NSW GOVERNMENT

Roads and Maritime Services

F6 Extension Stage 1

New M5 Motorway at Arncliffe to President Avenue at Kogarah

Environmental Impact Statement

Appendix H
Biodiversity Development Assessment Report

Volume 5

H

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Contents

Glossary of terms and abbreviations

Term	Definition
Assessment area	The area of land encompassed by the 500 metre buffer from the construction boundary of the project. This area is used to examine landscape features including IBRA Region and Subregion, Mitchell landscape and native vegetation extent.
Biodiversity credits	Ecosystem credits or species credits
Biodiversity credit report	The report produced by the Biodiversity Credit Calculator 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 (OEH 2017).
Biodiversity offsets	Management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development (OEH 2017).
Biodiversity Credit Calculator (BCC)	The computer program that provides decision support to assessors and proponents by applying the BAM, and which calculates the number and class of biodiversity credits required to offset the impacts of a development or created at a biodiversity stewardship site (OEH 2017).
Construction boundary	The area required for project construction is referred to as the 'construction boundary'.
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 the project SEARs for cumulative impact assessment requirements.
Development footprint	The area of land that is directly impacted on by a proposed development, including access roads, and areas used to store construction materials (OEH 2017). Land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land.
Direct impact	An impact on biodiversity values that is a direct result of vegetation clearance for a development. It is predictable, usually occurs at or near to the development site and can be readily identified during the planning, design, construction, and operational phases of a development (OEH 2017).
Ecosystem credit	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at a biodiversity stewardship site.
Ecosystem credit species	A measurement of the value of threatened species habitat for species that can be reliably predicted to occur with a PCT (OEH 2014).
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component.
Indirect impact	An impact on biodiversity values that occurs when development related activities affect threatened species, threatened species habitat, or ecological communities in a manner other than direct impact. Compared to direct impacts, indirect impacts often: • • occur over a wider area than just the site of the development • • have a lower intensity of impact in the extent to which they occur compared to direct impacts • • occur off site • • have a lower predictability of when the impact occurs • • have unclear boundaries of responsibility (OEH 2017).
Local population	The population that occurs in the study area. In cases where multiple populations occur in the study area or a population occupies part of the study area, impacts on each subpopulation must be assessed separately (OEH 2017).

Term	Definition
MNES	A matter of national environmental significance (MNES) protected by a provision of Part 3 of the EPBC Act
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (OEH 2014).
Mitigation	Action to reduce the severity of an impact (OEH 2014).
Mitigation measure	Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality.
Population	A group of organisms, all of the same species, occupying a particular area.
Project area/ Project site	The area of land that is directly impacted on by a proposed Major Project that is under the EP&A Act, including access roads, and areas used to store construction materials (OEH 2014).
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.
Species credit species	Threatened species that are assessed according to Section 6.4.of the BAM
Study area	The project area and any other areas surveyed and assessed for biodiversity values which may be subject to indirect impacts.
Target species	A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.
Threatened Biodiversity Data Collection	Part of the BioNet database, published by OEH and accessible from the BioNet website at www.bionet.nsw.gov.au.

Abbreviation	Definition
BAM	Biodiversity Assessment Method
BAR	Biodiversity Assessment Report (under previous 'Framework for Biodiversity Assessment' methodology)
BAMC	Biodiversity Assessment Method Credit Calculator
BC Act	Biodiversity Conservation Act 2016 (NSW)
BDAR	Biodiversity Development Assessment Report
BSSAR	Biodiversity Stewardship Site Assessment Report
CBD	Central Business District
CEEC	Critically Endangered Ecological Community
DoEE	Commonwealth Department of Environment and Energy
DPE	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
FM Act	Fisheries Management Act 1994 (NSW)
GDE	Groundwater Dependent Ecosystem
GIS	Geographic Information System
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
LGA	Local Government Area
LLS	Local Land Service
NSW	New South Wales
NTU	Nephelometric Turbidity Unit
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSI	State Significant Infrastructure
SWSOOS	Southern and Western Sydney Ocean Outfall System
TEC	Threatened Ecological Community
VIS	Vegetation Information System

Executive summary

The NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the F6 Extension Stage 1 which would comprise a new multi-lane road between the New M5 Motorway at Arncliffe and President Avenue at Kogarah. The project would connect underground with the New M5 Motorway tunnel and to a new surface level intersection at President Avenue, Kogarah.

The project has been declared State significant infrastructure (SSI 8931). Secretary's Environmental Assessment Requirements (SEARs) for the EIS were issued by the NSW Department of Planning and Environment (DPE) on 12 December 2018. Approval for the project is being sought under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act).

This technical report forms the Biodiversity Development Assessment Report (BDAR) to support the environmental impact statement (EIS). In preparing this report, the SEARs issued for the project have been addressed as well as comments received by the NSW Department of Planning and Environment (DP&E) and from government agencies during the preparation of the SEARs. Where appropriate, considerations identified by the NSW Department of Primary Industries (DPI) have been addressed in this BDAR. Accordingly, biodiversity impacts have been assessed under the Biodiversity Assessment Method (BAM), as required by the SEARs.

The project area incorporates tunnels which would comprise two mainline tunnels (about 3 kilometres in length) in each direction and entry and exit ramp tunnels to President Avenue (about 1.5 kilometres in length). Each mainline tunnel would extend from the underground connection with the New M5 Motorway through to stub tunnels for a connection to a future stage of the F6 Extension (just north of Bay Street). The mainline tunnel would be connected to the surface road network at President Avenue via the entry and exit ramp tunnels leading to and from the surface.

The project would include three construction ancillary facilities at Arncliffe, Rockdale and Kogarah.

The assessment included both desktop analysis and field assessments, using the BAM to assess the presence of native vegetation, habitat for threatened species and condition of any ecological communities.

The development footprint and other areas likely to be indirectly impacted (study area) have been assessed in this technical working paper and are shown in Figure 8-1. The project footprint and project area defined in this report is the same as the development footprint. Sufficient flexibility has been provided in the footprint assessed to allow for refinement of the project area during detailed design or in response to submissions received during the exhibition of the EIS.

Three Plant Community Types (PCT), defined as native vegetation by BAM were recorded within the project area. These PCT were:

- PCT1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion
- PCT1795 Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin
- PCT1808 Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline.

A fourth type of vegetation mapped, Urban Native and Exotic Cover was also identified in the project area. This vegetation type could not be reliably assigned to any PCT due to the highly modified and disturbed nature of the vegetation. The project is located in a highly urbanised environment and much of the area is entirely modified and disturbed, and contains exotic species, weeds and planted native or non-indigenous species. It is characterised by urban parks, landscaped road verges, compacted soils, introduced fill, existing dwellings and other infrastructure.

This BDAR assessed the type and number of credits using BAM. The following PCT require offsetting in accordance with the online credit calculator:

- Eight credits for about 0.47 hectares of PCT1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion
- Eleven credits for about 0.30 hectares of PCT1795 Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin

- Eight credits for about 0.77 hectares of PCT1808 Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline.

Targeted threatened species surveys were conducted for *Syzygium paniculatum* (Magenta Lilly Pilly), *Litoria aurea* (Green and Golden Bell Frog)and threatened bats. These surveys were completed for those species credit species initially considered to have the potential to occur in the project area.

The Magenta Lilly Pilly occurred within the project area. The plants were recorded from landscaping in the area at the President Avenue construction ancillary facility. The origins and provenance of these plants are unknown. The area where they were recorded is not known as a population for this species as identified in the Recovery Plan. They were an even aged cohort, planted in lines within landscape plantings at the Rockdale Bicentennial Park, and thus are considered to be landscape plantings. These plants will be affected by the project. they are not proposed to be offset in accordance with BAM because they are not part of a known naturally occurring population. The application of the Commonwealth Significant Impact Criteria (Commonwealth of Australia 2013) assessment concluded that the project would not have a significant impact on this species, and as such, a referral to the Commonwealth was not required.

Impacts to the Green and Golden Bell Frog have were considered in relation to Commonwealth Guidelines *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* and the specific *Significant impact guidelines for the vulnerable green and golden bell frog (Litoria aurea) Nationally threatened species and ecological communities EPBC Act policy statement 3.19*. Green and Golden Bell Frog habitat would not be directly affected by the project. This is because the project would use the existing construction compounds at the Arncliffe construction ancillary facility. This compound is in use by the New M5 Motorway project and offsets have already been provided under the approval for that project. This project however is likely to indirectly affect Green and Golden Bell Frog habitat within Kogarah Golf Course, adjacent to the Arncliffe construction ancillary facility. Intensive monitoring indicates that this habitat is currently unoccupied but is still considered potential habitat consistent with EPBC Act guidelines. Green and Golden Bell Frogs have not been detected in the area to be affected since 2016, despite intensive survey by several different teams of ecologists. Indirect impacts would include noise, dust and vibration. While some of these impacts are less than incurred under the New M5 Motorway project, they are likely to remain operational residual impacts. The assessment concluded that the project would not have a significant impact on this species, and as such, a referral to the Commonwealth was not required.

Roads and Maritime has instigated, as part of the Green and Golden Bell Frog Management Plan for the New M5 Motorway project, a program of captive breeding and new habitat creation at Marsh Street. Animals are currently in captive husbandry and have not yet been introduced into their new habitat which is currently under construction. The F6 Extension Stage 1 will not impact on the new habitat at Marsh Street (which is located on the other side of the M5 East Motorway). Any decision to introduce frogs into Marsh Street or the RTA ponds as part of the New M5 Motorway mitigation measures will consider any indirect impacts arising from this project along with an assessment of the ongoing viability and suitability of the RTA ponds to provide habitat for this species. Use of the Arncliffe construction ancillary facility site by the F6 Extension Project will, however, mean that plans to re-instate adjacent habitat will now need to be deferred. No biodiversity credits are proposed to be retired to offset these indirect impacts.

The Grey-headed Flying Fox was considered likely to use some of the study area for foraging and has been recorded foraging adjacent to the project area. The Grey-headed Flying-fox is an ecosystem credit species under the BAM in relation to foraging habitat. No roosting sites or camps occur within the study area, and thus will not be affected by the works. The closest Grey-headed Flying Fox camps are the Royal Botanic Gardens, Centennial Park and Turrella, about 12 kilometres north-east, 10 kilometres north-east and 3 kilometres north-west respectively. Since there is no breeding habitat in the project area, no separate species credits are required for the Grey-headed Flying-fox.

An area of about one hectare of native vegetation likely to be Grey-headed Flying-fox foraging habitat would be directly affected by the project. It would be offset through the ecosystem credits required for impacts on this native vegetation. An additional area of planted urban native trees may also be foraging habitat for this species. This is a prescribed biodiversity impact and would be managed through the application of mitigation measures. Prescribed impacts are usually associated with values other than native vegetation or native habitat. For these impacts, the biodiversity values may be difficult to quantify, replace or offset.

An assessment of the Commonwealth Significant Impact Criteria (Commonwealth of Australia 2013) was undertaken for the Grey-headed Flying-fox. The assessment concluded that the project would not have a significant impact on this species, and as such, a referral to the Commonwealth was not required.

Potential *Myotis macropus* (Southern Myotis) habitat would be directly affected by the construction of the intersection at President Avenue. President Avenue crosses a waterway flowing south from the Rockdale Bicentennial Park to Scarborough Park North. The road crosses over a culvert which conveys water from north to the south. The culvert may be potential habitat for this threatened bat, listed as vulnerable under the BC Act. Impacts on this artificial habitat are prescribed under the BAM. Mitigation measures will be implemented consistent with the Roads and Traffic Authority *Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects.*

The project has substantially avoided biodiversity impacts by using, as much as possible, already disturbed sites for above ground components, and due to most of the infrastructure being underground. The proponent has decided to not use the surface corridor that has been reserved as a transport corridor for a variety of environmental and planning reasons. This has avoided impacts to land, including areas containing biodiversity values. Opportunities to further avoid impacts in the design have also been explored.

A number of potential indirect impacts that have been considered in the assessment include:

- Hydrological changes
- Edge effects on adjacent native vegetation
- Injury and mortality to flora and fauna
- Spread of weeds
- Invasion and spread of pests
- Invasion and spread of pathogens
- Acidification
- Dust, noise, vibration and light impacts.

A number of mitigation measures to minimise ecological direct and indirect impacts would be implemented as part of the project in line with Roads and Maritime *Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority 2011). These measures would be detailed in the flora and fauna management plan for the project which would include: site-specific environmental induction; identification of clearing limits and protective fencing; vegetation clearance procedures; pre-clearance surveys; erosion and sediment controls; weed management and monitoring.

The following, while not matters assessed under BAM, are also covered in this report:

- Aquatic biodiversity listed under the *Fisheries Management Act 1994* (NSW) (FM Act)
- Groundwater dependent ecosystems (GDEs)
- Matters of national environmental significance (MNES) listed under the EPBC Act.

Several GDEs occur in the study area. These include at the President Avenue construction ancillary facility, the Landing Lights Wetland and Rockdale Wetlands. An assessment of the potential impacts on GDEs and aquatic habitats within the study area concluded there would be no significant impact as a result of the project. There is likely to be no significant impact to aquatic flora and fauna listed under the FM Act and no protected marine vegetation would be harmed.

Impacts to MNES have been avoided as far as practicable and all impacts have been assessed in accordance with Commonwealth guidelines. Mitigation strategies have been put into place to manage potential impacts to MNES.

1 Introduction

The project would comprise a new multi-lane road between the New M5 Motorway at Arncliffe and President Avenue at Kogarah. The project would connect underground with the New M5 Motorway tunnel and to a new surface level intersection at President Avenue, Kogarah.

1.1 Overview of the project

Key components of the project would include:

- An underground connection to the existing stub tunnels at the New M5 Motorway at Arncliffe
- Twin motorway tunnels (around four kilometres in length) between the New M5 Motorway at Arncliffe and President Avenue, Kogarah
- A tunnel portal and entry and exit ramps connecting the tunnels to a surface intersection with President Avenue
- Intersection improvements at the President Avenue / Princes Highway intersection
- Mainline tunnel stubs to allow for connections to future stages of the F6 Extension
- Shared pedestrian and cycle pathways connecting Bestic Street, Rockdale to Civic Avenue, Kogarah via Rockdale Bicentennial Park (including an on-road cycleway)
- An Operational Motorway Control Centre to be located off West Botany Street, Rockdale
- Ancillary infrastructure and operational facilities for signage (including electronic signage), ventilation structures and systems at Rockdale, fire and safety systems, and emergency evacuation and smoke extraction infrastructure
- A permanent power supply connection from the Ausgrid Canterbury subtransmission substation
- Temporary construction ancillary facilities and temporary works to facilitate the construction of the project.

Once complete, the F6 Extension Stage 1 would improve connections and travel times between Sydney and the Princes Highway and enhance connections for residents and businesses within the broader regional area as well as promote and support economic development in areas to the south, such as Sutherland and the Illawarra.

Approval for the project is being sought under Part 2, Division 5.2 of the EP&A Act. Future stages of the F6 Extension would be subject to separate planning applications and assessments would be undertaken accordingly.

The configuration and design of the project will be further developed to take into consideration the outcomes of community and stakeholder engagement.

1.2 Project location

This project would be generally located within the Bayside local government area. The project commences about 8 kilometres south west of the Sydney central business district (CBD). The proposed President Avenue intersection would be located about 11 kilometres south east of the Sydney CBD.

1.3 Purpose of this report

This Biodiversity Development Assessment Report (BDAR) has been prepared by Dr Meredith Henderson, who is an Accredited Person (BAAS17001) under the NSW *Biodiversity Conservation Act 2016* (BC Act). This document reports on the outcomes of the application of the Biodiversity Assessment Method (BAM) to meet the requirements for assessment of terrestrial biodiversity. The BDAR is required to address matters set out in the Secretary's Environmental Assessment Requirements (SEARs) (see Section 1.4).

This report does not include an assessment the proposed permanent power supply. Refer to the main volume Environmental Impact Statement for a high level assessment.

1.4 SEARs and Agency comments

An outline of the SEARs for biodiversity and where these are addressed in the report are provided in **Table 1-1** below. In addition, relevant considerations provided by NSW DPI from the Water and Fisheries sections and NSW Office of Environment and Heritage have been provided.

Table 1-1 SEARs – Biodiversity

Key issue and desired performance outcome	Assessment requirement	Where addressed in this report
The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.	1. Biodiversity impacts related to the proposal are to be assessed in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR).	This BDAR has been developed in accordance with the Biodiversity Assessment Method
	2. The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s. 6.12), Biodiversity Conservation Regulation 2017 (s 6.8) and Biodiversity Assessment Method (BAM) including details of the measures proposed to address the offset obligation as follows: (a) the total number and classes of biodiversity credits required to be retired for the developments/project; (b) the number of classes of like-for-like biodiversity credits proposed to be retired; (c) the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; (d) any proposal to fund a biodiversity conservation action; and (e) any proposal to make a payment to the Biodiversity Conservation Fund.	Information regarding credits and details of measures proposed to address the offset obligation are provided in Chapter 10 and Annexure C
	3. If requesting the application of the variation rules, the BDAR must contain details of what reasonable steps have been taken to attempt to obtain the required like-for-like biodiversity credits	This BDAR does not propose to apply a variation rule to seeking offsets

Key issue and desired performance outcome	Assessment requirement	Where addressed in this report
	4. The BDAR must be prepared by a person accredited in accordance with the Accreditation scheme for the Application of the Biodiversity Assessment Method Order 2017 under s. 6.10 of the Biodiversity Conservation Act 2016.	This report has been prepared by Dr Meredith Henderson, who is an accredited person and conducted the assessment in accordance with the requirements of the legislation and the Biodiversity Assessment Method
	5. In accordance with section 9.1 and 9.2 of the BAM the BDAR must assess all direct and indirect impacts of the project on native vegetation, threatened ecological communities and threatened species habitat based on current records including recent survey data held by Bayside Council.	Potential impacts are assessed in Chapter 8
	6. The biodiversity assessment must consider impacts on: (a) wetland vegetation communities over the entire alignment of the tunnel; and (b) wetland fauna habitat.	Potential impacts to wetland vegetation communities and wetland fauna habitat are considered in Chapter 4, Chapter 5, Chapter 7, Chapter 8 and Annexure D
	7. The biodiversity assessment must assess cumulative impacts with current road projects such as additional impacts, prolongment of biodiversity impacts, and deferment of habitat rehabilitation works.	Cumulative impacts are assessed in section 8.6
	8. Impacts on biodiversity values that cannot be assessed using the BAM must also be otherwise assessed. The values include: (a) Impacts on fish habitats and nurseries within and adjoining the project area; and (b) matters of national significance listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.	Impacts on other biodiversity values are assessed in Chapter 5, Chapter 6 and Chapter 8
	9. The assessment of aquatic habitats must include opportunities for improvement including measures to reduce the potential for de-oxygenation of and increased nutrient inputs to waters, and measures to control aquatic weeds within the Rockdale wetlands, both during construction and operation of the project.	Opportunities for the improvement of aquatic habitats are considered in Chapter 7, Chapter 9, Chapter 10 and Appendix K (Surface water and flooding) of the EIS
	10. Where waterbodies are to be reconstructed, the design should be consistent with the current guidelines.	Chapter 7, Chapter 9, Chapter 10 and Appendix K (Surface water and flooding) of the EIS
	11. Species declared as threatened under the Biodiversity Conservation Act 2016 and recorded recently (since 1990) within approximately 1.5 kilometres of the project's development corridor should be considered as likely to be affected by the proposal.	Threatened species within 1.5 kilometres of the project are considered in Chapter 5 and Annexure A

1.5 Personnel

This BDAR was carried out by appropriately qualified and experienced ecologists, environmental professionals and accredited assessors under the BC Act as demonstrated in Table 1-2.

Table 1-2 Personnel

Name	Role	Qualifications
Dr Steven Ward	Project Director/Quality Assurance	Doctor of Philosophy, University of Western Sydney, 2002 Bachelor of Science Honours, Wollongong University, 1994 Bachelor of Science, Major in Botany / Zoology, University of Western Australia, 1992 Accredited Person (BAAS17062)
Dr Meredith Henderson	Biodiversity Assessment, Accredited Person nominated for this BDAR	Doctor of Philosophy, Victoria University, Melbourne 2003 Bachelor of Science (Honours), University of Wollongong 1991 Accredited Person (BAAS17001)
Dr Matthew Dowle	Biodiversity Assessment	Doctor of Philosophy, Macquarie University, Sydney 2012 Bachelor of Advanced Science (Honours), University of NSW 2004 Accredited Person (BAAS17043)
Mr Ian Dixon	Aquatic Assessment	AUSRIVAS Accreditation (Australian River Assessment System), 2011 Master of Tropical Environmental Management, Charles Darwin University, 2006 Graduate Diploma of Tropical Environmental Management, Charles Darwin University, 2001 Bachelor of Landscape Architecture, 1999
Dr Peter Hancock	Groundwater Dependent Ecosystem Assessment	Doctor of Philosophy, University of New England, 2004 Bachelor of Natural Resources. University of New England, 1996
Dr Rodney Armistead	Biodiversity Survey	Doctor of Philosophy, Murdoch University, Perth Bachelor of Advanced Science (Honours), Deakin University, Geelong
Mr Mike Lawrie	Biodiversity Survey	Bachelor of Environmental Science and Management - University of Newcastle, 2011 Master of Environment (Specialisation in Environmental Science), Macquarie University, 2016
Mr Byron Heffernan	GIS Analysis and Mapping	Bachelor of Science (Biological Sciences), University of Wollongong, 2006
Ms Louise Upton	Biodiversity Survey	Bachelor of Science (Land & Heritage Management), University of Wollongong, 2015 Diploma in Horticulture (2007)
Ms Stacey Wilson	Biodiversity Survey	Master of Environment, Macquarie University, 2015 Bachelor of Biodiversity and Conservation, Macquarie University, 2013
Mr Brendan Dowd	Commonwealth Approvals Advice	Bachelor of Science: University of Wollongong, 2000 Diploma of Advanced Chemical Sciences, Institute of Technology Wollongong, 1995
Mr Jack Talbert	Biodiversity Survey	Bachelor of Environmental Science (Honours), University of Wollongong, 2012

1.6 Structure of this report

This report is the Biodiversity Development Assessment Report (BDAR) for the project. It therefore follows the structure as outlined in BAM (OEH 2017). The report is divided into several chapters, which reflect the requirements of the BAM (see Annexure E):

- Executive summary
- Chapter 1 – Introduction
- Chapter 2 – The project
- Chapter 3 – Landscape features
- Chapter 4 – Native vegetation
- Chapter 5 – Threatened species
- Chapter 6 – Matters of National Environmental Significance
- Chapter 7 – Avoid and minimise impacts
- Chapter 8 – Impact assessment
- Chapter 9 – Mitigating and managing impacts
- Chapter 10 – Offsetting required
- Chapter 11 – References
- Annexure A – Habitat assessment
- Annexure B – Vegetation Plot Data
- Annexure C – Biodiversity Credit Report
- Annexure D – EPBC Act Impact Assessment
- Annexure E– Biodiversity Assessment Method and where addressed in document.

1.6.1 Sources of information used

As per Table 25 of the BAM, the information sources used for this assessment must be identified in the introduction of the BDAR. The following data sources were reviewed as part of this report:

- BioNet Vegetation Classification (OEH 2018a)
- Bionet Atlas (OEH 2018b)
- Threatened Biodiversity Data Collection (OEH 2018c)
- Directory of Important Wetlands Australia
- Sydney Metropolitan Catchment Management Authority Vegetation Mapping v 3.0 (OEH 2016)
- Soil Landscapes of the Sydney 1:100,000 Sheet (Chapman and Murphy 1989)
- EPBC Act Protected Matters Search Tool (5 kilometre radius search) (DoEE 2017)
- NSW DPI Fisheries threatened and protected species records viewer (FM Act) (DPI 2018a)
- NSW DPI Fisheries Key Fish Habitat Map (DPI 2018b)
- NSW Fisheries Marine Vegetation Map (Botany Bay and Cooks River)
- National Atlas of Groundwater Dependent Ecosystems, accessed February 2018 (http://www.bom.gov.au/water/groundwater/gde/)
- Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 (accessed March 2018)
- Monitoring report for Green and Golden Bell Frog population at Arncliffe (Biosphere Environmental Consultants 2000-2017)

1.6.2 Assessment guidelines used in this report

- Biodiversity Assessment Method (OEH 2017)
- Policy and Guidelines for fish habitat conservation and management (update 2013)
- Risk Assessment Guidelines for Groundwater Dependant Ecosystems (DPI 2012)
- NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft Nov 2004 (NSW Department of Environment and Conservation (DEC) 2004)
- NSW Threatened Species Survey and Assessment Guidelines: Field survey methods for fauna (Amphibians) (NSW Department of Environment and Climate Change (DECC) 2009)
- Matter of National Environmental Significance Significant Impact Guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2013)
- Significant impact guidelines for the vulnerable green and golden bell frog (*Litoria aurea*) Nationally threatened species and ecological communities EPBC Act policy statement 3.19 (Commonwealth of Australia 2009)
- Referral guideline for management actions in Grey-head and Spectacled Flying-fox camps (Commonwealth of Australia 2015)
- EPBC Act Policy Statement 3.21 Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (Commonwealth of Australia 2015)
- Survey guidelines for Australia's threatened frogs, guidelines for detecting frogs listed under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2010).

2 The Project

2.1 Project features

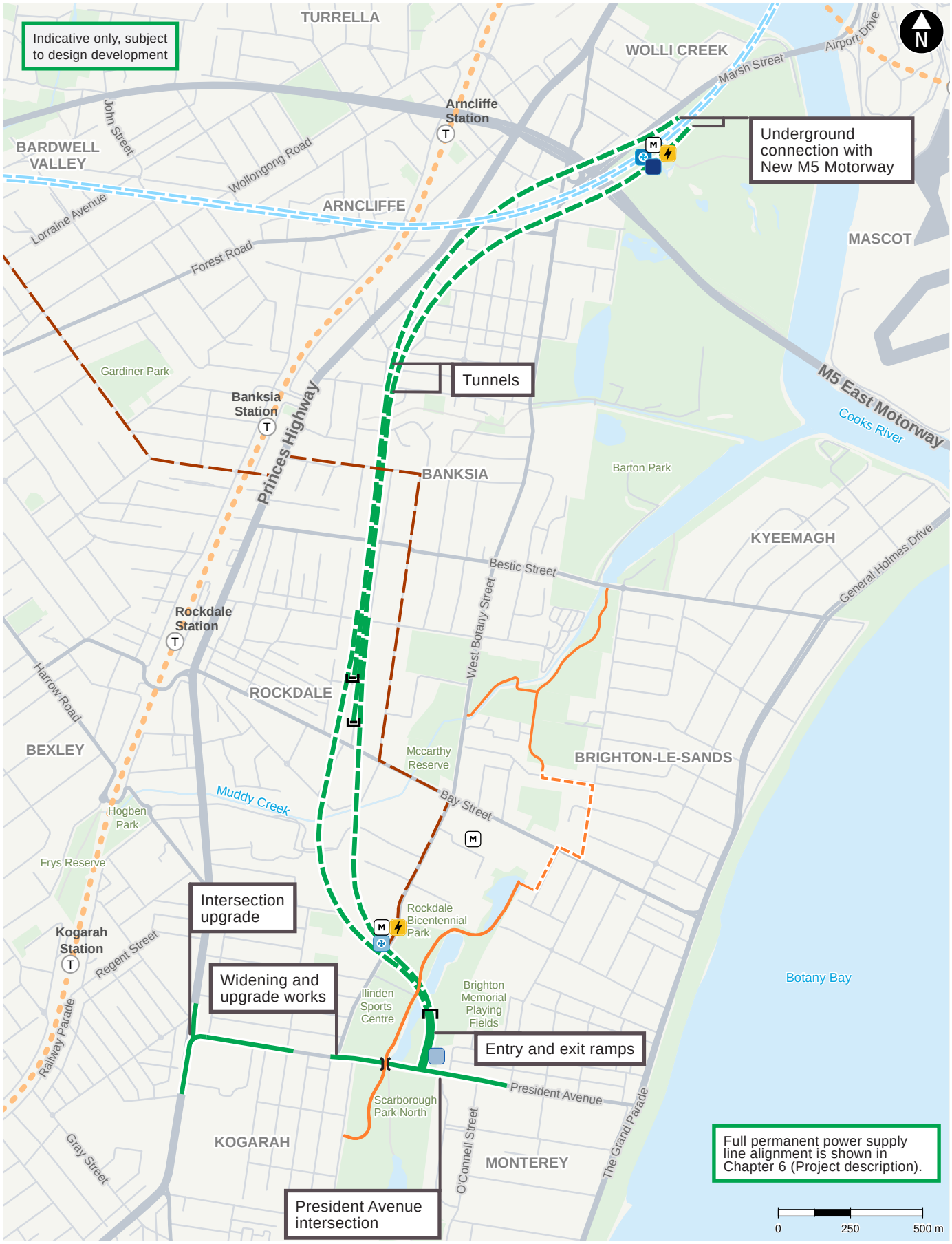
The project would comprise a new multi-lane underground road link between the New M5 Motorway and a surface intersection at President Avenue, Kogarah.

Key components of the project would include:

- Twin mainline tunnels. Each mainline tunnel would be around 2.5 kilometres in length, sized for three lanes of traffic, and line marked for two lanes as part of the project
- A tunnel-to-tunnel connection to the New M5 Motorway southern extension stub tunnels, including line marking of the New M5 Motorway tunnels from St Peters interchange to the New M5 Motorway stub-tunnels
- Entry and exit ramp tunnels about 1.5 kilometres long (making the tunnel four kilometres in length overall) and a tunnel portal connecting the mainline tunnels to the President Avenue intersection
- An intersection with President Avenue including entry and exit ramps and the widening and raising of President Avenue
- Upgrade of the President Avenue / Princes Highway intersection to improve intersection capacity
- Shared cycle and pedestrian pathways connecting Bestic Street, Brighton-Le-Sands to Civic Avenue, Kogarah (including an on-road cycleways)
- Three motorway operation complexes:
  - Arncliffe, including a water treatment plant, substation and fitout (mechanical and electrical) of a ventilation facility currently being constructed as part of the New M5 Motorway project
  - Rockdale (north), including a motorway control centre, deluge tanks, a workshop and an office
  - Rockdale (south), including a ventilation facility, substation and power supply.
- Reinstatement of Bicentennial Park and recreational facilities
- In-tunnel ventilation systems including jet fans and ventilation ducts connecting to the ventilation facilities
- Drainage infrastructure to collect surface water and groundwater inflows for treatment
- Ancillary infrastructure for electronic tolling, traffic control and signage (both static and electronic signage)
- Emergency access and evacuation facilities (including pedestrian and vehicular cross and long passages); and fire and life safety systems
- New service utilities, and modifications and connections to existing service utilities
- A permanent power supply connection from the Ausgrid Canterbury subtransmission substation, to Rockdale Motorway Operations Complex south .

The project does not include ongoing motorway maintenance activities during operation or future upgrades to other intersections in the vicinity during operation. These works are permitted under separate existing approvals and are subject to separate assessment and approval in accordance with the EP&A Act.

The key features of the project are shown on **Figure 2-1**.



LEGEND

- The project in tunnel
- The project on surface
- On-road cycleway
- Shared cycle and pedestrian pathways
- President Avenue shared cycle and pedestrian bridge
- Tunnel stub
- Tunnel portal
- Water quality basin
- Water treatment facility
- Rockdale ventilation facility
- Motorway operations complex
- Substation
- Permanent power supply line
- New M5 Tunnel
- Arncliffe ventilation facility*
- * Under construction as part of the New M5 Motorway project
- Road
- Waterway
- Railway line
- Railway station
- Parks and recreation

Figure 2-1 Project features

2.2 Construction

2.2.1 Construction activities

The proposed construction activities for the project would include:

- Preparatory investigations
- Site establishment and enabling work
- Tunnelling
- Surface earthworks and structures
- Construction of motorway operations complexes
- Drainage and construction of operational water management infrastructure
- Construction of the permanent power supply connection
- Road pavement works
- Finishing works.

These activities would be undertaken within the construction boundary discussed in **section 2.2.2**, which includes the following five construction ancillary facilities:

- Arncliffe construction ancillary facility (C1) at Arncliffe, within the Kogarah Golf Course currently being used for construction of the New M5 Motorway
- Rockdale construction ancillary facility (C2) at Rockdale, within a Roads and Maritime depot at West Botany Street
- President Avenue construction ancillary facility (C3) at Rockdale, north and south of President Avenue within Rockdale Bicentennial Park and part of Scarborough Park North, and a site west of West Botany Street
- Shared cycle and pedestrian pathways construction ancillary facilities (C4 and C5) at Brighton-le-Sands, within the recreation area between West Botany Street and Francis Avenue, near Muddy Creek
- Princes Highway construction ancillary facility (C6), on the north-east corner of the President Avenue and Princes Highway intersection.

2.2.2 Construction boundary

The area required for project construction is referred to as the 'construction boundary'. This comprises the surface construction works area, and construction ancillary facilities (refer to **Figure 2-2**). Utility works to support the project would occur within and outside the construction boundary (refer to **Chapter 7** (Construction) of the EIS).

In addition to these works, the underground construction boundary (including mainline tunnel construction and temporary access tunnels) is also shown on **Figure 2-2.**

C1

- Tunnelling and spoil handling
- Construction of MOC1 (Water treatment plant, substation)
- Fitout, testing and commissioning of tunnels and MOC 1

C2

- Construction of the decline tunnel
- Tunnelling and spoil handling
- Pavement works for internal access road
- Construction of MOC2
- Reconfiguration of the site to enable ongoing/future use for maintenance activities

C3

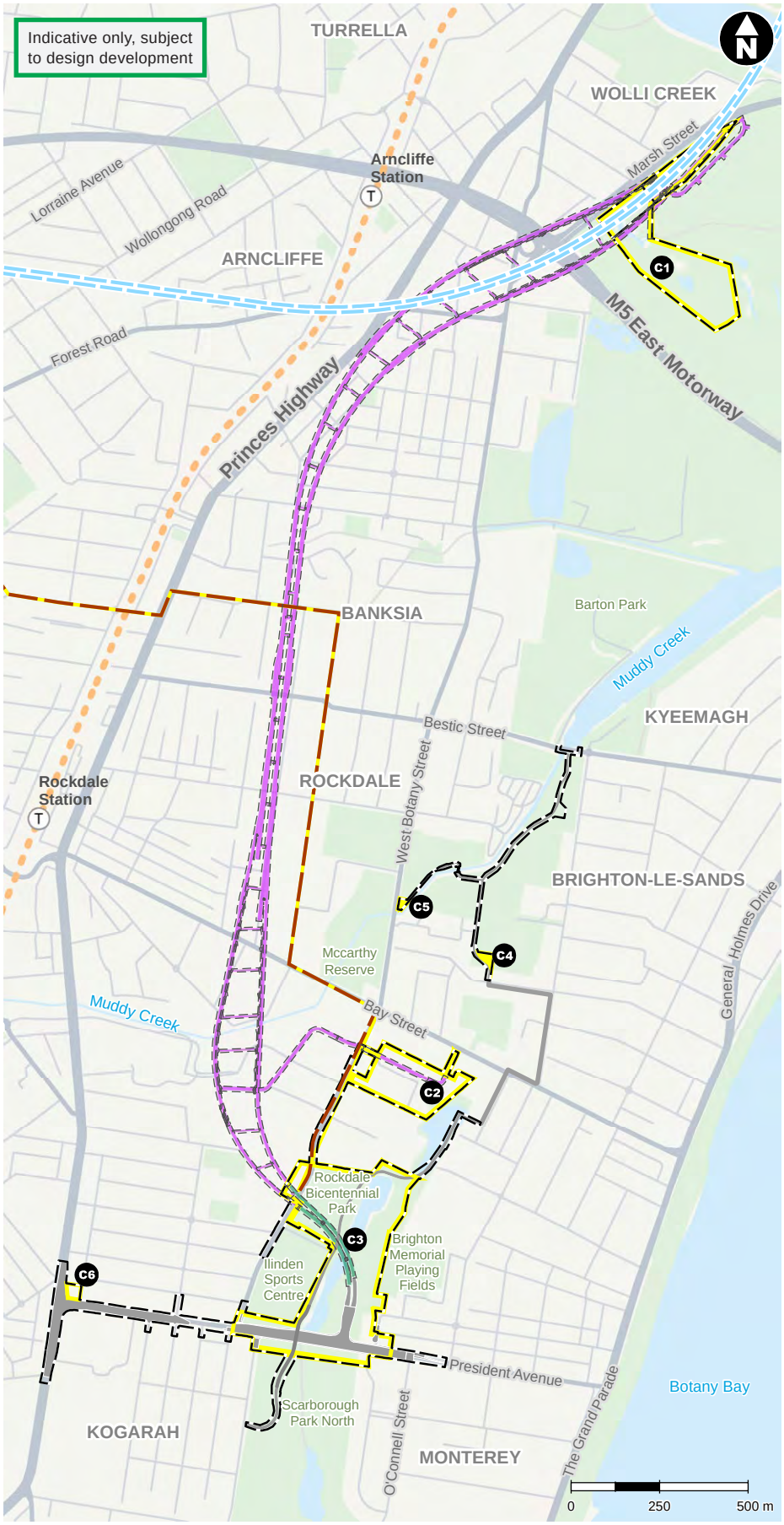
- Demolition of buildings and vegetation clearing and removal
- Relocation of utilities
- Temporary stockpiling of spoil and fill materials
- Management of any contaminated land, including acid sulphate soils
- Construction of cut-and-cover structures
- Construction of MOC3 (Rockdale ventilation facility and substation)
- President Avenue intersection upgrade works
- Construction of shared pedestrian and cyclist path and overpass

C4/C5

- Site establishment
- Vegetation clearing and removal, topsoil stripping areas and land-form shaping
- Temporary stockpiling of materials
- Construction of the shared pedestrian and cyclist path
- Finishing works including lighting, line marking and signage installation

C6

- Property adjustment and demolition
- Relocation of utilities, stormwater infrastructure, underground storage tanks and substation
- Laydown and parking of construction vehicles and equipment
- Reinstatement of site



LEGEND

- Surface works
- Construction boundary
- Cut-and-cover structures
- Underground construction
- Construction ancillary facility
- Permanent power supply line
- Permanent power supply construction route
- New M5 Tunnel
- Road
- Waterway
- Railway line
- Railway station
- Parks and recreation

Figure 2-2 Construction boundary and construction ancillary facilities

2.2.3 Construction program

The project would be constructed over a period expected to be around four years, including commissioning which would occur concurrently with the final stages of construction (refer to **Figure 2-3**).

The project is expected to be completed towards the end of 2024.

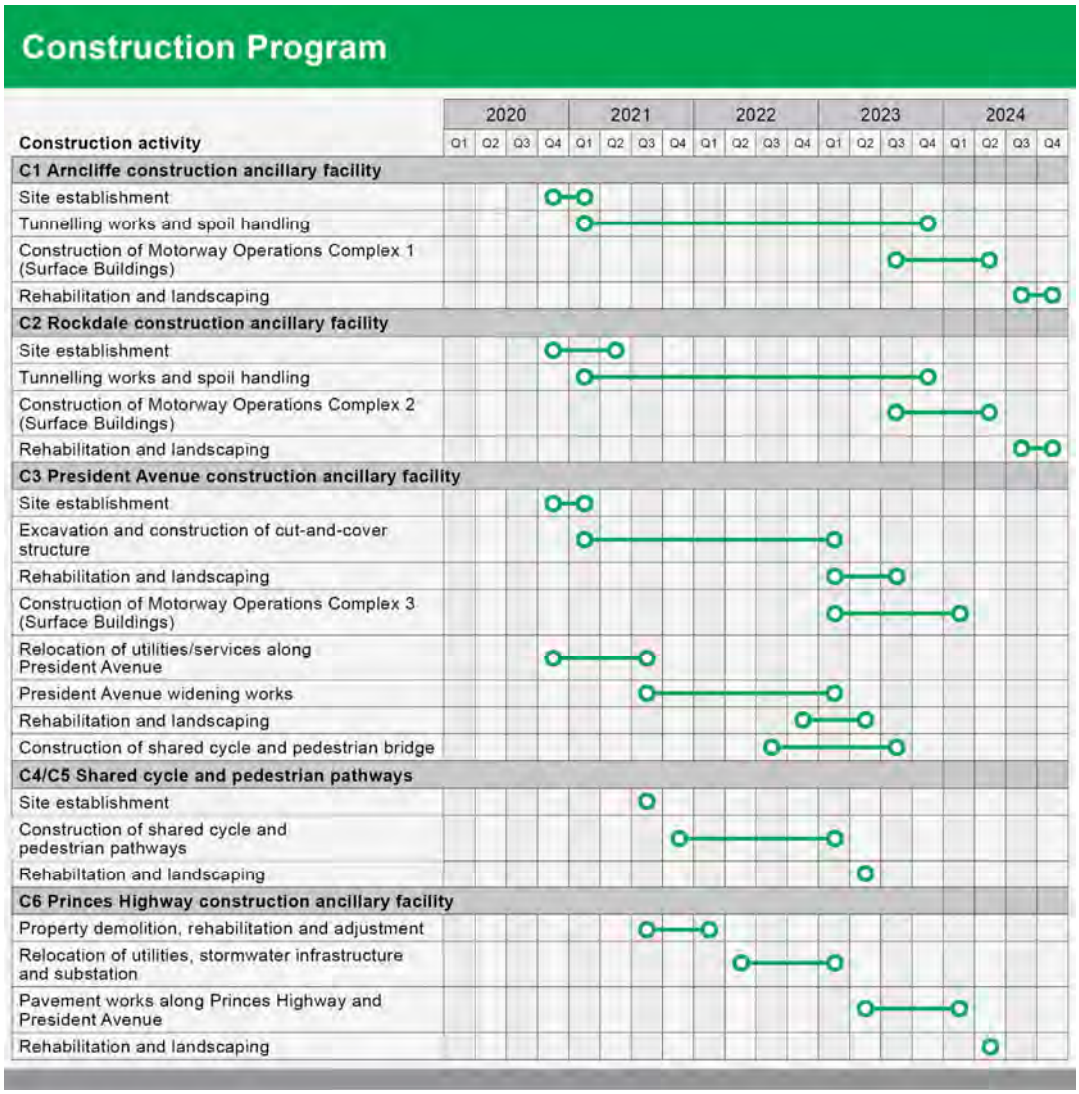


Figure 2-3 Indicative construction program

2.3 Context of the Biodiversity Development Assessment Report

As part of an application for State significant infrastructure under the EP&A Act, a proponent must prepare an EIS that addresses the SEARs provided by the NSW Department of Planning and Environment (DP&E).

The BC Act and the SEARs require the BAM to be applied to assess impacts on biodiversity. The BAM outlines the assessment methodology to quantify and describe the biodiversity values on the project footprint, and the biodiversity offsets required for any unavoidable impacts. This report has been prepared by Dr Meredith Henderson, who is an accredited person and conducted the assessment in accordance with the requirements of the legislation and the BAM.

The BAM applies only to terrestrial impacts. However, assessment of impacts to aquatic biodiversity is provided in this BDAR, along with requirements for avoiding, minimising and offsetting these impacts as guided by the Fisheries NSW *Policy and guidelines for fish habitat conservation and management (Update 2013)* (Fisheries NSW policy and guidelines).

3 Landscape Features

3.1 Identified features

In accordance with Chapter 4 of the BAM, the BDAR is required to identify a number of landscape features such as the Interim Biogeographic Regionalisation for Australia (IBRA) region, IBRA sub-region, Mitchell landscape, rivers and streams, extent of native vegetation in the area assessed for the project area. The landscape features of the project area are shown **Figure 3-1** to **Figure 3-3** and described below.

3.1.1 IBRA Regions and subregions

The project area is located entirely within the Sydney Basin Bioregion (**Table 3-1**), which extends north to the Hunter Valley, west to Mudgee and south to Batemans Bay, and is within the Pittwater IBRA subregion (**Table 3-2**). The project occurs within a highly urbanised setting surrounded by extensive areas of established urban development to the east, west, north and south. The construction boundary was used for the 500 metre buffer (see **section 3.1.2**). The 500 metre buffer area will be referred to as the assessment area.

Table 3-1 IBRA Region

IBRA Region	Assessment area within region (hectares)
Sydney Basin	590.55

Table 3-2 IBRA subregion

IBRA subregion	Assessment area within subregion(hectares)
Pittwater	590.55

3.1.2 NSW Landscape Region

The project area occurs across two NSW Landscape Regions (Mitchell Landscape).These regions are Sydney - Newcastle Barriers and Beaches and Woronora Plateau (Mitchell 2002) (**Figure 3-1**). Most of the construction boundary is within the Sydney - Newcastle Barriers and Beaches.

3.1.3 Native vegetation extent

The linear assessment method was selected for this project, as defined in the BAM. A buffer of 500 metres was applied to the project area in accordance with Section 4.2.1.2 of the BAM. This was used to assess the area of surrounding vegetation cover (**Figure 3-2**).

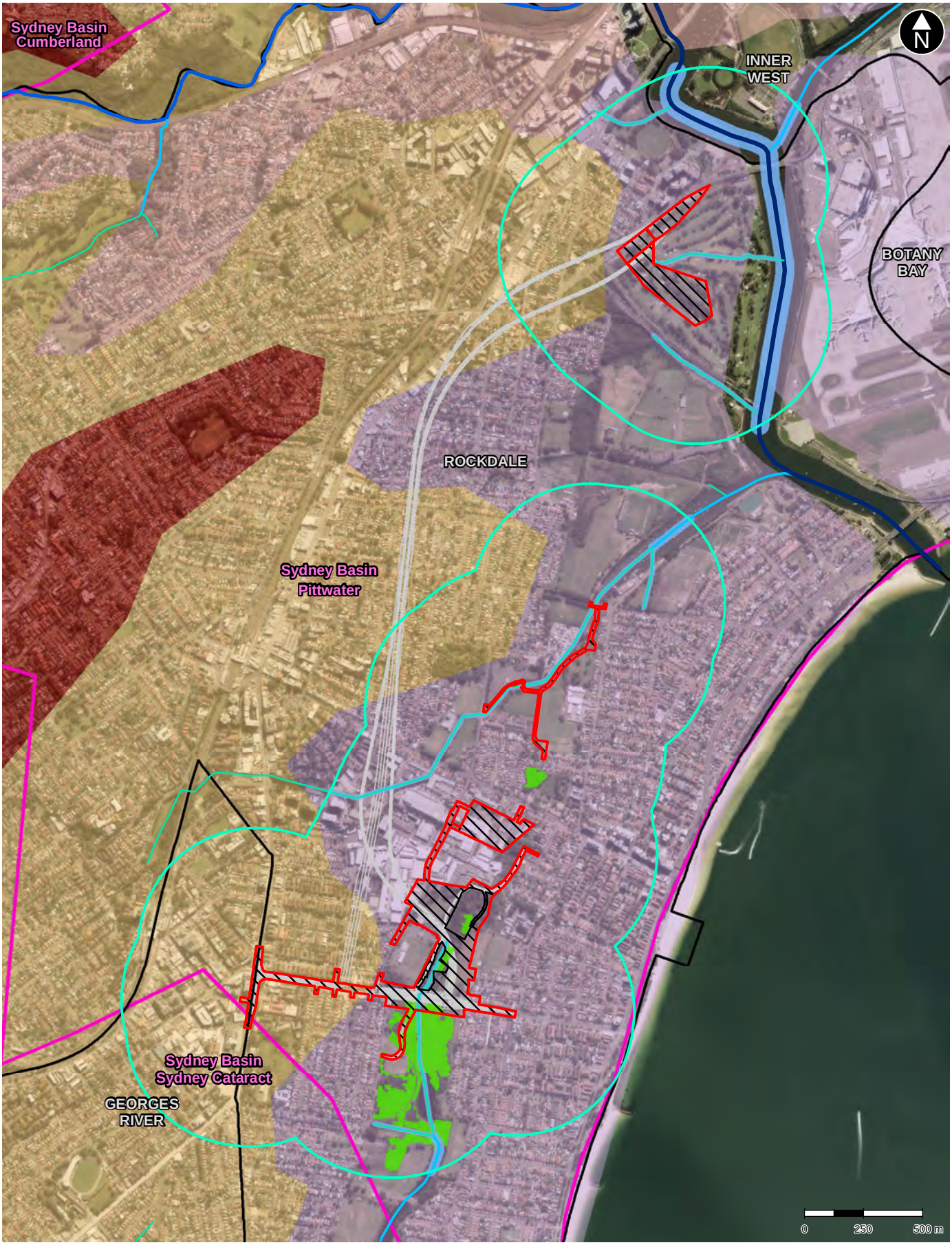
The amount of native vegetation within the assessment area before the development was calculated using ArcGIS, and the vegetation mapping from the Native Vegetation of the Sydney Metropolitan Area (OEH 2016) (excluding the non-native categories). Where this layer did not cover the whole assessment area, the gaps were filled in manually based on interpretation of recent aerial imagery.

To determine the native vegetation cover after development in the assessment area, the total amount of clearing was subtracted from the pre-development cover. The development footprint was then used to calculate the amount of vegetation loss. **Table 3-3** outlines the native vegetation cover within the development footprint and within the assessment area.

The assessment area recorded about 21.46 hectares of native vegetation cover before development (**Table 3-3**).

Table 3-3 Native vegetation extent

Area of native vegetation within the development footprint (hectares)	Area of native vegetation within the assessment area (hectares)
1.54	21.46



LEGEND

F6 Extension S1

Construction Boundary
Development Footprint
Assessment Area
F6 Extension - Stage 1

Mitchell Landscape

Ashfield Plains
Port Jackson Basin
Sydney - Newcastle Barriers and Beaches
Woronora Plateau

Local Government Area
IBRA Region and Subregion
Drainage Buffers
Intact Native Vegetation

Strahler Stream Order

1st Order Stream
2nd Order Stream
3rd Order Stream
4th Order Stream

Figure 3-1 Landscape features IBRA Region, IBRA subregion and Mitchell Landscape

LEGEND

F6 Extension S1

- Construction Boundary
- Development Footprint
- Assessment Area
- F6 Extension - Stage 1
- Drainage Buffers
- Intact Native Vegetation

Strahler Stream Order

- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream

Figure 3-2 Native vegetation extent

LEGEND

F6 Extension S1

- Construction Boundary
- Development Footprint
- Assessment Area
- F6 Extension - Stage 1
- Towra Point Ramsar Wetland
- Landing Lights Wetland
- Marsh Street Wetland
- Eve Street Wetland
- Spring Street Wetland

Strahler Stream Order

- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream
- 7th Order Stream

Figure 3-3 Rivers, streams and wetlands

3.1.4 Rivers and streams

The assessment area intersects with three waterways (see **Table 3-4**). Two of these waterways intersect with the development footprint and these were Muddy Creek and the unnamed waterway running through the Rockdale Bicentennial Park.

Table 3-4 Rivers and streams in the assessment area

River / stream name	Stream order	Riparian buffer (metres)	Key fish habitat (DPI Fisheries)
Cooks River (near Kogarah Golf Course)	4th	40	Yes
Muddy Creek (upstream of Bestic Street)	1st	10	Yes: tidal portion No: freshwater portion
Waterway through Rockdale Bicentennial Park and south of President Ave	1st	10	No

3.1.5 Wetlands

There are several Coastal Wetlands and Proximity Areas for Coastal Wetlands in the assessment area (**Table 3-5**). Artificial waterbodies are scattered across the assessment area as detention basins and ponds. The Eve Street wetland is listed in the Directory of Nationally Important Wetlands and is located near the construction boundary (about 500 metres). The Landing Lights, Marsh Street, and Spring Street wetlands are within the assessment area but do not fall within the construction boundary. They are not listed in the Directory of Nationally Important Wetlands, but are locally important. A small section of the Scarborough Park North wetland is within the project footprint. It is not listed in the Directory of Nationally Important Wetlands.

Table 3-5 Wetlands in the buffer area

Wetland name	Classification	Wetland buffer (metres)	Within development footprint?
Eve Street Wetland	Nationally important	50	No
Marsh Street Wetland	Locally important	20	No
Landing Lights wetland	Locally important	20	No
Spring Street wetland	Locally important	20	No
Scarborough Park North wetland	Locally important	20	Yes

3.1.6 Connectivity features

There is a corridor of land extending south from Brighton-Le-Sands to Ramsgate that is primarily open space and is a local wildlife corridor. This corridor forms part of the reserved road corridor for the F6. The open space and minor areas of native vegetation do not connect large patches of intact native vegetation or habitat. However they would provide for stepping stones for relatively common urban wildlife.

3.1.7 Areas of geological significance and soil hazard

The development footprint does not contain any areas of geological significance. There are areas at the President Avenue construction ancillary facility that are known to have the potential for acid sulfate soils.

3.1.8 Site context

Method applied

The linear assessment method has been applied.

Per cent native vegetation in the landscape

The current per cent native vegetation cover in the landscape was assessed in a Geographic Information System (GIS) using aerial imagery sourced from high resolution aerial imagery (eg SIX Maps). The total within the assessment area was 590.55 hectares, and the total area of native vegetation was 21.46 hectares. The results of this analysis is that the native vegetation cover of about 3.63 per cent would be in the 0-10 per cent class.

Patch size

Patch size was calculated using available vegetation mapping for all patches of intact native vegetation on and adjoining the development footprint. Patch size is calculated for each patch of vegetation that occurs on or adjoins the development footprint where there is a gap (<100 metres woody, <30 metres non-woody) and the vegetation is intact.

The patch size for use in the Biodiversity Credit Calculator (BCC) was 11.84 hectares.

4 Native Vegetation

Eco Logical Australia Pty Ltd (ELA) employed a series of survey methods to undertake the field assessment of the biodiversity values within the assessment area. The surveys conducted were consistent with the SEARs, BAM, survey guidelines and relevant impact assessment guidelines. The methods used and rationale behind their selection is described in **section 4.1** and **section 4.2**.

4.1 Method

4.1.1 Background research

Data searches

ELA reviewed aerial photography as well as vegetation and soil datasets as described **section 1.6.1**.

4.1.2 Previous reports

To understand the context of the assessment area in relation to previous biodiversity studies, reviews of relevant reports were conducted, including:

- The New M5 Motorway EIS – Biodiversity Assessment Report (ELA 2015)
- Rockdale Council Biodiversity Strategy (Rockdale Council 2014).

The New M5 Motorway EIS – Biodiversity Assessment Report

The New M5 Motorway project was declared as SSI and was assessed using the Framework for Biodiversity Assessment, as outlined in the project's SEARs. The New M5 Motorway completely overlaps with this project's construction area at the Arncliffe construction ancillary facility (C1).

The assessment determined that the New M5 Motorway would result in 3.31 hectares of direct impacts on native vegetation (ecosystem credits), comprising the following plant community types:

- PCT725 Broad-leaved Ironbark - *Melaleuca decora* shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion
- PCT1181 Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion
- PCT1064 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion.

The New M5 Motorway project was also deemed to result in an impact upon the Green and Golden Bell Frog, a species credit species, through the removal of potential breeding and known foraging, dispersal and sheltering habitat.

Accordingly, the project Biodiversity Assessment Report (BAR) assessed the type and number of credits using the Framework for Biodiversity Assessment. These calculations identified the following offset requirements for the project:

- A total of 58 ecosystem credits consisting of 31 Broad-leaved Ironbark - *Melaleuca decora* shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 725) credits and 27 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT 1046) credits
- A total of 203 credits for Green and Golden Bell Frog.

In addition to the offsetting required, the New M5 Motorway BAR proposed numerous mitigation measures including:

- Preparation and implementation of a specific plan to manage impacts to Green and Golden Bell Frog habitat at Arncliffe during construction
- Enhancement of Green and Golden Bell Frog habitat within the Kogarah Golf Course during construction
- Creation of new habitat for Green and Golden Bell Frog at Marsh Street

- Capture of adult Green and Golden Bell Frogs for inclusion in a captive breeding program at an offsite facility.

Rockdale Council Biodiversity Strategy

This document from the City of Rockdale (now Bayside Council) provides a framework for the protection and enhancement of biodiversity in the Local Government Area (LGA). The strategy identifies ecological values present (flora and fauna, and threatened ecological communities) within the LGA. It also identifies potential threats, areas of biodiversity connectivity, and priority biodiversity sites .

A key habitat for biodiversity in the LGA occurs in the Rockdale Wetlands corridor. The strategy identified numerous native vegetation communities and threatened ecological communities within this corridor. The Rockdale Bicentennial Ponds were listed as a priority natural area. The conservation significance assessment rated the Rockdale Wetlands corridor as having high conservation significance.

The construction boundary occurs within the Rockdale Wetlands corridor (at the Rockdale construction ancillary facility (C2) and the President Avenue construction ancillary facility (C3)), but was not identified as containing, shorebird, or Grey-headed Flying Fox roosting habitat. The corridor was identified as containing potential foraging habitat for Grey-headed Flying Fox and 'selected' microbats. The strategy noted that while Wallum Froglet was identified in the LGA, this was most likely a misidentification (Rockdale City Council 2014).

The priority species listed in the strategy that would occur in this construction boundary and surrounds would include small birds (not threatened) and some microbats. Anecdotal advice suggests that the ponds at Rockdale Bicentennial Park are receivers of Eastern Long-necked Turtle and other aquatic reptiles as part of fauna relocation in the LGA.

4.2 Vegetation surveys

The existing vegetation community mapping (OEH 2016) within the construction boundary was verified to confirm the presence or absence of native vegetation communities, including presence of any threatened ecological communities (TECs). Vegetation communities were identified from a combination of floristic surveys and transect traverses, and checked to see if a Plant Community Type (PCT) could be assigned, or if they were non-native vegetation, by comparing the dominant canopy species, the general description of location, soil type and other attributes as described in the OEH online BioNet Vegetation Classification database (OEH 2017a).

Where vegetation was present but it could not be classified as any particular PCT, it was combined into a category in the vegetation mapping as 'Urban Exotic and Native Cover' (see **section 4.3**).

Vegetation within the assessment area is shown on **Figure 4-1** to **Figure 4-5**.

4.2.1 Survey effort

Vegetation validation occurred in 2016 as part of initial scoping for the project. Full floristics, vegetation integrity and condition plots were undertaken within the construction boundary on 6 December 2017 (**Figure 4-1** to **Figure 4-5**).

A total of four full floristic vegetation plots were surveyed to identify PCTs and TECs on the project footprint (**Table 4-1**).

Table 4-1 Full-floristic PCT identification plots

PCT ID	PCT Name	Number of plots surveyed
1232	Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	1
1795	Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	1
1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	1

PCT ID	PCT Name	Number of plots surveyed
-	Urban exotic and native cover	1

A total of four vegetation integrity plots were undertaken in the construction boundary in accordance with the BAM (Table 4-2). These were conducted at the same location as the full-floristic vegetation plots.

All field data collected at full-floristic and vegetation integrity plots is included in Annexure B.

Table 4-2 Vegetation integrity plots

Veg Zone	PCT ID	PCT Name	Condition	Area (ha)	Plots required	Plots surveyed
1	1232	Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	M-G	0.47	1	1
2	1795	Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	M-G	0.30	1	1
3	1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	M-G	0.77	1	1
-	N/a	Urban Exotic and Native Cover	-	3.76	0	1

4.2.2 Limitations

The floristics and integrity plot for Vegetation Zone 1 was altered to best fit the long narrow strip of vegetation present. Instead of a 50 metre by 20 metre plot, with a nested 20 metre by 20 metre floristic plot, the dimensions used were 100 metres by 10 metres, with a 40 metre by 10 metre full floristics plot.

Street trees were not sampled as separate vegetation types. These could not be assigned to any meaningful PCT and at the time of writing, there has not been clear direction from OEH as to how these trees should be assessed under BAM. This vegetation is therefore not addressed further in the BDAR. Furthermore, the ecological value of street trees for threatened biodiversity values is generally low. They do provide local amenity such as shade, visual benefits, and resources for fauna species that utilise urban areas.

Plant community types (PCT) were assigned based on best fit but was problematic in some instances due to the highly disturbed nature of the urban environment and the planting that has occurred in the past, thus the PCT were selected on a ‘best fit’ basis.

No field assessments were conducted for the assessment of GDEs. The GDE assessment was based on a desktop assessment only.

Figure 4-1 Native vegetation in the C1 project area

LEGEND

F6 Extension S1

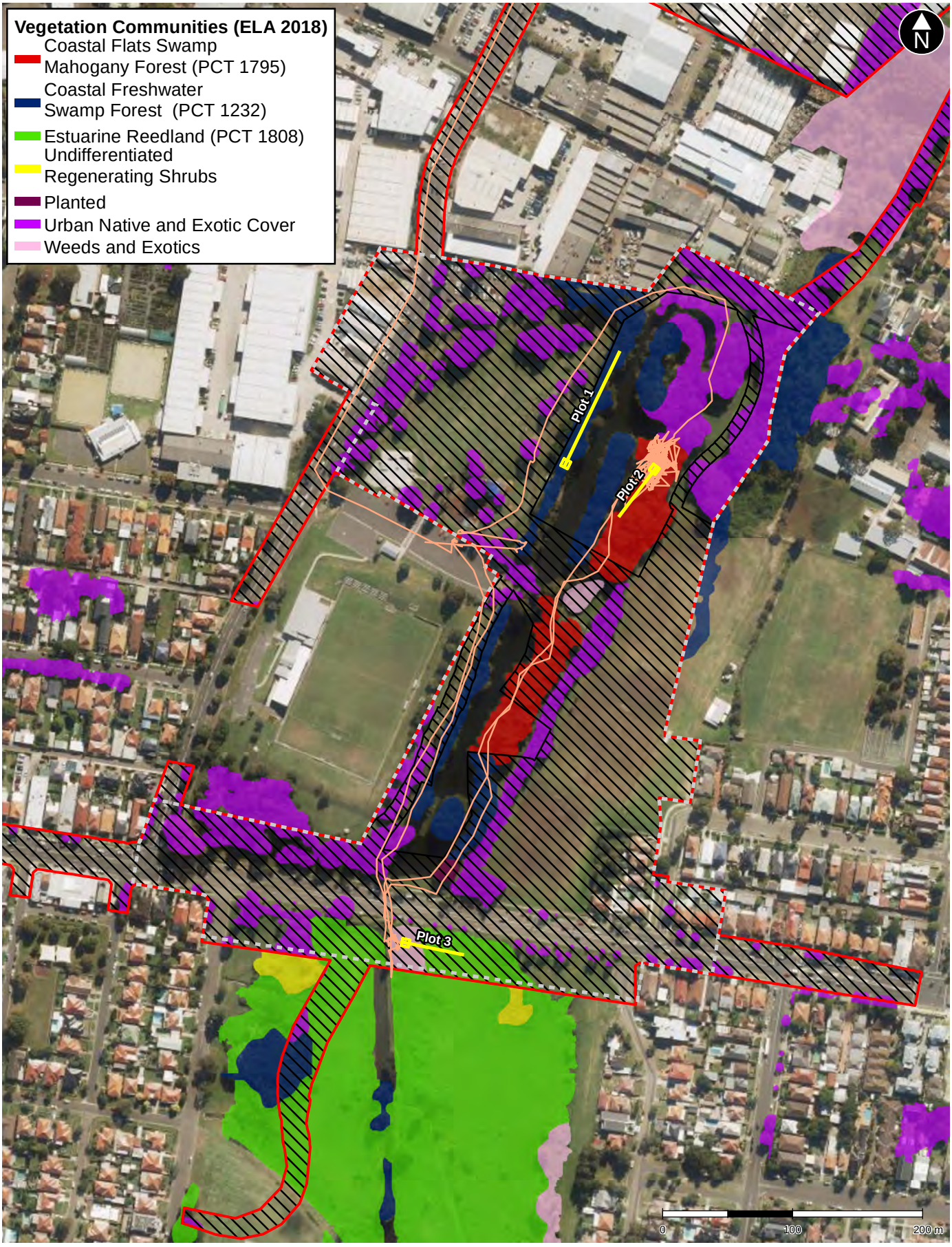
Construction Boundary

C2 - Rockdale construction ancillary facility

Development Footprint

GPS Tracks

Figure 4-2 Native vegetation in the C2 project area



LEGEND

F6 Extension S1

- Construction Boundary
- C3 - President Avenue construction ancillary facility
- Development Footprint
- GPS Tracks
- Plots

Figure 4-3 Native vegetation in the C3 project area

LEGEND

F6 Extension S1

Construction Boundary

C4 - ATC east construction ancillary facility

Development Footprint

Vegetation Communities (ELA 2018)

Coastal Flats Swamp Mahogany Forest (PCT 1795)

Urban Native and Exotic Cover

Figure 4-4 Native vegetation in the C4 project area

LEGEND

F6 Extension S1

- Construction Boundary
- C5 - ATC west construction ancillary facility
- Development Footprint
- GPS Tracks

Vegetation Communities (ELA 2018)

- Planted
- Urban Native and Exotic Cover

Figure 4-5 Native vegetation in the C5 project area

Figure 4-6 Threatened ecological communities in the C1 project area

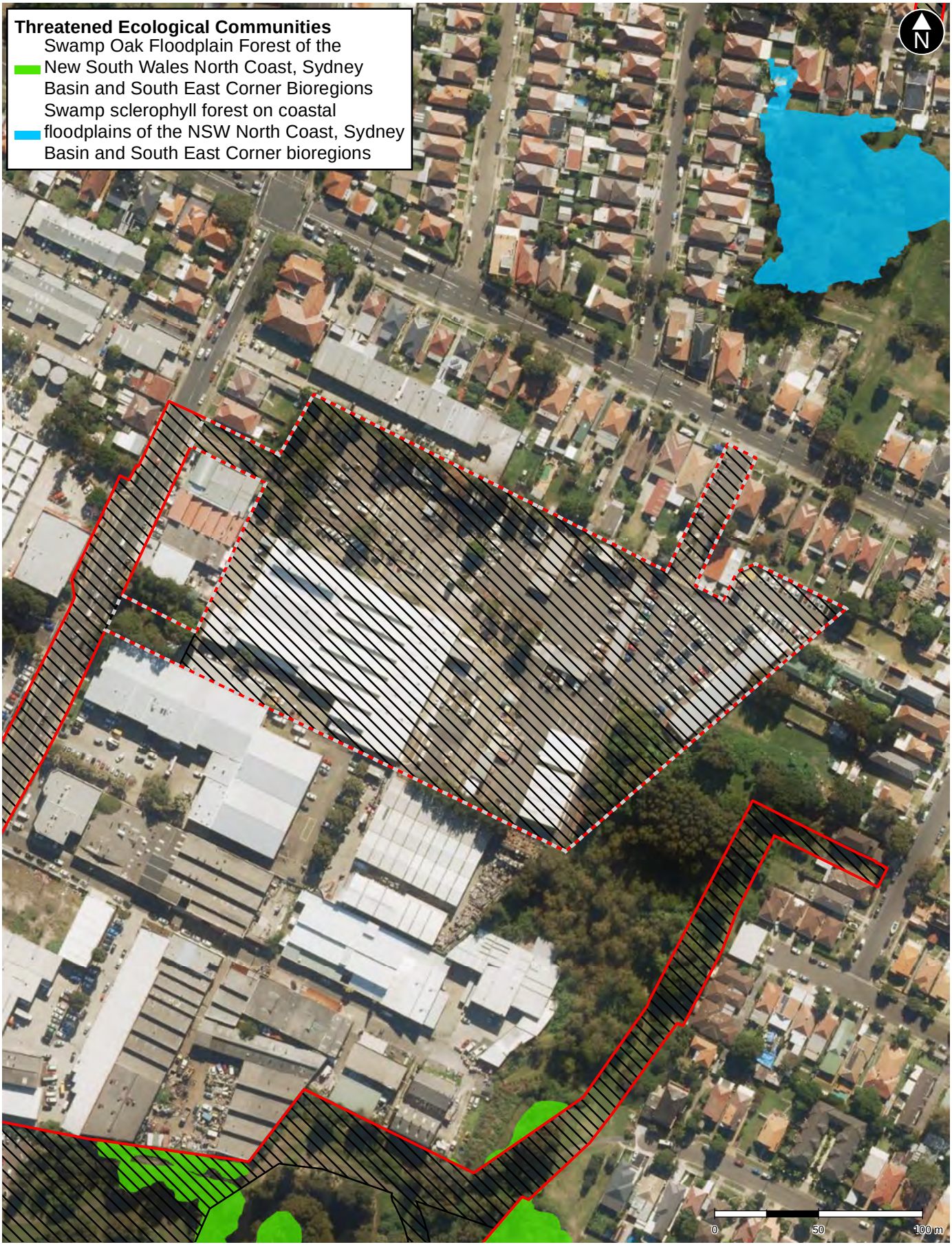


Figure 4-7 Threatened ecological communities in the C2 project area

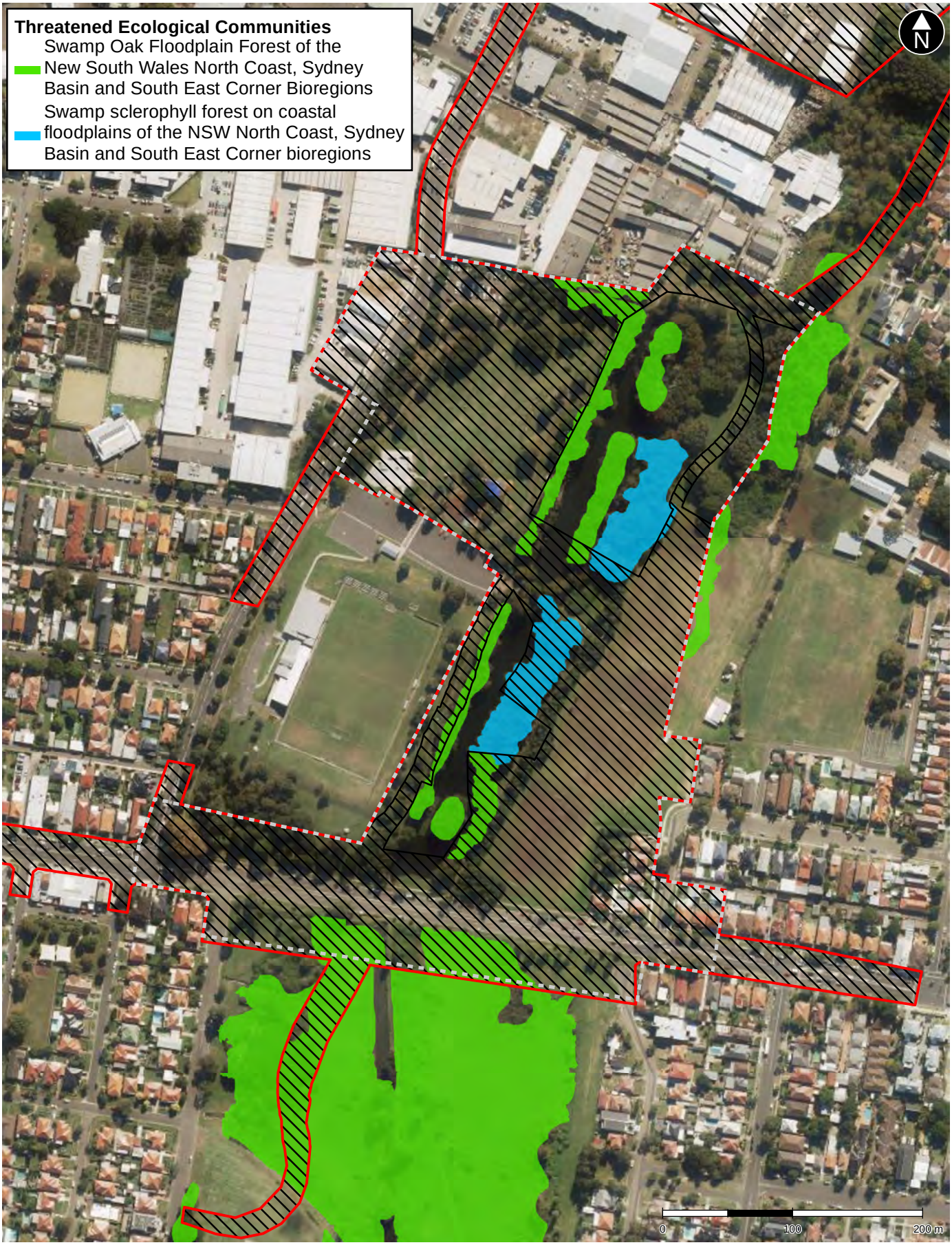


Figure 4-8 Threatened ecological communities in the C3 project area

LEGEND

F6 Extension S1

Construction Boundary

C4 - ATC east construction ancillary facility

Development Footprint

Threatened Ecological Communities

Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions

Figure 4-9 Threatened ecological communities in the C4 project area

LEGEND

F6 Extension S1

Construction Boundary

C5 - ATC west construction ancillary facility

Development Footprint

Figure 4-10 Threatened ecological communities in the C5 project area

4.3 Plant Community Types present

The BAM requires that the extent of native vegetation within the development footprint be mapped. This native vegetation is to be classified using PCTs defined in the BioNet Vegetation Classification database (OEH 2018a).

Previous mapping by OEH (2016) identified the following vegetation communities in the assessment area for the project:

- Plantation (native and/or exotic)
- Coastal Flats Swamp Mahogany Forest (PCT 1795)
- Coastal Freshwater Swamp Forest (PCT 1232)
- Riverflat Paperbark Swamp Forest (PCT 1798)
- Estuarine Swamp Oak Forest (PCT 1234)
- Coastal Swamp Paperbark-Swamp Oak Scrub (PCT 1236)
- Estuarine Reedland (PCT 1808)
- Coastal Foredune Wattle Scrub (PCT 772)
- Estuarine Mangrove Forest (PCT 920)
- Estuarine Saltmarsh (PCT 1126)
- Undifferentiated Regenerating Shrubs
- Urban Exotic/Native
- Weeds and Exotics.

A total of three vegetation types corresponding with three PCTs were identified within the construction boundary (**Figure 4-1** to **Figure 4-5** and **Table 4-3**). Justification for the selection of PCTs occurring is based on a quantitative analysis of full-floristic plot data and is provided in **Table 4-4**. The PCTs are listed TECs under the BC Act (**Table 4-5**, **Figure 4-6** to **Figure 4-10**). A fourth vegetation type was identified within the project area, but could not be classified into a PCT. This vegetation was mapped as 'Urban Exotic and Native Cover'. Under the OEH (2016) mapping project:

- 'Non-native vegetation cover comprised two classes: 'weeds and exotics' and 'urban exotics and natives'
- The label 'weeds and exotics' was applied to vegetation patches greater than 0.1 hectare in size with a complete cover of exotic species in the upper strata (ie where no visible native species could be discerned)
- The label 'urban exotics and natives' was applied to polygons greater than 0.1 hectares in size for which urban land use covered more than 70 per cent of the polygon and there was evidence of both exotic and native species in the upper or lower strata. Typically these areas include backyard trees, street trees, gardens, median strips and other small-scale features that are small isolated stands".

No PCT could be reliably assigned to 'weeds and exotics' and 'Urban Native and Exotic Cover', and therefore no integrity score could be calculated. This vegetation type was excluded from further assessment.

Vegetation types that are saline, such as saltmarsh or mangrove forest are not quantified or assessed as per BAM. These are addressed and described in **section 5.5**.

Table 4-3 Plant Community Types

PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Area	Percent cleared
1232	Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Coastal Swamp Forest	Forested Wetlands	0.47	95

PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Area	Percent cleared
1795	Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Coastal Swamp Forest	Forested Wetlands	0.30	50
1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	Coastal Freshwater Lagoons	Freshwater Wetlands	0.77	41

The BAM requires that a systematic and robust justification of the PCT selected for each vegetation type is presented in the BDAR. Use of spreadsheet based tools was not useful due to the low number of native species encountered in each full floristics plot. The OEH BioNet Vegetation Classification Database was used to assist in the justification of the selected PCT along with the information provided in the source material for the mapping in the Sydney Metropolitan Catchment Management Area (OEH 2016). The selection criteria and the species relied on are listed for each PCT (**Table 4-4**).

Table 4-4 PCT selection justification

PCT ID	PCT Name	Selection Criteria	Species relied upon for identification of vegetation type and relative abundance
1232	Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Local Government Area – Rockdale/Kogarah Elevation – 1-6 metres Soil type – alluvium rather than marine sediments	Casuarina glauca (20% cover) Melaleuca quinquenervia (5% cover)
1795	Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Local Government Area – Rockdale/Kogarah Elevation – 1-6 metres Soil type – alluvium rather than marine sediments Vegetation matches the TEC Swamp sclerophyll forest and is restricted to this PCT only in the Sydney metropolitan region	Eucalyptus robusta (70% cover) Acacia longifolia (1% cover) Dodonaea triquetra (0.3%) Entolasia marginata Oplismenus aemulus Phragmites australis
1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	Local Government Area – Rockdale Landform – low lying swamp on riverbank subject to tidal influence	Phragmites australis

4.3.1 Urban Exotic and Native Cover

Vegetation formation and class: Not applicable

PCT: Mapped as Urban Exotic and Native Cover. Noted that although this mapped vegetation includes some plants native to NSW this vegetation does not fit with a locally occurring PCT

Other mapping sources: Native Vegetation of the Sydney Metropolitan Area (OEH 2016).

Conservation status: Not listed

Extent in the development footprint: About 4.64 hectares

Description

Urban exotic and native cover consisted of planted, non-indigenous native and exotic species within local parklands and street trees. These areas often contained large expanses of exotic grasses and other weeds and generally occurred where the soil profile had been extensively modified. Some areas only contain large established trees (native and exotic) over exotic grasses, with no shrub layer or evidence of regenerating overstorey species.

A typical area at Rockdale Bicentennial Park was dominated by exotic vegetation, also with planted indigenous or non-indigenous and disturbance tolerant species across all vegetation layers, including, *Lantana camara* (Lantana), *Ficus microcarpa hillii* and the occasional Eucalyptus species planted as park and street trees. The ground layer was dominated by exotic grasses including *Melinis repens* (Red Natal Grass), *Eragrostis curvula* (African Love Grass), *Pennisetum* spp., (Swamp Foxtail and Kikuyu) and *Chloris gayana* (Rhodes Grass).

Figure 4-11 Urban Native and Exotic Cover

4.3.2 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion

Vegetation formation and class: Coastal Swamp Forest; Forested Wetlands

PCT: Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion

PCT number: 1232

Other mapping sources: Native Vegetation of the Sydney Metropolitan Area (OEH 2016)

Conservation status: Endangered (BC Act) and listed as *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions*

Extent in the development footprint: About 0.47 hectares

Description

Coastal Freshwater Swamp Forest is located at Rockdale Bicentennial Park, along the drainage line. This community was in a disturbed condition, with a high occurrence of weeds in the understorey. Much of the community is landscaped and there is regular human traffic through the area.

The canopy was dominated by *Casuarina glauca* (Swamp oak) forming an open to dense canopy along a thin strip adjacent to the drainage line. Melaleuca species (paperbarks) were present on occasion, with exotic species dominating the understorey.

Figure 4-12 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion at Rockdale Bicentennial Park with canopy species

4.3.3 Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin

Vegetation formation and class: Coastal Swamp Forest; Forested Wetlands

PCT: Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin

PCT number: 1795

Other mapping sources: Native Vegetation of the Sydney Metropolitan Area (OEH 2016)

Conservation status: Endangered (BC Act) and listed as *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions.* This is not listed under the EPBC Act.

Extent in the development footprint: About 0.30 hectares

Description

The community is likely to have been reconstructed and planted as part of bush regeneration works at Rockdale Bicentennial Park. The canopy was dominated by *Eucalyptus robusta* (Swamp Mahogany) with a subdominant tree layer of *Allocasuarina littoralis* (Swamp oak), *Banksia integrifolia* (Coast Banksia), *Banksia serrata* (Old Man Banksia) and *Pittosporum undulatum* (Sweet Pittosporum). The understorey was predominantly planted native herbs and grasses with a few exotic species. The understorey had obviously been planted as this patch was part of an area subject to bush regeneration. Newer areas of regeneration were located nearby the area sampled. The species present reflect a subset of the species likely to be found in this PCT plus other species that would be native to coastal alluvial flats.

Figure 4-13 Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin

4.3.4 Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline

Vegetation formation and class: Freshwater Wetlands; Coastal Freshwater Lagoons

PCT: Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline

PCT number: 1808

Other mapping sources: Native Vegetation of the Sydney Metropolitan Area (OEH 2016)

Conservation status: Endangered (BC Act) and listed as *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions*

Extent in the development footprint: About 0.77 hectares

Description

To the south of President Avenue, this PCT was present as a treeless vegetation type, along the edges of the drainage line south of President Avenue. The community was in a disturbed condition with a high occurrence of weeds, such as *Rubus fruticosus* (Blackberry) and *Lantana camara* (Lantana).

The reedlands were dominated by *Phragmites australis* (Common Reed) with *Typha orientalis* occurring less frequently. A canopy layer was very sparse and consisted of the occasional low growing *Casuarina glauca* (She Oak) on the banks of the drainage line. This PCT includes areas where the canopy may be absent due to inundation and hydrological cycles.

Figure 4-14 Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline

4.4 Threatened ecological communities

There were two threatened ecological communities present as three PCTs identified in the development footprint. These are described above in **section 4.3** and in **Table 4-5**.

Table 4-5 Threatened Ecological Communities

PCT ID	BC Act			EPBC Act		
	Listing status	Name	Area (ha)	Listing status	Name	Area (ha)
1232	Endangered	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	0.47	Not listed (but nominated however would not meet minimum threshold requirements)	n/a	n/a
1795	Endangered	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	0.30	Not listed	n/a	n/a
1808	Endangered	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	0.77	Not listed (but nominated however would not meet minimum threshold requirements)	n/a	n/a

4.5 Vegetation integrity assessment

A vegetation integrity assessment using the BCC was undertaken and the results are outlined in **Table 4-6**.

Table 4-6 Vegetation integrity

Veg Zone	PCT ID	Condition	Area (ha)	Composition Condition Score	Structure Condition Score	Function Condition Score	Current vegetation integrity score
1	1232	moderate to good	0.47	24.7	27.5	48	32
2	1795	moderate to good	0.30	78	58	63.2	65.9
4	1808	moderate to good	0.77	25.6	15.4	n/a	19.9

4.6 Groundwater dependent ecosystems

Groundwater Dependant Ecosystems (GDEs) are defined as ecosystems whose current species composition, structure and function are reliant on a supply of groundwater in addition to surface water supplies from overland flow paths. The frequency of groundwater influence may range from daily to inter-annually, however it becomes clearly apparent when either the supply of groundwater or its quality (or both) is altered for a sufficient length of time to cause changes in plant function. Groundwater use by an ecological community or individual species does not necessarily imply groundwater dependence.

LEGEND

F6 Extension S1
Construction Boundary
F6 Extension - Stage 1
GDE Study Area
Ecosystems That Rely on Subsurface Presence of Groundwater

Data Sources:
Australian Atlas of Groundwater Dependent Ecosystems(GDE) V 1.0
© Commonwealth of Australia (Bureau of Meteorology) 2012.

Figure 4-15 Groundwater dependent ecosystems

The assessment process followed the steps outlined in the risk assessment guidelines for groundwater dependent ecosystems (NSW DPI 2012). A search of the National GDE Atlas was conducted for the study area (inclusive of the mainline tunnel alignment and its adjacent areas), and the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 was reviewed for high priority GDEs. Potential GDEs were assessed by a GDE expert (Dr Peter Hancock) for their type and level of groundwater dependence, as well as their ecological value (where this was known).

The GDE assessment does not estimate the impacts of the project on groundwater, rather it attempts to estimate and assess the impacts of groundwater extraction on the biodiversity values of GDEs.

A map of the Groundwater Dependent Ecosystems, in relation to the project area is provided in **Figure 4-15**. ELA relied on information available at the time to determine the type and intensity of potential impacts.

In Australia, many ecosystems have a dependence on groundwater, although the full understanding of the role of groundwater in maintaining ecosystems is generally poor. Most wetland communities and many river systems have some degree of dependence on groundwater resources.

GDEs are generally classified into six categories:

- *Terrestrial vegetation* – forests and woodland which develop a permanent or seasonal dependence on groundwater, often by extending roots into the water table
- *Base flow in streams* – aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow
- *Aquifer and cave systems* – aquatic ecosystems that occupy caves or aquifers
- *Wetlands* – aquatic communities and fringing vegetation that depend on groundwater fed lakes and wetlands
- *Estuarine and near shore marine ecosystems* – various ecosystems including mangroves, saltmarsh and seagrass, whose ecological function has some dependence on groundwater discharge
- *Terrestrial fauna* – fauna species assemblages reliant on groundwater for drinking water.

A final category is also recognised ‘not apparently dependant’. This category acknowledges that some ecosystems, particularly wetland and riparian vegetation, might superficially appear to be groundwater dependent while in fact they are dependent entirely on surface flows and or rainfall.

The most likely GDE types in the Sydney region are terrestrial vegetation communities with deep roots that use groundwater, wetlands, and river baseflow systems. The area through which the road corridor passes contains some areas of native vegetation. The *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* identifies potential GDEs in the Greater Metropolitan Region. The map at Appendix 1 of that Plan does not identify any GDEs occurring within the project footprint nor any within the study area for GDEs. However, a search of the GDE Atlas (Bureau of Meteorology 2018) indicated that there are some areas within the study area that have a moderate potential to be dependent on groundwater.

There are areas of vegetation mapped as highly likely to be groundwater dependent at Kogarah Golf Course. Phreatophytic vegetation (vegetation sourcing most of its water from the ground) here could be affected if the water table is lowered to a point beyond the rooting depth.

The Cooks River is also likely to interact with groundwater as an inflow-dependent ecosystem. There are several waterways and lagoons in the Kogarah Golf Course that may have some level of groundwater interaction, but are unlikely to be dependent on this. Likewise, while the Cooks River may receive nutrients and water from the underlying aquifer, the volume of this is likely to be minor compared to tidal and runoff contributions.

There are some small patches of mapped Coastal Freshwater Swamp Forest and Coastal Flats Swamp Mahogany Forest at Rockdale Bicentennial Park, north of President Avenue. These correspond to Swamp Oak floodplain swamp forest and Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin PCTs. These have a moderate potential to be reliant on the subsurface connections to groundwater in the unconsolidated Botany Sandbeds.

5 Threatened Species

5.1 Candidate species

5.1.1 Ecosystem credit species

The BAM requires that a list of threatened species that can be reliably predicted by habitat surrogates are identified. These species are called ecosystem credit species and they are automatically generated based on the PCT, the IBRA subregion of the construction boundary, the cover and patch size of vegetation. The BAM allows an assessor to determine whether any of the habitat components for the predicted threatened species are present or not.

If they are not present, an assessor does not need to identify the ecosystem credit species as being present in the vegetation zone. Where the assessor determines that none of the habitat components are present in a vegetation zone for a predicted threatened species , the species is considered unlikely to occur and no further assessment is required for that species in that vegetation zone. The assessor must record in the BDAR the reasons for determining that a predicted species is unlikely to occur in the vegetation zone.

Where the assessor determines that none of the habitat components are present on the entire development footprint for the threatened species predicted for assessment, the species is considered unlikely to occur and no further assessment is required for that species. The assessor must record in the BDAR the reasons for determining that a predicted species is unlikely to occur on the subject land.

If the species is a vagrant in the IBRA subregion, the species is considered unlikely to occur and no further assessment is required. The assessor must record in the BDAR the reasons for determining that the species is unlikely to occur on the development footprint.

Predictors for the species list (ie PCT, landscape, patch size), are limiting and do not take into account the broader surrounding environment. This project is located in a highly urbanised environment, lacks linking habitat to large areas of high quality habitat, and is already disturbed from several sources (eg light, noise, weeds and human activity). Many of the species generated by the BCC are not known in the area, or to occur within these urban habitats. Professional judgement, ecological experience and knowledge were applied to refine the list and make it more accurate and applicable to the project and development footprint.

5.1.2 Species credit species

Species credit species are typically generated by the BCC based on the PCTs present within the project area, and a series of habitat and geographic location questions within the BCC. Once the list of species credit species is generated, they undergo a second filtering step to determine whether they are filtered into the assessment for consideration as a species credit species.

5.2 Ecosystem credit species

Ecosystem credit species predicted to occur on the development footprint, their associated habitat constraints, geographic limitations and sensitivity to gain class is included in **Table 5-1**.

Table 5-1 Predicted ecosystem credit species

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Act listing status
Anthochaera phrygia	Regent Honeyeater	-	-	High	CE	CE
Botaurus poiciloptilus	Australasian Bittern	-	-	Moderate	E	E
Calidris alba	Sanderling	-	-	High	V	-

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Act listing status
Calidris ferruginea	Curlew Sandpiper	-	-	High	E	CE
Calyptorhynchus lathami	Glossy Black-Cockatoo	-	-	High	V	-
Circus assimilis	Spotted Harrier	-	-	Moderate	V	-
Daphoenositta chrysoptera	Varied Sittella	-	-	Moderate	V	-
Dasyurus maculatus	Spotted-tailed Quoll	-	-	High	V	E
Glossopsitta pusilla	Little Lorikeet	-	-	High	V	-
Haliaeetus leucogaster	White-bellied Sea-eagle	-	-	High	V	-
Hieraaetus morphnoides	Little Eagle	-	-	Moderate	V	-
Ixobrychus flavicollis	Black bittern	-	-	Moderate	V	-
Lathamus discolor	Swift Parrot	-	-	Moderate	E	CE
Limicola falcinellus	Broad-billed Sandpiper	-	-	High	V	-
Limosa limosa	Black-tailed Godwit	-	-	High	V	-
Lophoictinia isura	Square-tailed Kite	-	-	Moderate	V	-
Miniopterus australis	Little Bentwing-bat	-	-	High	V	-
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	-	-	High	V	-
Mormopterus norfolkensis	Eastern Freetail-bat	-	-	High	V	-
Ninox strenua	Powerful Owl	-	-	High	V	-
Pandion cristatus	Eastern Osprey	-	-	Moderate	V	-
Phascolarctos cinereus	Koala	-	-	High	V	V
Pteropus poliocephalus	Grey-headed Flying-fox	-	-	High	V	V
Rostratula australis	Australian Painted Snipe	-	Within 5 km of Homebush Bay	Moderate	E	E
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	-	-	High	V	-

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Act listing status
Scoteanax rueppellii	Greater Broad-nosed Bat	-	-	High	V	-
Tyto novaehollandiae	Masked Owl	-	-	High	V	-
Varanus rosenbergi	Rosenberg's Goanna	-	-	High	V	-
Xenus cinereus	Terek Sandpiper	-	-	High	V	-

Ecosystem credit species which have been excluded from the assessment and relevant justification is included in **Table 5-2**.

Table 5-2 Justification for exclusion of predicted ecosystem credit species

Species	Common Name	Justification for exclusion of species
Anthochaera phrygia	Regent Honeyeater	Vagrant only 1 sighting in Sydney CMA in 20 years (2017 at Homebush of dubious origin). Two records 20 years ago - associated with heavy bushland. Ingleside and Ku-ring-gai Chase National Park
Calidris alba	Sanderling	No habitat in development footprint
Circus assimilis	Spotted Harrier	No known population in the vicinity
Daphoenositta chrysoptera	Varied Sittella	No habitat with suitable complexity in the development footprint
Dasyurus maculatus	Spotted-tailed Quoll	No suitable habitat, highly urbanised area, and never recorded in area
Lathamus discolor	Swift Parrot	Vagrant
Ninox strenua	Powerful Owl	Not in the vicinity, highly urbanised context and unlikely to fly long distances over this fragmented habitat. No habitat present within the development footprint and limited prey habitat present.
Phascolarctos cinereus	Koala	Small area of remnant bushland, isolated from known population in Campbelltown, isolated, many threats such as cats, dogs and vehicles
Tyto novaehollandiae	Masked Owl	Not in the vicinity, highly urbanised context and unlikely to fly long distances over this fragmented habitat
Varanus rosenbergi	Rosenberg's Goanna	No suitable habitat and highly urbanised area, never recorded in area, needs larger stands of vegetation for shelter
Xenus cinereus	Terek Sandpiper	No habitat present (needs mangrove swamp, tidal mudflat and seashore)

5.3 Species credit species

Species credit species predicted to occur by the BCC (ie candidate species), their associated habitat constraints, geographic limitations and sensitivity to gain class is included in **Table 5-3**.

Table 5-3 Candidate species credit species

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC listing status
Anthochaera phrygia (breeding)	Regent Honeyeater	-	-	High	CE	CE
Burhinus grallarius	Bush Stone-curlew	Fallen/standing dead timber including logs	-	High	E	-
Calidris alba (breeding)	Sanderling	-	-	High	V	-
Calidris ferruginea (breeding)	Curlew Sandpiper	-	-	High	E	CE
Callocephalon fimbriatum - endangered population	Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas	-	Hornsby and Ku-ring-gai Local Government Areas	High	E population	-
Calyptorhynchus lathami (breeding)	Glossy Black-Cockatoo	-	-	High	V	-
Cercartetus nanus	Eastern Pygmy-possum	-	-	High	V	-
Chalinolobus dwyeri	Large-eared Pied Bat	Cliffs Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels	-	Very High	V	V
Crinia tinnula	Wallum Froglet	-	Kurnell Penninsula, the margins of Botany Bay	Moderate	V	-
Dasyornis brachypterus	Eastern Bristlebird	-	-	Moderate	E	E
Haliaeetus leucogaster (breeding)	White-bellied Sea-Eagle	-	-	High	V	-

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC listing status
Heleioporus australiacus	Giant Burrowing Frog	-	-	Moderate	V	V
Hieraaetus morphnoides (breeding)	Little Eagle	-	-	Moderate	V	-
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	Other Requires dense ground cover in a variety of habitats	-	High	E	E
Lathamus discolour (breeding)	Swift Parrot	-	-	Moderate	E	CE
Limicola falcinellus (breeding)	Broad-billed Sandpiper	-	-	High	V	-
Limosa limosa (breeding)	Black-tailed Godwit	-	-	High	V	-
Litoria aurea	Green and Golden Bell Frog	Semi-permanent/ephemeral wet areas Within 1km of wet areas|Swamps Within 1km of swamp|Waterbodies Within 1km of waterbody	-	High	E	V
Litoria brevipalmata	Green-thighed Frog	-	-	Moderate	V	-
Lophoictinia isura (breeding)	Square-tailed Kite	-	-	Moderate	V	-
Melaleuca biconvexa	Biconvex Paperbark	Swamps Swamp margins or creek edges	-	High	V	V
Miniopterus australis (breeding)	Little Bentwing-bat	-	-	Very High	V	-
Miniopterus schreibersii oceanensis (breeding)	Eastern Bentwing-bat	-	-	Very High	V	-
Myotis macropus	Southern Myotis	Hollow bearing trees Within 200 m of riparian zone|Other Bridges, caves or artificial structures within 200 m of riparian zone	-	High	V	-

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC listing status
Neophema chrysogaster	Orange-bellied Parrot	-	-	Moderate	CE	CE
Ninox strenua (breeding)	Powerful Owl	-	-	High	V	-
Pandion cristatus (breeding)	Eastern Osprey	-	-	Moderate	V	-
Petaurus norfolcensis	Squirrel Glider	-	-	High	V	-
Phascolarctos cinereus (breeding)	Koala	-	-	High	V	V
Pteropus poliocephalus (breeding)	Grey-headed Flying-fox	-	-	High	V	V
Tyto novaehollandiae (breeding)	Masked Owl	-	-	High	V	-
Wilsonia backhousei	Narrow-leafed Wilsonia	Margins of salt marshes and lakes, both coastal and inland	-	High	V	-
Xenus cinereus	Terek Sandpiper	-	-	High	V	-

5.4 Targeted threatened species surveys

Targeted surveys for species credit species were undertaken at the project footprint on the dates outlined in **Table 5-4**. The location of targeted surveys are shown on **Figure 4-1** to **Figure 4-3** and **Figure 6-1**.

Table 5-4 Targeted surveys

Date	Surveyors	Target species
26 September 2017	Meredith Henderson and Louise Upton	Syzygium paniculatum (Magenta Lilly Pilly) Acacia terminalis subsp. terminalis (Sunshine Wattle)
10 October 2017	Rodney Armistead and Louise Upton	Birds including: Actitis hypoleucos (Common Sandpiper) Ardea ibis (Cattle Egret) Arenaria interpres (Ruddy Turnstone) Botaurus poiciloptilus (Australasian Bittern) Calidris acuminata (Sharp-tailed Sandpiper) Calidris alba (Sanderling) Calidris canutus (Red Knot) Calidris ferruginea (Curlew Sandpiper) Calidris ruficollis (Red-necked Stint) Calidris tenuirostris (Great Knot) Charadrius leschenaultia (Greater Sand-plover) Charadrius mongolus (Lesser Sand-plover) Haematopus fuliginosus (Sooty Oystercatcher) Haematopus longirostris (Pied Oystercatcher) Hirundapus caudacutus (White-throated Needletail) Ixobrychus flavicollis (Black Bittern) Limicola falcinellus (Broad-billed Sandpiper) Limosa lapponica (Bar-tailed Godwit) Limosa limosa (Black-tailed Godwit) Numenius madagascariensis (Eastern Curlew) Pluvialis fulva (Pacific Golden Plover) Sternula albifrons (Little Tern) Tringa incana (Wandering Tattler) Xenus cinereus (Terek Sandpiper)
24 October 2017	Jack Talbert and Louise Upton	As above for bird survey
9 November 2017	Rodney Armistead and Louise Upton	As above for bird survey
21 November 2017	Rodney Armistead and Louise Upton	As above for bird survey
19 December 2017	Rodney Armistead and Louise Upton	As above for bird survey
19 January 2018	Meredith Henderson and Louise Upton	Hollow bearing tree search for microchiropteran bat and large forest owl habitat
14 February 2018	Rodney Armistead	Microchiropteran bats (habitat search), Green and Golden Bell Frog (habitat search)
26 February 2018	Rodney Armistead and Louise Upton	Green and Golden Bell Frog survey
27 February 2018	Rodney Armistead and Louise Upton	Green and Golden Bell Frog survey
14 March 2018	Matthew Dowle and Meredith Henderson	Green and Golden Bell Frog survey

Date	Surveyors	Target species
19 March 2018	Louise Upton and Meredith Henderson	Green and Golden Bell Frog survey
27 March 2018	Rodney Armistead and Louise Upton	Microchiropteran bat survey
28 March 2018	Rodney Armistead and Louise Upton	Microchiropteran bat survey

Weather conditions during the targeted surveys are outlined in **Table 5-5**.

Table 5-5 Weather conditions[1]

Date	Rainfall (mm)	Minimum temperature °C	Maximum temperature °C
26 September 2017	0	12.4	20.6
10 October 2017	0	15.4	22.8
24 October 2017	0	13.7	26.9
9 November 2017	0	12.2	23.0
21 November 2017	0	17.7	23.9
19 December 2017	0	21.1	34.2
19 January 2018	0	17.7	32.0
14 February 2018	0	22.9	40.0
26 February 2018[2]	44	17.0	22.2
27 February 2018	2	17.4	24.8
14 March 2018[2]	4.4	18.4	28.2
19 March 2018	0	21.0	31.0
27 March 2018	0	14.0	24.1
28 March 2018	0	16.9	28.4

Notes:

1 All data from BoM weather station at Sydney Airport (Station number 066037).

2 Rainfall from the previous seven days was over 50 mm as recorded at the Sydney Airport weather station, and thus survey conditions were suitable for Green and Golden Bell Frog survey which was conducted on these dates.

Survey effort undertaken in the development is outlined in **Table 5-6**.

Table 5-6 Survey effort

Method	Habitat (ha)	Total effort	Target species
Parallel transects	7.49	11 hours	Flora
Random meander	7.49	10 hours	Flora
Wetland census	5	10 hours	Birds
Hollow bearing tree survey	7.49	13 hours	Bats, Large Forest Owls
Culvert inspection	2	2 hours	Bats
Wetland census	About 3	12 hours	Frogs
Culvert watching	Less than 1	8 hours	Bats
Echolocation detection	Less than 1	8 hours	Bats

Following completion of targeted surveys, no species credit species were included in the assessment.

The BAM allows assessors to exclude candidate species credit species from the assessment. The species excluded and the rationale is shown in **Table 5-7**.

Table 5-7 Justification for exclusion of candidate species credit species

Species	Common Name	Justification for exclusion of species
Anthochaera phrygia (breeding)	Regent Honeyeater	Site is not breeding area
Burhinus grallarius	Bush Stone-curlew	Lack of habitat within in project area
Calidris alba (breeding)	Sanderling	Site is not breeding area
Calidris ferruginea (breeding)	Curlew Sandpiper	Site is not breeding area
Callocephalon fimbriatum - endangered population	Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas	Not in the correct LGA
Calyptorhynchus lathami (breeding)	Glossy Black-Cockatoo	No breeding habitat present
Cercartetus nanus	Eastern Pygmy-possum	Lack of habitat within in project area
Chalinolobus dwyeri	Large-eared Pied Bat	Lack of habitat within in project area
Crinia tinnula	Wallum Froglet	Lack of habitat in project area and record likely to be incorrect
Dasyornis brachypterus	Eastern Bristlebird	Lack of habitat within in project area
Haliaeetus leucogaster (breeding)	White-bellied Sea-Eagle	No breeding habitat present, no large nests present within the development footprint or construction boundary
Heleioporus australiacus	Giant Burrowing Frog	Lack of habitat within project area
Hieraaetus morphnoides (breeding)	Little Eagle	No breeding habitat present, no nests present within development footprint or construction boundary
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	Lack of habitat within project area
Lathamus discolour (breeding)	Swift Parrot	No breeding habitat present
Limicola falcinellus (breeding)	Broad-billed Sandpiper	No breeding habitat present
Limosa limosa (breeding)	Black-tailed Godwit	No breeding habitat present
Litoria aurea	Green and Golden Bell Frog	Surveys did not detect any frogs within suitable habitat in the assessment area – see discussion in Chapter 6 and Annexure D
Litoria brevipalmata	Green-thighed Frog	Lack of habitat within project area
Lophoictinia isura (breeding)	Square-tailed Kite	No breeding habitat present
Melaleuca biconvexa	Biconvex Paperbark	Not present following survey
Miniopterus australis (breeding)	Little Bentwing-bat	Lack of breeding habitat within project area Not detected during survey
Miniopterus schreibersii oceanensis (breeding)	Eastern Bentwing-bat	Lack of breeding habitat within project area Not detected during survey

Species	Common Name	Justification for exclusion of species
Myotis macropus	Southern Myotis	Habitat is culvert and is not associated with a PCT instead is included in the prescribed biodiversity impacts Not detected during survey
Neophema chrysogaster	Orange-bellied Parrot	Lack of habitat within project area
Ninox strenua (breeding)	Powerful Owl	Lack of breeding habitat (ie suitable hollow bearing trees) within project area
Pandion cristatus (breeding)	Eastern Osprey	Lack of breeding habitat within project area
Petaurus norfolcensis	Squirrel Glider	Lack of habitat within project area
Phascolarctos cinereus (breeding)	Koala	Lack of breeding habitat within project area
Pteropus poliocephalus (breeding)	Grey-headed Flying-fox	No camps present in project area
Tyto novaehollandiae (breeding)	Masked Owl	Lack of breeding habitat (ie suitable hollow bearing trees) in project area
Wilsonia backhousei	Narrow-leafed Wilsonia	Not present following survey
Xenus cinereus	Terek Sandpiper	Lack of suitable habitat in the project area

5.5 Aquatic habitat and threatened species

The aquatic environment includes the intertidal and subtidal ecosystem of the estuary, freshwater streams, their bed and banks, and fringing vegetation.

5.5.1 Aquatic assessment methodology

A desktop review of threatened species considered a broad context for mobile aquatic species in estuarine waters. Traditionally a 10 kilometre radius search is used, however, a larger search area is suitable where connectivity is possible (eg water or vegetation corridors) or when flora/fauna surveys are historically limited or difficult (eg underwater). The following databases and online searches were reviewed for an area encompassing all of Botany Bay and its freshwater tributaries:

- EPBC Act – Protected Matters Search Tool
- BC Act – Threatened Species Search Tool (BioNet)
- FM Act – Listed protected and threatened species and populations, including species profiles, 'Primefact' publications and expected distribution maps (Riches et al 2016)
- Online Zoological Collections of Australian Museums (OZCAM).

This desktop assessment helped determine the likelihood of occurrence for listed species, populations and communities. Strictly terrestrial species were filtered from the results, with focus given to fish, sharks, rays, aquatic mammals, aquatic reptiles, and pelagic birds. Other populations filtered out are those with defined geographic boundaries outside of the study area. Frogs and migratory birds are discussed in the terrestrial chapters of this report.

Following the desktop assessment, survey was conducted at Rockdale Bicentennial Park, Cooks River and Muddy Creek on 23 January 2018.

5.5.2 Aquatic results

Desktop assessment

Database searches returned a result of 108 threatened species, populations and ecological communities related to freshwater or estuarine habitat. This included fish, sharks, rays, turtles, marine mammals, frogs, saltmarsh and seagrass. Frogs and wetland, shore and migratory birds are discussed in the terrestrial chapters of this report. A refined review of known locations, expected distribution maps and habitat requirements narrowed this list further in preparation for a site visit. Other protected flora and fauna listed under the FM Act were assessed for their likelihood of occurrence, such as marine vegetation (macroalgae, seagrass, mangroves and saltmarsh) and fish (certain sharks, finfish and seahorses).

Existing environment

The site visit targeted four distinct habitat types and locations (**Figure 5-1** and **Figure 5-2**) which are described in the sections below

Waterway through Rockdale Bicentennial Park

This 30 metre wide artificial pond extended 500 metres north of President Ave. The pond receives stormwater discharge from several large pipe culverts and the water level is regulated by a small weir at President Avenue. Riparian vegetation was a dense cover of native trees with scattered shrubs and groundcovers. Dense weeds, such as *Lantana camara* (Lantana) and *Erythrina crista-galli* (Cockspur Coral Tree), occurred in patches, and there was evidence of recent weed control. Banks were steep with exposed soil, rocky rubble and building waste (eg bricks). Two long and narrow islands hugged the eastern side of the pond, one in the northern half and one in the southern half. A thin band of sedges was growing along the shallow margins, with water depth likely inhibiting their spread towards the centre.

Water quality appeared variable across three test spots, possibly influenced by algal growth and waterbird activity. For example, water quality was more turbid (28 Nephelometric Turbidity Unit (NTU)) near the central footbridge where people feed the waterbirds. Swimming action disturbs the soft substrate causing upwelling of suspended solids in the water column. This then blocks sunlight and inhibits plant growth, leading to lower dissolved oxygen concentration (18 per cent saturation). A high density of birds would also increase nutrient and organic input through faecal matter.

Conversely, water was clearer away from the bridge (15 NTU) where a dense cover of filamentous algae and floating *Lemna* spp. (Duckweed) occurred. The presence of these species suggests a source of high nutrient concentrations feeding the system. Here, aquatic plant growth would increase dissolved oxygen concentrations (83-101 per cent saturation) during the day via photosynthesis, but result in a rapid drop in dissolved oxygen concentration overnight when oxygen-consuming bacteria break down detritus. Such variation in dissolved oxygen concentrations are unfavourable to fish, especially when concentrations are lowest just before sunrise, but given the large pond size there may be patches of habitat suitable for fish survival. The presence of piscivorous bird species (fish eaters) suggests fish were present. Salinity was low (freshwater) and similar at three test sites (average 0.1 ppt). The pH was variable, from neutral (7.24 near the footbridge) to acidic (9.08 near President Avenue). This reach is not mapped as Key Fish Habitat (KFH) by DPI Fisheries.

LEGEND

F6 Extension S1

- Construction Boundary
- Development Footprint
- Assessment Area
- GPS Tracks
- Estuarine Saltmarsh (ELA 2018)

Figure 5-1 Aquatic habitat assessment

LEGEND

F6 Extension S1

- Construction Boundary
- Development Footprint
- Assessment Area
- F6 Extension - Stage 1
- GPS Tracks
- Coastal Freshwater Swamp Forest (PCT 1232)
- Estuarine Reedland (PCT 1808)

Figure 5-2 Aquatic habitat assessment at Scarborough Park North

Waterway entering Scarborough Park North

This narrow (10 metre) waterway was directly downstream of President Avenue and received water spilled over the Rockdale Bicentennial Park weir. The channel was extremely shallow with a thick sediment deposition. Riparian vegetation consisted of dense reedland of *Typha orientalis* (Typha) and *Phragmites australis* (Common Reed) which extended westward of the channel, while the eastern bank supported scattered *Casuarina glauca* (She Oak) trees. A 'Bandalong' style litter trap was located close to President Avenue. Dissolved oxygen concentration was poor (7 per cent saturation) and unlikely to support fish life. Salinity was high (22 ppt), indicating saline input from groundwater (no tidal influence was observed). This waterway extended south for about 2 kilometres before entering a stormwater culvert beneath Ramsgate. The southern portion of the system (from about 800 metres south of President Avenue) is mapped as Key Fish Habitat by DPI Fisheries.

Muddy Creek upstream of Bestic Street

This waterway was a wide (14 metre) concrete-lined channel. The northern portion was tidal, indicated by the presence of saltmarsh and mangroves (discussed below). The southern half towards West Botany Road was freshwater, with occasional spring tide influence. The channel was fully lined on its beds and banks with concrete for two kilometres upstream of West Botany Road and natural downstream of Bestic Street. The downstream portion had a narrow band of mangroves and modified embankments.

A school of juvenile *Mugil cephalus* (Sea Mullet) were observed in the freshwater reach. Riparian vegetation included high impact weeds such as *Juncus acutus* (Sharp Rush) at the southern extent of the saltmarsh. Two small drainage lines entered the channel from the south. One was a narrow mangrove forest originating from a stormwater culvert at Cairnsfoot Special School. The other was west of the football field, comprised of mown lawn and reeds (*Phragmites australis*). Both were modified drainage lines constrained by public parkland. The tidal portion of this concrete channel is mapped as Key Fish Habitat by DPI Fisheries, starting 260 metres south of Bestic Street.

Cooks River near Kogarah Golf Course

This channel was wide (145 metres) with seawalls on both banks. No mangroves or saltmarsh have established in these disturbed conditions. Common marine molluscs inhabited the sloping stone seawall. An underwater survey (video camera on 5 metre pole) found rock rubble, oysters, coarse sand/gravel and fine woody debris in the subtidal zone. No seagrass or macroalgae was observed within 5 metres of the bank. Four small stormwater culverts flow into the river within the study area. A sewage outlet is located near a utility bridge (over the M5 East tunnel), which was flowing at the time of survey (outgoing tide). With the exception of material released from the outfall, the river had reasonable water clarity, indicating good tidal flushing. A large number of *Girella tricuspidata* (Luderick) were active near the sewer outlet. This river is mapped as Key Fish Habitat by DPI Fisheries.

Summary

No threatened aquatic species or populations were observed at these four locations, and none were considered likely to depend on the habitat for survival. Within the study area, there is no valuable or specific habitat capable of supporting threatened aquatic/estuarine species or populations. At the Cooks River, it is possible some species may opportunistically pass through the area given the connectivity to the broader bay and coastal habitats, but they are unlikely to depend on habitat within the site for their survival.

One threatened aquatic ecological community occurred along Muddy Creek (**Figure 5-1**), where Coastal Saltmarsh has established above the concrete-lined drain. The estuarine water here appears to overtop the channel during the highest tidal cycle. A narrow (1-2 metres) sandy flat supports several saltmarsh species, such as *Atriplex* sp., *Sarcocornia quinqueflora* (Samphire), *Suaeda australis* (Austral seablite) and *Tetragonia tetragonioides* (Native spinach).

Protected aquatic flora listed under the FM Act was observed at Muddy Creek, with saltmarsh and *Avicennia marina* (Grey Mangrove) growing in the intertidal zone. This marine vegetation was growing under disturbed conditions forming a patchy or narrow strip. Although these types of marine vegetation provide important functions in an estuary, their value and potential to expand on site is reduced by past development, concrete-lined channels and seawalls. No marine vegetation was observed at Cooks River within 5 metres of the waterline.

Protected aquatic fauna listed under the FM Act are unlikely to occur in the study area, due to lack of suitable habitat, such as rocky reefs, deep water and dense seagrass or macroalgae.

5.6 Use of local data

No local data is proposed to be used for this project.

5.7 Expert reports

No expert reports are proposed for this project.

6 Matters of National Environmental Significance

The following MNES protected under the EPBC Act were considered for their relevance in regards to the project:

- World Heritage Properties (sections 12 and 12A)
- National Heritage Places (sections 15B and 15C)
- wetlands of international importance (sections 16 and 17B)
- listed threatened species and communities (sections 18 and 18A)
- listed migratory species (sections 20 and 20A)
- Commonwealth land (for actions outside Commonwealth Land that may impact on the environment on Commonwealth Land) (section 26 and 27A).

Of these, only listed threatened and migratory species were considered relevant for this report.

6.1 Threatened species

The project area is considered to contain potential habitat for the following threatened species:

- *Litoria aurea* (Green and Golden Bell Frog)
- *Pteropus poliocephalus* (Grey-headed Flying Fox)
- *Syzygium paniculatum* (Magenta Lilly Pilly).

6.1.1 Green and Golden Bell Frog

The Arncliffe population of Green and Golden Bell Frog, prior to the construction of the M5 East Motorway, was centred on the Marsh Street Wetland. With the construction of the M5 East Motorway, impacts to the Marsh Street Wetland precipitated the construction of the 'RTA Ponds'. The 'RTA Ponds' were purpose built breeding ponds for Green and Golden Bell Frog and were constructed located along Marsh Street, adjacent to the Southern and Western Sydney Ocean Outfall System (SWSOOS) and the Kogarah Golf Course (**Figure 6-1**). The Green and Golden Bell Frog population in and at the RTA Ponds and Kogarah Golf Course was monitored annually from 2003 to 2015 (Biosphere Environmental Consulting 2003-2015).

The population was considered stable up to April 2015, after which the population has been in decline. The decline has been attributed to poor climatic conditions and potentially due to predation (Biosphere 2017).

In 2016 the New M5 Motorway was approved for construction, which included a construction ancillary facility within Kogarah Golf Course, adjacent to the RTA Ponds. Part of the approval for the New M5 Motorway was the development of management plans including the requirement to establish an insurance population of Green and Golden Bell Frog in captivity. A total of 18 adult frogs were captured between 2016 and 2017 and transferred to the captive breeding facility. New habitat ponds are currently being established at Marsh Street to mitigate impacts of the New M5 Motorway project on this population.

The monitoring of this population between the commencement of the construction of the New M5 Motorway to now has revealed that the frogs do not appear to be using the RTA ponds as breeding habitat (Biosphere Environmental 2015, 2016, 2017).

Green and Golden Bell Frog individuals were identified in the vicinity of the RTA Ponds and Kogarah Golf Course between November 2016 and March 2017 near a detention basin at Barton Park, south of the SWSOOS, Kogarah Golf Course and RTA Ponds. Eight adults were observed (White, pers. comm. 2017). Two of these adults were taken as part of the captive breeding program for the New M5 Motorway project.

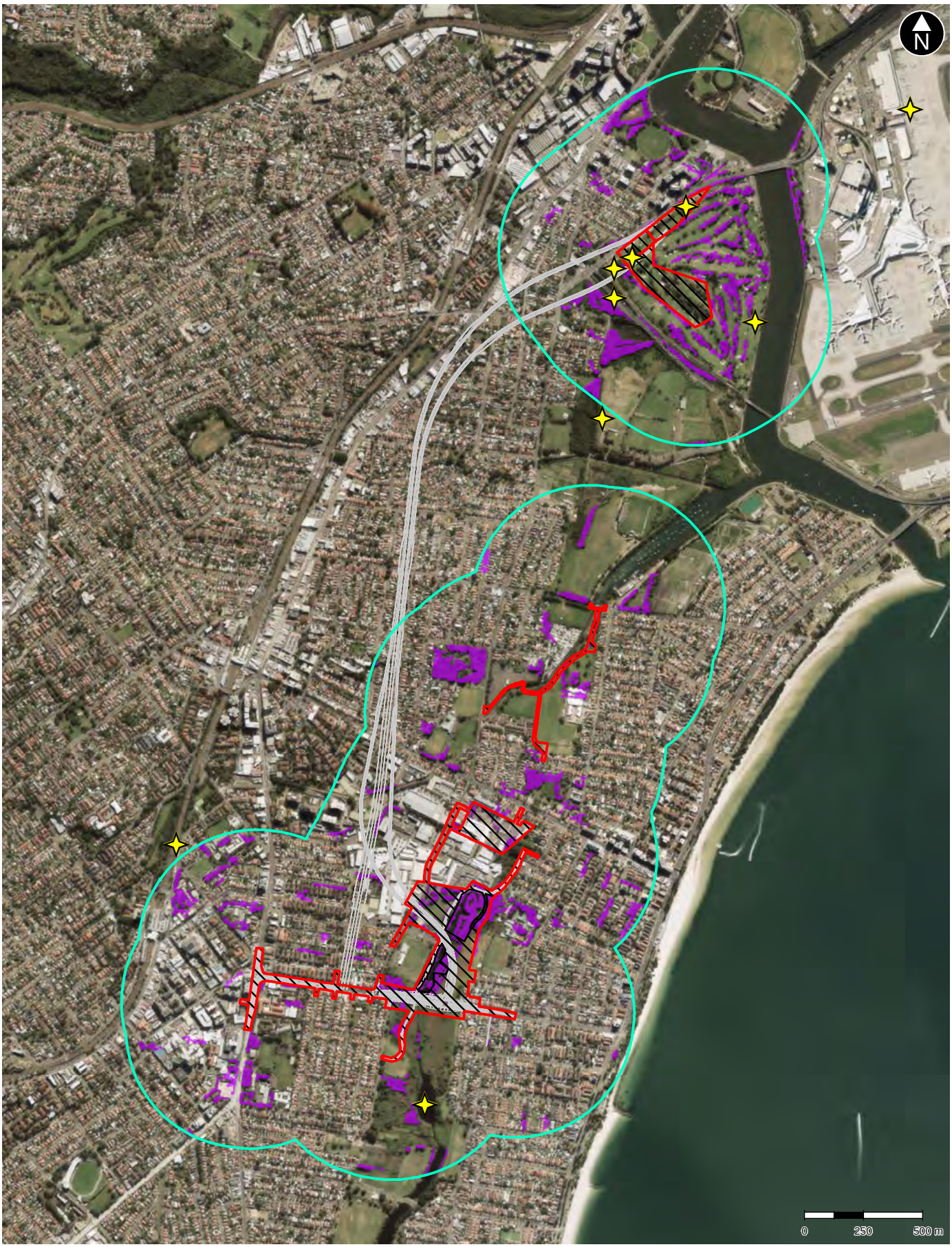
Targeted surveys for this species were conducted in February 2018, following 50 millimetres of rainfall at the Sydney Airport. The survey area covered the lands adjacent to the Arncliffe construction ancillary facility, Barton Park, the Kogarah Golf Course and the RTA Ponds. A follow up survey was conducted in March 2018 at the RTA Ponds, the Kogarah Golf Course, lands adjacent to the Arncliffe construction ancillary facility, Barton Park and Scarborough Park North. These surveys did not detect any Green and Golden Bell Frogs, despite other species of frog being present.

Subsequent to these surveys, one adult Green and Golden Bell Frog was found by another survey team on the evening of 23 March 2018 (A. White pers. comm.). This frog was seen, but not captured. It was found on the Kogarah Golf Course in a small area with Estuarine Mangrove vegetation. This area is about 260 metres from the proposed Arncliffe construction ancillary facility (C1).

Figure 6-1 Green and Golden Bell Frog records and habitat

6.1.2 Grey-headed Flying Fox

The project contains potential foraging habitat for *Pteropus poliocephalus* (Grey-headed Flying Fox). The potential foraging habitat is at Rockdale Bicentennial Park and on the Kogarah Golf Course where there are numerous planted *Melaleuca quinquenervia*, *Ficus hillii*, *Eucalyptus robusta* and *Eucalyptus botryoides* x *saligna* among other potential food sources (**Figure 6-2**). No breeding camps occur within the project area, however there is a large, Nationally Important camp at Turrella, which is close to the project area (3 kilometres north-west). Due to the surface works at the Rockdale construction ancillary facility, the proposed action would affect potential foraging habitat, but would not affect any breeding camp.



LEGEND

F6 Extension S1

Construction Boundary

Development Footprint

Assessment Area

F6 Extension - Stage 1

Grey-headed Flying-fox Records (OEH 2018)

Potential Grey-headed Flying Fox Habitat

Figure 6-2 Grey-headed Flying Fox records and habitat

6.1.3 Magenta Lilly Pilly

The project area contains planted *Syzygium paniculatum* (Magenta Lilly Pilly). About 20 adult individuals were recorded at Rockdale Bicentennial Park in landscape plantings (**Figure 6-3**). These adult plants were not fruiting or flowering and their origins are unknown.

While the plants present are within the natural range of this species, this site is not known as part of the natural populations of the species. Surface works at Rockdale Bicentennial Park would affect some of these planted individuals.

LEGEND

F6 Extension S1

Construction Boundary

C3 - President Avenue construction ancillary facility

Development Footprint

Assessment Area

Lilly Pilly (*Syzygium paniculatum*)

Figure 6-3 Magenta Lilly Pilly records

6.2 Migratory species

The project would largely be constructed as tunnels, which affect groundwater. While there were no wetlands within the construction boundary likely to provide habitat, the project was considered to potentially indirectly affect the Landing Lights wetland, which has historically provided habitat for the following migratory species:

- *Calidris acuminata* (Sharptailed Sandpiper)
- *Calidris ferruginea* (Curlew sandpiper)
- *Limosa limosa* (Black-tailed Godwit)
- *Xenus cinereus* (Terek Sandpiper).

For migratory birds, the impacts are unlikely to be significant. The migratory species occasionally visit the Landing Lights Wetland (nearby to the proposed action), preferring to use the resources at Towra Point wetland and Shell Point Botany Bay. These species do not breed in Australia. They migrate south for the southern summer, using wetlands, shores and exposed mudflats for foraging. Surveys conducted between October and December 2017 did not record any EPBC Act listed migratory species. Publicly available data from Bayside Council also revealed that between April 2016 and June 2017, no EPBC Act migratory species were recorded from the wetland (Bayside Council 2018).

Landing Lights wetland (shown on **Figure 3-3**) is generally tidal influenced and subject to overland flows. Anecdotally, this wetland is also known to occasionally dry out, possibly due to a lack of both rainfall and high tides.

7 Avoid and minimise impacts

7.1 Avoiding impacts

7.1.1 Locating a project to avoid and minimise impacts on vegetation and habitat

The majority of the project is tunnels. Preliminary documentation and identification of site constraints in 2016 helped inform the proposed design, which has avoided some areas of native vegetation. By using tunnels, the proposed development has largely avoided impacts to biodiversity values along the majority of the route.

The proposed Arncliffe construction ancillary facility (C1) is already occupied by the New M5 Motorway construction ancillary facility. Rather than affecting additional areas, the F6 Extension project would utilise the areas already cleared for construction by the New M5 Motorway project. By using the existing construction compound, there are fewer impacts than would be expected from using an undeveloped site. This would include reduction in construction noise, vibration dust and light spill (see **Table 7-1**).

The proposed tunnels are distant from potentially sensitive wetlands. This minimises the potential indirect impacts to migratory bird habitat at the Landing Lights wetland and habitat at Eve Street wetland.

The development has been located in a way which avoids and minimises impacts as outlined in **Table 7-1**, particularly considering the small area of native vegetation to be affected.

Table 7-1 Locating a project to avoid and minimise impacts on vegetation and habitat

Approach	How addressed	Justification
Locating the project in areas where there are no biodiversity values	Tunnel along majority of route	The project is mostly underground tunnels which avoids surface impacts. The gazetted surface area for the existing motorway corridor is 16.73 hectares The proposed surface impact area is inside the gazetted corridor is 5.89 hectares but avoids open space at Eve Street wetland, Barton Park, Spring Street wetlands, Landing Lights wetland, and land between Bestic and Bay Streets Building noise would be reduced compared with New M5 Motorway because this project would make use of an already constructed building within the proposed Arncliffe construction ancillary facility
Reducing light impacts	Re-use of areas already constructed	Potential impacts arising from light spill would be reduced at the Arncliffe construction ancillary facility because floodlighting would not be required to construct the ancillary buildings
Reducing noise, dust and vibration impacts	Re-use of areas already constructed	Potential impacts arising from noise, dust and vibration would be reduced at the Arncliffe construction ancillary facility because the ancillary facilities are already constructed Truck movements at Arncliffe would be fewer than New M5 Motorway project because spoil would be hauled from southern end of constructed tunnels

Approach	How addressed	Justification
Locating the project in areas where the native vegetation or threatened species habitat is in the poorest condition	Reuse of areas already cleared	The Arncliffe construction ancillary facility is to be used as part of this project. It was previously considered Green and Golden Bell Frog habitat and has been cleared as part of the New M5 Motorway project. This habitat is no longer present within the Arncliffe construction ancillary facility.
	Siting of water treatment plant	A water treatment plant was proposed for an area adjacent to the Cooks River and near recent Green and Golden Bell Frog records. This project element was revised and removed from this area. The water treatment plant would make use of an already cleared area at the Arncliffe construction ancillary facility.
Locating the project in areas that avoid habitat for species and vegetation in high threat categories (e.g. an EEC or CEEC), indicated by the biodiversity risk weighting for a species	Reuse of areas already cleared	The Arncliffe construction ancillary facility is to be used as part of this project. It was previously considered Green and Golden Bell Frog habitat was cleared as part of the New M5 Motorway project. This habitat is no longer present within the Arncliffe construction ancillary facility.
	Avoid tracts of EEC	By being tunnel, the project has avoided areas of EEC between the Arncliffe construction ancillary facility and the Rockdale construction ancillary facility.
Locating the project such that connectivity enabling movement of species and genetic material between areas of adjacent or nearby habitat is maintained	Siting of water treatment plant	An earlier iteration of the design included a water treatment plant near the bank of the Cooks River at Barton Park. This location at Barton Park is in the vicinity of recent observations of Green and Golden Bell Frog. The plan was revised to determine if an area within the Arncliffe construction ancillary facility could be used for the treatment plant. The location of the water treatment plant has been moved to the already disturbed Arncliffe construction ancillary facility. This change in design has resulted in avoiding an area that could have affected dispersal habitat for the Green and Golden Bell Frog.

7.1.2 Designing a project to avoid and minimise impacts on vegetation and habitat

The development has been designed in a way which avoids and minimises impacts as outlined in **Table 7-2**.

Table 7-2 Designing a project to avoid and minimise impacts on vegetation and habitat

Approach	How addressed	Justification
Reducing the clearing footprint of the project	Tunnel along majority of route	The project is mostly tunnels which avoids surface impacts
Locating ancillary facilities in areas where there are no biodiversity values	Tunnel along majority of route	The project is mostly tunnels which avoids surface impacts

Approach	How addressed	Justification
Locating ancillary facilities in areas where the native vegetation or threatened species habitat is in the poorest condition (i.e. areas that have a lower vegetation integrity score)	Reuse of areas already cleared	The Arncliffe construction ancillary facility is to be used as part of this project. It was previously considered Green and Golden Bell Frog habitat and has been cleared as part of the New M5 Motorway project. Green and Golden Bell Frog habitat is no longer present in the footprint of the Arncliffe construction ancillary facility.
Locating ancillary facilities in areas that avoid habitat for species and vegetation in high threat status categories (e.g. an EEC or CEEC)	Reuse of areas already cleared	The Arncliffe construction ancillary facility is to be used as part of this project. It was previously considered Green and Golden Bell Frog habitat and has been cleared as part of the New M5 Motorway project. This habitat is no longer present within the footprint of the Arncliffe construction ancillary facility.
	Siting of water treatment plant	A water treatment plant was proposed for an area adjacent to the Cooks River and near recent Green and Golden Bell Frog records. This project element was revised and removed from this area. The water treatment plant would, under the revised plan, make use of an already cleared area at the Arncliffe construction ancillary facility.
Making provision for the demarcation, ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat on the development footprint.	Standard mitigation measures	Demarcation of areas of native vegetation retained would limit accidental incursions and raise the profile of the nature of these areas. There would be opportunities to rehabilitate areas where cut and cover construction methods are used at the Rockdale construction ancillary facility.
Minimising potential impacts on threatened bat habitat in the culvert underneath President Avenue at Rockdale	Standard fauna mitigation measures	Standard measures consistent with Roads and Traffic Authority Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects would be implemented. Measures would include pre-clearance surveys, daily surveys, timing works to avoid critical life cycle events such as breeding.

8 Impact assessment

8.1 Direct impacts

The project would have direct impacts on a range of biodiversity values. These impacts are summarised in the following:

- Native vegetation affected during construction and operation are outlined in **Table 8-1**
- Threatened ecological communities affected during construction and operation are outlined in **Table 8-2**
- Threatened species and threatened species habitat affected during construction and operation is outlined in **Table 8-3**
- Prescribed biodiversity impacts is outlined in **section 8.2**.

Direct impacts including the final project footprint (construction and operation) are shown on **Figure 8-1**.

Table 8-1 Direct impacts to native vegetation

PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Direct Impact (ha)
1232	Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Coastal Swamp Forest	Forested Wetlands	0.47
1795	Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Coastal Swamp Forest	Forested Wetlands	0.30
1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	Coastal Freshwater Lagoons	Freshwater Wetlands	0.77

Table 8-2 Direct impacts on threatened ecological communities

PCT ID	BC Act			EPBC Act
	Listing Status	Name	Direct impact (ha)	Listing status
1232	Endangered	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	0.47	Not listed (but nominated however unlikely to meet minimum threshold requirements)
1795	Endangered	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	0.30	Not listed
1808	Endangered	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	0.77	Not listed (not considered part of the nominated community because no Casuarina glauca canopy present)

Table 8-3 Direct impacts on threatened species and threatened species habitat

Species	Common Name	Direct impact habitat (ha)	BC Act listing status	EPBC Act listing status
Pteropus poliocephalus (foraging)	Grey-headed Flying Fox	4.45	Vulnerable	Vulnerable

8.1.1 Change in vegetation integrity

The change in vegetation integrity measures the changes between the current and future condition scores, based on the plots in each vegetation zone. For vegetation that will be completely removed, the future integrity score is zero (**Table 8-4**).

Table 8-4 Change in vegetation integrity

Veg Zone	PCT ID	Condition	Area (ha)	Current vegetation integrity score	Future vegetation integrity score	Change in vegetation integrity
1	1232	Moderate to good	0.47	32	0	32
2	1795	Moderate to good	0.30	65.9	0	65.9
3	1808	Moderate to good	0.77	19.9	0	19.9

LEGEND

F6 Extension S1

- Construction Boundary
- Development Footprint
- Operational Footprint
- Assessment Area
- F6 Extension - Stage 1

Figure 8-1 Final project footprint

8.2 Prescribed biodiversity impacts

8.2.1 Non-native vegetation and human made structures

The project would affect non-native vegetation at the Rockdale construction ancillary facility during construction and operation (**Table 8-5**). The non-native vegetation is comprised of parks containing exotic managed grassland and planted mature trees and shrubs. This vegetation is potential foraging habitat for the Grey-headed Flying Fox. The impacts would occur during construction with the vegetation being removed to allow for the proposed cut and cover tunnel and associated activities. While there would be an opportunity to rehabilitate the cut and cover areas following construction, there would be a lag in the time that the vegetation would reach maturity.

There is potential microbat habitat present as culverts under President Avenue where the unnamed waterway is conveyed from Rockdale Bicentennial Park to Scarborough Park North and pipes entering the unnamed waterway. The culvert is a concrete, single box construction. During construction of the project, this culverts would be affected directly, and indirectly during operation by noise, light and vibration.

Table 8-5 Prescribed impacts associated with the removal of non-native vegetation

Species or ecological community affected	Non-native vegetation or human made structure with potential to be habitat	Nature, extent and duration of long and short-term impacts due to removal of non-native vegetation	Importance within the bioregion of the habitat of these species	Consequence of the impacts for the local and bioregional persistence
Pteropus poliocephalus (Grey-headed Flying Fox)	Parkland trees at Rockdale construction ancillary facility	The vegetation would be removed during construction Vegetation removal would be a short term impact with the proposal to increase habitat through planting species suitable for foraging habitat	The national Recovery Plan for this species states that important habitat includes any foraging habitat within 50 km of a camp that has sustained more than 30,000 individuals The area subject to the proposed action is about 10 km south-west of a long-term camp at Centennial Park. This camp has supported between 16,000 and 49,000 individuals since November 2016 The total area impacted on by the project would be about 4.45 hectares There is about 41.9 hectares of foraging habitat within the 500 metre buffer area This is a small proportion of habitat in the bioregion	The species exists as a dynamic single population which utilises a range of habitats along the Australian east coast The impacts on removal of non-native vegetation are anticipated to be small relative to the available habitat for this species The vegetation removal is not likely to result in the long term decrease of the species in the local area (considered to include the camp at Turrella) or within the bioregion

Species or ecological community affected	Non-native vegetation or human made structure with potential to be habitat	Nature, extent and duration of long and short-term impacts due to removal of non-native vegetation	Importance within the bioregion of the habitat of these species	Consequence of the impacts for the local and bioregional persistence
Myotis macropus	Culverts and pipes within the Rockdale construction ancillary facility	The pipes and culvert would be disturbed by construction noise, dust, light and vibration Light, dust and vibration would be a short term impact during the construction period only Noise would continue to be present during operation of the motorway due to increased traffic movement close to the pipes and culvert	This species is known to occupy a range of resources in the Sydney region. A study by Gonsalves and Law (2017) showed that in Port Jackson, it was widely distributed, being present at about 93% of the 56 sites sampled. While it was present in a large number of sites, feeding was concentrated around a few key locations. Most of the sites associated with the presence of this species were associated with mangrove and seagrass cover and negatively associated with total suspended solids. The culverts and surrounding habitat at the Rockdale Bicentennial Park are of low quality, have high turbidity with neither seagrass nor mangrove plants present. Given this, the culverts are unlikely to be a key habitat for this species in the bioregion. This species was not detected during survey at the President Avenue construction ancillary facility.	Impacts on the culvert at President Avenue are unlikely to be of great consequence to the species bioregional persistence, given the low quality of the habitat and the presence of the species in Port Jackson and other coastal lagoon locations. Locally, there are several culverts at Princes Highway, Bay Street, West Botany Street and Bestic Street, all conveying water along Muddy Creek. South from the project would be culverts under Barton Street, Ramsgate Road and Ferry Street. The Gonsalves and Law (2017) study showed that roosting fidelity was high for one area (west Harbour). Where urbanisation was high, activity levels were low. It is expected given the high urbanisation, and number of culverts near the project, the consequences of impacts on this culvert would not be high. Appropriate mitigation measures would be applied to reduce potential impacts on this species.

8.3 Indirect impacts

8.3.1 Changes to hydrology

The F6 Extension Stage 1: Surface Water and Flooding Assessment (AECOM, 2018) (Appendix 18, EIS) states that 'no adverse cumulative surface water quality impacts are anticipated with implementation of appropriate management measures as part of the project and the residual risk to the environment would be low'.

Therefore, the project is unlikely to affect present surface or groundwater hydrology, given the lack of major rivers or streams altered within the project footprint. The waterway running through the Rockdale Bicentennial Park is a minor tributary of Botany Bay, and is highly modified, consisting of a constructed urban stormwater pond. There is a low potential for permanent impact to occur on this waterway from the project, taking into account the proposed rehabilitation. Dissecting this pond during cut and cover construction would temporarily reduce water circulation (eg wind and inflow movement) and obstruct local fish passage (discussed below).

Muddy Creek, which is a tributary of the Cooks River, is adjacent to works for the shared cycle and pedestrian pathways north of Rockdale. Muddy Creek is a concrete lined channel with a narrow band of saltmarsh, and would not be directly affected by the project though there is potential for minor indirect impacts to surface flows during operation due to a small increase in impervious surface area.

8.3.2 Edge effects on adjacent native vegetation and habitat

Edge effects on native vegetation are considered likely to occur as a result of the works during construction and operation. At the President Avenue construction ancillary facility, there would be native vegetation remaining south of President Avenue in the area dominated by Common Reedlands (PCT1808). The reedlands retained would potentially be subject to increased light and weed invasion because of the project. These impacts would operate during construction and operation. Only a small area of reedlands are proposed to be cleared (about 0.77 hectares) and about 10 hectares would remain. These indirect impacts would be limited through the implementation of relevant mitigation measures (see **Chapter 9**).

Habitat for native species includes non-remnant vegetation (such as planted street trees and exotic species), which was recorded adjacent to the site. Edge effects on these areas are likely to occur, but would be limited through the implementation of relevant mitigation measures.

8.3.3 Injury and mortality of fauna

Fauna injury or mortality could occur as a result of the construction and operation of the project.

During the construction of the project, injury or mortality to fauna may occur as a result of direct collision with vehicles and equipment within construction compounds. Some mobile species may be able to move away quickly and easily, such as some birds. However, other less mobile species, or those which have high fidelity with their home range, may be slower to move away or may not relocate at all, potentially resulting in injury or mortality of the individual.

During construction works at the President Avenue construction ancillary facility, there is a possibility that Grey-headed Flying-fox may be injured or stressed due to disturbances associated with noise, dust or light. Direct mortality is unlikely. Individuals are likely to actively avoid the area during works and therefore the risk to fauna would be low.

The project may potentially result in some injury or mortality of some common peri-urban fauna species. However, the project is unlikely to cause a substantial increase in fauna injury or mortality incidents as the majority of the route alignment occurs underground. Where ancillary infrastructure or construction compounds occur, the surrounding land is highly urbanised. Implementation of mitigation measures would reduce the chances or injury or mortality of fauna during construction. Actions such as fauna rescue and relocation during dewatering and bunding of the waterway in the President Avenue construction ancillary facility would reduce potential injury to aquatic fauna (e.g. Eastern Long-necked Turtle). Mortality of fish and turtles are expected to be minimised through standard rescue and release protocols. Fencing or other appropriate separation mechanisms would be used during the operation of the project which would minimise terrestrial fauna from entering the motorway, however no one measure would completely eliminate the risk of vehicle strike during operation.

8.3.4 Invasion and spread of weeds

Weeds were frequently encountered within the study area with some areas supporting weed infestations, particularly the Rockdale Bicentennial Park. Listed and environmental weeds recorded within the study area during the survey period are identified in **Table 8-6**. The table also lists those species considered as high threat exotic species by the BAM. These plants are high threat if they are not controlled and will outcompete native plants. These species would be controlled as part of the standard mitigation measures for the project. Unless otherwise noted, all species have a general biosecurity duty under the *Biosecurity Act 2015*.

Table 8-6 Listed and environmental weeds recorded in the study area

Scientific name	Common name	WoNS	High threat exotic
Anredera cordifolia	Madeira Vine	Yes	Yes
Araujia sericifera	Moth Vine		Yes
Bidens pilosa	Cobbler's Pegs		Yes
Cestrum parqui [R]	Green Cestrum		Yes
Chrysanthemoides monilifera subsp. rotundata [+]	Bitou Bush	Yes	Yes
Cinnamomum camphora	Camphor Laurel		Yes
Conyza bonariensis	Fleabane		
Ehrharta erecta	Panic Veldt Grass		Yes
Erythrina crista-galli	Cockspur Coral		Yes
Foeniculum vulgare	Fennel		
Hydrocotyle bonariensis			
Ipomoea alba	A Morning Glory		Yes
Lantana camara	Lantana	Yes	Yes
Ochna serrulata	Mickey Mouse Bush		Yes
Parietaria judaica	Asthma Weed		
Paronychia brasiliana			
Pennisetum clandestinum	Kikuyu		
Ricinus communis	Castor Oil Plant		Yes
Rubus fruticosus sp. agg.	Blackberry	Yes	Yes
Rumex crispus	A Dock		
Tradescantia fluminensis	Trad		Yes

Notes: 'R' denotes plant subject to regional recommended measure for the Greater Sydney Local Land Services Area

'+' denotes that the whole of NSW Biosecurity Zone applies to this species

8.3.5 Invasion and spread of pests

Given the study area is disturbed and within a highly urbanised setting it is highly likely that animal pests would be present within the study area. The following species were recorded during field surveys:

- European Red Fox (*Vulpes vulpes*)
- European Rabbit (*Oryctolagus cuniculus*)
- Common Myna (*Acridotheres tristis*).

While not recorded during field surveys, feral cats are likely to occur within the assessment area.

The European Red Fox can be found in a range of habitats. They prey on medium-sized ground-dwelling and semi-arboreal mammals and ground-nesting birds. 'Predation by the European Red Fox *Vulpes vulpes*' is a KTP listed under both the EPBC Act and the BC Act. Evidence of the European Red Fox was recorded within the study area. However, the project is not likely to exacerbate the impacts of the European Red Fox on native fauna during either construction or operation, due to its existence within the study area, highly urban context and lack of native fauna present.

The European Rabbit causes a number of environmental problems in the Australian landscape. The rabbit can increase the likelihood of soil erosion by creating numerous burrows, threaten the survival of a number of native animal species by altering habitat, reducing native food sources, displacing small animals from burrows and attracting introduced predators such as foxes. 'Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*)' is a listed KTP under both the EPBC Act and the BC Act. The project is unlikely to exacerbate the impacts of the European Rabbit given the existing presence of the species within the study area and the highly degraded condition of the habitats within and adjoining the study area.

Cats can be found in almost all terrestrial environments in Australia. Predation by feral cats is a particular problem affecting small mammals (such as rodents, dasyurids, and burramyids) and ground-nesting birds. 'Predation by the feral cat (*Felis catus*)' is a listed KTP under both the EPBC Act and the BC Act. Feral cats were not recorded during the field survey. However they are likely to forage the study area given the surrounding urban development. Given the likely abundance of cats in the locality and study area, the project is unlikely to increase the abundance of cats, introduce them into new areas, or increase predation pressure on native fauna.

The Common Myna is an aggressive invader and competes with forest and woodland birds. It is common in urban areas. The project is unlikely to exacerbate the impacts of this species on bird assemblages in the study area during construction or operation.

8.3.6 Invasion and spread of pathogens and diseases

A number of pathogens are of concern in NSW that have the potential to affect native flora and fauna. Activities that involve movement of equipment over large areas are of particular concern given the high potential for pathogen spread over large areas.

Although no sign of pathogen infection was identified during the field survey or literature search it is important to assess the potential impacts of these pathogens and mitigate against their spread. The main pathogens of concern are:

- Myrtle Rust (*Uredo rangelli*)
- Chytrid Fungus (*Batrachochytrium dendrobatidis*)
- Phytophthora (*Phytophthora cinnamomi*).

Myrtle Rust is an air-borne plant fungus that attacks the young leaves, shoot tips and stems of Myrtaceous plants eventually causing plant death. It is spread by movement of contaminated material such as clothing, infected plants, vehicles and equipment etc. The 'introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae' is a listed KTP under the BC Act.

Chytrid fungus is a water-borne fungus that affects amphibians. It is spread by cross contamination of water bodies and improper handling of frogs. Chytridiomycosis is the infection that causes lethargy, emaciation, skin sloughing and a range of other symptoms that eventually result in death. The infection of frogs by amphibian chytrid fungus causing the disease Chytridiomycosis' is a listed KTP under both the EPBC Act and the BC Act.

Phytophthora is a soil-borne fungus capable of causing tree death (dieback) by attacking the roots of native plants. Spores can be spread over large areas by water, vehicle and machinery movement as well as human and animal movement. 'Dieback caused by Phytophthora' is a listed KTP under both the EPBC Act and the TSC Act.

It is unknown if any of these three pathogens are present within the study area. However, considering the highly urban context of the site, it is unlikely that Phytophthora is present and Myrtle rust would be limited to any landscaped or planted Eucalypts. It is possible that the Chytrid fungus could be present at the Arncliffe tunnel site, where frog habitat occurs adjacent to the site.

8.3.7 Acidification

The project has the potential to result in impacts on biodiversity caused by acid sulfate soils during construction only. Within the President Avenue construction ancillary facility, an area occupied by cut and cover and trough structures may have a 'high probability of occurrence' for acid sulfate soil. It has been assumed that a large portion of the excavation for the cut and cover and trough structures would be through acid sulfate soils.

Management of acid sulfate soil to be consistent with the *Acid Sulfate Soil Manual* (Stone et al 1998). The preference is to treat acid sulfate soils (and any groundwater) on site prior to reuse on site or disposal off-site. For this project the majority of excavated material will be disposed off-site. Water affected by acid sulfate soils would be collected and treated prior to disposal.

Implementation of mitigation measures would limit the potential indirect impacts of exposure to acid sulfate soils.

8.3.8 Noise, light and vibration

The project has the potential to result in indirect impacts on biodiversity caused by noise, vibration, light and dust during construction. This is particularly the case given that construction activities would occur during the day and night and would not be restricted to just daylight hours. Indirect impacts on biodiversity may also result from changes in noise levels or lighting during operation. However these impacts can be largely avoided at the Arncliffe construction ancillary facility through the reuse of the existing compound. The impacts arising from this project would be less than those for the New M5 Motorway. This is because the project would use already constructed facilities, reducing the overall generation of construction noise, light, dust and vibration.

Truck movements at Arncliffe would be fewer than for New M5 Motorway because spoil would be hauled from the southern end of the constructed tunnels, as well as from the Arncliffe construction ancillary facility, rather than a single exit point. These impacts would operate only during construction.

8.3.9 Prolongation of noise, light, dust and vibration at Arncliffe

By reusing the existing construction compound at Arncliffe for this project, the potential indirect impacts such as noise, dust, light and vibration would continue during construction of the project. These potential impacts are however likely to be less than for the New M5 Motorway (see **section 8.3.8**). These impacts would reduce at the completion of construction, but would still occur during operation for the permanent facilities located here.

8.3.10 Deferral of habitat reinstatement for Green and Golden Bell Frog

Habitat for Green and Golden Bell Frog was deemed to be present over Kogarah Golf Course prior to the commencement of construction of the New M5 Motorway. This project was consented on the basis of implementing a raft of mitigation and offset measures in relation to this species, including the reinstatement of the majority of the Arncliffe construction ancillary facility site back to golf course and habitat for this species.

The F6 Extension project would prolong the use of the Arncliffe construction ancillary facility which has already been cleared of vegetation by the New M5 Motorway project. In the absence of the F6 Extension project this area would have been reinstated following completion of the New M5 Motorway (as a condition of consent). By using the existing New M5 Motorway construction compound, the habitat reinstatement would be temporarily deferred to allow for the construction of the F6 Extension.

The New M5 Motorway project has been implementing an offsite captive breeding program for the Arncliffe Green and Golden Bell Frog population for approximately 20 months now. Recent surveys by Biosphere Consulting (2016, 2017) and by ELA (this EIS) have indicated that the frogs are currently absent from areas adjacent to the Arncliffe construction ancillary facility including the RTA Ponds. This absence of frogs is assumed to be the result of the removal of frogs for the offsite captive breeding program as well as the continuation of a recent population trend.

On this basis, while indirect impacts have the potential to occur, their consequences would be affecting historically occupied habitat only, not known individuals.

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8.4 Matters of National Environmental Significance

8.4.1 Threatened species

Application of the impact assessment guidelines were carried out for the following species:

- Green and Golden Bell Frog (*Litoria aurea*)
- Magenta Lilly Pilly (*Syzygium paniculatum*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*).

The assessments concluded that the project is not likely to have a significant impact on these threatened species (see Annexure D).

For Green and Golden Bell Frogs, the local population appears to be in decline, seemingly related to stochastic factors. This is likely to be due to predation and poor climatic conditions (A White, pers. comm. 2017) and therefore outside the control of the proposed action. The proposed action would result in the continuation of impacts arising from the use of an area for the New M5 Motorway at Arncliffe, which is adjacent to the RTA Ponds. Current measures to mitigate against the impacts of the New M5 Motorway include construction and maintenance of a habitat enhancement area adjacent to the New M5 Motorway construction compound, monitoring of the population on the Kogarah Golf Course, maintenance of a frog exclusion fence, use of an acoustic shed, development of a captive breeding colony offsite and establishment of purpose built habitat at Marsh Street.

The frogs have not been detected at the RTA Ponds since October 2016 despite intensive survey on several occasions. This is likely to be due to a combination of the capture and removal of adults for inclusion in the offsite breeding program combined with a decline in the population which appeared to have commenced in 2013/2014, when no adults were recorded in the RTA Ponds or Kogarah Golf Course. In the survey period during the 2017/2018 season (ie October to March), few frogs were found. No frogs were found by surveys undertaken for this project, and only one adult was seen at a location some 260 metres from the Arncliffe construction ancillary facility. No frogs were detected in the RTA Ponds or on the areas of habitat immediately adjacent to the Arncliffe construction ancillary facility as part of surveys undertaken by the project or any other party.

Indirect impacts on the historically occupied habitat at the RTA Ponds and Kogarah Golf Course are likely to arise from the prolongation of construction activity within the compound at Arncliffe. These indirect impacts would be related to light, noise, dust and vibration resulting from the prolonged use of the site for construction. The construction period would be prolonged by approximately four years over that of the New M5 Motorway construction period. This prolonged use of the site would also result in a delay in the reinstatement of habitat (originally proposed as part of the New M5 Motorway site rehabilitation).

There would also be an increase in the permanent take of land for this project above what was approved for the New M5 Motorway. This additional area of permanent take would have consisted of fairways, rough and small unmanaged ponds (water hazards) on the golf course. This area would now be occupied by a water treatment plant and electrical substation for the F6 Extension project. While there would be less area able to be reinstated to golf course/habitat if this project were approved, the impact on the population of Green and Golden Bell Frog is not likely to be significant. The area of permanent take is not likely to sever any habitat corridor or prevent frogs from dispersing across the remaining parts of the reinstated golf course. This additional area of permanent take was included in the biodiversity offsets sought for the New M5 Motorway project and as such no further offsets are required.

Impacts to Grey-headed Flying-fox would not be significant. The proposed action would remove a small area of potential foraging habitat. Two camps within 10 kilometres of the proposed action would remain and would not be directly affected by the project.

The impacts to Magenta Lilly Pilly would not be significant. The individuals have been used in landscape plantings at Rockdale Bicentennial Park. The provenance of these individuals is not known. These plants do not form part of an important population and are not known to naturally occur at the Rockdale Bicentennial Park.

8.4.2 Migratory species

For migratory birds, the impacts are unlikely to be significant. The migratory species occasionally visit the Landing Lights Wetland (nearby to the project), but prefer to use the resources within the Towra Point wetland and Shell Point Botany Bay. These species do not breed in Australia. They migrate south for the southern summer, using wetlands, shores and exposed mudflats for foraging. While the species do occasionally occur close to the project, the species do not occur in the project area, and thus it is only indirect impacts that may potentially affect these species via possible hydrological changes, such as a reduction in groundwater supply to wetlands that are important habitat.

8.5 Other impacts not covered by BAM

8.5.1 Aquatic impacts

The F6 Extension Stage 1: Surface Water and Flooding Assessment (AECOM, 2018) (Appendix 18, EIS) states that 'no adverse cumulative surface water quality impacts are anticipated with implementation of appropriate management measures as part of the project and the residual risk to the environment would be low'.

Impact to aquatic habitat would be relatively minor, considering existing conditions, scale and recovery potential. Each unique habitat type in the sections below.

Waterway through Rockdale Bicentennial Park

The largest scale impact would occur at this site due to the proposed cut and cover road construction. The process of severing the pond to allow for dry excavation would likely require: bunding the northern and southern extent of the project footprint; dewatering and desilting the pool isolated between bunds; and diverting flows across the cut (eg pumping through an 'aerial' conduit north to south). This would result in a direct loss of about 0.2 hectares of aquatic and riparian habitat, and would obstruct fish passage longitudinally. Aquatic and semi-aquatic fauna dependant on this pond would be segregated into two populations, occupying a 1 hectare northern pool and 1 hectare southern pool. The pond would be restored after the roadway is covered, however there remains a risk to the northern pool given the isolation during the construction period. The size of the refuge pools, may not be large enough to sustain current population sizes, increasing risk of mortality to those species present. However, species currently inhabiting the pond are likely to be those tolerant of urban pressures, such as poor water quality, shallow habitat and disconnection from any large flowing river. As such, these species are expected to adapt to the change in habitat and ecology.

Other impacts may be from noise generated by excavation works and the installation of sheet piles, resulting in disturbance or physical impact to aquatic fauna in the area. Fish in the vicinity may be affected by excessive underwater noise, with the impact ranging from mortality to interruption of communication, depending on species anatomy (eg fish with swim bladders closer to the ear are more sensitive to acoustic impact than species with swim bladders further from the ear). Fish populations in this waterway are unlikely to be from a listed species, however there is a risk that prolonged noise may cause increased fish mortality.

Restoration of riparian vegetation post-construction would replace trees lost during the cut and cover at Rockdale Bicentennial Park pond. Immediately post-construction there would be a temporary loss of habitat and shading that the existing mature trees provide. This would recover over time with application of a landscape planting program. However, if deep rooted trees are not appropriate above the covered roadway then impacts would be permanent.

Infilling of the southern boundary of this habitat would result from alteration to President Avenue (increased embankment height). A slice of fringing sedges, small trees/shrubs and aquatic habitat would be lost, however the loss of this small area (<10 metre channel length) and the currently poor quality habitat along the fringing area would not significantly alter the ecological value of this reach.

The project footprint and proposed works in this location are not within Key Fish Habitat as defined by DPI Fisheries, therefore, fish habitat offsets are not required for this freshwater reach.

Waterway entering Scarborough Park North

Infilling of the northern boundary of this habitat would result from alteration to President Avenue (increased embankment height). A small area of reeds and aquatic habitat would be lost, however the loss of this small area (<10 metre channel length) and currently poor quality habitat along the fringing area would not significantly alter the ecological value of this reach. Replacement culverts beneath the road and any minor channel works to tie in the modified road corridor would disturb soft benthic sediment, creating sediment plumes downstream if not contained. Any dredged material would be tested for acid sulfate soil potential and treated accordingly. Other likely contaminants include heavy metals bonded to solids, such as lead and zinc (not tested here but typical in urban areas). Physical disturbance and mixing of substrate may release metals more rapidly than natural processes, resulting in dissolved metals moving downstream during high rainfall events.

The project footprint and proposed works in this location are not within Key Fish Habitat as defined by DPI Fisheries, and there would be no harm to marine vegetation. Therefore, fish habitat offsets are not required for this saline reach.

Muddy Creek upstream of Bestic Street

The potential impact on Muddy Creek and associated drainage lines is minor. The proposed shared pedestrian cyclist pathways would not require clearing of mangroves or saltmarsh (ie no harm to marine vegetation). Earthworks would not affect the concrete channel or banks. There would be no obstruction of fish passage. A small increase in impervious surface area would result from the path installation, which can lead to faster surface runoff and warmer water. However, given the majority of the catchment is impervious, a small addition is likely to be insignificant. Infilling or shading of *Phragmites australis* (Common Reed) may be required around stormwater channels leading to Muddy Creek. These small stands currently help filter water by trapping sediment and pollutants before they enter the main channel, and their removal or shading would reduce this process. However, existing grass swales and a mangrove channel also contribute to this function, and the protection or enhancement of those elements may balance the filtering process.

The project footprint and proposed works upstream of the intertidal area are not within Key Fish Habitat as defined by DPI Fisheries. The project footprint adjacent to the intertidal area is mapped as Key Fish Habitat, but there would be no harm to marine vegetation or loss of other fish habitat. Therefore, fish habitat offsets are not required for this intertidal reach.

Cooks River near Kogarah Golf Course

There would be no potential impacts to this aquatic habitat. The project would not affect an artificial seawall or a small number of common marine molluscs (oysters, barnacles and gastropods). This habitat is classed as *Type 3 – minimally sensitive Key Fish Habitat* according to DPI Fisheries' guidelines (Fairfull et al 2013). No marine vegetation (seagrass, macroalgae, mangroves, saltmarsh) occurs in the area.

DPI Fisheries' policy states there is to be no 'net loss' of Key Fish Habitat of any type. Offsetting any potential disturbance is an unlikely requirement for the project, because no impacts would occur to this habitat.

8.5.2 Groundwater dependent ecosystems

There are no GDEs that would be highly reliant on groundwater identified within the study area, however there are several wetlands identified as potential GDEs in the BoM GDE Atlas. The wetlands at Rockdale Bicentennial Park are highly modified, and further modification will be required due to the need to temporarily divert the wetlands during construction of the diaphragm walls at the President Avenue ramp tunnels. The wetlands will be reinstated and remediated after construction, as per AECOM (2018).

The NSW Aquifer Interference Policy states that predicted drawdowns of greater than 10% of natural variation will require adaptive management for high priority GDEs (eg monitoring and mitigation/remediation during operation), should the project be approved. Natural seasonal variation in monitoring data is in the order of one metre, therefore the drawdown threshold for predicted impact reporting has been taken as 0.1 m. It should be noted that none of the GDEs are of high priority.

GDEs located within the Rockdale Bicentennial Park and Scarborough Park North would experience drawdowns of greater than 0.1 metres if they are in direct hydraulic connection with the regional water table (Chapter 17 (Groundwater and geology) of this EIS). The Rockdale Bicentennial Park GDEs are predicted to have drawdowns of up to 0.32 metres due to the project (not inclusive of any impacts associated with the temporary diversions due to construction) and up to 0.12 metres at Scarborough Park south of President Avenue (Chapter 17 (Groundwater and geology) of this EIS). There is no additional drawdown at these GDE locations due to cumulative works with the New M5 Motorway.

The GDEs at Rockdale Bicentennial Park are highly modified and consist of remnant and planted vegetation on the banks of the unnamed waterway. The waterway is fed from surface flows and stormwater runoff. These potential GDEs have a moderate reliance on subsurface water. A potential drawdown of up to 0.32 metres is likely to be mediated by the inflow of water from stormwater and other overland flows.

At Scarborough Park North, the GDE is fed by both surface flows (including stormwater from the unnamed waterway) and a weak tidal influence from Botany Bay. The potential GDE is present as reedlands and is fed by stormwater inflows from the unnamed waterway as well as a weak tidal influence. This potential GDE has a moderate reliance on subsurface water. A potential drawdown of up to 0.12 metres is likely to be mediated by the inflow of water from stormwater.

Drawdown in excess of the seasonal variation of 0.05 metres is predicted at Landing Lights, Eve Street, Spring Street, King Street and Marsh Street Wetlands, with long term drawdown predicted to vary from 0.28 metres at Landing Lights Wetland to 0.47 metres at the Marsh Street Wetland (refer to **Chapter 17** (Groundwater and geology)). These predicted drawdowns are not considered to be of concern because the wetlands are not dependent on groundwater.

8.6 Cumulative impacts

8.6.1 WestConnex New M5 Motorway

The New M5 Motorway project involves construction and operation of a new, tolled multi-lane road link between the existing M5 East Motorway, east of King Georges Road, and St Peters. The project also includes an interchange at St Peters and connections to the existing road network. The New M5 Motorway Arncliffe construction ancillary facility occupies the same footprint as the proposed F6 Extension with Arncliffe construction ancillary facility.

The New M5 Motorway was assessed as a Major Project using the Framework for Biodiversity Assessment methodology, which differs from the assessment methodology for the F6 Extension project. The assessment is summarised at **section 4.1.2** of this BDAR.

The New M5 Motorway was assessed as resulting in 3.31 hectares of direct impacts on native vegetation. Accordingly, the project BAR assessed the type and number of credits using the Framework for Biodiversity Assessment methodology. These calculations identified the following offset requirements for the project:

- A total of 58 ecosystem credits consisting of 31 Broad-leaved Ironbark - *Melaleuca decora* shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 725) credits and 27 Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (PCT 1046) credits
- A total of 203 credits for Green and Golden Bell Frog.

In addition to the above impacts, 10.80 hectares of planted native and exotic vegetation would be affected, which may represent potential foraging habitat for the Grey-headed Flying-fox.

The F6 Extension project overlaps with the New M5 Motorway at Arncliffe, with the F6 Extension project utilising the existing New M5 Motorway construction ancillary facility. The F6 Extension project would require the deferment of the New M5 Motorway's post-construction habitat reinstatement requirements at the Arncliffe construction ancillary facility site. The use of the existing civil and tunnel site by the F6 Extension project would prevent approximately 7.6 hectares of land that was previously golf course fairways and landscaping from being reinstated at the conclusion of the New M5 Motorway. This land would continue to be used for the construction of the F6 Extension project. .

The prolonged use of the Arncliffe construction facility by the F6 Extension project is unlikely to significantly affect Green and Golden Bell Frog. This is because the species is not likely to be present in the RTA Ponds or on the areas of habitat immediately adjacent to the Arncliffe construction ancillary facility due to a decline in the population, and the removal of adult frogs for the offsite captive breeding program (undertaken as part the of the development of the New M5 Motorway).

During operation some of the F6 Extension operational infrastructure would be co-located with the New M5 Motorway operational infrastructure. The remainder of the F6 Extension operational infrastructure would be located on its own site located adjacent to the New M5 Motorway operational infrastructure. This would increase this area of permanent take for the F6 Extension project.

Management measures proposed by the F6 Extension project for biodiversity values are consistent with those adopted for the New M5 Motorway, apart from the requirement to establish a captive breeding colony or new habitat at Marsh Street. These measures have already been undertaken by the New M5 Motorway project.

The F6 Extension project would remove a small amount of foraging habitat (suitable feed trees; up to 4.45 hectares) for the Grey-headed Flying-fox in the form of planted native or exotic vegetation, contributing to a minor cumulative impact on this species.

8.6.2 Major Roads and Maritime and other transport projects

Marsh Street widening

Roads and Maritime proposed to widen Marsh Street, Arncliffe to provide three continuous westbound lanes between the Giovanni Brunetti Bridge and the M5 Motorway intersection. That project is located adjacent to the Kogarah Golf Course and the RTA Ponds at Arncliffe.

The Marsh Street widening project was assessed as a Part 5 activity under the EP&A Act and was subject to a Review of Environmental Factors (REF). The REF concluded that about 2.02 hectares of vegetation would be removed including 0.1 hectares of 'Swamp Oak Forest'. That project included an area of steep batters to the north of the RTA Ponds and widening Marsh Street at this location.

That project would have affected Green and Golden Bell Frog habitat. Mitigation measures provided in the project REF for this species included:

- Delineation of Green and Golden Bell Frog habitat from the construction zone by a frog-proof fence
- Pre-clearance survey for this species
- Direction of surface water runoff away from the RTA Ponds
- Maintenance of the water supply to the RTA Ponds.

No offsets were proposed from that project.

This project abuts the Marsh Street widening project. The Marsh Street widening project commenced in April 2016 and has not yet been completed, though is known to be very near completion. The two projects, along with the New M5 Motorway, would mean that the area close to the RTA Ponds have been affected continuously for several years, should this project be approved. While the F6 Extension project would not intensify activity at the Arncliffe construction ancillary facility it would prolong the indirect impacts such as noise, light, dust and vibration, which would have also been produced by the widening of Marsh Street.

8.6.3 Other projects

Residential development at Cooks Cove, Wolli Creek, Arncliffe, Banksia and Turrella

The Department of Planning and Environment, with Bayside Council, developed a Land Use and Infrastructure Strategy for the Bayside West Precincts. These precincts include parts of the suburbs of Arncliffe, Banksia and Turrella. The draft Strategy identifies that parts of these precincts could be subject to further development, especially for residential housing.

Development and land use change in these areas is subject to further assessment. However the draft strategy signals an intent to explore intensification of land use, which would include in areas containing biodiversity values, such as in the Kogarah Golf Course, adjacent to the RTA Ponds and in surrounding Green and Golden Bell Frog habitat such as at the Marsh Street Green and Golden Bell Frog habitat site. The draft strategy suggests that any future development in this precinct 'maximises the existing heritage elements…this encompasses ecological, [and] environmental elements' (DPE 2016). Future planning proposals for this area would need to consider their impacts on Green and Golden Bell Frog habitat.

8.7 Impact summary

A summary of the anticipated impacts arising from the project are provided (see **Table 8-7**).

Table 8-7 Summary of impacts arising from the project

Impact	Biodiversity values	Serious and irreversible impact	Nature of impact	Extent of impact	Duration	Does the project constitute or exacerbate a key threatened process?
Native vegetation and habitat						
Removal of native vegetation and habitat	Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions	No	Direct	Site based	Short term Long term During construction	Clearing of native vegetation Removal of dead wood and dead trees

Impact	Biodiversity values	Serious and irreversible impact	Nature of impact	Extent of impact	Duration	Does the project constitute or exacerbate a key threatened process?
Indirect impacts on native vegetation and habitat	Native vegetation	No	Indirect	Site based	Short term During construction	Invasion and establishment of exotic vines and scramblers Invasion, establishment and spread of Lantana camara Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants Predation by the European red fox (Vulpes Vulpes) Predation by the feral cat (Felis catus) Predation by Plague Minnow or Mosquito Fish (Gambusia holbrooki) Infection of native plants by Phytophthora cinnamomi Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
Removal of threatened plants	Syzygium paniculatum (Magenta Lilly Pilly)	No	Direct	Site based	Long term During construction	Clearing of native vegetation
Prescribed biodiversity impacts						
Impacts to habitat in non-native vegetation and human made structures	Grey-headed Flying Fox and threatened microchiropteran bats	No	Direct	Site based	Short term During construction	Clearing of native vegetation

Impact	Biodiversity values	Serious and irreversible impact	Nature of impact	Extent of impact	Duration	Does the project constitute or exacerbate a key threatened process?
Impacts not covered by the BAM						
Loss of aquatic habitat	Scarborough Park North Unnamed waterway at Rockdale	No	Direct	Site based	Short term During and post construction	No
Loss of groundwater due to drawdown	Groundwater dependent ecosystems Wetland habitat at Landing Lights Wetland Native vegetation at Rockdale	No	Indirect	Local	Long term During construction Post construction	No
Indirect impacts to MNES (noise, light dust)	Green and Golden Bell Frog	No	Cumulative Indirect	Site based Local	During construction	The following processes may be exacerbated if mitigation measures are not implemented properly: • Predation by Plague Minnow or Mosquito Fish (Gambusia holbrooki) • Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
Habitat removal for a MNES	Grey-headed Flying Fox	No	Direct	Site based	Short term During construction	Clearing of native vegetation
Removal of MNES individuals	Magenta Lilly Pilly	No	Direct	Site based	Short term	Clearing of native vegetation

Impact	Biodiversity values	Serious and irreversible impact	Nature of impact	Extent of impact	Duration	Does the project constitute or exacerbate a key threatened process?
Reduction in groundwater supply to wetlands	Migratory waterbirds	No	Indirect	Local	Short term During and post construction	No

9 Mitigating and managing impacts

The mitigation measures to minimise direct and indirect ecological impacts would be implemented as part of the project in line with Roads and Maritime *Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority 2011). These measures would be detailed in the Construction Flora and Fauna Management Plan (CFFMP) for the project which would include: site-specific environmental induction; identification of clearing limits and protective fencing; vegetation clearance procedures; pre-clearance surveys; erosion and sediment controls; weed management and monitoring.

The New M5 Motorway project would continue to implement the New M5 Motorway Green and Golden Bell Frog Plan of Management, in line with the planning approval requirements for that project. For impacts created by the project, mitigation measures would be implemented consistently with that plan.

In addition to the implementation of the project in accordance with the above guideline, the project specific mitigation and management measures provided in **Table 9-1** would be implemented during construction and operation of the project to reduce or minimise the potential impacts discussed in **section 8**.

Table 9-1 Environmental management measures - Biodiversity

Impact	Reference	Environmental management measures	Timing
Removal of native vegetation and habitat, including threatened plants	B1	Detailed design will avoid or minimise the need for native vegetation and habitat removal for the construction of the project, where feasible. A plan for the rehabilitation of all areas directly affected by construction, including water bodies, would be included as part of the CFFMP (refer B4 below).	Detailed design
Indirect impacts on native vegetation and habitat	B2	Detailed design of the project will avoid or minimise artificial light impacts on biodiversity within and immediately adjacent to the operational project (e.g. downward-facing lighting along the shared cycle and pedestrian pathways)	Detailed design
Impacts to wetlands and riparian land	B3	Detailed design of the project will avoid or minimise disturbance to wetlands and riparian land during both construction and operation, as far as practical. This will include location of stockpiles outside of riparian corridors where reasonable and feasible.	Detailed design

Impact	Reference	Environmental management measures	Timing
Impacts to flora and fauna	B4	A Construction Flora and Fauna Management Plan (CFFMP) will be prepared. The CFFMP would outline processes and responsibilities with regard to avoiding, managing and/or mitigating biodiversity impacts during construction. The plan will include: • A process for pre-clearance surveys prior to vegetation clearing • A process for vegetation clearing including the establishment of exclusion zones at the limit of clearing to protect sensitive areas. Exclusion zones will be established in accordance with Guide 2 Exclusion Zones of Roads and Maritime's Biodiversity Guidelines[1] • An unexpected finds procedure for both flora and fauna • A procedure for managing inadvertent impacts to both flora and fauna • A process for identifying and managing priority and environmental weeds and other pests prior to, during, and after construction (including within vegetation exclusion zones) • A protocol to minimise the potential for the spread of pathogens such as Chytrid or Phytophthora fungus into and out of the site during construction • A process for dewatering and restoration of the Rockdale Wetland, including measures developed by an aquatic ecologist to handle and relocate aquatic fauna. The processes and procedures will be prepared in accordance with relevant Roads and Maritime guidelines.	Prior to construction
Impacts to Green and Golden Bell Frogs	B6	All construction site inductions will contain a relevant section on identifying and managing potential risks to the Green and Golden Bell Frog. This will include identification of the frog and its habitat, a clear outline of the location of no-go zones for construction personnel, equipment and materials (including herbicides and pesticides), hygiene protocols and what to do in the event of an unexpected find. Frog exclusion fencing and sediment controls will installed. Any Green and Golden Bell Frogs encountered within the construction boundary during construction are to be collected by a qualified and experienced herpetologist and relocated within the adjacent golf course by the herpetologist. Impacts to Green and Golden Bell Frog due to light spill will be mitigated with lighting directed to minimise construction night time light spill outside of all construction areas, particularly onto the RTA ponds and Kogarah Golf Course. The ground surface within the Arncliffe construction ancillary facility (excluding the operational footprint) will be reinstated to a condition the same or better than prior to the commencement of construction of the New M5 Motorway project in consultation with relevant stakeholders.	Construction, and post-construction

[1] RTA, 2011, *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects.*

10 Offsetting required

Following use of the BAM and the BCC, offset requirements have been determined for the areas as shown on **Figure 10-1**. A biodiversity credit report is included in Appendix D.

10.1 Offset for Serious and Irreversible Impacts (SAII)

The development does not have any Serious and Irreversible Impacts (SAII). No offsets for matters subject to SAII are required.

10.2 Areas not requiring offsets or assessment

Areas not requiring assessment or offset were:

- Cleared areas – associated with tracks, roads, buildings, and other infrastructure
- Areas dominated by exotics - classified in this assessment as urban native and exotic vegetation.

These areas are shown on **Figure 10-2**.

LEGEND

F6 Extension S1

Construction Boundary

C3 - President Avenue construction ancillary facility

Development Footprint

Assessment Area

Areas requiring offset

Coastal Flats Swamp Mahogany Forest (PCT 1795)

Coastal Freshwater Swamp Forest (PCT 1232)

Estuarine Reedland (PCT 1808)

Figure 10-1 Areas requiring offset

LEGEND

F6 Extension S1

Construction Boundary

Development Footprint

Assessment Area

F6 Extension - Stage 1

Areas not requiring assessment

Figure 10-2 Areas not requiring assessment

10.3 Ecosystem credits

The number of ecosystem credits required for the development are outlined in **Table 10-1**.

Table 10-1 Ecosystem credits required

PCT ID	PCT Name	Vegetation Formation	Direct impact (ha)	Credits required
1232	Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Coastal Swamp Forest	0.47	8
1795	Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Coastal Swamp Forest	0.30	10
1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	Freshwater Wetlands	0.77	8

10.4 Species credits

No species credits required are for the development.

10.5 Offset strategy

The proposed offset strategy is to seek, purchase and retire appropriate credits. There is a number of options to discharge and offset obligation available including:

- Seeking, purchasing and retiring like-for-like biodiversity credits from vendors.
- Payment into the Biodiversity Conservation Trust.
- Application of approved conservation measures
- Application of variation rules to seek biodiversity offsets from similar but not like-for-like biodiversity values.

It is the intention of Roads and Maritime to purchase credits available from vendors. Roads and Maritime do not intend to use conservation measures, variation rules or payment to the Biodiversity Conservation Trust. **Table 10-2** outlines the progress made towards seeking the biodiversity credits required to discharge the offset obligation of this project.

Table 10-2 Progress towards meeting offset requirements

Credit type required	Number of credits secured, transferred or retired	Outstanding balance	Number of credits available for sale (issued)
1232	0	8	Nil
1795	0	11	Nil
1808	0	8	Nil

10.6 Conclusion

The BAM and use of the BCC were applied to the project. The assessment found that three PCT would be directly affected by the project. These three PCT would require biodiversity offsets consistent with the following:

- Eight ecosystem credits for PCT1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion
- Eleven ecosystem credits for PCT1795 Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin
- Eight ecosystem credits PCT1808 Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline.

No species credits would be required by the project. There are two prescribed biodiversity impacts within the development footprint. These are impacts on non-native vegetation and man-made structures. Neither of these can be assessed in the BCC. They are associated with potential foraging habitat and roosting habitat for the Grey-headed Flying-fox and Southern Myotis, respectively.

Areas of Green and Golden Bell Frog habitat would be affected indirectly. However numerous mitigation measures would be implemented to minimise these impacts. No additional biodiversity credits would be required for this project.

Several Magenta Lilly Pilly individuals which were planted would be directly affected. The origins of these plants are unknown and they are not proposed to be offset.

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Annexure A - Habitat assessment table

An assessment of likelihood of occurrence was made for threatened ecological communities and species identified from the desktop review. This was based on database records, habitat features of the site, results of the field surveys and professional judgement. Some Migratory or Marine species from the Commonwealth database search have been excluded from the assessment, due to lack of habitat. The terms for likelihood of occurrence are defined in Table A.1.

Table A.1 Likelihood of occurrence criteria

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

Note; assessments of occurrence were made both prior to field survey and following field survey. The pre-survey assessments were performed to determine which species were “affected species”, and hence determine which sorts of habitat to look for during field survey. The post-survey assessments to determine “final affected species” were made after observing the available habitat in the study area and are depicted in the table below.

It is noted that some threatened fauna that are highly mobile, wide ranging and vagrant may use portions of the study area intermittently for foraging. For these species, potential habitat impacted is not considered important for the long-term survival of a local occurrence of the species, particularly in relation to similar habitat remaining in the locality.

The records column refers to the number of records occurring within 5 km of the site (locality), as provided by the NSW Wildlife Atlas (BioNet) database search (OEH 2018a). Information provided for the habitat associations has primarily been extracted (and modified) from the Commonwealth Species Profile and Threats Database (DotE 2018a), the NSW Threatened Species Profiles (OEH. 2018b) and NSW Department of Primary Industries (DPI 2018).

- CE = Critically Endangered
- E = Endangered (EPBC Act, BC Act and FM Act)
- EP = Endangered Population (BC Act and FM Act)
- V = Vulnerable
- Mi = Migratory (EPBC Act)
- P = Protected (FM Act)

Table A.2 Threatened ecological communities – habitat assessment table

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat Associations	Likelihood of occurrence
Blue Gum High Forest	PMST	CE	CE	A moist, tall open forest community, with dominant canopy trees of *Eucalyptus saligna* (Sydney Blue Gum) and *E. pilularis* (Blackbutt). *Allocasuarina torulosa* (Forest Oak) and *Angophora costata* (Sydney Red Gum) also occur. Species adapted to moist habitat such as *Acmena smithii* (Lillypilly), *Ficus coronata* (Sandpaper Fig), *Calochlaena dubia* (Soft Bracken) and *Adiantum aethiopicum* (Maiden Hair) may also occur. Originally restricted to the ridgelines in Sydney's north from Crow's Nest to Hornsby, and extending west along the ridges between Castle Hill and Eastwood. Occurs only in areas where rainfall is high (above 1100 millimetres per year) and the soils are relatively fertile and derived from Wianamatta shale. In lower rainfall areas, it grades into Sydney Turpentine-Ironbark Forest.	None
Castlereagh Scribbly Gum and Agnes Banks Woodlands	PMST	V	E	Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion mainly occurs within the local government areas of Bankstown, Blacktown, Campbelltown, Hawkesbury, Liverpool and Penrith. It is almost exclusively found on soils derived from Tertiary alluvium, or on sites located on adjoining shale or Holocene alluvium. It is dominated by *Eucalyptus parramattensis*, *Angophora bakeri* and *E. sclerophylla*. A small tree stratum of *Melaleuca decora* is sometimes present, generally in areas with poorer drainage. It has a well-developed shrub stratum consisting of sclerophyllous and the ground stratum consists of a diverse range of forbs.	None
Coastal Upland Swamps	PMST	E	E	This EEC includes open graminiod heath, sedgeland and tall scrub associated with periodically waterlogged soils on the Hawkesbury sandstone plateau. The Coastal Upland Swamp is endemic to NSW and confined to the Sydney Basin Bioregion. It occurs in the eastern Sydney Basin from the Somersby district in the north to the Robertson district in the south. In the north it occurs on the Somersby-Hornsby plateaux, in the the south it occurs on the Woronora plateau. It occurs in elevations from 20 m to over 600 m above sea level, with the majority of swamps occurring within 200 and 450 m elevation. Coastal Upland Swamps occur primarily on impermeable sandstone plateau with shallow groundwater aquifers in the headwaters and impeded drainage lines of streams, and on sandstone benches with abundant seepage moisture.	None
Cooks River/Castlereagh Ironbark Forest	PMST	E	CE	Occurs in western Sydney, with the most extensive stands occurring in the Castlereagh and Holsworthy areas. Ranges from open forest to low woodland, with a canopy dominated by *Eucalyptus fibrosa* and *Melaleuca decora*. The canopy may also include other eucalypts such as *E. longifolia*. The dense shrubby understorey consists of *Melaleuca nodosa* and *Lissanthe strigosa*, with a range of 'pea' flower shrubs, such as *Dillwynia tenuifolia*, *Pultenaea villosa* and *Daviesia ulicifolia* can be locally abundant. The sparse ground layer contains a range of grasses and herbs. Was observed during the field surveys.	None

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat Associations	Likelihood of occurrence
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	PMST	CE	CE	Occurs on soils derived from Wianamatta Shale, and throughout the driest part of the Sydney Basin. Good examples can be seen at Scheyville National Park and Mulgoa Nature Reserve. The dominant canopy trees of Cumberland Plain Woodland are *Eucalyptus moluccana* (Grey Box) and *E. tereticornis* (Forest Red Gum), with *E. crebra* (Narrow-leaved Ironbark), *Corymbia maculata* (Spotted Gum) and *E. eugenioides* (Thin-leaved Stringybark) occurring less frequently. The shrub layer is dominated by *Bursaria spinosa* (Blackthorn), and it is common to find abundant grasses such as *Themeda australis* (Kangaroo Grass) and *Microlaena stipoides var. stipoides* (Weeping Meadow Grass).	None
Eastern Suburbs Banksia Scrub	PMST	E	E	Once occupied around 5,300 hectares of land between North Head and Botany Bay in Sydney's eastern suburbs. Surviving stands totalling about 146 hectares have been recorded from the local government areas of Botany, Randwick, Waverley, and Manly. Predominantly a sclerophyllous heath or scrub community although, depending on site topography and hydrology, some remnants contain small patches of woodland, low forest or limited wetter areas. Common species include *Banksia aemula*, *B. ericifolia*, *B. serrata*, *Eriostemon australasius*, *Lepidosperma laterale*, *Leptospermum laevigatum*, *Monotoca elliptica* and *Xanthorrhoea resinifera*.	None
Freshwater Wetlands on Coastal Floodplains	OEH 2016	E	-	Known from along the majority of the NSW coast. It is associated with coastal areas subject to periodic flooding and in which standing freshwater persists for at least part of the year in most years. Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes but may also occur in back barrier landforms where floodplains adjoin coastal sandplains. They are dominated by herbaceous plants with very few woody species. The structure and composition varies both spatially and temporally depending on the water regime: Those that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, such as *Paspalum distichum, Leersia hexandra, Pseudoraphis spinescens* and *Carex appressa*. Was observed during the field surveys. This EEC does not include artificial wetlands or ponds. This EEC does not occur in the project footprint.	None
Freshwater Wetlands of the Sydney Basin Bioregion	OEH 2016	E	-	Occurs on sand dunes and low-nutrient sandplains along coastal areas in the Sydney Basin bioregion. It is known from the Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Woollahra, Waverley, Botany, Rockdale, Randwick, Sutherland and Wollongong local government areas, but is likely to occur elsewhere within the bioregion. Characteristic species include sedges and aquatic plants such as *Baumea* species, *Eleocharis sphacelata, Gahnia species, Ludwigia peploides* subsp*. montevidensis* and *Persicaria* species.	None
Shale Sandstone Transition Forest	PMST	CE	CE	Occurs at the edges of the Cumberland Plain, where clay soils from the shale rock intergrade with soils from sandstone, or where shale caps overlay sandstone. The main tree species include *Eucalyptus tereticornis* (Forest Red Gum), (*E. punctata*) Grey Gum, *E. globoidea, E. eugenioides* (Thin-leaved Stringybark) and *E. fibrosa* (Broad-leaved Ironbark) and *E. crebra* (Narrow-leaved Ironbark). Areas of low sandstone influence have an understorey that is closer to Cumberland Plain Woodland. High sandstone influence have poor rocky soils.	None

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat Associations	Likelihood of occurrence
Subtropical and Temperate Coastal Saltmarsh	PMST	E	V	Found on the river flats of the coastal floodplains. Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The structure of the community may vary from tall open forests (>40m) to woodlands. The most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *A. subvelutina* (broad-leaved apple). This EEC occurs in the buffer of the project but not within the project area.	Known from within study area (but outside project footprint)
Swamp Oak Floodplain Forest	OEH 2016	E	-	It is known from a number of LGA's in Sydney and along the coast of NSW occurring on coastal floodplains. It has a dense to sparse tree layer in which *Casuarina glauca* (Swamp Oak) is the dominant species. Other trees including *Acmena smithii* (Lilly Pilly), *Glochidion* spp. (Cheese Tree) and *Melaleuca* spp. (paperbarks) may be present as subordinate species. The understorey is characterised by frequent occurrences of vines, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter. This EEC occurs in the project area.	Known
Swamp Sclerophyll Forest	OEH 2016	E	-	It is known from a number of LGAs in Sydney and along the coast of NSW. It has an open to dense tree layer of eucalypts and paperbarks although some remnants now only have scattered trees as a result of partial clearing. The most widespread and abundant dominant trees include *Eucalyptus robusta* (swamp mahogany), *Melaleuca quinquenervia* (paperbark) and, south from Sydney, *Eucalyptus botryoides* (bangalay) and *Eucalyptus longifolia* (Woollybutt). A layer of small trees may also be present. Shrubs include *Acacia longifolia, Dodonaea triquetra, Ficus coronata, Leptospermum polygalifolium* subsp. *polygalifolium* and *Melaleuca* spp. The groundcover is composed of abundant sedges, ferns, forbs, and grasses. This EEC occurs in the project area.	Known
Turpentine-Ironbark Forest	PMST	E	CE	Open forest, with dominant canopy trees including *Syncarpia glomulifera* (Turpentine), *Eucalyptus punctata* (Grey Gum), *E. paniculata* (Grey Ironbark) and *E. eugenioides* (Thin-leaved Stringybark). In areas of high rainfall *E. saligna* (Sydney Blue Gum) is more dominant. The shrub stratum is usually sparse and may contain mesic species such as *Pittosporum undulatum* (Sweet Pittosporum) and *Polyscias sambucifolia* (Elderberry Panax). Occurs close to the Shale/Sandstone boundary on the more fertile shale influenced soils, in higher rainfall areas on the higher altitude margins of the Cumberland Plain, and on the shale ridge caps of sandstone plateaux.	None
Upland Basalt Eucalypt Forests	PMST	-	E	The Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion is typically tall open eucalypt forests found on basalt and basalt-like substrates in, or adjacent to, the Sydney Basin Bioregion. The ecological community usually occurs at elevations between 650 m and 1050 m above sea level although outliers may occur at elevations as low as 350 m (e.g. closer to the coast) or as high as 1200 m . (e.g. on higher plateau). The ecological community occurs in areas of high rainfall, generally ranging from 1000 to 1800 mm/year.	None
Western Sydney Dry Rainforest and Moist Woodland on Shale	PMST	E	CE	This community represents certain occurrences of dry rainforest and moist woodland generally found on shale soil in the Cumberland Plain Sub-region of the Sydney Basin Bioregion. It occurs generally in gullies, sheltered slopes and rugged terrain in isolated patches, largely on the edges of the Cumberland Plain in NSW, with some patches on undulating terrain in the central parts of the Cumberland Plain.	None

Table A.3 Threatened flora – habitat assessment table

Common Name *(Scientific Name)*	Source	BC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Bynoe's Wattle *(Acacia bynoeana)*	PMST	E	V	*Acacia bynoeana* is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains, and has recently been found in the Colymea and Parma Creek areas west of Nowra. It is found in heath and dry sclerophyll forest, typically on a sand or sandy clay substrate, often with ironstone gravels.	2	None – suitable habitat not present	Species
(Acacia gordonii)	PMST	E	E	*Acacia gordonii* is restricted to the north-west of Sydney, occurring in the lower Blue Mountains in the west, and in the Maroota/Glenorie area in the east, within the Hawkesbury, Blue Mountains and Baulkham Hills local government areas. Grows in dry sclerophyll forest and heathlands amongst or within rock platforms on sandstone outcrops.	1	None – suitable habitat not present	Species
Downy Wattle *(Acacia pubescens)*	PMST	V	V	It occurs mainly around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravely soils, often with ironstone. Grows in open woodland and forest, in a variety of plant communities, including Cooks River-Castlereagh Ironbark forest, Shale-Gravel Transition forest and Cumberland Plain woodland.	-	None – suitable habitat not present. No records in locality	Species
Sunshine Wattle *(Acacia terminalis* subsp. *terminalis)*	SEARS	E	E	This species has a very limited distribution, mainly in near-coastal areas from the northern shores of Sydney Harbour south to Botany Bay, with most records from the Port Jackson area and the eastern suburbs of Sydney. It occurs in coastal scrub and dry sclerophyll woodland on sandy soils.	4	None – suitable habitat not present	Species
(Allocasuarina glareicola)	PMST	E	E	*Allocasuarina glareicola* is primarily restricted to the Richmond district on the north-west Cumberland Plain, with an outlier population found at Voyager Point. It grows in Castlereagh woodland on lateritic soil.	-	None – suitable habitat not present. No records in locality	Species
Nielsen Park She-oak *(Allocasuarina portuensis)*	PMST	E	E	*Allocasuarina portuensis* was originally recorded at Nielson Park in the Woollahra local government area. None of the original individuals are left within the area it was discovered and the species presently only persists from propagation material. This species once grew in tall closed woodlands on shallow sandy siliceous, coarsely textured soils.	-	None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	Source	BC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
(Asterolasia elegans)	PMST	E	E	It is restricted to a few localities on the NSW Central Coast north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs. It is found in sheltered forests on mid- to lower slopes and valleys, in or adjacent to gullies.	-	None – suitable habitat not present. No records in locality	Species
Thick Lip Spider Orchid *(Caladenia tessellata)*	PMST	E	V	*Caladenia tessellata* occurs in grassy sclerophyll woodland, often growing in well-structured clay loams or sandy soils south from Swansea, usually in sheltered moist places and in areas of increased sunlight. It flowers from September to November.	2	None – suitable habitat not present	Species
(Callistemon linearifolius)	BioNet	V	-	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. Grows in dry sclerophyll forest on the coast and adjacent ranges.	-	None – suitable habitat not present. No records in locality	Species
Leafless Tongue-orchid *(Cryptostylis hunteriana)*	PMST	V	V	Kknown from a range of vegetation communities including swamp-heath and woodland. The larger populations typically occur in woodland dominated by *Eucalyptus sclerophylla* (Scribbly Gum)*, E. sieberi* (Silvertop Ash), *Corymbia gummifera* (Red Bloodwood) and *Allocasuarina littoralis* (Black Sheoak); where it appears to prefer open areas in the understorey and is often found in association with *Cryptostylis subulata) Cryptostylis erecta.*	-	None – suitable habitat not present. No records in locality	Species
(Darwinia biflora)	PMST	V	V	*Darwinia biflora* is an erect or spreading shrub to 80 cm high associated with habitats where weathered shale capped ridges intergrade with Hawkesbury Sandstone, where soils have a high clay content.	1	None – suitable habitat not present	Species
(Deyeuxia appressa)	PMST	E	E	Little is known of the habitat and ecology of this highly restricted NSW endemic known only from two records in the Sydney area; first collected in 1930 at Herne Bay, Saltpan Creek, off the Georges River, south of Bankstown; then collected in 1941 from Killara, near Hornsby. Grows in moist conditions.	-	None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	Source	BC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
(Dillwynia tenuifolia)		V	-	The core distribution is the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee. In western Sydney, may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone.	-	None – suitable habitat not present. No records in locality	Species
(Epacris purpurascens var. *purpurascens)*	BioNet	V	-	*Epacris purpurascens* var. *purpurascens* has been recorded between Gosford in the north to Avon Dam in the south, in a range of habitats, but most have a strong shale soil influence.	1	None – suitable habitat not present	Species
Camfield's Stringybark *(Eucalyptus camfieldii)*	BioNet	V	V	*Eucalyptus camfieldii i*s associated with shallow sandy soils bordering coastal heath with other stunted or mallee eucalypts, often in areas with restricted drainage and in areas with laterite influenced soils, thought to be associated with proximity to shale.	-	None – suitable habitat not present. No records in locality	Species
Narrow-leaved Black Peppermint *(Eucalyptus nicholii)*	BioNet	V	V	*Eucalyptus nicholii* naturally occurs in the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield. Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite. This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. Plantings undertaken for horticultural and aesthetic purposes are not considered threatened species under the TSC Act.	6	None – suitable habitat not present. Records are landscaped plantings	Species
Bauer's Midge Orchid *(Genoplesium baueri)*	PMST	E	E	Known from coastal areas from northern Sydney south to the Nowra district. Previous records from the Hunter Valley and Nelson Bay are now thought to be erroneous. Grows in shrubby woodland in open forest on shallow sandy soils.	6	None – suitable habitat not present	Species
(Grammitis stenophylla	BioNet	E	-	Occurs in moist places usually near streams, on rocks or in trees, within rainforest and moist eucalypt forest.	-	None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	Source	BC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Caley's Grevillea *(Grevillea caleyi)*	PMST	E	E	Restricted to an 8 km square area around Terrey Hills, about 20 km north of Sydney. Occurs in three major areas of suitable habitat, namely Belrose, Ingleside and Terrey Hills/Duffys Forest within the Ku-ring-gai, Pittwater and Warringah Local Government Areas. Sites occur on the ridgetops in association with laterite soils and a vegetation community of open forest, generally dominated by *Eucalyptus sieberi* and *E. gummifera*. Commonly found in the endangered Duffys Forest ecological community	-	None – suitable habitat not present. No records in locality	Species
(Hibbertia puberula)	PMST	CE	CE	*Hibbertia puberula* is currently only known from near Warrimoo in Blue Mountains National Park on the Central Coast. There also several old records from a number of localities in the Sydney basin. It grows in heathy open forest in thin rocky/sandy light brown soil over sandstone.	1	None – suitable habitat not present	Species
(Lasiopetalum joyceae)	PMST	V	V	Has a restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the Hawkesbury River. It is currently known from 34 sites between Berrilee and Duffys Forest. Seventeen of these are reserved. Grows in heath on sandstone.	-	None – suitable habitat not present. No records in locality	Species
(Leptospermum deanei)	PMST	V	V	Limited distribution in the north-west suburbs of Sydney with records between Port Jackson and Broken Bay. Found in riparian shrubland, woodland and open forest on sandy alluvial soil or sand on lower hillsides and along permanent freshwater creeks in Hawkesbury Sandstone areas below 100 m above sea level.	-	None – suitable habitat not present. No records in locality	Species
Deane's Paperbark *(Melaleuca deanei)*	PMST	V	V	Found in heath on sandstone, and also associated with woodland on broad ridge tops and slopes on sandy loam and lateritic soils.	10	None – suitable habitat not present	Species
Hairy Geebung *(Persoonia hirsuta)*	PMST	E	E	*Persoonia hirsuta* occurs from Singleton in the north, south to Bargo and the Blue Mountains to the west. It grows in dry sclerophyll eucalypt woodland and forest on sandstone.	4	None – suitable habitat not present	Species
Nodding Geebung *(Persoonia nutans)*	PMST	E	E	Nodding Geebung is restricted to the Cumberland Plains region of western Sydney, NSW. The species is confined to aeolian and alluvial sediments, below 60 m above sea level. Vegetation communities in which the species has been found include Agnes Banks Woodland, Castlereagh Scribbly Gum Woodland, Cooks River/Castlereagh Ironbark Forest and Shale Sandstone Transition Forest.		None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	Source	BC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Omeo Stork's-bill *(Pelargonium* sp. *Striatellum)*	PMST	E	E	The species is known to occur in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes. During dry periods, the species is known to colonise exposed lake beds. It is not known if the species' rhizomes and/or soil seedbank persist through prolonged inundation or drought	-	None – suitable habitat not present. No records in locality	Species
(Pimelea curviflora var. *curviflora)*	PMST	V	V	*Pimelea curviflora* var. *curviflora* is confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. It grows on shale/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. Associated with the Duffys Forest Community, shale lenses on ridges in Hawkesbury sandstone geology.	1	None – suitable habitat not present	Species
Spiked Rice-flower *(Pimelea spicata)*	PMST	E	E	In western Sydney, *Pimelea spicata* occurs on an undulating topography of well-structured clay soils, derived from Wianamatta shale. It is associated with Cumberland Plains Woodland, in open woodland and grassland often in moist depressions or near creek lines. Has been located in disturbed areas that would have previously supported.	-	None – suitable habitat not present. No records in locality	Species
Seaforth Mintbush *(Prostanthera marifolia)*	PMST	E	CE	*Prostanthera marifolia* is currently only known from the northern Sydney suburb of Seaforth and has a very highly restricted distribution. It occurs in localised patches in or in close proximity to the Duffys Forest EEC. It grows on deeply weathered clay-loam soils associated with ironstone and scattered shale lenses.	4	None – suitable habitat not present	Species
Sydney Plains Greenhood *(Pterostylis saxicola)*	PMST	E	E	Terrestrial orchid predominantly found in Hawkesbury Sandstone Gully Forest growing in small pockets of soil that have formed in depressions in sandstone rock shelves. Known from Georges River National Park, Ingleburn, Holsworthy, Peter Meadows Creek, St Marys Tower.	-	None – suitable habitat not present. No records in locality	Species
(Pultenaea parviflora)	PMST	E	V	Endemic to the Cumberland Plain. Core distribution is from Windsor to Penrith and east to Dean Park. May be locally abundant, particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland.	-	None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	Source	BC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Magenta Lilly Pilly *(Syzygium paniculatum)*	BioNet SEARS	E	V	This species occupies a narrow coastal area between Bulahdelah and Conjola State Forests in NSW. On the Central Coast, it occurs on Quaternary gravels, sands, silts and clays, in riparian gallery rainforests and remnant littoral rainforest communities. Plantings undertaken for horticultural and aesthetic purposes are not considered threatened species under the BC Act.	4	Present	Species
(Tetratheca glandulosa)	BioNet	V	-	Associated with ridgetop woodland habits on yellow earths also in sandy or rocky heath and scrub. Often associated with sandstone / shale interface where soils have a stronger clay influence. Flowers July to November.	1	None – suitable habitat not present	Species
Black-eyed Susan *(Tetratheca juncea)*	BioNet	V	V	Occurs on predominantly low nutrient soils with a dense grassy understorey of grasses although it has been recorded in heathland and moist forest. It is associated with dry open forest or woodland habitats dominated by *Corymbia gummifera, Eucalyptus capitellata, E. haemastoma* and *Angophora costata*. *Themeda australis* is generally the dominant ground cover. *T. juncea* also displays a preference for southern aspect slopes, although is slopes with different aspects. Flowers July to December.	13	None – suitable habitat not present	Species
Austral Toadflax *(Thesium australe)*	PMST	V	V	Widespread throughout the eastern third of NSW but most common on the North Western Slopes, Northern Tablelands and North Coast. Occurs in grassland or grassy woodland. Often found in damp sites in association with *Themeda australis*. The preferred soil type is a fertile loam derived from basalt although it occasionally occurs on metasediments and granite.	-	None – suitable habitat not present. No records in locality	Species
(*Zannichellia palustris)*	BioNet	E	-	In NSW, known from the lower Hunter and in Sydney Olympic Park. Grows in fresh or slightly saline stationary or slowly flowing water. Flowers during warmer months. NSW populations behave as annuals, dying back completely every summer	-	None – suitable habitat not present. No records in locality	Species

Common Name *(Scientific Name)*	Source	BC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
FUNGI							
An agaric fungus *(Hygrocybe collucera)*	BioNet	E	-	Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (Glochidion ferdinandi) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	1	None – suitable habitat not present	Species
An agaric fungus *(Hygrocybe grieoramosa)*	BioNet	E	-	Occurs in gallery warm temperate forests dominated by Lilly Pilly (Acmena smithii), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	1	None – suitable habitat not present	Species

Table A.4 Threatened fauna likelihood of occurrence

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Giant Burrowing Frog *(Heleioporus australiacus)*	PMST	V	V	Forages in woodlands, wet heath, dry and wet sclerophyll forest. Associated with semi-permanent to ephemeral sand or rock based streams, where the soil is soft and sandy so that burrows can be constructed.	-	None – suitable habitat not present. No records in locality	Species (land within 40 m of heath, woodland or forest)
Green and Golden Bell Frog *(Litoria aurea)*	BioNet SEARS	E	V	Utilises natural and man-made waterbodies such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands, stormwater basins, farm dams, bunded areas, drains, ditches and other structures capable of storing water. Preferable habitat includes shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading. Large permanent swamps and ponds exhibiting well-established fringing vegetation, adjacent to open grassland areas for foraging are preferable.	190	Known – species habitat occurs within the study area	Species (land within 100 m of emergent aquatic or riparian vegetation)
Growling Grass Frog, *(Litoria raniformis)*	PMST	E	V	Relatively still or slow-flowing sites such as billabongs, ponds, lakes or farm dams, especially where Typha sp., Eleocharis sp. and Phragmites sp. (Bulrushes) are present. This species is common in lignum shrublands, black box and River Red Gum woodlands, irrigation channels and at the periphery of rivers in the southern parts of NSW. This species occurs in vegetation types such as open grassland, open forest and ephemeral and permanent non-saline marshes and swamps. Open grassland and ephemeral permanent non-saline marshes and swamps have also been associated with this species.	-	None – suitable habitat not present. No records in locality	Species (land within 100 m of emergent aquatic or riparian vegetation)
Stuttering Frog *(Mixophyes balbus)*	PMST	E	V	Occurs in a variety of forest habitats from rainforest through wet and moist sclerophyll forest to riparian habitat in dry sclerophyll forest that are generally characterised by deep leaf litter or thick cover from understorey vegetation. Breeding habitats are streams and occasionally springs. Not known from streams disturbed by humans or still water environments.	-	None – suitable habitat not present. No records in locality	Species (rainforest or tall open wet forest with understorey and/or leaf litter and within 100 m of streams)

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Wallum Froglet *(Crinia tinnula)*	BioNet SEARS	V	-	The Wallum Frog is restricted to the Wallum swamps and associated low land meandering watercourses on coastal plains. Occurs in elevations up to around 50 m and is closely related to freshwater habitats in the coastal zone. Found most commonly in Wallum wetlands characterised by low nutrients, highly acidic, tannin-stained waters that are typically dominated by paperbarks and tea-trees. Also found in sedgeland and wet heathland.	1	None – suitable habitat not present	Species (land within 40m of coastal swamps and wet heaths)
Sydney Hawk Dragonfly *(Austrocordulia leonardi)*		E (FM Act)-	-	The known distribution of the species includes three locations in a small area south of Sydney, from Audley to Picton. The species is also known from the Hawkesbury-Nepean, Georges River and Port Hacking drainages. The Sydney Hawk Dragonfly has specific habitat requirements, and has only ever been collected from deep and shady riverine pools with cooler water. Larvae are found under rocks where they co-exist with *Austrocordulia refracta*.	-	None – suitable habitat not present. No records in locality	Not Applicable – FM Act species only
Adam's Emerald Dragonfly (*Archaeophya adamsi)*		E (FM Act)	-	Adam's Emerald Dragonflies are one of Australia's rarest dragonflies. The species is only known from a few sites in the greater Sydney region. Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian.	-	None – suitable habitat not present. No records in locality	Not Applicable – FM Act species only
Black Rockcod *(Epinephelus daemelii)*		V (FM Act)	V	They are found in warm temperate and subtropical parts of the south-western Pacific, and naturally occurred along the entire NSW coast including Lord Howe Island. Adult black cod are usually found in caves, gutters and beneath bomboras on rocky reefs. They are territorial and often occupy a particular cave for life. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries.	-	None – suitable habitat not present. No records in locality	Not Applicable – FM Act species only
Australian Grayling *(Prototroctes maraena)*		P (FM Act)	V	Australian grayling occur in freshwater streams and rivers, especially clear gravelly streams with a moderate flow, as well as estuarine areas. Australian grayling need to migrate to and from the sea to complete their life cycle (catadromous), and the construction of barriers such as dams and weirs has had a major impact on populations in some river systems.	-	None – suitable habitat not present. No records in locality	Not Applicable – FM Act species only

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Broad-headed Snake *(Hoplocephalus bungaroides)*	PMST	E	V	Typical sites consist of exposed sandstone outcrops and benching where the vegetation is predominantly woodland, open woodland and/or heath on Triassic sandstone of the Sydney Basin. They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer.	-	None – suitable habitat not present. No records in locality	Species (land within 500 m of sandstone escarpments with hollow-bearing trees, rock crevices or flat sandstone rocks on exposed cliff edges and sandstone outcropping)
Dusky Woodswallow *(Artamus cyanopterus cyanopterus)*	BioNet	V	-	The Dusky Woodswallow is often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests	6	None – suitable habitat not present	Not provided in Bionet (recently listed threatened species)
Regent Honeyeater *(Anthochaera phrygia)*	PMST	E	CE	Mostly occur in dry box-ironbark eucalypt woodland and dry sclerophyll forest associations, wherein they prefer the most fertile sites available, e.g. along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing *Casuarina cunninghamiana* (River Oak), and with *Amyema cambagei* (Needle-leaf Mistletoe) are also important for feeding and breeding. At times of food shortage (e.g. when flowering fails in preferred habitats), they also use other woodland types and wet lowland coastal forest dominated by *Eucalyptus robusta* (Swamp Mahogany) or *E. maculata* (Spotted Gum).	1	None – suitable habitat not present	Species

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Australasian Bittern *(Botaurus poiciloptilus)*	BioNet SEARS	E	E	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats. Found along the east coast and in the Murray-Darling Basin, notably in floodplain wetlands of the Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers. Favours permanent shallow waters, edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate. Also occurs in Lignum Muehlenbeckia florulenta and Canegrass *Eragrostis australasica* on inland wetlands.	1	None – suitable habitat not present	Species (land containing brackish or freshwater wetlands)
Bush Stone-curlew *(Burhinus grallarius)*	BioNet	E	-	Associated with dry open woodland with grassy areas, dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland. Forages in areas with fallen timber, leaf litter, little undergrowth and where grass is short and patchy. Is thought to require large tracts of habitat to support breeding, in which there is a preference for a sparely vegetated understorey.	5	None – suitable habitat not present. No records in locality	Ecosystem
Curlew Sandpiper *(Calidris ferruginea)*	PMST SEARS	E	CE	Intertidal mudflats of estuaries, lagoons, mangrove channels; around lakes, dams, floodwaters, flooded saltbush surrounds of inland lakes.	13	None – suitable habitat not present. No records in locality	Ecosystem
Great Knot *(Calidris tenuirostris)*	PMST SEARS		CE; Mi	Sheltered coastal habitats containing large intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and inlets, or exposed reefs or rock platforms.	1	None – suitable habitat not present. No records in locality	Ecosystem
Glossy Black-Cockatoo *(Calyptorhynchus lathami)*	BioNet	V	-	Associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils. Intact drier forest types with less rugged landscapes are preferred. Nests in large trees with large hollows.	1	Low – suitable habitat not present	Ecosystem
Eastern Bristlebird *(Dasyornis brachypterus)*	PMST	E	E	Habitat is characterised by dense, low vegetation and includes sedgeland, heathland, swampland, shrubland, sclerophyll forest and woodland, and rainforest, as well as open woodland with a heathy understorey. In northern NSW, it occurs in open forest with tussocky grass understorey. All of these vegetation types are fire prone, aside from the rainforest habitats utilised by the northern population as fire refuge.	-	None – suitable habitat not present. No records in locality	Species Dense (>80% projected cover) heath/sedgeland or woodland with dense heath understorey.

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
White-fronted Chat *(Epthianura albifrons)*	BioNet	V	-	Endemic to Australia, in particular southern regions of Australia. In NSW it occupies temperate to arid habitats from foothills to 1000 m altitude In NSW the White-fronted Chat occurs in open habitats near the coast in close proximity to waterways including estuaries, saltmarsh or marshy wetlands.	4	None – suitable habitat not present. No records in locality	Ecosystem
Red Goshawk *(Erythrotriorchis radiatus)*	PMST	E	V	Associated with forests and woodlands with a mosaic of vegetation types, an abundance of birds and permanent water. In NSW, this species is thought to favour mixed subtropical rainforest, Melaleuca Swamp Forest, and open eucalypt forest along rivers, often in rugged terrain. The Red Goshawk nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within 1 km of permanent water.	1	None – suitable habitat not present	Not provided for Sydney Metro CMA
Black Falcon *(Falco subniger)*	BioNet	V	-	Has broad range across inland regions New South Wales, where it has a sparse distributed. However, there are reports of 'Black Falcons' occurring on the tablelands and along the NSW coast. These reports are likely to represent Brown Falcons. In New South Wales there is assumed to be a single population that is continuous with a broader continental population, given that falcons are highly mobile, commonly travelling over hundreds of kilometres.	1	None – suitable habitat not present	Not provided in BioNet
Little Lorikeet *(Glossopsitta pusilla)*	BioNet	V	-	In New South Wales Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands White Box *Eucalyptus albens* and Yellow Box *E. melliodora* are particularly important food sources for pollen and nectar respectively.	1	None – suitable habitat not present. No records in locality	Ecosystem

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Painted Honeyeater *(Grantiella picta)*	PMST	V	V	A nomadic species that typically inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests with abundant mistletoe. It is a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias, preferring *Amyema sp mistletoe*.	-	None – suitable habitat not present. No records in locality	Ecosystem
Little Eagle *(Hieraaetus morphnoides)*	BioNet	V	-	The Little Eagle is widespread in mainland Australia, central and eastern New Guinea. The Little Eagle is seen over woodland and forested The population of Little Eagle in NSW is considered to be a single population. This species was recently listed as vulnerable due to a moderate reduction in population size based on geographic distribution and habitat quality lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest.	1	Low – suitable habitat not present	Ecosystem
Black Bittern *(Ixobrychus flavicollis)*	BioNet SEARS	V	-	Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation. In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves.	1	None – suitable habitat not present	Species (land within 40 m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation or emergent aquatic vegetation)
Swift Parrot *(Lathamus discolor)*	PMST	E	CE	Breeds in Tasmania between September and January. Feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts. Favoured feed trees include winter flowering species such as *Eucalyptus robusta*, *Corymbia maculata, C. gummifera, E. sideroxylon, E. albens* and *E. tereticornis.* Box-ironbark habitat in drainage lines, and coastal forest in NSW is thought to provide critical food resources during periods of drought or low food abundance elsewhere.	1	None – suitable habitat not present	Ecosystem

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Turquoise Parrot *(Neophema pulchella)*	BioNet	V	-	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species. Spends much of the time on the ground foraging on seed and grasses. It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs.	1	None – suitable habitat not present	Ecosystem
Scarlet Robin *(Petroica boodang)*	BioNet	V	-	Found in south-eastern and south-western Australia, as well as on Norfolk Island, from south of latitude 25°S from south-eastern Queensland along the coast of New South Wales (and inland to western slopes of Great Dividing Range) to Victoria and Tasmania, and west to Eyre Peninsula, South Australia. It lives in open forests and woodlands, but prefers rainforest habitats on Norfolk Island. During winter, it will visit more open habitats such as grasslands and will be seen in farmland and urban parks and gardens at this time.	1	None – suitable habitat not present	Ecosystem
Flame Robin *(Petroica phoenicea)*	BioNet	V	-	Flame Robins are found in a broad coastal band around the south-east corner of the Australian mainland, from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. Flame Robins prefer forests and woodlands up to about 1800 m above sea level.	1	None – suitable habitat not present	Ecosystem
Superb Fruit-Dove *(Ptilinopus superbus)*	BioNet	V	-	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees. Part of the population is migratory or nomadic. At least some of the population, particularly young birds, moves south through Sydney, especially in autumn. Breeding takes place from September to January.	7	Low – suitable habitat not present	Ecosystem
Diamond Firetail *(Stagonopleura guttata)*	BioNet	V	-	Typically found in grassy eucalypt woodlands, but also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. It is often found in riparian areas and sometimes in lightly wooded farmland. Appears to be sedentary, though some populations move locally, especially those in the south.	1	None – suitable habitat not present. No records in locality	Ecosystem

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Freckled Duck *(Stictonetta naevosa)*	BioNet	V	-	Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters.	1	None – suitable habitat not present	Ecosystem
Powerful Owl *(Ninox strenua)*	BioNet	V	-	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes. Large trees with hollows at least 0.5 m deep are required for shelter and breeding.	102	Low – suitable roosting habitat not present. Marginal foraging habitat may be present within site	Ecosystem
Masked Owl *(Tyto novaehollandiae)*	BioNet	V	-	Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland and especially the ecotone between wet and dry forest, and non-forest habitat. Known to utilise forest margins and isolated stands of trees within agricultural land and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained.	1	None – suitable roosting habitat not present	Ecosystem
Sooty Owl *(Tyto tenebricosa)*	BioNet	V	-	Associated with tall wet old growth forest on fertile soil with a dense under-storey and emergent tall Eucalyptus. Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes caves. Typically associated with an abundant and diverse supply of prey and a selection of large tree hollows.	1	None – suitable roosting habitat not present	Ecosystem
Large-eared Pied Bat *(Chalinolobus dwyeri)*	PMST	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces.	-	None – suitable habitat not present. No records in locality	Ecosystem and Species (land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels)

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Little Bentwing-bat *(Miniopterus australis)*	BioNet	V	-	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. It known to roost in caves, hollows and structures.	1	None – targeted surveys did not record this species. Suitable habitat not present	Ecosystem and Species
Eastern Bentwing Bat *(Miniopterus schreibersii oceanensis)*	BioNet SEARS	V	-	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland. It forages above and below the tree canopy on small insects. Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter.	4	TBC	Ecosystem and Species
Eastern Freetail-bat *(Mormopterus norfolkensis)*	BioNet	V	-	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range. Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges. Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut.	10	None – targeted surveys did not record this species. Suitable breeding habitat not present	Ecosystem
Southern Myotis *(Myotis macropus)*	BioNet SEARS	V	-	Occupies moist habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, as long as they are close to water. While roosting it is most commonly associated with caves, but has been observed to roost in tree hollows, amongst vegetation, in clumps of Pandanus, under bridges, in mines, tunnels and stormwater drains. Species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used.	2	TBC	Ecosystem and Species (hollow-bearing trees, bridges, caves or artificial structures within 200 m of riparian zone)
Yellow-bellied Sheathtail-bat *(Saccolaimus flaviventris)*	BioNet	V	-	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland, open country, mallee, rainforests, heathland and waterbodies. Roosts in tree hollows, but may also use caves; and has also been recorded in abandoned sugar glider nests. Dependent on hollows to provide roosts, which may be a limiting factor on populations in cleared or fragmented habitats.	-	Recorded Possible call from targeted surveys - foraging activity.	Ecosystem

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Grey-headed Flying-fox *(Pteropus poliocephalus)*	BioNet SEARS	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. Camps are often located in gullies, typically close to water, in vegetation with a dense canopy.	16	High – suitable foraging habitat only. No camps or roost sites within the site	Ecosystem and Species (Species credit species only if impacts occur to known camps or roost sites)
Long-nosed Bandicoot population in inner western Sydney *(Perameles nasuta)*	BioNet	EP	-	The Long-nosed Bandicoot is a medium sized marsupial with an extensive distribution throughout eastern Australia. The inner western Sydney population is restricted to the inner city suburbs within the Marrickville and Canada Bay local government areas (LGA) where it shelters beneath older houses and buildings and forages in parks and back yards. The full distribution of this species is unknown and may occur over a broader region.	25	None – targeted surveys did not record this species.	Species
Eastern Quoll *(Dasyurus viverrinus)*	PMST	E	CE	Associated with a variety of habitats, including dry sclerophyll forest, shrub, heath land, riparian forests and agricultural areas. Requires features such as hollow logs and rock piles for shelter.	1	None – suitable habitat not present	Not provided in BioNet
Spotted-tailed Quoll SE mainland population) *(Dasyurus maculatus maculatus)*	PMST	V	E	It inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests, more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in. Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows.	-	None – suitable habitat not present. No records in locality	Ecosystem
Greater Glider *(Petauroides volans)*	PMST	-	V	The greater glider is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and Woodlands. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	-	None – suitable habitat not present. No records in locality	Not provided in BioNet

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Brush-tailed Rock-wallaby *(Petrogale penicillata)*	PMST	E	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices.	-	None – suitable habitat not present. No records in locality	Species (land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines)
Koala (Combined populations of Qld, NSW and the ACT). *(Phascolarctos cinereus)*	PMST	V	V	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of about 10 to 70 per cent, with acceptable Eucalypt food trees. Some preferred Eucalyptus species are: *Eucalyptus tereticornis, E. punctata, E. cypellocarpa, E. viminalis.*	-	None – suitable habitat not present. No records in locality	Species
Southern Brown Bandicoot (Eastern) *(Isoodon obesulus obesulus)*	PMST	E	E	Associated with heath, coastal scrub, sedgeland, heathy forests, shrubland and woodland on well drained, infertile soils, within which they are typically found in areas of dense ground cover. Suitable habitat includes patches of native or exotic vegetation which contain understorey vegetation structure with 50–80 per cent average foliage density in the 0.2–1 m height range. Is thought to display a preference for newly regenerating heathland and other areas prone to fire, but requires a mosaic of burnt and unburnt areas for survival.	-	None – suitable habitat not present. No records in locality	Species
New Holland Mouse *(Pseudomys novaehollandiae)*	PMST	-	V	A small burrowing native rodent with a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Inhabits open heathlands, open woodlands with a heathland understorey and vegetated sand dunes. A social animal, living predominantly in burrows shared with other individuals. The home range of the New Holland Mouse ranges from 0.44 ha to 1.4 ha and the species peaks in abundance during early to mid-stages of vegetation succession typically induced by fire.	-	None – suitable habitat not present. No records in locality	Ecosystem
Common Sandpipe *(Actitis hypoleucos)*	BioNet SEARS		Mi	In Australia, it is found in coastal or inland wetlands, both saline and fresh. It is found mainly on muddy edges or rocky shores. During the breeding season in the northern hemisphere, it prefers freshwater lakes and shallow rivers.	1	Moderate – targeted survey did not detect species	Not applicable

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Fork-tailed Swift *(Apus pacificus)*	PMST	-	Mi	Sometimes travels with Needletails. Varied habitat with a possible tendency to more arid areas but also over coasts and urban areas.	6	None – suitable habitat not present	Not applicable
Cattle Egret *(Ardea ibis)*	SEARS	-	Ma	Forages on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes and they avoid marine environments. Likely to spend winter dispersed along the coastal plain and only a small number have been recovered west of the Dividing Range.	1	None – suitable habitat not present	Not applicable
Wedge-tailed Shearwater *(Ardenna pacificus)*	PMST	-	Mi	The Wedge-tailed Shearwater is a pelagic, marine bird known from tropical and subtropical waters. The species tolerates a range of surface-temperatures and salinities, but is most abundant where temperatures are greater than 21 °C and salinity is greater than 34.6 %.	4	None – suitable habitat not present	Not applicable
Ruddy Turnstone *(Arenaria interpes)*	PMST SEARS	-	Mi	Frequents beaches along the coast of NSW. Flies from Siberia or Alaska to Australia in August - September each year (ibid).	1	Moderate – targeted survey did not detect species	Not applicable
Sharp-tailed Sandpiper *(Calidris acuminata)*	PMST SEARS	-	Mi	It prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewerage treatment ponds, flooded grasslands, mudflats, mangroves, rocky shores and beaches.	12	Moderate – targeted survey did not detect species	Not applicable
Sanderling *(Calidris alba)*	PMST SEARS	-	Mi	Occur in coastal areas on low beaches, near reefs and inlets along tidal mudflats and bare open coastal lagoons. Rarely seen in near-coastal wetlands such as lagoons, hypersaline lakes, saltponds and samphire flats.	2	Moderate – targeted survey did not detect species	Not applicable
Red Knot *(Calidris canutus)*	PMST SEARS	-	Mi	Red Knots are widespread around the Australian coast, less in the south and with few inland records. Small numbers visit Tasmania and off-shore islands. It is widespread but scattered in New Zealand. They breed in North America, Russia, Greenland and Spitsbergen. Red Knots are a non-breeding visitor to most continents.	1	Moderate – targeted survey did not detect species	Not applicable
Pectoral Sandpiper *(Calidris melanotos)*	PMST	-	Mi	Prefers shallow fresh to saline wetlands, found at coastal lagoons, estuaries, bays, swamps, inundated grasslands, saltmarshes and artificial wetlands. This species breeds in the Northern Hemisphere.	9	None – targeted survey did not detect species	Not applicable

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Red-necked Stint *(Calidris ruficollis)*	PMST SEARS	-	Mi	The Red-necked Stint breeds in north-eastern Siberia and northern and western Alaska. It follows the East Asian-Australasian Flyway to spend the southern summer months in Australia. It is found widely in Australia, except in the arid inland. In Australia, Red-necked Stints are found on the coast, in sheltered inlets, bays, lagoons, estuaries, intertidal mudflats and protected sandy or coralline shores. They may also be seen in saltworks, sewage farms, saltmarsh, shallow wetlands including lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats, flooded paddocks or damp grasslands. They are often in dense flocks, feeding or roosting.	18	Moderate – targeted survey did not detect species	Not applicable
Greater Sand-plover *(Charadrius leschenaultii)*	PMST SEARS	-	Mi	Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries, roosting during high tide on sandy beaches or rocky shores.)	3	Moderate – targeted survey did not detect species	Not applicable
Lesser Sand-plover *(Charadrius mongolus)*	PMST SEARS	-	Mi	Favours coastal areas including beaches, mudflats and mangroves where they forage. They may be seen roosting during high tide on sandy beaches or rocky shores.	1	Moderate – targeted survey did not detect species	Not applicable
Oriental Cuckoo *(Cuculus optatus)*	PMST	-	Mi	It mainly inhabits forests, occurring in coniferous, deciduous and mixed forest. It feeds mainly on insects and their larvae, foraging for them in trees and bushes as well as on the ground.	-	None – suitable habitat not present. No records in locality	Not applicable
Latham's Snipe *(Gallinago hardwickii)*	PMST	-	Mi	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover. Occupies a variety of vegetation around wetlands including wetland grasses and open wooded swamps.	9	None – suitable habitat not present	Not applicable
Sooty Oystercatcher *(Haematopus fuliginosus)*	PMST SEARS	-	Mi	A coastal species that inhabits rock coastlines, coral cays, reefs and occasionally sandy beaches.	1	Low – targeted survey did not detect species	Not applicable
Pied Oystercatcher *(Haematopus longirostris)*	PMST SEARS	-	Mi	Roosts and forages on sandy beaches, sand banks, mudflats and estuaries.	3	Low – targeted survey did not detect species	Not applicable

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
White-bellied Sea-Eagle *(Haliaeetus leucogaster)*	PMST	-	Mi	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas. Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away.	25	None – suitable habitat not present	Not applicable
White-throated Needletail *(Hirundapus caudacutus)*	PMST SEARS	-	Mi	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas. Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather.	1	Low – suitable habitat present bit project not likely to impact on suitable habitat	Not applicable
Caspian tern *(Hydrophone caspia)*	PMST	-	Mi	The Caspian Tern is mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and saltworks.	3	None – suitable habitat not present	Not applicable
Broad-billed Sandpipe *(Limicola falcinellus)*	PMST SEARS	V	Mi	It breeds in northern Siberia before migrating southwards in winter to Australia on the northern coast, particularly in the north-west, with birds located occasionally on the southern coast. In NSW, the main site for the species is the Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary. Broad-billed Sandpipers favour sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat .	2	Moderate – targeted survey did not detect species	Not applicable
Bar-tailed Godwit *(Limosa lapponica)*	PMST SEARS	-	Mi	Mainly coastal, usually sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats. Breeds in Northern Russia, Scandinavia, NW Alaska.	5	Moderate – targeted survey did not detect species	Not applicable
Black-tailed Godwit *(Limosa limosa)*	PMST SEARS	-	Mi	Primarily found along the coast on sandspits, lagoons and mudflats. The species has also been found to occur inland on mudflats or shallow receding waters of portions of large muddy swamps or lakes.	2	Moderate – targeted survey did not detect species	Not applicable

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Rainbow Bee-eater *(Merops ornatus)*	PMST	-	Mi	Resident in coastal and subcoastal northern Australia; regular breeding migrant in southern Australia, arriving September to October, departing February to March. Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs.	-	None – suitable habitat not present. No records in locality	Not applicable
Black-faced Monarch *(Monarcha melanopsis)*	PMST	-	Mi	Rainforest and eucalypt forests, feeding in tangled understorey.	-	None – suitable habitat not present. No records in locality	Not applicable
Spectacled Monarch *(Monarcha melanopsis)*	PMST	-	Mi	Rainforest and eucalypt forests, feeding in tangled understorey.	-	None – suitable habitat not present. No records in locality	Not applicable
Yellow Wagtail *(Motacilla flava)*	PMST	-	Mi	An insectivorous bird, inhabiting open country near water, such as wet meadows. It nests in tussocks.	-	None – suitable habitat not present. No records in locality	Not applicable
Satin Flycatcher *(Myiagra cyanoleuca)*	PMST	-	Mi	Wetter, denser forest, often at high elevations	-	None – suitable habitat not present. No records in locality	Not applicable
Eastern Curlew *(Numenius madagascariensis)*	PMST SEARS	-	CE	Intertidal coastal mudflats, coastal lagoons, sandy spits. Breeds in Russia and NE China (ibid).	1	Moderate – targeted survey did not detect species	Not applicable
Little Curlew *(Numenius minutus)*	PMST	-	Mi	The Little Curlew is known to breed in Siberia, with migrants arriving after early April. Southern migration begins in September following the Chinese coast and, after a staging in Mongolia, continues to Northern Australia and New Guinea. Outside of the breeding season, the species inhabits grasslands, open plains, parklands and mud-flats of Northern Australia.	2	None – targeted survey did not detect species	Not applicable

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Whimbrel *(Numernius phaeopus)*	PMST	-	Mi	Intertidal coastal mudflats, river deltas and mangroves, occasionally sandy beaches. Breeds Siberia and Alaska (ibid.).	1	None – targeted survey did not detect species	Not applicable
Pacific Golden Plover *(Pluvialis fulva)*	PMST SEARS	-	Mi	Breeds North Siberia, Alaska. Mainly coastal, beaches, mudflats and sandflats and other open areas such as recreational playing fields in Australia (ibid.).	1	Moderate – targeted survey did not detect species	Not applicable
Rufous Fantail *(Rhipidura rufifrons)*	PMST	-	Mi	Summer breeding migrant to south-eastern Australia. The Rufous Fantail is found in rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation. Open country may be used by the Rufous Fantail during migration.	-	None – suitable habitat not present. No records in locality	Not applicable
Common Tern *(Sterna hirundo)*	PMST	-	Mi	Common Terns are marine, pelagic and coastal. In Australia, they are recorded in all marine zones, but are commonly observed in near-coastal waters, both on ocean beaches, platforms and headlands and in sheltered waters, such as bays, harbours and estuaries with muddy, sandy or rocky shores.	15	None – targeted survey did not detect species	Not applicable
Little Tern *(Sternula albifrons)*	PMST SEARS	E	Mi	Almost exclusively coastal, preferring sheltered areas, however may occur several kilometres inland in harbours, inlets and rivers. Australian birds breed on sandy beaches and sand spits.	36	None – targeted survey did not detect species	Species Land within 40 m of inshore coastal waters or shallow waters of estuaries, coastal lagoons and/or lakes)
Grey-tailed Tattler *(Tringa brevipes)*	PMST	-	Mi	Found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. It can also be found at intertidal rocky, coral or stony reefs as well as platforms and islets that are exposed at low tide.	3	None – targeted survey did not detect species	Not applicable
Wood Sanpiper *(Tringa glareola)*	PMST	-	Mi	Uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially Melaleuca and River Red Gums.	2	None – targeted survey did not detect species	Not applicable

Common Name *(Scientific Name)*	Source	TSC Act	EPBC Act	Habitat requirements	Number of records	Likelihood of occurrence	Ecosystem or species credit?
Wandering Tattler *(Tringa incana)*	PMST SEARS	-	Mi	Uses rocky coasts with reefs and platforms, offshore islands, shingle beaches or beds and occasionally uses coral reefs or beaches.	1	None – targeted survey did not detect species	Not applicable
Common Greenshank *(Tringa nebularia)*	PMST	-	Mi	Found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms	2	None – targeted survey did not detect species	Not applicable
Marsh Sandpiper *(Tringa stagnatilis)*	PMST	-	Mi	Coastal - Permanent or ephemeral wetlands of varying degrees of salinity, commonly inland. Breeds Eastern Europe to Eastern Siberia.	2	None – targeted survey did not detect species	Not applicable
Terek Sandpiper *Xenus cinereus*	PMST SEARS	V	Mi	In Australia, has been recorded on coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 km inland around brackish pools.	3	Moderate – targeted survey did not detect species	Not applicable

Annexure B Vegetation plot data

Recorded flora with cover and abundance according to BAM

Scientific name	Common name	Growth Form	1 C	1 A	2 C	2 A	3 C	3 A
Acacia longifolia	-	Shrub (SG)			1	5		
Acacia longifolia subsp. sophorae	Coastal Wattle	Shrub (SG)						
Acacia ulicifolia	Prickly Moses	Shrub (SG)			0.2	2		
Allocasuarina littoralis	Black She-oak	Tree (TG)			0.1	1		
Anredera cordifolia	Madeira Vine	0					2	100
Araujia sericifera	Moth Vine	0						
Avena barbata	Bearded Oats	0						
Banksia integrifolia	Coast Banksia	Tree (TG)			0.5	1		
Banksia serrata	Old-man Banksia	Tree (TG)			0.1	4		
Bidens pilosa	Cobblers Pegs	0			0.1	7	0.1	20
Breynia oblongifolia	Coffee Bush	Shrub (SG)			3	10		
Bromus catharticus	Prairie Grass	0	2	10	0.1	7	0.1	20
Callistemon spp.	-	Shrub (SG)	2	1				
Canna indica	Tous-les-mois Arrowroot	0					1	10
Carex appressa	Tall Sedge	Grass & grasslike (GG)			2	100		
Casuarina glauca	Swamp Oak	Tree (TG)	20	100				
Centaurium tenuiflorum	-	0						
Cestrum parqui	Green Cestrum	0					10	20
Chrysanthemoides monilifera	Bitou Bush	0						
Cinnamomum camphora	Camphor Laurel	0	1	2	0.1	1		
Commelina cyanea	-	Forb (FG)			2	50		
Conyza bonariensis	Flaxleaf Fleabane	0						
Cynodon dactylon	Couch	Grass & grasslike (GG)	5	1000				
Dianella caerulea	Blue Flax-lily	Forb (FG)	1	5				
Dianella spp.	-	Forb (FG)			2	20		
Dodonaea triquetra	Large-leaf Hop-bush	Shrub (SG)			0.3	3		
Ehrharta erecta	Panic Veldtgrass	0	5	1000	0.1	5		
Entolasia marginata	Bordered Panic	Grass & grasslike (GG)			0.1	1		
Erythrina spp.	-	0	1	1			0.1	1
Eucalyptus robusta	Swamp Mahogany	Tree (TG)			70	15		
Eucalyptus tereticornis	Forest Red Gum	Tree (TG)	2	1				

Scientific name	Common name	Growth Form	1 C	1 A	2 C	2 A	3 C	3 A
Euphorbia peplus	Petty Spurge	0	3	200				
Ficus spp.	-	0	1	5				
Foeniculum vulgare	Fennel	0					0.1	10
Gahnia spp.	-	Grass & grasslike (GG)			0.5	6		
Hardenbergia violacea	Purple Coral Pea	Other (OG)			1	3		
Hibbertia scandens	Climbing Guinea Flower	Other (OG)			0.5	5		
Homalanthus populifolius	Bleeding Heart	Shrub (SG)			5	20		
Hydrocotyle bonariensis	Largeleaf Pennywort	0					2	100
Hypochaeris radicata	Catsear	0	1	3				
Imperata cylindrica	Blady Grass	Grass & grasslike (GG)			8	200		
Ipomoea alba	-	0					2	20
Lactuca spp.	-	0	1	5				
Lantana camara	Lantana	0						
Leptospermum laevigatum	Coast Teatree	Shrub (SG)			10	40		
Leptospermum polygalifolium	Tantoon	Shrub (SG)			0.1	1		
Leucopogon juniperinus	Prickly Beard-heath	Shrub (SG)			0.1	1		
Lolium perenne	Perennial Ryegrass	0						
Lomandra longifolia	Spiny-headed mat-rush	Grass & grasslike (GG)			4	50		
Medicago spp.	-	0						
Melaleuca quinquenervia	Broad-leaved Paperbark	Tree (TG)	5	5				
Microlaena stipoides	Weeping Grass	Grass & grasslike (GG)			3	100		
Modiola caroliniana	Red-flowered Mallow	0	0.5	100				
Ochna serrulata	Mickey Mouse Plant	0	1	2				
Oplismenus aemulus	Australian Basket Grass	Grass & grasslike (GG)			0.5	3		
Ozothamnus diosmifolius	Rice Flour	Shrub (SG)			0.1	2		
Parietaria judaica	Pellitory	0						
Paronychia brasiliana	Chilean Whitlow Wort	0	1	50				
Pennisetum clandestinum	Kikuyu	0	2	200			30	1000
Phragmites australis	Common Reed	Grass & grasslike (GG)	2	50	0.1	1	25	1000

Scientific name	Common name	Growth Form	1 C	1 A	2 C	2 A	3 C	3 A
Pittosporum undulatum	Native Daphne	Shrub (SG)	2	1				
Plantago lanceolata	Lamb's Tongues	0						
Podocarpus elatus	Plum Pine	Tree (TG)	1	1				
Pomax umbellata	-	Forb (FG)			0.1	2		
Pteridium esculentum	Common Bracken	Fern (EG)					0.1	2
Ricinus communis	Castor Oil Plant	0						
Rubus fruticosus sp. agg.	Blackberry	0					3	5
Rumex crispus	Curled Duck	0					0.1	10
Senecio madagascariensis	Fireweed	0						
Sida rhombifolia	Paddy's Lucerne	0	0.5	100				
Solanum nigrum	Black-berry Nightshade	0			0.1	7		
Solanum spp.	-	Forb (FG)					2	0.1
Sonchus spp.	-	0	1	3				
Sonchus oleraceus	Common Sowthistle	0			0.1	3		
Synoum glandulosum subsp. glandulosum	Scentless Rosewood	Shrub (SG)	1	0.1	0.1	5		
Taraxacum officinale	Dandelion	0						
Themeda triandra	Kangaroo Grass	Grass & grasslike (GG)			0.1	1		
Tradescantia fluminensis	Wandering Jew	0					3	1
Trifolium spp.	-	0						
Typha orientalis	Broadleaf Cumbungi	Grass & grasslike (GG)					5	100
Verbena bonariensis	Purpletop	0						
Verbena spp.	-	Forb (FG)						

Notes:

C = cover of plant species within the full floristics plot

A = abundance of plant species within the full floristics plot

Annexure C - Biodiversity credit report

NSW GOVERNMENT

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00009652/BAAS17001/18/00009654

Proposal Name
F6 Extension Stage 1_footprint 23Feb2018

Report Created
26/03/2018

Assessor Name
Meredith Henderson

Assessor Number
0

Proponent Names

Candidate Serious and Irreversible Impacts

No Data

No Data

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

NSW GOVERNMENT

BAM Biodiversity Credit Report (Like for like)

Predicted Threatened Species Not On Site

Name
Dasyurus maculatus / Spotted-tailed Quoll
Lathamus discolor / Swift Parrot
Ninox strenua / Powerful Owl
Phascolarctos cinereus / Koala
Tyto novaehollandiae / Masked Owl
Varanus rosenbergi / Rosenberg's Goanna
Anthochaera phrygia / Regent Honeyeater
Daphoenositta chrysoptera / Varied Sittella
Limicola falcinellus / Broad-billed Sandpiper

Ecosystem Credit Summary

PCT	TEC	Area	Credits
1232-Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.5	8.00
1795-Swamp Mahogany / Cabbage Tree Palm - Cheese Tree - Swamp Oak tall open forest on poorly drained coastal alluvium in the Sydney basin	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.3	11.00

NSW GOVERNMENT

BAM Biodiversity Credit Report (Like for like)

1808-Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.8	8.00

Credit classes for 1232

Like-for-like options

Any PCT with the below TEC	Containing HBT	In the below IBRA subregions
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (including PCT's 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808)	Yes	Pittwater,Cumberland, Sydney Cataract, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Credit classes for 1795

Like-for-like options

Any PCT with the below TEC	Containing HBT	In the below IBRA subregions
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (including PCT's 837, 839, 971, 1064, 1092, 1227, 1230, 1231, 1232, 1235, 1649, 1715, 1716, 1717, 1718, 1719, 1721, 1722, 1723, 1724, 1725, 1730, 1795, 1798)	Yes	Pittwater,Cumberland, Sydney Cataract, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

NSW GOVERNMENT

BAM Biodiversity Credit Report (Like for like)

Credit classes for 1795	
Credit classes for 1808	**Like-for-like options**

Any PCT with the below TEC	Containing HBT	In the below IBRA subregions
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (including PCT's 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808)	No	Pittwater,Cumberland, Sydney Cataract, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

No Species Credit Data

Annexure D EPBC Act impact assessment

Threatened species

The project area is considered to contain potential habitat for the following threatened species:

- *Litoria aurea* (Green and Golden Bell Frog) (Vulnerable under the EPBC Act)
- *Pteropus poliocephalus* (Grey-headed Flying Fox) (Vulnerable under the EPBC Act)
- *Syzygium paniculatum* (Magenta Lilly Pilly) (endangered under the EPBC Act).

The Arncliffe population of Green and Golden Bell Frog prior to the construction of the-M5 East was centred on the Marsh Street Wetland. With the construction of the M5 East, impacts to the Marsh Street Wetland precipitated the construction of the 'RTA Ponds' to the north-east of the M5 East. The RTA Ponds were purpose built breeding ponds located along Marsh Street, adjacent to the Southern and Western Sydney Ocean Outfall System (SWSOOS) and the Kogarah Golf Course. The population in and around the RTA Ponds and Kogarah Golf Course was monitored annually (Biosphere Environmental Consulting 2003-2015).

The population was considered stable up to April 2015, after which the population has been in decline. The decline has been attributed to poor climatic conditions and predation. (Biosphere 2017).

In 2016, the New M5 Motorway was approved for construction. Part of the approval for the New M5 Motorway was the development of management plans, including the requirement to establish an insurance population of Green and Golden Bell Frog in captivity. A total of 18 adult frogs were captured between 2016 and 2018 and transferred to the captive breeding habitat facility (A. White, pers. comm. 2017).

The population monitoring from prior to the commencement of the construction of the Marsh St widening project and the New M5 Motorway to now, has revealed that the frogs do not appear to be using the RTA ponds as breeding habitat.

Surveys for Green and Golden Bell Frog indicated that individuals were last detected between November 2016 and March 2017 near a detention basin at Riverine Park, south of the SWSOOS, Kogarah Golf Course and RTA Ponds. Eight adults were observed (White, pers. Comm. 2017). Two of these adults were taken as part of the captive breeding program for the New M5 Motorway.

The proposed action also contains potential foraging habitat for *Pteropus poliocephalus* (Grey-headed Flying Fox). The potential foraging habitat is at Rockdale Bicentennial Park where there are numerous planted *Ficus hillii*, *Eucalyptus robusta* and *Eucalyptus botryoides* x *saligna* among other potential food sources. No breeding camps occur within the project area, however there is a large camp at Turella, which is close to the project area. Due to the surface works at Rockdale, the proposed action would impact on the potential foraging habitat, but would not directly impact on any breeding camp.

The proposed action area contains known habitat for *Syzygium paniculatum* (Magenta Lilly Pilly). About 20 adult individuals were recorded at Rockdale Bicentennial Park in landscape plantings. These adult plants were not fruiting or flowering and their origins are unknown, although they are likely to have been planted as part of the park landscaping. While the plants present are within the natural range of this species, this site is not known as part of the natural populations of the species. Surface works at Rockdale Bicentennial Park would impact on some of these planted individuals.

Impact assessment Green and Golden Bell Frog

The significant impact guidelines (DEWHA 2009) for this species outlines there is a potential for a significant impact to occur if the action results in:

- 1 - The removal or degradation of aquatic or ephemeral habitat where the green and golden bell from has been recorded since 1995 or habitat that has been assessed as being suitable according to the guidelines. This can include impacts from chytrid, Gambusia originating off-site.
- 2 - The removal or degradation of terrestrial habitat within 200 m of habitat identified in threshold 1
- 3 - Breaking the continuity of vegetation fringing ephemeral or permanent waterways or other vegetated corridors linking habitats meeting the criteria in threshold 1.

The significant impact thresholds above give guidance to the level of impact that is likely to be significant for the species at a site. They are not intended to be exhaustive or prescriptive, but rather to highlight the need to maintain the ecological function of the habitat.

Within the Arncliffe key population, the species has been observed numerous times since 1995, specifically around the RTA Ponds and on the Kogarah Golf Course, as part of annual monitoring surveys and public sightings. Part of the area where the species has been recorded, is subject to a Controlled Action decision by the Commonwealth (EPBC 2015/7520).

This proposed action is to include use of the existing construction site near the RTA Ponds (the Arncliffe Site Works Area). This Site Works Area was part of the New M5 Motorway construction works compound and was approved by the Commonwealth in 2016.

The RTA ponds and habitat on the Kogarah Golf course have been surveyed yearly since 2000. In 2016, the search area was expanded to include Riverine Park to the south of the M5 East.

No adult frogs have been detected within the RTA ponds since October 2016, despite annual monitoring in 2016, 2017 and 2018 which has been completed to be consistent with an approved management plan (associated with the approved action (New M5 Motorway)), and suitable survey conditions. Similarly, frogs have not been sighted on the Kogarah Golf Course in the habitat adjacent to the New M5 Motorway construction compound since December 2016, despite the above surveys.

Despite the lack of frogs detected recently at the RTA Ponds and Kogarah Golf Course, the proposed action has the potential to indirectly impact on historically occupied habitat, where frogs have been recorded since 1995 and could be used for foraging and dispersal.

The proposed action would not break continuity of vegetation fringing ephemeral or permanent waterways or other vegetated corridors linking terrestrial and aquatic habitats. No aquatic habitats are proposed to be affected on by the action. The proposed action would occur on an area that has already been cleared as part of an approved action, thus avoiding the need to impact on more Green and Golden Bell Frog habitat.

To further examine whether the proposed action is likely to result in a significantly impact upon this species, the impact assessment guidelines for matters of National Environmental Significance were also examined.

The significant impact criteria for vulnerable species have been considered. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will

- **Lead to a long-term decrease in the size of an important population of a species:**

The proposed action is unlikely to lead to long term decrease in the population at Arncliffe.

The population at Arncliffe is dynamic and since 1998, when regular monitoring commenced, has generally centred on the Marsh Street wetland and RTA ponds following their establishment in 2003 (see map below).

Surveys were conducted annually at the RTA Ponds and Kogarah Golf Course between 2003 and the present.

Prior to the construction of the New M5 Motorway (in July 2016), there was a noticeable decrease in the number of frogs detected (A. White pers. comm. 2017). This was thought to have been via predation and less favourable climatic conditions.

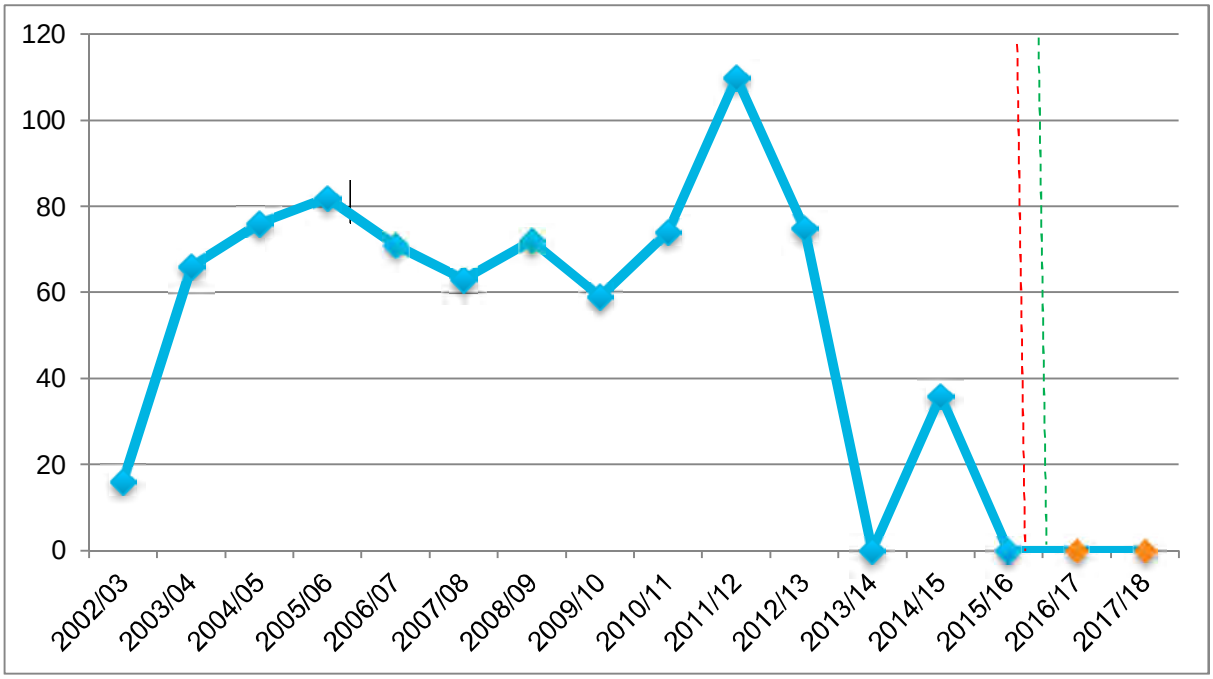
The population at Arncliffe has not been detected at the RTA ponds since October 2016, nor at the Kogarah Golf Course since December 2016, despite intensive annual monitoring in suitable conditions (see graph below). One adult frog was detected in March 2018 about 260 metres south east of the New M5 Motorway construction compound in margrave vegetation. Adult frogs were found at Riverine Park south of the proposed action in late 2016 and early 2017.

The proposed action is unlikely to lead to long term decrease in the population at Arncliffe. This is because frogs that form part of the Arncliffe important population (including previously micro-chipped individuals) have been detected at Riverine Park, south of the Arncliffe Site Works Area and RTA Ponds, and not at the Arncliffe Site Works area itself. Furthermore, despite a reduction in frog sightings, none of suitable habitat where frogs have previously been recorded will be directly impacted.

Indirect impacts are expected to arise on historically occupied habitat and would include dust, light spill and noise. However these indirect impacts are expected to be less than those for the New M5 Motorway. This is because the bulk earthworks for the construction of the works compound has already occurred, truck movements are expected to be fewer, resulting in less dust, noise and vibration within the Arncliffe construction ancillary facility than experienced for the New M5 Motorway. These indirect impacts would occur for the duration of construction only and would cease at the commencement of operation.

Frogs were detected in aquatic habitat in Riverine Park in January and March 2017. It is possible that these have been recorded as a result of a recent increase in survey areas and effort. The basin where they were detected is not managed for Gambusia as it has not been constructed to be drained and refilled for the purposes of Green and Golden Bell Frog breeding.

The graph below outlines the approximate population number at the RTA Ponds and Kogarah Golf Course. The dotted red line indicates when the Marsh Street widening project was commenced (in about April 2016) and the green dotted line indicates when the New M5 Motorway commenced (in July 2016). While there were no significant droughts during this time, anecdotally there are localised rainfall deficits that have occurred 2015/2016 survey season (A. White pers. comm. 2018).



- **Reduce an area of occupancy in such a manner as to result in a significant impact upon an important population:**

The proposed action would not reduce an area of occupancy in such a manner as to result in a significant impact upon an important population.

The area proposed for use at the Arncliffe construction ancillary facility has already been cleared as part of an approved action, and therefore would not reduce an area at of occupancy.

- **Fragment an important population into two or more populations:**

The proposed action would not fragment an important population into two or more populations.

The proposed action would make use of an area that has already been cleared, thus avoiding the need to clear new areas. Annual intensive surveys indicate that the Green and Golden Bell Frog no longer occurs at the RTA Ponds or on the Kogarah Golf Course adjacent to the New M5 Motorway construction compound. There were about eight adults detected at Riverine Park between January and March 2017 (A. White, pers. comm; BioNet records 2018), however this area would not be affected as part of this action. If there are still adults present at Riverine Park, the population would still be able to use the land at Kogarah Golf Course and potentially disperse south and west. Since 1998, the frogs have been using various habitats in and around the suburb of Arncliffe.

There would be no large barrier that would prevent movement, or fragment the population into two or more populations.

- **Adversely affect habitat critical to the survival of a species:**

The proposed action is unlikely to adversely affect habitat critical to the survival of the population.

The RTA ponds were a known breeding area for the frogs in the past. As part of the approved action (the New M5 Motorway), adult frogs were collected from the Arncliffe Site Works Area, and have been taken off site as part of an ongoing captive breeding program. The proposed action would not prevent or modify habitat at the RTA Ponds for release of these, or captive bred individuals.

No frogs have been detected around the Arncliffe Site Works Area or at the RTA ponds since October 2016.

- **Disrupt the breeding cycle of an important population:**

The proposed action is not likely to disrupt breeding of the population as the breeding habitat at the RTA ponds would remain and no direct impacts to these ponds are proposed. The RTA ponds appear to have been abandoned by the frogs in recent years and no evidence of breeding has been detected during the 2016/2017 monitoring season at the RTA ponds (A White pers. comm. 2017).

- **Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline:**

The proposed action will not lead to modification of dispersal and shelter habitat at the Site Works Area in Arncliffe, near the RTA Ponds.

No frogs have been found in the area subject to the proposed action. Moreover, the proposed action would occur on land that has been disturbed as part of the New M5 Motorway, rather than disturbing other habitat.

There may be potential indirect impacts such as noise, vibration and dust during the use of the construction compound near the RTA Ponds. These potential indirect impacts would be temporary and would not continue past the construction period.

- **Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat:**

The proposed action is not likely to result in the introduction of a species harmful to the population. There is a plan of management in place to minimise the risks of this predatory species reaching the RTA ponds.

- **Introduce disease that may cause the species to decline:**

The proposed action will not introduce a disease that would cause the species to decline. There are existing strict hygiene protocols in place to manage the chytrid fungus and these would be expected to continue if this action was approved.

- **Interfere with the recovery of the species:**

The proposed action is not likely to interfere with the recovery of the species. The project is unlikely to substantially interfere with the management plan put in place for the local population as part of the New M5 Motorway beyond potentially delaying release of captively bred frogs into the RTA ponds due to concerns about ongoing indirect impacts. This decision will be made closer to the time of release and in consultation with relevant experts and relevant Agencies.

There are likely to be cumulative and indirect impacts from continued use of the Arncliffe Site Works Area. Impacts would include potential for noise, vibration, dust and light impacts. These impacts would be temporary and would occur during construction. However, it is unlikely that the impacts at this location would significantly affect the Green and Golden Bell Frog population. This is mainly because the area has already been disturbed, no undisturbed habitat would be cleared or modified as part of this proposed action and no frogs have been recorded at the RTA Ponds or on Kogarah Golf Course since October 2016.

Impact assessment for Grey-headed Flying-fox

The Grey-headed Flying Fox does not have any camps present in the area subject to the proposed action. This species is likely to occasionally use canopy species for foraging. There are two Nationally Important camps within 10 km of the project area. One is located at Centennial Park, the other at Turrella. There is potential foraging habitat within the project area at Rockdale Bicentennial Park. The foraging habitat consists of a mix of planted native and exotic species including non-indigenous eucalypts, figs and Eucalyptus species.

The significant impact criteria for vulnerable species have been considered:

- **Lead to a long-term decrease in the size of an important population of a species:**

The proposed action is unlikely to lead to a long-term decrease in the sized on an important population. For Grey-headed Flying Fox, the entire population within Australia is considered important, as it intermixes throughout its extent. The removal of a small number of potential foraging trees is unlikely to reduce the population overall. The proposed action is largely an underground development, which has avoided other potential habitat including street trees.

- **Reduce an area of occupancy in such a manner as to result in a significant impact upon an important population:**

The action would not reduce an area of occupancy for this important population. While the removal of some canopy forage species is unavoidable, the proposed action would not reduce the area of occupancy. The population is still likely to remain along the length of the eastern seaboard and within the Sydney urban area. No camps would be directly impacted.

The proposed action would potentially result in indirect impacts such as noise and light impacts, however it is unlikely that these impacts would affect the camps at either Turrella or at Centennial Park.

- **Fragment an important population into two or more populations:**

The proposed action would not fragment an important population into two or more populations. The important population of Grey-headed Flying Foxes includes all individuals within Australia. Impacts to a small area of potential foraging habitat is unlikely to significantly impact on the population such that it is fragmented.

- **Adversely affect habitat critical to the survival of a species:**

The proposed action would adversely affect habitat critical to the survival of the population. Habitat critical to the survival of this species includes foraging habitat within 50 km of a camp which supports more than 30,000 individuals (among other things). The area subject to the proposed action is about 10 km south-west of a long-term camp at Centennial Park. This camp has supported between 16,000 and 49,000 individuals since November 2016. Therefore, foraging habitat within 50 km of this camp must be considered as critical to the survival of the population. The foraging habitat proposed for removal would be a relatively small area and therefore a small proportion of the total potential foraging habitat available to this population.

- **Disrupt the breeding cycle of an important population:**

The proposed action is not likely to disrupt breeding of the population as there are no breeding camps close to the proposed action. There is a camp at Turrella, which is about 1.9km north-west of the proposed action. While the proposed action may result in increased light and noise during construction at the Rockdale Bicentennial Park, this is unlikely to disrupt breeding. Noise and light are disturbances already impacting on the Turrella camp from the surrounding urban land use, roads and industry. Given the distance to the camp site, it is unlikely that the construction impacts would significantly impact on breeding at Turrella.

- **Modify, destroy, remove or isolate or decrease: the availability or quality of habitat to the extent that the species is likely to decline:**

The proposed action would not significantly modify or isolate habitat for this species. While the habitat likely to be impacted is potential foraging habitat, the small area of habitat and its relatively urban context would not present a barrier to movement or breeding for this species. Grey-headed Flying Fox forage across a wide range of vegetation.

- **Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat:**

The proposed action is not likely to result in the introduction of a species harmful to the population. No species have been listed as likely to predate on Grey-headed Flying Fox. The proposed action is unlikely to introduce any species that would reduce habitat quality or increase impacts to the population.

- Introduce disease that may cause the species to decline:

The proposed action will not introduce a disease that would cause the species to decline. The population of Grey-headed Flying Fox is a reservoir for the Australian Bat Lyssa Virus. The proposed action would not introduce this virus to any camp as all camps and individuals are assumed to be carriers of this virus.

- **Interfere with the recovery of the species:**

The proposed action is not likely to interfere with the recovery of the species. The species would remain at the two closest camps at Turrella and Centennial Park and along the east coast in general. By tunnelling, the project has largely avoided impacts to other areas where potential foraging habitat is located.

The proposed action is not likely to result in a significant impact on this species.

Impact assessment for *Syzygium paniculatum* (Magenta Lilly Pilly)

Planted individuals of this species were found at the Rockdale Bicentennial Parkland. Twenty adult plants were observed adjacent to a public walking track. No juveniles were observed and there was no evidence of recent flowering or fruiting. It is considered that the plants would have been used as part of the landscaping in the park, as this species has frequently been used as part of landscape plantings in the Sydney region, and the provenance is not known. The Rockdale Bicentennial Park is not listed as one of the known populations in the National Recovery Plan for this species. The known natural population extends from Upper Landsdowne to Conjola National Park.

Five metapopulations are: Jervis Bay, Coalcliff, Botany Bay (at Towra Point, Captain Cook Drive and Kurnell), Central Coast and Karuah-Manning. The Recovery Plan also suggests that any isolated individuals in the Sydney Metropolitan area should 'be treated with caution, due to the popularity of the species in ornamental plantings' (OEH 2012). All naturally occurring populations are considered important. However, individuals used as part of landscaping should not be considered as important populations due to the lack of information about the origins of these plants.

The significant impact criteria for vulnerable species have been considered:

- **Lead to a long-term decrease in the size of an important population of a species:**

The plants at Rockdale Bicentennial park are not considered part of an important population.

- **Reduce an area of occupancy in such a manner as to result in a significant impact upon an important population:**

The plants at Rockdale Bicentennial park are not considered part of an important population.

- **Fragment an important population into two or more populations:**

The plants at Rockdale Bicentennial park are not considered part of an important population.

- **Adversely affect habitat critical to the survival of a species:**

All habitat where naturally occurring habitat exists is considered habitat critical to the survival of the species. The plants at Rockdale are not part of a naturally occurring population and therefore the habitat cannot be considered critical to the survival of the species.

- **Disrupt the breeding cycle of an important population:**

The plants at Rockdale Bicentennial park are not considered part of an important population.

- **Modify, destroy, remove or isolate or decrease: the availability or quality of habitat to the extent that the species is likely to decline**

The plants at Rockdale are not part of a naturally occurring population. Furthermore, potential direct and indirect impacts such as clearing, changes in light and sedimentation, would not impact on the species such that it would increase extinction risk.

- **Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat:**

The plants at Rockdale do not form part of a naturally occurring population. There are invasive species (e.g. *Lantana camara* and *Ligustrum sinense*) near these plants. The proposed action is not likely to result in the invasion of a species that would impact on the habitat of the Magenta Lilly Pilly.

- **Introduce disease that may cause the species to decline:**

Naturally occurring populations of Magenta Lilly Pilly are at risk from the disease known as Myrtle Rust. The entire known distribution of Magenta Lilly Pilly occurs within the predicted distribution of Myrtle Rust. The proposed action is therefore unlikely to introduce this disease to the area where these plants occur, since it is likely to occur there already.

- **Interfere with the recovery of the species:**

The proposed action will not interfere substantially with the recovery of the species. The National Recovery Plan specifically excludes from any conservation effort any plants that are of dubious origin. Removal of up to five plants, which are part of landscaping, would not interfere with the recovery of the species.

Impact assessment for migratory species

***Calidris acuminata* Sharp-tailed Sandpiper**

There is evidence to suggest that the European population (200,000-510,000 pairs, occupying 50-74% of the global breeding range) has declined by up to 30% over ten years (three generations), but this may reflect shifts in breeding populations, populations in Asia are not thought to be declining and wintering populations in Africa appear to be increasing. The global population is estimated to number > c.160,000 individuals, while the population in Russia has been estimated at c.100-100,000 breeding pairs and c.50-10,000 individuals on migration (Bird Life International 2016a).

This species is a migrant to Australia usually arriving in August from breeding sites in Siberia. It has been observed in the past at Landing Lights Wetland. Surveys between October and December 2017 have not detected this species as being present. It was last recorded at Landing Lights wetland in 2007 according to Bionet data. The proposed action would not directly impact on the Landing Lights wetland and indirect impacts would be minimal.

Following the significant impact guidelines, the Landing Lights (nearby to the proposed action) wetland is unlikely to be important habitat for this species. Furthermore, there would be no direct impact on the Landing Lights Wetland, and indirect would be minimal due to the mitigation measures implemented during construction.

- **Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species:**

It would not support an ecologically significant proportion of the population as only one record of about 22 individuals has been recorded there in recent times.

- **Habitat that is of critical importance to the species at particular life-cycle stages:**

The habitat is not likely to be critical to the species as it would not be breeding habitat and does not appear to be favoured for roosting or foraging.

- **Habitat utilised by a migratory species which is at the limit of the species range:**

The species is not at the limit of its range. It appears in Australia around almost the Australian coast, with preference for the south-east into Victoria and SE South Australia.

- **Habitat within an area where the species is declining:**

The species is considered by the IUCN as to be of least concern and with a 'stable' global population.

The significant impact criteria were applied as follows:

- **Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species:**

The proposed action will not substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for this migratory species. The habitat at the Landing Lights wetland (nearby to the project area) is not considered to be important habitat for this species.

- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species:**

The proposed action will not result in an invasive species that is harmful to this migratory species becoming established in an area of important habitat for the migratory species. The habitat is not considered important habitat nor would the proposed action be likely to introduce any species to the habitat at the Landing Lights wetland.

- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species:**

The proposed action is not likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of this migratory species. While *Calidris acuminata* have been recorded at Landing Lights wetland, there have been no records in the last 10 years. It is unlikely that the proposed tunnelling would impact on the wetland such that feeding or resting behaviour of these migratory birds would be affected.

***Calidris ferruginea* Curlew Sandpiper**

This species is listed as Near Threatened on the IUCN red list owing to a global population decline. It has an extremely large range and the overall population trend is very difficult to determine due to varying trends in populations along different flyways. The population using the East Asian-Australasian Flyway is thought to be experiencing severe declines due to habitat loss in the Yellow Sea, and the population using the East Atlantic Flyway may also be undergoing declines (Bird Life International 2017a).

The global population is estimated to number c.1,085,000-1,285,000 individuals. The East Asian-Australasian Flyway population has been estimated at 90,000 individuals (Bird Life International 2017a). It is thought that declines in this population are due to losses of habitat in the Northern Hemisphere, specifically in the Yellow Sea where up to 65% of the tidal flats have been lost in the last 50 years.

This species is a migrant to Australia usually arriving in August from breeding sites in Siberia. It has been observed in the past at Landing Lights Wetland. Surveys between October and December 2017 have not detected this species as being present. It was last recorded at Landing Light wetland in 2007 according to Bionet data. There was only one individual recorded in 2007.

The Landing Light wetland is unlikely to be important habitat for this species. Furthermore, there would be no direct impact on the Landing Lights Wetland, and indirect would be minimal due to the mitigation measures implemented during construction.

- **Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species:**

It would not support an ecologically significant proportion of the population as only one record of one individual has been recorded there in recent times.

- **Habitat that is of critical importance to the species at particular life-cycle stages:**

The habitat is not likely to be critical to the species as it would not be breeding habitat and does not appear to be favoured for roosting or foraging.

- **Habitat utilised by a migratory species which is at the limit of the species range:**

The species is not at the limit of its range. It appears in Australia around almost the Australian coast, with preference for the south-east into Victoria and SE South Australia.

- **Habitat within an area where the species is declining:**

The species is considered by the IUCN as to be 'near threatened' and with a global population 'in decline'. The decline in the global population appears to be occurring in the Northern Hemisphere and not in the vicinity of the proposed action.

The significant impact criteria were applied:

- **Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species:**

The proposed action will not substantially modify (including by fragmenting, altering fire regimes, nutrient cycles or hydrological cycles), destroy or isolate an area of important habitat for this migratory species. The habitat at the Landing Lights wetland is not considered to be important habitat for this species.

- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species:**

The proposed action will not result in an invasive species that is harmful to this migratory species becoming established in an area of important habitat for the migratory species. The habitat is not considered important habitat nor would the proposed action be likely to introduce any species to the habitat at the Landing Lights wetland.

- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species:**

The proposed action is not likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of this migratory species. While *Calidris ferruginea* have been recorded at Landing Lights wetland, there have been no records in the last 10 years. It is unlikely that the proposed tunnelling would impact on the wetland such that feeding or resting behaviour of these migratory birds would be affected.

***Limosa limosa* (Black-tailed Godwit)**

The global population is estimated at 614,000-809,000 individuals, and to number 160,000 in eastern and southern Asia and Australia. The overall trend is that the global population is in decline (Bird Life International 2017b). The subspecies *melanuroides* breeds in disjunct populations in Mongolia, northern China, Siberia (Russia) and the Russian Far East. These birds migrate across a broad front to winter from western South Asia to Australia, encompassing India, Indochina, Taiwan, the Philippines, Indonesia, and Melanesia.

Declines are thought to be due to a range of threats including a reduction in flood levels due to climate change (in Russia) and habitat change due to weed invasion in Australia, among other things.

This species is a migrant to Australia usually arriving in August from breeding sites in Siberia. It has been observed in the past at Landing Lights Wetland. Surveys between October and December 2017 have not detected this species as being present. It was last recorded at Landing Lights wetland in 2000 according to Bionet data. No data on the numbers observed were recorded.

The Landing Lights wetland is unlikely to be important habitat for this species. Furthermore, there would be no direct impact on the Landing Lights Wetland, and indirect would be minimal due to the mitigation measures implemented during construction:

- **Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species:**

It would not support an ecologically significant proportion of the population as it has not been recorded there in recent times.

- **Habitat that is of critical importance to the species at particular life-cycle stages:**

The habitat is not likely to be critical to the species as it would not be breeding habitat and does not appear to be favoured for roosting or foraging.

- **Habitat utilised by a migratory species which is at the limit of the species range:**

The species is not at the limit of its range. It appears in Australia around almost the Australian coast, with preference for the south-east into Victoria and SE South Australia.

- **Habitat within an area where the species is declining:**

The species is considered by the IUCN as to be 'near threatened' and with a global population 'in decline'. The decline in the global population appears to be mainly occurring in the Northern Hemisphere. Habitat improvement works have been conducted at Landing Lights, however there has not been an increase in the number of these birds observed.

The significant impact criteria were applied:

- **Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species:**

The proposed action will not substantially modify (including by fragmenting, altering fire regimes, nutrient cycles or hydrological cycles), destroy or isolate an area of important habitat for this migratory species. The habitat at the Landing Lights wetland is not considered to be important habitat for this species.

- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species:**

The proposed action will not result in an invasive species that is harmful to this migratory species becoming established in an area of important habitat for the migratory species. The habitat is not considered important habitat nor would the proposed action be likely to introduce any species to the habitat at the Landing Lights wetland.

- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species:**

The proposed action is not likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of this migratory species. While *Limosa limosa* have been recorded at Landing Lights wetland, there have been no records in the last 17 years. It is unlikely that the proposed tunnelling would impact on the wetland such that feeding or resting behaviour of these migratory birds would be affected.

***Xenus cinereus* (Terek Sandpiper)**

This species has an extremely large range. The population trend appears to be decreasing but the rate of decline is not thought to approach the thresholds for Vulnerable under the population trend criterion. The population is estimated to number c.160,000-1,200,000 individuals (Bird Life International 2016b).

In China and South Korea important migration staging areas of this species around the coast of the Yellow Sea are being lost through land reclamation, and degraded as a result of declining river flows (from water abstraction), increased pollution, unsustainable harvesting of benthic fauna and a reduction in the amount of sediment being carried into the area by the Yellow and Yangtze Rivers. This species is also potentially at risk from exposure to DDT in southern India (Bird Life International 2016b).

Xenus cinereus is a rare migrant to Australia, with the main areas of importance being the Richmond River and Hunter River estuaries. The species usually arrives in August from breeding sites in Siberia. It has been observed in the past at Landing Lights Wetland. Surveys between October and December 2017 have not detected this species as being present. It was last recorded at Landing Lights wetland in 2000 according to Bionet data. No data on the numbers observed were recorded.

The Landing Lights wetland is unlikely to be important habitat for this species Furthermore, there would be no direct impact on the Landing Lights Wetland, and indirect would be minimal due to the mitigation measures implemented during construction:

- **Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species:**

It would not support an ecologically significant proportion of the population as it has not been recorded there in recent times.

- **Habitat that is of critical importance to the species at particular life-cycle stages:**

The habitat is not likely to be critical to the species as it would not be breeding habitat and does not appear to be favoured for roosting or foraging.

- **Habitat utilised by a migratory species which is at the limit of the species range:**

The species is not at the limit of its range. It appears in Australia around almost the Australian coast, with preference for the south-east into Victoria and SE South Australia.

- **Habitat within an area where the species is declining:**

The species is considered by the IUCN being of 'least concern'. The decline in the global population appears to be mainly occurring in the Northern Hemisphere, where habitat is being lost due to reclamation of wetlands. The area of decline does not occur near the proposed action.

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species:

The proposed action will not substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for this migratory species. The habitat at the Landing Lights wetland is not considered to be important habitat for this species.

- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species:**

The proposed action will not result in an invasive species that is harmful to this migratory species becoming established in an area of important habitat for the migratory species. The habitat is not considered important habitat nor would the proposed action be likely to introduce any species to the habitat at the Landing Lights wetland.

- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species:**

The proposed action is not likely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of this migratory species. While *Xenus cinereus* have been recorded at Landing Lights wetland, there have been no records in the last 17 years. It is unlikely that the proposed tunnelling would impact on the wetland such that feeding or resting behaviour of these migratory birds would be affected.

Annexure E - BAM and where addressed in this report

Report section	Information	Maps and data	BAM reference)	Section in this report
Introduction	Introduction to the biodiversity assessment including: • identification of development site footprint, including: ○ operational footprint ○ construction footprint indicating clearing associated with temporary construction facilities and infrastructure • general description of development/biodiversity stewardship site • sources of information used in the assessment, including reports and spatial dat	Site Map (as described in Section 4.2) • Location Map (as described in Section 4.2) • Digital shape files for all maps and spatial data	Chapters 3 and 4	1 Introduction 2 The project
Landscape features	Identification of landscape features at the development/biodiversity stewardship site, including: • IBRA bioregions and subregions, NSW landscape region and area (ha) • native vegetation extent in the buffer area • cleared areas • evidence to support differences between mapped vegetation extent and aerial imagery • rivers and streams classified according to stream order • wetlands within, adjacent to and downstream of the site • connectivity features • areas of geological significance and soil hazard features • site context components, including: ○ identification of method applied (i.e. linear or site-based) ○ percent native vegetation cover in the landscape (development site and biodiversity stewardship site)	IBRA bioregions and subregions (as described in Paragraphs 4.2.1.3–4.2.1.4) • NSW landscape regions (as described in Paragraph 4.2.1.5) • Rivers and streams (as described in Paragraph 4.2.1.6) • Wetlands (as described in Paragraph 4.2.1.7) • Connectivity of different areas of habitat (as described in Paragraphs 4.2.1.8–4.2.1.11) • Areas of geological significance and soil hazard features (as described in Paragraphs 4.2.1.12–4.2.1.15) • Native vegetation extent (as described in Subsection 4.3.2)	Sections 4.2 and4.3, Appendix 3	3 Landscape features

Report section	Information	Maps and data	BAM reference)	Section in this report
Native vegetation	Identify native vegetation extent within the development/biodiversity stewardship site, including cleared areas and evidence to support differences between mapped vegetation extent and aerial imagery. Describe PCTs within the development/biodiversity stewardship site, including: • vegetation class • vegetation type • area (ha) for each vegetation type • species relied upon for identification of vegetation type and relative abundance • justification of evidence used to identify a PCT (as outlined in Paragraph 5.2.1.12) • TEC status (as outlined in Paragraphs 5.2.1.14–5.2.1.15) • estimate of percent cleared value of PCT(as outlined in Paragraph 5.2.1.16) Perform a vegetation integrity assessment of the development/biodiversity stewardship site, including: • mapping vegetation zones (Subsection 5.3.1) • patch size (development site and biodiversity stewardship site) • assessing vegetation integrity using benchmark data (Subsection 5.3.3) • survey effort as described in Subsection 5.3.4 (number of plots) • determining the vegetation integrity score (Appendix 6): ○ composition condition score ○ structure condition score ○ function condition score ○ vegetation integrity score. Where use of local data is proposed: • identify relevant vegetation type • identify source of information for local benchmark data • justify use of local data in preference to database values.	Map of native vegetation extent within the development/biodiversity stewardship site (as described in Section 5.1) • Map of PCTs within the development/biodiversity stewardship site (as described in Section 5.2) • Map of plot locations relative to PCTs • Map of TECs • Plot field data (MS Excel format) • Plot field data sheets • Patch size of intact native vegetation (as described in Subsection 5.3.2) • Table of current vegetation integrity scores for each vegetation zone within the development/biodiversity stewardship site.	Chapter 5 and Appendix 6	4 Native vegetation Annexure B

Report section	Information	Maps and data	BAM reference)	Section in this report
Threatened species	Identify ecosystem credit species associated with PCTs on both the development site and biodiversity stewardship site as outlined in Section 6.2, including: • list of species derived • justification for exclusion of any ecosystem credit species predicted above. Identify species credit species on both the development site and the biodiversity stewardship site as outlined in Sections 6.3 to 6.5, including: • list of candidate species • justification for inclusions and exclusions based on habitat features • indication of presence based on targeted survey or expert report • details of targeted survey technique, effort, timing and weather • species polygons • biodiversity risk weighting for the species • threatened species survey • additional requirements for wind farm developments. Where use of local data is proposed: • identify relevant species • identify aspect of species data • identify source of information for local data • justify use of local data in preference to database values. Where expert reports are used in place of targeted survey: • identify the relevant species • justify the use of an expert report • indicate and justify the likelihood of presence of the species and information considered in making this assessment • estimate the number of individuals or area of habitat (whichever unit of measurement applies to the species/individual) for the development site or biodiversity stewardship site, including a description of how the estimate was made • identify the expert and provide evidence of their expert credentials.	Table of habitats or habitat components and their sensitivity classes • Table detailing the list of species credit species and presence status on site as determined by targeted survey, indicating also where presence was assumed and/or where presence was determined by expert report • Species credit species polygons (as described in Paragraph 6.4.1.33) • Table detailing species and habitat feature/component associated with species and its abundance on site (as described in Paragraph 6.4.1.34) • Table detailing biodiversity risk weighting for species on site (as described in Section 6.6) • For wind farm developments: maps of habitual flight paths for nomadic and migratory species likely to fly over the site and maps of likely habitat for threatened aerial species resident on the site	Chapter 6	5 Threatened species 6 Matters of national Environmental Significance Annexure A Habitat assessment

Report section	Information	Maps and data	BAM reference)	Section in this report
Avoid and minimise impacts	Demonstration of efforts to avoid and minimise impact on biodiversity values in accordance with Chapter 8. Assessment of direct and indirect impacts unable to be avoided at the development site in accordance with Sections 9.1 and 9.2. The assessment would include but not be limited to: type, frequency, intensity, duration and consequence of impact. For major projects: details of the adaptive management strategy proposed to monitor and respond to impacts on biodiversity values that are uncertain (Section 9.4).	• Table of measures to be implemented before, during and after construction to avoid and minimise the impacts of the project, including action, outcome, timing and responsibility • Map of final project footprint, including construction and operation • Maps demonstrating indirect impact zones where applicable	Chapter 8	7 Avoid and minimise impacts 8 Impact assessment 9 Mitigating and managing impacts
Impact summary	Identification and an assessment of the impacts which are potential serious and irreversible impacts, in accordance with Subsections 10.2.2 for impacts on CEECs and 10.2.3 for threatened species. Identification of impacts requiring offset in accordance with Section 10.3. Identification of impacts not requiring offset in accordance with Paragraph 10.3.2.2. Identification of areas not requiring assessment in accordance with Section 10.4.	Map showing the location of serious and irreversible impacts • Map of impacts requiring offset • Map of impacts not requiring offset • Map of areas not requiring assessment	Chapter 10	10 Offsetting required
Impact summary	Ecosystem credits and species credits that measure the impact of the development on biodiversity values, including: • future vegetation integrity score for each vegetation zone at the development site (Equations 17 and 18 in Appendix 6) • change in vegetation integrity score (Subsection 9.1.3) • number of required ecosystem credits for the impact of development on each vegetation zone at a development site (Subsection 11.2.3) number of required species credits for each threatened species that is impacted on by development (Subsection 11.2.4).	Table of PCTs requiring offset and the number of ecosystem credits required • Table of threatened species requiring offset and the number of species credits required Submitted proposal in the Credit Calculator	Subsections 11.2.3 and 11.2.4	10 Offsetting required
Biodiversity credit report	Credit classes for ecosystem credits and species credits at the development site	Table of credit class and matching credit profile	Subsection 11.3	Annexure C

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