spp. and *Melaleuca* spp. The community may also contain areas that have low canopy presence, and dominated by areas of ferns and reeds/sedges (Threatened Species Scientific Committee 2011). Generally it is associated with humic clay and sandy loam soils on waterlogged or periodically flooded areas with saline influence (Threatened Species Scientific Committee 2011). The NSW Scientific Committees final determination of Swamp Sclerophyll Forest community delineates it to be intact.

Swamp Sclerophyll Forest within the study area

Within the study area, the EEC is consistent with PCT 1627 in low condition. The proposed works will result in the clearing of approximately 0.2 hectares of low condition Swamp Sclerophyll Forest.

(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.

(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 local occurrence of Swamp Sclerophyll Forest is defined as a patch of continuous riparian vegetation occurring within and in the vicinity of 100-200 metres of the study area, occurring adjacent to the unnamed tributary of Winding Creek, which extends from the north-east, southward. Vegetation within the study area contains a high level of weed ingress and has been determined as low condition.

Removal of low condition roadside vegetation of approximately 0.2 hectares in area is not considered likely to have an adverse effect on the extent of the local occurrence of the EEC, such that its local occurrence is placed at risk of extinction, as a large proportion of the local occurrence of the vegetation community (0.96 hectares) will be retained within the study area.

Furthermore, the local occurrence of the community contains a high level of weed ingress and in low condition, such that the modification of approximately 0.2 hectares is unlikely to 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,

Approximately 0.2 hectares of low condition Swamp Sclerophyll Forest habitat is proposed to be removed as a result of the proposed works. This is likely to result in minor disruptions to connectivity of the vegetation and minor fragmentation of habitats on either side of Hillsborough Road.

Although it is likely that 0.2 hectares of this habitat will have a minor increase in fragmentation and connectivity, the patch of vegetation to be impacted is contiguous with a larger patch of Swamp Sclerophyll Forest (approximately 0.96 hectares within the study area, and approximately 3.5 hectares in the broader locality). The proposed works will not result in this habitat becoming isolated and will only cause minor fragmentation that will not affect connectivity within the broader landscape.

The vegetation to be removed is low condition Swamp Sclerophyll Forest. This vegetation is degraded and currently subject to a high level of weed ingress, with the proposed works unlikely to further exacerbate edge effects which already occur. The vegetation to be removed is small in relation to the local occurrence and is therefore unlikely to reduce the long-term survival of species or the native community assemblage in the locality. A large proportion of the EEC will remain in the study area and will therefore remain as habitat for flora and fauna species that utilise the area. Therefore the impacts on habitat will not be of a magnitude likely to affect the long-term survival of the 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),

The proposed works will not impact on an area declared as of outstanding biodiversity value.

(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.

The proposed works have the potential to result in the following key threatening processes which are listed under the Schedule 4 of the BC Act, and which are considered relevant to Swamp Sclerophyll Forest:

- Clearing of native vegetation.

However, the degree to which the above key threatening process will be enacted as a result of the proposed works is minor and not considered likely to result in a significant impact to this community.

Conclusion

The proposed works are unlikely to significantly impact Swamp Sclerophyll Forest for the following reasons:

- The proposed works are limited to removal of low condition vegetation that is currently subject to edge effects and a high level of weed ingress.
- The local occurrence of Swamp Sclerophyll Forest exists in an intact landscape with minimal fragmentation. The 0.2 hectares to be cleared represents a small portion of the

total extent of the EEC, with a large proportion of the EEC being retained in the study area, thus will not result in significant fragmentation of the EEC.

- The proposed works is unlikely to significantly alter the extent, species assemblages or structural diversity of the EEC to the point where it becomes locally extinct.
- The localised nature of the proposed works will not significantly trigger or exacerbate any key threatening processes.

Therefore, further assessment in the form of a BDAR or a SIS is not required.

Appendix E – Significant Impact Criteria

Black-eyed Susan *Tetratheca juncea*

Tetratheca juncea is listed as Vulnerable under the EPBC Act. It is a low shrub that grows in clumps of single or multiple stems with downward facing flowers that usually have 4 petals and range from white to pink to dark purple in colour. This species is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape, and generally prefers well-drained sites below 200m elevation and annual rainfall between 1000 - 1200mm. The distribution of this species is confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock.

Occurrence in the study area

Approximately 77 clumps of *Tetratheca juncea* were recorded within the study area during field investigations. The proposal will result in the removal of up to 2.9 hectares of PCT 1627, PCT 1638 and PCT 1648, which may provide potential habitat for the species. The proposed works will avoid all clumps recorded within the study area, however, the proposed works have the potential for indirect impacts towards the species.

Significant impact within the study area

Based on the assessment below it is concluded that *Tetratheca juncea* is unlikely to be significantly impacted by the proposed works. This conclusion was made on the basis that the proposed works:

- Will not lead to the long term decrease of a population, reduce the areas of occupancy or fragment an existing population – No known individuals will be removed. Impacts are limited to those of an indirect nature.
- Will not disrupt the breeding cycle of the species
- Will not modify the species habitat, or introduce invasive species/diseases - project safeguards are to be implemented to mitigate any potential weed invasion.
- Will not interfere with the recovery of the species.

Considering the above, application of the BOS or preparation of a SIS is not required.

Table A 1 Black-eyed Susan *Tetralthea juncea*, EPBC vulnerable species – assessment against Significant Impact Criteria (Commonwealth of Australia 2013)

Significant impact criteria (vulnerable species)	Likelihood of significant impact	Justification
Lead to the long-term decrease in the size of an important population of a species.	Unlikely	<i>Tetralthea juncea</i> was recorded within the study area during field surveys. Approximately 77 clumps of <i>Tetralthea juncea</i> and 2.9 hectares of potential dispersal habitat occurs within the study area. The individuals present within the study area likely form part of a larger population that extends south of the study area, with 5,683 records of the species recorded within a 10km radius (DPE 2022a). However all plants recorded within the study area will be avoided during vegetation clearing. Indirect impacts to the recorded clumps include potential ground/soil disturbance (impacts to seedbank), dust settlement and accidental introduction/spread of competitive weeds. However clearing will be limited roadside vegetation along Hillsborough Road which is currently subject to edge effects, and therefore impacts are considered small and localised in nature. Further to this, safeguards will be implemented during the course of works to mitigate any accidental impacts. As such, this impact is considered small in the context of the overall population of the species and it is considered unlikely that there will be a long-term decrease in the size of the local population of <i>Tetralthea juncea</i> .
Reduce the area of occupancy of an important population.	Unlikely	The proposed works will not remove any known habitat for <i>Tetralthea juncea</i> as records occur outside of the area to be directly impacted. Potential impacts are indirect and limited to ground/soil disturbance, dust settlement and accidental introduction/spread of competitive weeds. As field investigations did not confirm the presence of the species in the impact area, the proposal is unlikely to directly impact on the population, and it is likely the worst case scenario would be the proposed works introduce weeds and create sub-optimal growing conditions. These indirect impacts can be successfully managed through the use of project safeguards and mitigation measures as listed in Section 6 of the report. As such the proposed works are not considered substantial enough to result in a reduction to the area of occupancy of the species.
Fragment an existing important population into two or more populations.	Unlikely	<i>Tetralthea juncea</i> was recorded within the study area during the field investigation, however all individual plants will be avoided under the current proposal. Nevertheless, potential habitat within the study area for the species may be indirectly impacted by the proposed works. These indirect impacts can be successfully managed through the use of mitigation measures. Considering this, and the fact that no new physical barrier to connectivity will be created, it is unlikely that the local population, and the recorded individuals of <i>Tetralthea juncea</i> , will suffer significant fragmentation.
Adversely affect habitat critical to the survival of a species	Unlikely	Critical habitat has not yet been declared for <i>Tetralthea juncea</i> .

Disrupt the breeding cycle of an important population.	Unlikely	<i>Tetradlea juncea</i> reproduces sexually via seed, being pollinated by insects, and also reproduces vegetatively from rootstock. With this in consideration, two important factors for the life cycle of <i>Tetradlea juncea</i> are the presence of insects, as well as undisturbed soil. The proposed works are unlikely to inhibit the movement of insects, and any soil disturbance will be localised in nature and will be managed utilising project safeguards. Therefore, the proposed works are unlikely to disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely	<i>Tetradlea juncea</i> was recorded within the study area, however all individual plants will be avoided under the current proposal. Impacts as a result of the proposed works are of an indirect nature and are limited to clearing of roadside vegetation, ground/soil disturbance, dust settlement and accidental introduction/spread of competitive weeds. This level of habitat disturbance is not considered likely to cause <i>Tetradlea juncea</i> numbers to decline, considering recorded individuals are being retained, and any indirect impacts will be mitigated by the use of the project safeguards.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.	Unlikely	The proposed works will be safeguarded by mitigation measures. These mitigation measures include those for managing invasive and exotic species and therefore the proposed works are unlikely to exacerbate the current level of invasive species threat operating within the study area.
Introduce disease that may cause the species to decline	Unlikely	The proposal will not result in the introduction of a disease that is harmful to <i>Tetradlea juncea</i> .
Interfere with the recovery of the species	Unlikely	<p>There is no adopted or made Recovery Plan for this species, however the Approved Conservation Advice outlines regional and local priority actions to support the recovery of the species. Some of the high priority actions significant to the proposed works are:</p> <ul style="list-style-type: none"> • <i>Monitor known populations to identify key threats</i> • <i>Identify populations of high conservation priority.</i> • <i>Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary</i> • <i>Undertake weed control activities as appropriate using approved bush regeneration methods at priority sites on private and public land (DECC, 2005b).</i> • <i>Enable Recovery of Additional Sites and/or Populations by undertaking appropriate seed collection and storage and investigate options for linking, enhancing or establishing additional populations.</i> • <i>Implement national translocation protocols (Vallee et al., 2004) if establishing additional populations is considered necessary and feasible.</i> • <i>Raise awareness of T. juncea within the local community, particularly with state conservation area users.</i> <p>Considering the above factors, the proposal will not interfere substantially with any of the recovery actions for <i>Tetradlea juncea</i>, and project safeguards will be implemented to control manage invasive and exotic species.</p>

Swift Parrot *Latham discolor* – Critically Endangered

Swift Parrot is listed as Critically Endangered under the EPBC Act. It breeds in Tasmania during spring and summer, migrating in the autumn and winter months (March to October) to south-eastern Australia from Victoria and eastern parts of South Australia up to south-east Queensland. In NSW it occurs mostly on the coast and south west slopes (DPE 2022c).

Whilst on the mainland they are typically found in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Their favoured trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *Corymbia gummifera*, Mugga Ironbark *Eucalyptus sideroxylon* and White Box *Eucalyptus albens*. Commonly used lerp infested trees include Inland Grey Box *Eucalyptus microcarpa*, Grey Box *Eucalyptus moluccana* and Blackbutt *Eucalyptus pilularis*. Individuals are known to return to some foraging sites on a cyclic basis depending on food availability (DPE 2022c).

Occurrence in the study area

The Lower Hunter Region has been identified as a critically important area for Swift Parrot (Birdlife Australia 2014). Swift Parrot was not recorded during the surveys (no targeted survey was undertaken) however there are known records of the species within 10 kilometres of the study area (DPE 2022a). There is potential for the study area to be used occasionally by this species for foraging, although it is unlikely that individuals rely upon resources in the study area.

Significant impact assessment

Based on the assessment provided below it is concluded the proposal is unlikely to lead to a significant impact to Swift Parrot. Swift Parrots were not recorded during surveys within the study area and whilst small numbers of individuals may occasionally forage within the vegetation within the study area the vegetation would be considered relatively poor quality as it occurs along the edge of Hillsborough Road. The study area occurs within a larger patch a higher quality vegetation, which extends to the; south, west and north of the study area. As such the removal of a narrow band of native vegetation along the edge of the road is not likely to constitute a significant impact to an important population.

Table A 2 Swift Parrot *Latham discolor*, EPBC critically endangered species – assessment against Significant Impact Criteria (Commonwealth of Australia 2013)

Significant impact criteria (critically endangered / endangered community)	Likelihood of significant impact	Justification
Lead to a long-term decrease in the size of a population	Unlikely	Vegetation within the study includes a key feed tree species for the Swift Parrot including; Swamp Mahogany, Spotted Gum, and Red Bloodwood. However vegetation to be removed occurs within a narrow band along Hillsborough Road, which is subject to negative impact associated with edge effects. As such, it would be considered to represent poor quality foraging resources particularly given the intact vegetation which can be found throughout the broader locality. As such it is unlikely that the proposed removal of this relatively small impacted stretch of vegetation would within the study area will lead to a long-term decrease in the size of a population.

Reduce the area of occupancy of the species	Unlikely	The Swift Parrot is a migratory species that occurs over a large range from Tasmania to south-east Queensland. The proposed works will result in the removal of 4.1 ha of native vegetation comprised of PCT 1627, 1638 and 1649. Vegetation to be removed occurs along either side of Hillsborough Road in a long linear strip, which is connected to large, intact forested areas to the south, west and east of the study area. Given the large range of the species, that the proposal does not propose to remove any habitat and the availability of nearby habitat it is unlikely the proposal will result in a decrease in the area of occupancy for this species.
Fragment an existing population into two or more populations	Unlikely	Vegetation connectivity within the study area is fractured by the placement of the current Hillsborough Road. As the works are only expected to widen the road corridor no additional fragmentation is expected to occur given the mobile nature of the species. As a result, the proposal will not fragment the population into two or more populations.
Adversely affect habitat critical to the survival of a species	Unlikely	<p>Habitat critical to the survival of this species is defined in the Swift Parrot National Recovery Plan (Saunders & Tzaros 2011) as: Those areas of priority habitat for which the Swift Parrot has a level of site fidelity or possess phenological characteristics likely to be of importance to the Swift Parrot or are otherwise identified by the recovery team.</p> <p>The study area does not include areas mapped as significance habitat for the Swift Parrot, has only been assessed to contain low to moderate value habitat (Birdlife Australia 2014) and does not have any records with one kilometer of the study area.</p> <p>The proposed works will result in the removal of 3.8 ha of native vegetation comprised of PCT 1627, 1638 and 1649. Several key tree species listed for this species include; Swamp Mahogany, Spotted Gum, and Red Bloodwood occur throughout the study area (Saunders & Tzaros 2011). Vegetation to be removed occurs along either side of Hillsborough Road in a long linear strip, which is connected to large, intact forested areas to the south, west and east of the study area. While vegetation to be removed does contain some key feed trees, given that the vegetation to be removed occurs along a narrow band either side Hillsborough Road, foraging habitat to be impacted as a result of the proposed work would not be considered to be critical habitat to the survival of the species. As large tracks of highly productive forest will be maintained in the broader landscape it is unlikely that the works will adversely affect habitat critical to the survival of the Swift Parrot.</p>
Disrupt the breeding cycle of a population	Unlikely	This species breeds in Tasmania and therefore there is no breeding habitat within the study area(DPE 2022c).

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely	<p>The proposed works will result in the removal of 4.1 ha of native vegetation comprised of PCT 1627, 1638 and 1649. While the proposed works will decrease available foraging resources within the immediate study area. The removal of 4.1 hectares of native vegetation along a narrow band of edge effected vegetation, located within a large higher quality patch of >100 ha is unlikely to reduce habitat ability to an extent that would lead to the decline of the species.</p> <p>Impact to retained native vegetation may reduce the overall quality of foraging resources within the study area. However modification to retained vegetation is not expected to result in the abandonment of these potential foraging resources by this species.</p>
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Unlikely	<p>The proposal is unlikely to exacerbate the current level of invasive species threat operating within the study area to the point that they become harmful to the Swift Parrot.</p>
Introduce disease that may cause the species to decline	Unlikely	<p>The proposed action is unlikely to introduce a disease that causes the Swift Parrot to decline.</p>
Interfere with the recovery of the species	Unlikely	<p>The National Recovery Plan for Swift Parrot outlines four recovery actions:</p> <ol style="list-style-type: none"> 1. Identify the extent and quality of habitat 2. Manage and protect Swift Parrot habitat at the landscape scale 3. Monitor and manage the impact of collisions, competition and disease. 4. Monitor population and habitat <p>The study area contains potential foraging and roosting habitat for this species. However this habitat is degraded and higher quality habitat is located nearby. It is unlikely therefore that potential i impacts to vegetation will interfere with the recovery of Swift Parrot.</p>

Regent Honeyeater *Anthochaera phrygia*

Regent honeyeater is listed as Critically Endangered under the EPBC Act. It is a striking and distinctive, medium-sized, black and yellow honeyeater with a sturdy, curved bill. The Regent Honeyeater is a generalist forager, although it feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. The species mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands (OEH 2022).

Threatening processes impacting Regent Honeyeater include habitat loss, fragmentation and degradation from clearing for agricultural and residential development and major developments (mining), suppression of natural regeneration of overstorey tree species and shrub species from overgrazing. Other threats include competition from larger aggressive honeyeaters, particularly noisy miners, noisy friarbirds and red wattlebirds, and predation (OEH 2022).

Occurrence in the study area

The Lower Hunter Region has been identified as a critically important area for Regent Honeyeater (Birdlife Australia 2014). Regent Honeyeaters was not recorded during the surveys (no targeted survey was undertaken) however there are known records of the species within 10 kilometres of the study area (DPE 2022a). There is potential for the study area to be used occasionally by this species for foraging, although it is unlikely that individuals rely upon resources in the study area.

Significant impact assessment

Based on the asses, it is concluded the proposal is unlikely to lead to a significant impact to Regent Honeyeater. The significant impact assessment presented below has been undertaken with reference to the avoidance measures already pursued and further impact minimisation and mitigation measures available to the proposal. Regent Honeyeaters were not recorded during surveys within the study area and whilst small numbers of individuals may occasionally forage within the vegetation within the study area the vegetation would be considered relatively poor quality as it occurs along the edge of Hillsborough Road. The study area occurs within a larger patch a higher quality vegetation, which extends to the; south, west and north of the study area. As such the removal of a narrow band of native vegetation along the edge of the road is not likely to constitute a significant impact to an important population.

Table A 3 Regent Honeyeater (*Anthochaera phrygia*), critically endangered species - assessment against Significant Impact Criteria (CoA 2013)

Significant impact criteria (critically endangered / endangered species)	Likelihood of significant impact	Justification
Lead to a long-term decrease in the size of a population.	Unlikely	The study area does not include areas mapped as significance habitat for the Regent Honeyeater (DPE 2022b), although it is known to occur within the Lake Macquarie area (Birdlife Australia 2014). Vegetation within the study includes a key feed tree species for the Regent Honeyeater including; Swamp Mahogany, Spotted Gum, and Red Bloodwood. However vegetation to be removed occurs within a narrow band along Hillsborough Road, which is subject to negative impact associated with edge effects. As such, it would be considered to represent poor quality foraging resources particularly given the highly productive intact vegetation which can be found throughout the broader locality. As such, it is unlikely that the proposed removal of this relatively small (4.1 ha) stretch of vegetation within the study area will lead to a long-term decrease in the size of a population.
Reduce the area of occupancy of the species.	Unlikely	The proposed works will result in the removal of 4.1 ha of native vegetation comprised of PCT 1627, 1638 and 1649. Vegetation to be removed occurs along either side of Hillsborough Road in a long linear strip, which is connected to large, intact forested areas to the south, west and east of the study area. As the Regent Honey eater is comprised of a single national highly mobile population and as the study area occurs within the centre of the species known range is therefore unlikely that the removal of a relative small impacted patch of foraging habitat would reduce the area of occupancy for this species.
Fragment an existing population into two or more populations.	Unlikely	Due to its complex movement patterns typified by migration and local nomadism, the Regent Honeyeater has what is effectively a single national population. The species is highly mobile and individuals can move freely through areas of unsuitable and marginal habitat to seek out and exploit favourable habitat patches. As a result, the proposal will not fragment the population into two or more populations.

Adversely affect habitat critical to the survival of the species.	Unlikely	<p>Habitat critical to the survival of this species is defined in the Regent Honeyeater National Recovery Plan (Commonwealth of Australia 2016) as:</p> <p>Any breeding or foraging habitat in areas where the species is likely to occur.</p> <p>Any newly discovered breeding or foraging locations.</p> <p>While the proposal will result in the removal of areas of woodland that support tree species known to be used by Regent Honeyeater, it is unlikely that these foraging resources would be utilised with any regularity due to the degraded nature of the study area along Hillsborough Road. In an assessment undertaken on behalf of Lake Macquarie Council the study area was mapped as low value for Regent Honeyeaters (Birdlife Australia 2014). No known breeding location are expected to be impacted as a result of the proposed works.</p> <p>As such no habitat deemed critical to the survival of the species is expected to be impacted as a result of the proposed works.</p>
Disrupt the breeding cycle of a population.	Unlikely	<p>The study area does not incorporate any key Regent Honeyeater breeding areas. The Hunter Valley is recognised a 'Key breeding area' of importance in the national recovery plan for Regent Honeyeater (Commonwealth of Australia 2016), however this area lies to the west of the study area and will not be impacted as a result of the proposed works. Moreover, even if the species did occasionally breed within parts of the study area, which is considered unlikely, this would represent a small portion of the total population. Other pairs would be breeding elsewhere within the species' range and thus the breeding cycle would not be significantly disrupted.</p>
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Unlikely	<p>The proposed works will result in the removal of 4.1 ha of native vegetation comprised of PCT 1627, 1638 and 1649. While the proposed works will decrease available foraging resources within the immediate study area. The removal of 4.1 hectares of native vegetation along a narrow band of already degraded vegetation, located within a large higher quality patch of >100 ha is unlikely to reduce habitat ability to an extent that would lead to the decline of the species.</p> <p>Impact to retained native vegetation may reduce the overall quality of foraging resources within the study area. However modification to retained vegetation is not expected to result in the abandonment of these potential foraging resources by this species.</p>
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	Unlikely	<p>The proposal is unlikely to exacerbate the current level of invasive species threat operating within the study area to the point that they become harmful to the Regent Honeyeater.</p>
Introduce disease that may cause the species to decline.	Unlikely	<p>The proposed action is unlikely to introduce a disease that causes the Regent Honeyeater to decline.</p>

Interfere with the recovery of a species.

Unlikely

Given the study area is outside core habitat Regent Honeyeater and has been mapped as low values in an assessment undertaken by Lake Macquarie Council (Birdlife Australia 2014), it is unlikely that it would interfere with the species' recovery.

South-eastern Glossy Black-Cockatoo *Calyptorhynchus lathami lathami*– Vulnerable

South-eastern Glossy Black-Cockatoo *Calyptorhynchus lathami lathami*, listed as vulnerable under the EPBC Act, is a medium-sized cockatoo with a diagnostic combination of black-brown head, neck and underbody, red or orange-red panel in tail, and otherwise black plumage. Adult females also exhibit extensive patches of yellow feathering on head and neck. The species is closely associated with *Allocasuarina* spp. and *Casuarina* spp. dominated woodlands, or open sclerophyll forest where the middle stratum is *Allocasuarina* spp. They feed almost exclusively on the seed of *Allocasuarina* spp. but occasionally also take wood-boring insect larvae. The species is dependent on hollow-bearing trees for breeding habitat as they nest in the hollows formed in the trunk, stump, spout or limbs of eucalypt trees, living or dead (Higgins 1999, DPE 2022d).

The study area includes five tree hollows including one small hollow (<90 mm) and four medium hollows (90 – 150 mm), however these do not provide suitable nesting habitat for Glossy Black-Cockatoo as the species requires hollow greater than 150 mm in size and above 8 metres in height (DPE 2022d). *Allocasuarina* spp. were present within the study area, representing potential foraging resources for the species. The proposed works include the removal of hollow-bearing trees as well as the removal of a proportion of *Allocasuarina* spp. from the broader vegetation communities present within the study area.

Occurrence in the study area

No South-eastern Glossy Black-Cockatoo individuals were recorded during the field investigation, however there are known records of the species within 10 kilometres of the study area (DPE 2022a). Due to the presence of potential foraging habitat within the study area, a test for determining whether the proposed works are likely to significantly affect the species in accordance with Section 7.3 of the BC Act has been undertaken below.

Significant impact assessment

Based on the assessment provided below, it is concluded the proposal is unlikely to lead to a significant impact to South-eastern Glossy Black-Cockatoo. South-eastern Glossy Black-Cockatoos were not recorded during surveys within the study area and whilst small numbers of individuals may occasionally forage within the vegetation within the study area, the vegetation would be considered relatively poor quality, as it occurs along the edge of a busy and noisy roadway. The study area occurs within a larger patch a higher quality vegetation, which extends to the; south, west and north of the study area. As such the removal of a narrow band of native vegetation along the edge of the road is not likely to constitute a significant impact to an important population.

Table A 4 Glossy Black-cockatoo *Calyptorhynchus lathami*, EPBC vulnerable species – assessment against Significant Impact Criteria (Commonwealth of Australia 2013)

Significant impact criteria (critically endangered / endangered community)	Likelihood of significant impact	Justification
Lead to a long-term decrease in the size of a an important population	Unlikely	<p>No important populations for South-eastern Glossy Black-Cockatoo have currently been declared in an associated Recovery Plan or other listing document. Important populations are otherwise defined as those that are:</p> <ul style="list-style-type: none"> • 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. <p>The study area occurs centrally to the species known distribution in an urbanised landscape. Individuals, often a breeding pair and one offspring, that may utilise the study area for foraging on occasion, are not known or considered likely to be members of a sub-population that could defined as an important population. As an important population is not considered to be present, this criterion does not apply in this instance.</p>
Reduce the area of occupancy of an important population	Unlikely	As an important population is not considered to be present, this criterion does not apply in this instance.
Fragment an existing important population into two or more populations	Unlikely	As an important population is not considered to be present, this criterion does not apply in this instance.

Adversely affect habitat critical to the survival of a species	Unlikely	<p>No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat. However, habitat critical to the survival of a species or ecological community are areas that are necessary:</p> <ul style="list-style-type: none"> • for activities such as foraging, breeding, roosting, or dispersal; • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators); • to maintain genetic diversity and long-term evolutionary development; or • for the reintroduction of populations or recovery of the species or ecological community. <p>The habitat present within the study area which would be impacted could generally be considered habitat critical to the survival of the species as it provides foraging resources, albeit sub-optimal due to the urbanised landscape that surrounds it. While 4.1 linear hectares of native vegetation would be removed, the foraging resources within this vegetation (predominantly Black She-oak <i>Allocasuarina littoralis</i>) occur sparsely such that these resources are unlikely to be relied upon, in contrast to preferred areas where foraging resources can occur in dense thickets. In this context, the proposal is considered unlikely to adversely affect critical habitat such that might result in a population's decline.</p>
Disrupt the breeding cycle of an important population	Unlikely	<p>No breeding habitat for South-eastern Glossy Black-Cockatoo would be impacted by the proposal. As discussed in the criterion above, the removal of foraging resources proposed is unlikely to lead to malnourishment which may lower reproductive frequency and/or success.</p>
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Unlikely	<p>The proposed works will result in the removal of 4.1 linear hectares of native vegetation comprised of PCT 1627, 1638 and 1649. While the proposed works will decrease available foraging resources within the immediate study area. The removal of 4.1 hectares of native vegetation along a narrow band of edge effected vegetation, located within a large higher quality patch of >100 hectares is unlikely to reduce habitat ability to an extent that would lead to the decline of the species.</p> <p>Impact to retained native vegetation may reduce the overall quality of foraging resources within the study area. However modification to retained vegetation is not expected to result in the abandonment of these potential foraging resources by this species.</p>
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Unlikely	<p>The proposal is unlikely to exacerbate the current level of invasive species threat operating within the study area to the point that they become harmful to South-eastern Glossy Black-Cockatoo.</p>

Introduce disease that may cause the species to decline	Unlikely	The proposed action is unlikely to introduce a disease that causes South-eastern Glossy Black-Cockatoo to decline.
Interfere with the recovery of the species	Unlikely	At the time of writing, there is no National Recovery Plan for South-eastern Glossy Black-Cockatoo. The foraging resources that would be removed, albeit dwarfed in context of the surrounding habitat, is considered critical habitat. Broadly speaking, removal of habitat critical to the survival species would interfere with the species recovery. However, in this instance, the small scale of critical habitat proposed to be removed is unlikely to have an appreciable impact on the species local population or species recovery as whole.

