Review of Environmental Factors

The Cooks to Cove GreenWay (In-Corridor Works)

Appendix E: Flora and Fauna Assessment (ELA, 2021)

June 2021

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au

The Greenway In-Corridor Works – Flora and Fauna Assessment

Inner West Council

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

Project Name	The Greenway In-Corridor Works Flora and Fauna Assessment
Project Number	20SYD: 16451
Project Manager	Rebecca Ben-Haim
Prepared by	Belinda Failes, Alicia Scanlon and Rodney Armistead
Reviewed by	Dr Meredith Henderson
Approved by	Daniel Magdi
Status	**Final**
Version Number	**2**
Last saved on	**11 June 2021**

This report should be cited as 'Eco Logical Australia 2021. *The Greenway In-Corridor Works Flora and Fauna Assessment*. Prepared for Inner West Council.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Inner West Council

Template 2.8.1

Contents

List of Figures

List of Tables

List of Photos

Abbreviations

Abbreviation	Description
BAM	Biodiversity Assessment Methodology
BC Act	*Biodiversity Conservation Act 2016*
BDAR	Biodiversity Development Assessment Report
DAWE	Commonwealth Department of Agriculture, Water and the Environment (formally DoEE)
DCP	Development Control Plan
DoEE	Department of Environment and Energy (now DAWE)
DPIE	Department of Industry, Planning and Environment
ELA	Eco Logical Australia Pty Ltd
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EP&A Act	*Environmental Planning and Assessment Act 1979*
FFA	Flora and Fauna Assessment
FM Act	*Fisheries Management Act 1994*
HBT	Hollow bearing tree
LEP	Local Environmental Plan
MNES	Matters of National Environmental Significance
OEH	Office of Environment and Heritage
PCT	Plant Community Type
REF	Review of Environmental Factors
RSWMP	Regional Strategic Weed Management Plan
SEPP	State Environmental Planning Policy
SIS	Species Impact Statement
SMCMA	Sydney Metropolitan Catchment Management Authority
TEC	Threatened ecological community
WM Act	*Water Management Act 2000*
WoNS	Weeds of National Significance

Executive Summary

Eco Logical Australia Pty Ltd (ELA) was commissioned by Inner West Council to prepare a Flora and Fauna Assessment (FFA) report for the proposed construction of the Greenway In-corridor works package which includes an extension to the existing Cooks to Cove GreenWay pedestrian pathway. The works will be assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This FFA will accompany a Review of Environmental Factors (REF) prepared by ELA for the proposed works.

The study area has been subject to extensive vegetation and threatened species surveys over the last decade. The literature reviewed identified that the vegetation within the study area is not remnant native vegetation. Vegetation has been established through revegetation works. There are several bushcare sites within the study area which have included locally indigenous species as part of revegetation works. Additional landscaping works as part of the GreenWay project have incorporated native species. The field surveys confirmed that the study area does not contain remnant ecological communities.

The planted native vegetation was assigned Plant Community Types (PCTs) based on the likely pre-European vegetation type and characteristic species used in revegetation works. The planted native vegetation has been mapped as a modified version of a PCT. Two PCTs were mapped within the study area. *PCT 1232 Coastal Freshwater Swamp Forest* was mapped in the northern portion of the Central Links. A second PCT, *PCT 1281 Sydney Turpentine-Ironbark Forest* was mapped as two different vegetation zones to reflect differences in the vegetation structure and composition of species. Vegetation zone 2 *PCT 1281 Sydney Turpentine-Ironbark Forest_planted* contains bushcare sites with high native species diversity. Vegetation zone 3 *PCT 1281 Sydney Turpentine-Ironbark Forest_highly disturbed* contains regeneration by opportunistic native shrubs in highly modified environments and landscaped street trees.

No threatened flora species were recorded within the study area or were considered likely to occur based on literature review and field habitat assessment.

Three threatened fauna species were recorded during the recent field surveys:

- *Miniopterus australis* (Little Bent-winged Bat) – listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act)
- *Miniopterus orianae oceanensis* (Large Bent-winged Bat) – listed as vulnerable under the BC Act
- *Pteropus poliocephalus* (Grey-headed Flying-fox) – listed as vulnerable under the BC Act and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Both Bent-winged Bat species were recorded during recent targeted surveys within the study area. The Grey-headed Flying-fox was observed roosting in a *Cinnamomum camphora* (Camphor Laurel) within Cadigal Reserve.

Tests of Significance under the BC Act were undertaken for all three species listed above. A fourth Test of Significance was conducted for the endangered *Long-nosed Bandicoot (Perameles nasuta) population in inner western Sydney*. This endangered population was not recorded during the recent field surveys; however, this population has been previously recorded within the study area and potential habitat may

be affected by the proposed works. One Assessment of Significance under the EPBC Act was undertaken for the Grey-headed Flying-fox. The assessments under the BC Act and EPBC Act concluded that the proposed works are unlikely to result in a significant impact on threatened species and populations, except the Large Bent-winged Bat. There is potential that the proposed works may have a significant impact upon the Large Bent-winged Bat.

The proposed construction of the pedestrian pathway will be located within 15 m of the entrance to a known roost site for this species in Cadigal Reserve. The installation of artificial lighting and increase in human and animal activity near the entrance to the roost site may ultimately result in abandonment of the roost location. Disturbance to roost sites is listed as one of the main threats to the Large Bent-winged Bat species. Scientific studies have identified this species is sensitive to even minor disturbances at roost sites which can cause abandonment of roosts and lead to reduced breeding success for local populations that rely upon the impacted roost site. Therefore, there is potential that the proposed works may result in a significant impact upon the lifecycle of this species. In accordance with Section 7.8(3) of the BC Act, the preparation of a Biodiversity Development Assessment Report (BDAR) or Species Impact Statement (SIS) is therefore required to further assess potential impacts to the Large Bent-winged Bat.

Further to this, it is recommended that the following is prepared and implemented to outline management and mitigation measures to reduce impacts on Large Bent-winged Bat at the roost site:

- A Construction Microbat Management Plan (CMMP), detailing specific mitigation measures that are required to be implemented prior and during construction;
- An ongoing Microbat Monitoring Plan (MMP), detailing specific monitoring requirements of the roost during both construction and operation of proposed works; and
- An Adaptive Microbat Design Plan (AMDP), detailing specific design requirements within Cadigal Reserve to further reduce potential impacts to this species, which will be based on further survey investigations in 2021.

Additional recommendations have been provided to mitigate impacts to planted native vegetation and habitat for threatened species.

1. Introduction

1.1 Purpose of the Report

Eco Logical Australia Pty Ltd (ELA) was engaged by Inner West Council to prepare a Flora and Fauna Assessment (FFA) for the proposed GreenWay In-corridor works package. The In-corridor works package will involve construction of a pedestrian pathway at two disconnected locations between Taverners Hills in the north to Dulwich Hill in the south. The proposed pathway will be assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This FFA has been prepared to accompany a Review of Environmental Factors (REF).

1.2 Background

The proposed pedestrian pathway will become an extension to the existing Cooks to Cove GreenWay pathway. The Cooks to Cove GreenWay ('the GreenWay') is a 5.8 km urban environmental corridor linking the Parramatta River at Iron Cove with the Cooks River at Earlwood. The GreenWay follows the route of the Inner West Light Rail and Hawthorne Canal and features bike paths, foreshore pedestrian pathways, cultural and historical sites, cafes, native bushland areas and a range of parks, playgrounds and sporting facilities.

1.3 Study Area

The In-corridor works package considers the construction of a shared path, lighting and landscaping within the Inner West Light Rail Corridor and adjacent land. The corridor is intersected by several major arterial roads, including New Canterbury Road, Old Canterbury Road and Parramatta Road.

The In-Corridor package consists of two discrete areas known as the 'Central Links' and the 'Southern Links'. The Central Links extends from north of Parramatta Road to south of Old Canterbury Road while the Southern Links extends from Weston Street to Hercules Street.

The 'study area' is defined as a buffer around the proposed pathway which has been assessed during desktop and field surveys (see Figure 1).

1.4 Scope of Works

A summary of the proposed scope of works is provided below.

1.4.1 Central Links

The Central Links works will include the construction of the following:

- An elevated path cantilevered over the Hawthorne Canal (owned by Sydney Water) on the eastern side north of Parramatta Road, with footings integral with the Canal wall
- A suspended path under Parramatta Road (a state road managed by Transport for NSW) over the Hawthorne Canal, suspended from beams supported from the road bridge abutments
- An elevated path, south of Parramatta Road, cantilevered over the Hawthorne Canal on the eastern side, with footings integral with the Canal wall
- Realignment of a length of a 500 mm water main and modification to another existing water main, plus sewer and disused gas main near and under Parramatta Road

- Stairs linking from the GreenWay path to the southern side of Parramatta Road and Light Rail lift east of the Canal
- An on-grade path on the eastern side of the Hawthorne Canal (on land owned by Rail Corp NSW currently under control of Council), within Cadigal Reserve (also sometimes referred to as Gadigal Reserve)
- Channel access ramp and bridge construction in Cadigal Reserve to facilitate construction and maintenance
- Ecological restoration, a rest/nature play area on the eastern side and a separate observation area on the western side of Cadigal Reserve
- An elevated path under the main western rail line and whipple truss described in more detail in Section 1.4.3 below (on land owned by Rail Corp NSW)
- A jacked box culvert tunnel under Longport Street (a regional road managed by Council)
- A path through the light rail corridor (owned by Rail Corp NSW and operated by Transdev) west of the light rail tracks from Longport Street to Old Canterbury Road, connecting to the Summer Hill Flour Mills near Lewisham West light rail, and inclusive of rest areas
- Dog off leash area on the eastern side of the light rail tracks and north of Lewisham West Light Rail Stop
- A wetland on the eastern side of the light rail tracks and south of Lewisham West Light Rail Stop
- A path linking from the light rail corridor to Old Canterbury Road in the road reserve on the northern side of Old Canterbury Road
- Lighting and electrical work for all sections, including ecological sensitive lighting in Cadigal Reserve
- Associated fencing, landscaping, ecological restoration, signage and ancillary works.

1.4.2 Southern Links

The Southern Links works will include the construction of the following:

- A cut and cover tunnel (or jacked culvert) under Davis Street
- A low-level boardwalk from Davis Street to Jack Shanahan Reserve, inclusive of stormwater drainage works near Terry Road
- Upgrade of the path through Jack Shanahan Reserve including modification to the existing playground and surrounds
- A cut and cover tunnel (or jacked culvert) under Constitution Road, including retaining walls on the northern approach and a secant pile wall on southern approach, in close proximity to private property
- Protection and/or diversion of existing water and gas mains in Constitution Road during tunnel construction
- An elevated path from south of Constitution Road to south of New Canterbury Road, including through the back span under the New Canterbury Road bridge and connecting to the existing path south of New Canterbury Road
- A new on-grade path from Hercules Street near Consett Street to Jack Shanahan Reserve and Hercules Street near Terrace Road

- Creation of new parklands and ecological restoration area Hercules Street near Consett Street to Jack Shanahan Reserve and Hercules Street near Terrace Road, including earthworks and stormwater drainage improvements
- Lighting and electrical work for all sections, including ecological sensitive lighting in Cadigal Reserve
- Associated fencing, landscaping, ecological restoration, signage and ancillary works.

1.4.3 Elevated Pathway and Jacked Box Culvert Tunnel under Longport Street Detail Relevant to Microbat Roost

Construction of the elevated pathway (Appendix A - A1) and jacked box tunnel (Appendix A - A2) under Longport Street with associated lighting is relevant to evaluating the potential impacts to microbats and includes the following:

- The base of the elevated pathway will be supported on piles at a level of 8.9 m AHD which is just above the level of the top of the tunnel containing the bat colony (8.3 m AHD)
- The elevated pathway will adjoin the jacked box culvert with dimensions of 3 m wide by 2.4 m high
- The pathway will be located approximately 15 m away from the roost entrance and directly in the current flight path of the bats as they exit the roost
- There will be approximately 3 m of clearance above ground level beneath the elevated pathway.
- Supports for the elevated pathway will consist of piles constructed at intervals of 5-10 m by an excavator
- The enclosed section of the elevated pathway will extend from where the pathway meets the brick wall on Longport Street northwards parallel to Hawthorne Canal for a distance of approximately 15 m (level with the whipple truss historical rail line)
- The enclosed section will begin to open out on the eastern side of the elevated pathway at approximately 10-12 m from the brick wall
- The elevated pathway slopes downwards to ground level at a 5% grade reaching ground level on the northern side of the main western rail line pylon, on the eastern side of Hawthorne Canal
- The existing fence line that prevents unauthorised human access to the Cadigal Reserve roost will be moved from its current location on the northern side of the main western rail line more than 50 m from the roost to the whipple truss, bringing the fence line to within 25 m from the roost entrance
- Tunnel boring for the jacked boxed culvert beneath Longport Street will use machinery operating at slow speeds with low vibrations and move from the southern side of Longport Street to the northern side.

1.5 Key Definitions

The following key terms and definitions are used in this FFA:

- Local population – of a resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area
- Proposed works – as specified in Section 1.4

- Subject site – represents the footprint (i.e. the pathway, stairs, boardwalk and lighting). This is the area directly affected by the proposal as per the definition in the Threatened Species Assessment Guidelines (Department of Primary Industries 2008)
- Study area – this includes the proposed works area and any additional areas which are likely to be affected by the proposal (directly or indirectly) (as per the Department of Primary Industries 2008).

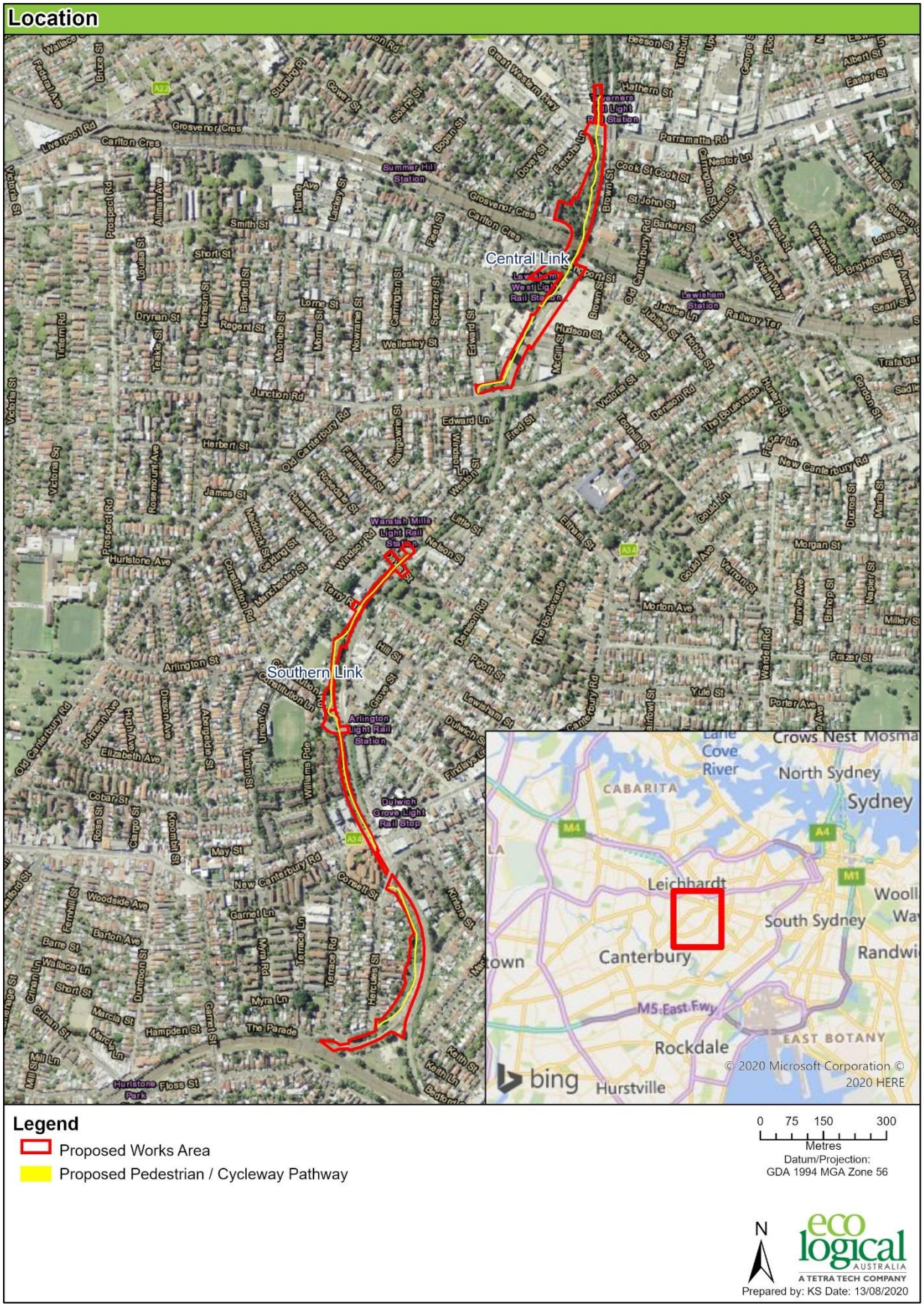


Figure 1: Location of In-Corridor Works study area

2. Legislative Context

Table 1: Legislative context

Name	Relevance to the project	Section in this report
	Commonwealth	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The EPBC Act protects Matters of National Environmental Significance (MNES), such as threatened species and ecological communities, migratory species (protected under international agreements), and National Heritage places (among others). Any actions that will or are likely to have a significant impact on the MNES require referral and approval from the Australian Government Environment Minister. Significant impacts are defined by the Commonwealth (reference http://www.environment.gov.au/epbc/guidelines-policies.html) for MNES. MNES have been identified within and near the study area. A Significance Assessment was undertaken for *Pteropus poliocephalus* (Grey-headed Flying-fox). The assessment concluded that the proposed works are unlikely to significantly impact on this species.	Appendix D
	State	
Biodiversity Conservation Act 2016 (BC Act)	The BC Act seeks to conserve biological diversity at bioregional and State scales; to maintain the diversity and quality of ecosystems and enhance their capacity to adapt to change and provide for the needs of future generations; to assess the extinction risk of species and ecological communities and identify key threatening processes through an independent and rigorous scientific process; and to establish a framework to avoid, minimise and offset the impacts of proposed development and land use change on biodiversity. Section 7.3 of the Act requires proponents of activities subject to Part 5 of the EP&A Act to determine whether they will have a significant impact on threatened species, populations and threatened ecological communities. If a significant impact is likely to occur, the proponent of the activity must prepare a Species Impact Statement (SIS) in accordance with section 7.20 or a Biodiversity Development Assessment Report (BDAR). Tests of Significance have been undertaken for the following threatened species and population: • *Miniopterus orianae oceanensis* (Large Bent-winged Bat) • *Miniopterus australis* (Little Bent-winged Bat) • *Pteropus poliocephalus* (Grey-headed Flying-fox) • endangered population of Long-nosed Bandicoot (*Perameles nasuta*) population in the inner West Sydney. The assessments concluded that the works are likely to result in a significant impact to one threatened species (Large Bent-winged Bat) and therefore, in accordance with Section 7.8(3), the preparation of a SIS or BDAR is required.	Appendix B, Appendix C
Biosecurity Act 2015 (Biosecurity Act)	The Biosecurity Act provides a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing	Section 4.2.5

Name	Relevance to the project	Section in this report
	with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers. Part 3 of the Biosecurity Act applies a general biosecurity duty for any person who deals with a biosecurity matter or a carrier to prevent, eliminate or minimise any biosecurity risk they may pose. Under section 23 of the Act, a person who fails to discharge a biosecurity duty is guilty of an offence. A number of priority weeds were present within the study area and will require management by Council.	
Environmental Planning and Assessment Act 1979 (EP&A Act)	The EP&A Act is the principal planning legislation for NSW. It provides a framework for the overall environmental planning and assessment of proposals. As Council is the proponent, the works are to be assessed as 'development permissible without consent' under Part 5 of the EP&A Act. Accordingly, Council must satisfy Sections 5.5 and 5.6 of that Act by examining, and taking into account to the fullest extent possible, all matters which are likely to affect the environment. This FFA is intended to assist, and ensure compliance, with the EP&A Act including Sections 5.5 and 5.6.	All
Fisheries Management Act 1994 (FM Act)	The FM Act provides for the protection, conservation and recovery of threatened species defined under the Act. It also makes provisions for the management of threats to threatened species, populations and ecological communities defined under the Act, as well as the protection of fish and fish habitat in general. The proposed works do not involve impacts to Key Fish Habitat, does not involve harm to marine vegetation, dredging, reclamation or obstruction of fish passage. A permit of consultation under the FM Act is not required.	N/A
Water Management Act 2000 (WM Act)	The WM Act aims to provide for the sustainable and integrated management of water resources for NSW. The Act requires developments on waterfront land to be ecologically sustainable and recognises the benefits of aquatic ecosystems to agriculture, fisheries, and recreation. The WM Act is administered by the Natural Resources Access Regulator (NRAR) and establishes an approval regime for activities within waterfront land, defined as the land 40 m from the highest bank of a river, lake or estuary. A Controlled Activity Approval (CAA) is typically required for work within waterfront land. Section 91E of the Act creates an offence for carrying out a controlled activity within waterfront land without approval. However, according to Section 41 of the *Water Management (General) Regulation 2018,* a public authority is exempt from Section 91E (1) of the Act. Therefore, Council does not need to obtain a CAA from the NRAR as part of these works. However, where possible, works should be designed and constructed as per the NRAR's *'Controlled Activities on Waterfront Land: Guidelines for watercourse crossings on waterfront land'* (DPI Water, 2012).	N/A
	Environmental Planning Instruments	
State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP)	The aim of this Policy is to facilitate the effective delivery of infrastructure across NSW by identifying whether certain types of infrastructure require consent, can be carried out without consent or are exempt development.	All

Name	Relevance to the project	Section in this report
	Pursuant to clause 79 of the Infrastructure SEPP, development for the purpose of rail infrastructure facilities may be carried out by or on behalf of a public authority without consent on any land. Under the definitions provided in clause 78 of the Infrastructure SEPP, rail infrastructure facilities include fences, tunnels, bridges, pedestrian and cycleway facilities. Part 2 of the Infrastructure SEPP contains provisions for public authorities to consult with other agencies prior to the commencement of development.	
State Environmental Planning Policy (Koala Habitat Protection) 2019 (Koala Habitat Protection SEPP)	The Koala Habitat Protection SEPP aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline. The Koala Habitat Protection SEPP does not relate to works under Part 5 of the EP&A Act. Therefore, this SEPP is not relevant to the proposed works.	N/A
Marrickville Local Environmental Plan 2011 (Marrickville LEP)	In accordance with the Marrickville LEP 2011, the study area is zoned as the following: • SP2 Infrastructure • R1 General Residential • RE1 Public Recreation. **6.4 Terrestrial Biodiversity** The objective of this clause is to maintain terrestrial biodiversity. The consent authority must not grant approval unless it is satisfied that the development will avoid significant environment impacts or cannot be reasonable avoided or the impacts cannot be minimised. The study area is mapped within the Terrestrial Biodiversity layer. However, consideration of these factors is not required for works under Part 5 of the EP&A Act.	Section 5.1
Leichhardt LEP 2013	The northern section of the study area is within the Leichhardt Local Government Area (LGA). The study area is zoned: • RE1 Public Recreation • SP2 Infrastructure (road). The Leichhardt LEP does not contain additional provisions relating to terrestrial biodiversity.	-
Ashfield LEP 2013	The middle section of the study area is located within the Ashfield LGA. The study area has been zone: • RE1 Public Recreation • SP2 Infrastructure (rail) • R2 Low Density Residential. The Ashfield LEP does not contain additional provisions relating to terrestrial biodiversity.	-

3. Methodology

3.1 Literature Review and Database Search

A review of readily available databases pertaining to the ecology and environmental features of the entire extent of the study area and surrounding area, and existing vegetation mapping was conducted to identify records of threatened species, populations and communities and their potential habitat.

Data and vegetation mapping that were reviewed included:

- BioNet (Atlas of NSW Wildlife) database search (5 km) for threatened species, populations and ecological communities listed under the BC Act (Department of Industry, Planning and Environment, DPIE 2020) (accessed September 2020)
- EPBC Act Protected Matters Search Tool (5 km) for threatened and migratory species, populations and ecological communities listed under the EPBC Act (Department of Agriculture, Water and the Environment (DAWE) October 2020)
- Previous vegetation mapping:
    - Sydney Metropolitan Catchment Management Authority (SMCMA) (Office of Environment and Heritage (OEH) 2016 and 2013)
- Review of relevant planning instruments, documentation, and information relating to biodiversity values and threatened habitat
- Relevant ecological surveys within the study area
- Aerial photography (Bing Maps and Google Earth) of the study area and surrounds were also used to investigate the extent of vegetation cover and landscape features. In addition, relevant Geographic Information System (GIS) datasets (soil, geology, drainage) were reviewed.

Species from both the BioNet Wildlife Atlas and DAWE online search were combined to produce a list of threatened species, populations and communities that may occur within the study area. The likelihood of occurrences for threatened species, populations and communities in the site were then determined based on location of database records, the likely presence or absence of suitable habitat in the study area, and knowledge of the species' ecology. This information informed the subsequent field assessments and targeted surveys.

After the field inspections had been completed the likelihood of occurrence of each species, population or communities was determined again. This was based on the increase in knowledge about the extent and type of habitats and which species were present on the site. The likelihood of occurrence of species, populations and communities following the field inspection is presented within the likelihood table in Appendix C.

3.2 Field Inspection

An initial site inspection was undertaken by ecologist Belinda Failes and fauna specialists Alicia Scanlon and Rodney Armistead on 4 September 2020. Follow-up visits to Cadigal Reserve to conduct further emergence surveys for the Large Bent-winged Bat roost were conducted by Rodney Armistead on 9 and 29 September 2020.

3.2.1 Vegetation Surveys

The vegetation survey consisted of the following:

- Validation and mapping of the extent and quality of native vegetation to Plant Community Types (PCT), and validation and mapping of threatened ecological communities listed under the BC Act and/or the EPBC Act if present
- Identification of threatened species or populations potential habitat within the study area.

The random meander method (Cropper 1993) was used to confirm the boundaries of vegetation communities and species assemblages within the study area. Where the boundaries of vegetation communities differed from existing vegetation mapping, these were modified on electronic maps and marked with a hand-held Global Positioning System (GPS).

The presence of threatened flora and fauna species identified as having the potential to occur in the study area was determined through a habitat assessment. Where threatened species or important habitat features were observed, such as hollow-bearing trees, their locations were marked using a hand-held GPS. Opportunistic sightings of all fauna present within the study area were also recorded.

3.2.2 Fauna Surveys

3.2.2.1 Diurnal Habitat Surveys – Long-nosed Bandicoot

Diurnal habitat surveys were conducted on 4 September to assess potential habitat for and search for evidence of occupancy by individuals of the endangered population of Long-nosed Bandicoot. Habitat surveys involved a traverse over the entire study area looking for potential habitat (i.e. dense groundcover species including weed thickets), direct (living Long-nosed Bandicoots) and indirect evidence of bandicoot activity and patch occupancy (i.e. characteristic conical diggings in the ground made by foraging bandicoots, scats, fur or dead animals).

3.2.2.2 Diurnal Habitat surveys - Microbats

Diurnal microbat habitat surveys were conducted on 4 September 2020 by Alicia Scanlon and Rodney Armistead to assess a range of artificial structures and vegetation as potential roosting and foraging habitat for threatened microbat species. Visual surveys of accessible bridges, culverts, stormwater channels and hollow-bearing trees both within the alignment and within close proximity to it which may provide roosting / breeding habitat for microbat species were undertaken using spotlights and binoculars. A diurnal inspection of the entrance to the known Large Bent-winged Bat roost in Cadigal Reserve was also undertaken. Due to the risk of disturbing roosting bats surveyors did not enter the roost to conduct counts of roosting bats.

3.2.2.3 Nocturnal Surveys

Nocturnal emergence surveys of the Large Bent-winged Bat roost in Cadigal Reserve were conducted on three separate occasions. On 4 September 2020 Rodney Armistead and Alicia Scanlon with assistance from Inner West Council conducted an emergence survey at the entrance to the roost from 30 minutes prior to sunset until 1 hour after sunset. The emergence survey was conducted in conjunction with ultrasonic call recordings at the roost entrance, at 18 m north of the roost on the western side of Hawthorne Canal and at 40 m north of the roost directly above Hawthorne Canal (Figure 4 and Figure 5). Two people were positioned on the western side of Hawthorne Canal approximately 4-5 m away

from the roost entrance and the third person was positioned approximately 8 m further to the north on the western side of Hawthorne Canal. From these vantage points it was possible to observe and count bats as they emerged from the roost and to observe flight paths as they left the area to forage.

On 9 September 2020, two staff carried out a second emergence survey commencing 30 minutes prior to sunset and concluding 1 hour after sunset. This survey was also undertaken in conjunction with ultrasonic call recording at the roost entrance, at 18 m north of the roost on the western side of Hawthorne Canal and at 40 m north of the roost directly above Hawthorne Canal. Two people were positioned on the western side of Hawthorne Canal approximately 4-5 m away from the roost entrance, and the third was positioned on the bridge to the dog walking area in Cadigal Reserve so comparisons could be made of the flyout paths of the bats.

On 29 September 2020 two staff carried out the third emergence survey which was conducted from 30 minutes prior to sunset until 2 hours after sunset in conjunction with ultrasonic call recording at the roost entrance and at 40 m north of the roost directly above Hawthorne Canal.

3.2.2.4 Passive Ultrasonic Surveys

Ultrasonic recording was undertaken using Anabat Swifts during each site visit on 4, 22 and 29 September 2020 (Table 2). As described above, ultrasonic recording was undertaken for the duration of emergence surveys on 4 and 9 September at locations in front of the roost entrance, 18 m to the north of the roost on the western side of Hawthorne Canal and at 40 m north of the roost directly above Hawthorne Canal.

On 29 September 2020, two Anabat Swifts recorded calls at the roost entrance for the duration of the emergence survey and were then left in place for 8 nights and collected on 7 October 2020. In addition to this one Anabat Swift was positioned at Fred Street Light Rail Biodiversity Offset site stormwater culvert, another potential roost location identified during the initial site inspection on 4 September and left in place until 7 October 2020.

Several other potential roost locations, including one in a stormwater culvert on Hercules Street and one beneath Parramatta Road Bridge were unable to be surveyed using ultrasonic detectors due to safety considerations surrounding the equipment and access issues related to proximity to the light rail corridor.

3.3 Survey Limitations

This assessment was not intended to provide an inventory of all species across the study area. Instead it provides an overall assessment of the ecological values of the subject site with particular emphasis on threatened species, endangered communities and key fauna habitat features.

Table 2. Microbat survey date, type of survey and climatic conditions at the time of the survey

Date	Survey type	Maximum daily temperatures (Celsius)	Minimum daily temperatures (Celsius)	Maximum wind speed (km/hr) and direction	Rainfall (mm)	Relative Humidity (%)
4 September 2020	1.5 hour emergence survey at the Cadigal Roost	20.7	18.4	28 WNW	0	53
22 September 2020	1.5 hour emergence survey at the Cadigal Roost	26.7	19.3	54 WNW	0	37
29 September 2020	2.5 hour emergence survey at the Cadigal Roost. Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	21.1	13.2	28 E	0	52
30 September 2020	Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	20.8	11.8	30 NNW	0	68
1 October 2020	Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	25.5	14.4	39 km/hr E	2.6	57
2 October 2020	Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	24.7	11.6	31 km/hr N	0.2	54
3 October 2020	Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	25.2	12.9	48 km/hr NNE	0	56
4 October 2020	Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	24.8	15.8	52 km/hr NNE	0	65
5 October 2020	Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	33.7	17.2	70 km/hr S	0	37
6 October 2020	Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	19.8	15.2	54 km/hr SSW	0	77

Date	Survey type	Maximum daily temperatures (Celsius)	Minimum daily temperatures (Celsius)	Maximum wind speed (km/hr) and direction	Rainfall (mm)	Relative Humidity (%)
7 October 2020	Static detectors set passively at the Cadigal roost and at the Fred Street Light Rail Biodiversity Offset site stormwater drain	21.5	16.2	24 km/hr SW	0	91

4. Results

4.1 Results of Literature Review

The study area has been subject to a number of extensive ecological surveys over the last decade. An analysis of previous ecological surveys and key results are provided in the Table 3. In summary, the majority of the previous vegetation surveys have noted that the vegetation is highly disturbed and has been established from revegetation works.

During the literature review it was noted there are two different spelling of Cadigal / Gadigal Reserve. Where a report has made reference to this reserve, the naming reflects the chosen spelling used by the author of the report. Where this FFA refers to the reserve, Cadigal Reserve has been used.

4.1.1 Prior Studies of the Roost and its Significance in a Regional Setting

The most recent review of Large Bent-winged Bat roosts within the Sydney Basin was conducted in 2004 (Hoye and Spence 2004). This review documented changes in the structure of populations present in the Sydney Basin from historical records dating back to 1892. Hoye and Spence found that Large Bent-winged Bats were present at a few historically utilised roosts throughout the year up until the 1980s. Following that time, surveys of known roosts have recorded occupation patterns that show Large Bent-winged Bats present in roosts in the Sydney Basin between March and September but largely vacant over the summer months. The Cadigal Reserve roost was not known at the time the review was conducted and was discovered in 2014.

Of the 28 historical and known roosts of Large Bent-winged Bats in the Sydney Region at the time of the review, six have been destroyed, had bats excluded or been abandoned by bats (Hoye and Spence 2004). Two of these six were the largest known roosts for Large Bent-winged Bats in the Sydney Basin containing between 1,000 and 2,000 individuals (Hoye and Spence 2004). The fate of eight roosts is uncertain, with limited locational information or positive reports from landowners suggesting that at least four of these are no longer functional (Hoye and Spence 2004). Whether the four natural cave roosts on the outskirts of Sydney continue to be used is also uncertain. The remaining fourteen roosts generally support colonies of a few individuals and up to 1,000 (Hoye and Spence 2004).

Unfortunately, the security of Large Bent-winged Bat roosts has also declined over time. Many of the larger and no longer functional roosts were contained within buildings or tunnels, and over half of the remaining roosts are known to occur in stormwater drains (Hoye and Spence 2004). Roosts in stormwater drains or culverts expose the bats to greater risks of death and injury from flooding, human disturbance, pollution and predation by foxes, rats and domestic and feral cats and dogs (Hoye and Spence 2004). Rates of injury in urban populations of Large Bent-winged Bats were shown to be four times higher than those in non-urban sites indicating that there is significant pressure on Large Bent-winged Bats residing in urban areas (Hoye and Spence 2004).

Whilst many of these pressures have been operating for years, the loss of large historical roosts and reduced security of existing roosts combined with an increasing human population and encroachment of built structures and lighting into the natural environment may result in urban populations acting as sinks with mortality levels greater than the wider Large Bent-winged Bat population can sustain (Hoye and Spence 2004). Preliminary modelling for the GreenWay indicates that there will be a five to seven-

fold increase in the presence of people and bikes through Cadigal Reserve as a result of the creation of the GreenWay path (Cardno 2019).

The effect that smaller and more fragmented winter roosts might have on the overall population biology of Large Bent-winged Bats is also uncertain given that mating occurs whilst the bats are at winter roost sites (Dwyer 1963). There is no information on the details of where and how mating and copulation occurs in Large Bent-winged Bat populations of the Sydney Basin. Studies by Lopez-Roig and Serra-Cobo (2014) on the effects of disturbance to roosting populations of *Pipistrellus pipistrellus* (Pipistrelle Bat) found a density dependent effect on the survival of female bats after disturbance indicating that female bats change roosts more regularly when there are fewer bats present – perhaps seeking safety in numbers at larger roosts; and that this behaviour affected survival rates. It is unknown whether a similar effect might occur for the Large Bent-winged Bats at the Cadigal Reserve roost. The risk of population level changes resulting from fewer, smaller and less secure roosts cannot be ruled out.

The Cadigal Reserve roost contains up to 200 Large Bent-winged Bats that are generally present within the roost between the months of March and October each year, with individuals also present during some summer months. No harp trapping studies have been carried out at the roost to determine the sex ratio and ages of individual bats roosting at the site. It is possible that mating activities and copulation occur at this roost site but there have been no studies to try and determine whether they do. There is evidence to suggest that some movement of individual bats between roosts across the Sydney Basin and as far away as the Hunter Valley occurs throughout the year (Gonsalves and Law 2018, Hoye 2000, Hoye pers comm, White 2011).

4.1.2 Soils, Topography and Hydrology

The study area traverses several soil landscapes. The northern portion of the study area is located on Birrong (Alluvial) soil landscapes. The middle portion is located on Blacktown (Residual) soil landscapes. The southern portion of the study area is located on Gymea (Erosional) soil landscapes.

Birrong soil landscapes are associated with gentle undulating alluvial floodplains on Wianamatta Group shales (Chapman and Murphy 1989). Soils are characterised by waterlogging and low fertility. Vegetation has been extensively cleared but may have comprised *Eucalyptus paniculata* (Grey Ironbark), *Syncarpia glomulifera* (Turpentine) and *E. saligna* (Sydney Blue Gum).

Blacktown soil landscapes (residual) are similar to Birrong soil landscapes with low fertile soils on Wianamatta Group shales, however remnant vegetation consists of *Eucalyptus pilularis* (Blackbutt) in inner city regions (Chapman and Murphy 1989).

Gymea soil landscapes are located on Hawkesbury Sandstone with localised steep slopes and shallow soils (Chapman and Murphy 1989). Vegetation is typically dry sclerophyll woodland. Where a canopy is present, this is comprised of *Corymbia gummifera* (Red Bloodwood), *Eucalyptus haemastoma* (Scribbly Gum) and *E. piperita* (Sydney Peppermint). Tall shrubs of Epacridaceae, Myrtaceae, Fabaceae and Proteaceae families are also well represented.

One 1st Strahler Order stream, Hawthorne Canal, was mapped within the study area. Hawthorne Canal is located adjacent to the western boundary of the Central Link. The canal was installed in 1895 and between 1922 to 1939 the canal was converted into a stormwater channel (AWC 2018).

4.1.3 Previous Vegetation Mapping

No native PCTs have previously been mapped in the study area (Figure 2). SMCMA (OEH 2016 and OEH 2013) have previously mapped Urban Exotic / Natives within the study area. This mapping is consistent with the results of the literature review.

Historic 1943 Aerial photography illustrates that the rail corridor was established, and the surrounding landscape consisted of dense residential housing similar to the landscape today. No vegetation was evident along the rail corridor from historic photos. The current extent of vegetation appears to have established after 1943. This is consistent from the literature review which states that revegetation works along the GreenWay commenced in 1977 (AWC 2018).

Table 3: Summary of literature review

Report and Author	Study Area	Methodology	Results
		ECOLOGICAL ASSESSMENT	
Ecological assessment: Sydney Light Rail Extension Stage 1 Parsons Brinckerhoff 2010	Inner West extension along Rozelle goods line corridor from Lilyfield to Dulwich Hill	Random meander technique used to determine vegetation type and condition and conducted over three days (18 and 24 August and 2 September 2010). Targeted survey for Long-nosed Bandicoot using remote cameras over two weeks (8-22 July 2010). Habitat surveys on 8 and 26 July 2010. Spotlighting at four locations no dates or survey effort is provided.	The literature review identified six bushcare sites which include some areas in Dulwich Hill have been revegetated to include representative species of Turpentine Ironbark Forest critically endangered ecological community. Due to the planted nature of the vegetation, it was not considered part of the conservation status under the BC Act and EPBC Act. No other native vegetation community was identified within the study area. No threatened flora species were recorded or were considered likely to occur based on poor habitat. Targeted surveys recorded one threatened fauna species, *Pteropus poliocephalus* (Grey-headed Flying-fox) and one migratory species, *Apus pacificus* (Fork-tailed Swift) under the EPBC Act. The *Monarcha melanopsis* (Black-faced Monarch) (also listed under the EPBC Act as a migratory species) has previously been recorded by other surveys. No evidence of Long-nosed Bandicoots was recorded. The surveys noted the high occurrence of cats within the study area.
Cooks River to Iron Cove Revegetation and Bushcare Plan Eco Logical Australia 2011	Cooks River to Iron Cove GreenWay	ELA was engaged to prepare a revegetation plan for the GreenWay corridor.	The report identified Waratah Mills in Dulwich Hills, Pigott Street and Davis Street bushcare sites consisted of extensive weed removal followed by revegetated using 100 representative species of Sydney Turpentine-Ironbark Forest. Gadigal Reserve has been revegetated using over 40 native species but does not represent a particular native vegetation community. The report provides additional revegetation and weed control schedule.
GreenWay Biodiversity Strategy Australian Wetlands Consulting Pty Ltd 2012	Cooks River to Iron Cove GreenWay	The GreenWay Biodiversity Strategy provides a framework for the short to long term actions to support the vision to protect flora and fauna habitat and connectivity between landscapes (on public and private lands).	A literature review identified there are examples of regenerating native vegetation at: • New Canterbury Road and Constitution Road (western side of corridor) • Between Dulwich Hill and Hurlstone Park stations (in the rail corridor). Ten bushcare sites are located along the GreenWay which include revegetation works of representative species of Sydney Turpentine-Ironbark Forest, Sydney Sandstone Forest and Sandstone Heath communities. Revegetation works represents the majority of native vegetation found along the Greenway.

Report and Author	Study Area	Methodology	Results
			The study area does not recognise the presence of threatened ecological communities (TEC), although it does recognise revegetation works including modified Swamp Oak Forest near the Cooks River (outside of the current study area) and Sydney Turpentine Ironbark Forest in bushcare sites along the GreenWay. These revegetated sites do not represent the TECs listed under the BC Act or EPBC Act. No threatened flora species has been previously recorded along the GreenWay. Two threatened species Grey-headed Flying-fox and *Miniopterus orianae oceanensis* (Eastern Bentwing Bat now called Large Bent-winged Bat) and the endangered population of *Perameles nasuta* (Long-nosed Bandicoot) are known to occur within the study area.
Cooks to Cove GreenWay – Missing Links Flora and Fauna Assessment Australian Wetlands Consulting Pty Ltd (AWC) 2018	Cooks River to Iron Cove GreenWay with focus on the southern sections including Gadigal Precinct, Mills Precinct, Parks Precinct, Dulwich Grove and Cooks River Precincts.	Flora, fauna and habitat data was collected at 11 locations along the GreenWay. Flora surveys involved transects recording dominant species, density, age class and patch size. Fauna assessments included: • Mammal – Call playback, motion detector cameras, hair tubes, ultrasonic detectors and habitat search over 4 nights • Diurnal birds – dawn and dusk transect over three days • Nocturnal birds – spotlighting, call playback over three nights • Reptiles – active searches • Amphibians – nocturnal searches using spotlighting and call playback • Macro invertebrate sampling in bushcare sites	A Literature review identified that bushcare works initiated in 1977 to include planting native grasses and Acacia species. Works for the Greenway were completed in 1991. This report identifies that the Dulwich Hill bushcare sites have been revegetated to resemble Turpentine-Ironbark Forest but did not previously contain remnant vegetation. Two patches of remnant vegetation were identified, between Dulwich Hill and Hurlstone Park station and in Marrickville Golf Course. Both of these sites are located outside of the study area for this current FFA. No threatened flora species were identified or were considered likely to persist in the study area. The targeted surveys recorded 43 birds, 7 mammals, 4 reptiles and no amphibians. Grey-headed Flying-fox and Large Bent-winged Bat were recorded. *Ninox strenua* (Powerful Owl), other microbat species and Long-nosed Bandicoot were considered likely to occur but not recorded during targeted surveys.

Report and Author	Study Area	Methodology	Results
Biodiversity Development Assessment Report Cardno 2019	Cooks River to Iron Cove	Field surveys involved: • random meander techniques • three Biodiversity Assessment Method (BAM) plots • diurnal bird surveys • opportunistic amphibians, herptofauna and gastropod • Nocturnal birds and mammals spotlighting and call playback • Microbat ultrasonic anabats x 2.	Two Plant Community Types (PCT)s were recorded: • PCT 1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion • PCT 1281 Turpentine-Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion. PCT 1281 did not satisfy the criteria for listing as part of the critically endangered ecological community Sydney Turpentine Ironbark Forest under the EPBC Act as it was in very poor condition. PCT 1232 was listed as part of a TEC under the BC Act. Two threatened fauna species were positively detected, and three additional threatened species were considered possible based on anabat calls during targeted surveys: • Large Bent-wing Bat • Grey-headed Flying-fox • *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) • *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) • *Scoteanax rueppellii* (Greater Broad-nosed Bat). The endangered population of Long-nosed Bandicoot (*Perameles nasuta*) population in the inner West Sydney and *Myotis macropus* (Southern Myotis) were not recorded but a species credits were calculated for offsets as a precautionary principle. The *Miniopterus australis* (Little Bent-winged Bat) was not recorded, however it was considered a candidate species and assumed present. Assumed present for two flora species as surveys did not coincide with survey periods: • *Caladenia tessellata* (Thick-lip Spider Orchid) • *Tetratheca glandulosa* Three Serious and Irreversible Impacts (SAII) were assessed, *Caladenia tessellata*, Large Bent-winged Bat and Little Bent-winged Bat. The BDAR concluded that the proposed works are unlikely to result in a significant impact.

BANDICOOT STUDIES

Report and Author	Study Area	Methodology	Results
Australian Museum Business Services 2007 Fauna Study	Marrickville LGA which include a portion of the current study area.	The 2007 study follows on from 1996 fauna survey in Marrickville Council to provide an inventory of species within the Marrickville LGA. Ten sites over three days and three nights. • Small mammal surveys at two sites (Tempe Lands and Dulwich) using Elliott A traps, cage traps and hair funnels. • Spotlighting for three nights for 1.5 hrs • Ultrasonic anabat detectors • Diurnal bird surveys – call playback • Reptile active search • Dip-net surveys for tadpoles and fish • Nocturnal streamside searches	One dead Long-nosed Bandicoot was recorded during surveys at Dulwich Hill, no live individuals were recorded from targeted surveys. Three species were recorded: • *Chalinolobus gouldii* (Gould's Wattle Bat) – non threatened • Little Bent-winged Bat - listed as vulnerable under the BC Act • Grey-headed Flying-fox – listed as vulnerable under the BC Act and EPBC Act. The report includes additional discussions regarding the Long-nosed Bandicoot at Dulwich Hills. These included Parks and Wildlife ear tagging two males in an urban backyard at Dulwich Hill in 2003. Subsequent surveys by Parks and Wildlife did not recaptured tagged individuals. A habitat assessment identified that the freight rail line at long Dulwich Hill provides dense undergrowth habitat in the form of native vegetation and exotic (*Lantana camara*) for this species.
Yuppie Bandicoots of inner western Sydney. Tanya Leary et al 2010	Studies include the current study area around Dulwich Hill	Literature review and targeted surveys were conducted for Long-nosed Bandicoot in inner western Sydney. Seven live and seven dead bandicoots have been recorded in inner western Sydney between 2002 and 2007. Additional public reports have also been considered and investigated. Targeted surveys were conducted at Lewisham following reports of bandicoot activity.	The survey caught two females from Lewisham and fitted them with radio transmitters. The bandicoots were tracked between 9 nights to 1 month until the transmitters fell off. The transmitters provide information regarding the movement and habitat use of these urbanised bandicoots. The radio-tracking individuals did not utilise the rail corridor for shelter or dispersal, instead, individuals preferred to hide under old buildings and utilise backyards of parks to forage.

Report and Author	Study Area	Methodology	Results
Inner West Light Rail Expansion Bandicoot Study – Price and Banks 2016	Surveys were conducted in Inner Western Sydney LGA	Public surveys and habitat modelling. Eight sites selected for monitoring adjacent to the Inner West Light Rail were selected including 6 bushcare sites. Two motion sensitive cameras were set up at each site for four months.	The literature review identified that there have been 17 observations from live or dead bandicoots in the inner west between 2002 and 2011. No bandicoots were recorded during the targeted survey. Cats, foxes and dogs were recorded at all eight sites and are likely to impact negatively on the population of Long-nosed Bandicoot.
		BATS	
Balmain flora and fauna assessment. Biosis 2012	Studies were conducted within the inner-west lightrail extension, Lilyfield.	Vegetation removal along rock-cutting within the inner-west lightrail extension. • Flora surveys and habitat assessment • Two motion activated cameras deployed for seven consecutive nights in July 2012. • Two ultrasonic bat detectors deployed for two consecutive nights in July 2020. • Spotlighting on foot over two nights • Thermal imaging transects using	Large Bent-winged Bat was recorded on two nights shortly after dusk, although these were unlikely to be roosting along the rock cutting. Scats were taken for analysis these included fox, dog and cat. No Long-nosed Bandicoot hair or bone fragments were detected in the scats. The high number of foxes and cats recorded in the rail corridor and likely to discourage the use by Long-nosed Bandicoot within the rail corridor.
Microbat survey Balmain Tunnel Eco Logical Australia 2013	Balmain Tunnel	Targeted surveys were conducted to determine presence of microbats in the Balmain Tunnel prior to Inner West Light Rail Extension • Four ultrasonic bat detectors (anabats) were deployed at entrances around the Balmain Tunnel for two consecutive nights in July 2013.	Two species were recorded, Large Bent-wing Bat and *Chalinolobus gouldii* (Gould's Wattled Bat) (which is a non-threatened microbat species). Based on the analysis of the anabat calls, the tunnel was utilised infrequently by microbats. There was no evidence of microbat roosting in the tunnel.
Cadigal Reserve Eastern Bentwing Bat roost.	Cadigal Reserve in Ashfield	Monitoring of Eastern Bentwing-bat (now called Large Bent-winged Bat) over	Only one species utilised the tunnel (Large Bent-winged Bat). This species was recorded during June to early October and late February to June. No activity was

Report and Author	Study Area	Methodology	Results
Narawan Williams 2017		12 months at known roost at Cadigal Reserve in Summer Hill • Count of microbat flyouts by two observers for 1.5 hrs each night • Ultrasonic bat detector recordings used by each observer.	recorded in November and January when individuals return to their breeding habitat. There is potential that some individuals remain during breeding season.
Lewisham Light Rail upgrade Eco Logical Australia 2018	Lewisham Light Rail within the current study area	Surveys were conducted to assess habitat for threatened species as part of the Lewisham Light Rail upgrade. • Habitat inspection and daytime roosting investigation of culvert • Stag watching 1.5 hrs at two locations • Anabats over two nights	Anabats were used to identify the possible presence of Eastern Bentwing-bat (now called Large Bent-winged Bat), however, no individuals were recorded flying out of the culvert. No evidence of threatened microbats or Long-nosed Bandicoots within the study area. The study area is unlikely to contain suitable habitat for these species given the presence of known predators (cats and foxes) for the Long-nosed Bandicoot and lack of habitat for the microbats.
Monitoring of Eastern Bentwing Bats in Cadigal Reserve. Hochuli et al 2019	The project involves a shared path through Cadigal Reserve.	Baseline surveys of the Eastern Bentwing-bat (now called Large Bent-winged Bat) for the Greenway project. • Thermal cameras on two occasions April and May 2019. • Acoustic surveys (anabat detectors) along the canal for two nights and the tunnel for two nights.	Counts estimate 130 -143 bats utilising the roost location at Cadigal Reserve. The Large Bent-winged Bat and occasional Gould's Wattle bat (non-threatened species) was recorded at Cadigal Reserve. There is potential that noise and vibrations during construction works of the path may significantly impact upon this species.

4.1.4 Threatened Species

The search for threatened species using the Protected Matters Search Tool and BioNet (Atlas of NSW Wildlife) (within a 5 km buffer around the study area) and the review of literature resulted in a list of six threatened ecological communities, 22 threatened flora species and 94 threatened or migratory fauna species (including 4 amphibians, one insect, 12 mammals and 77 birds) and one endangered population, which are shown in Appendix C.

It should be noted that the result of the Protected Matters Search Tool, which has been included in Appendix C, is only a list of species based on habitat modelling. Therefore, not all species listed in Appendix C are shown on the maps in this report. The Atlas of NSW Wildlife database records for the study area of threatened flora and fauna are shown in Figure 3. Due to the large extent of the study area BioNet results within a 2 km buffer are shown in Figure 3. The full 5 km results are tubulised in Appendix C.

There are three threatened fauna species previously recorded from BioNet records within and adjacent to the study area:

- Large Bent-winged Bat
- Grey-headed Flying-fox
- Long-nosed Bandicoot endangered population in the inner western Sydney.

There are no threatened flora species BioNet records identified from within the study area. The majority of the BioNet records within a 5 km radius of the study area are historical records:

- *Wilsonia backhousei* (Narrow-leafed Wilson) recorded in 1905.
- *Tetratheca juncea* (Black-eyed Susan) 1905 – 1913
- *Acacia bynoeana* (Bynoe's Wattle) 1913
- *Melaleuca deanei* (Deane's Paperbark) 1901-1912.

The exception is *Eucalyptus nicholii* (Narrow-leaved Black Peppermint) recorded in 2006. This species has a highly restricted distribution in the New England Tablelands, although it is widely used as cultivar for street plantings around Sydney. *Eucalyptus nicholii* is not considered a locally indigenous species to the study area.

Figure 2: Previous vegetation mapping

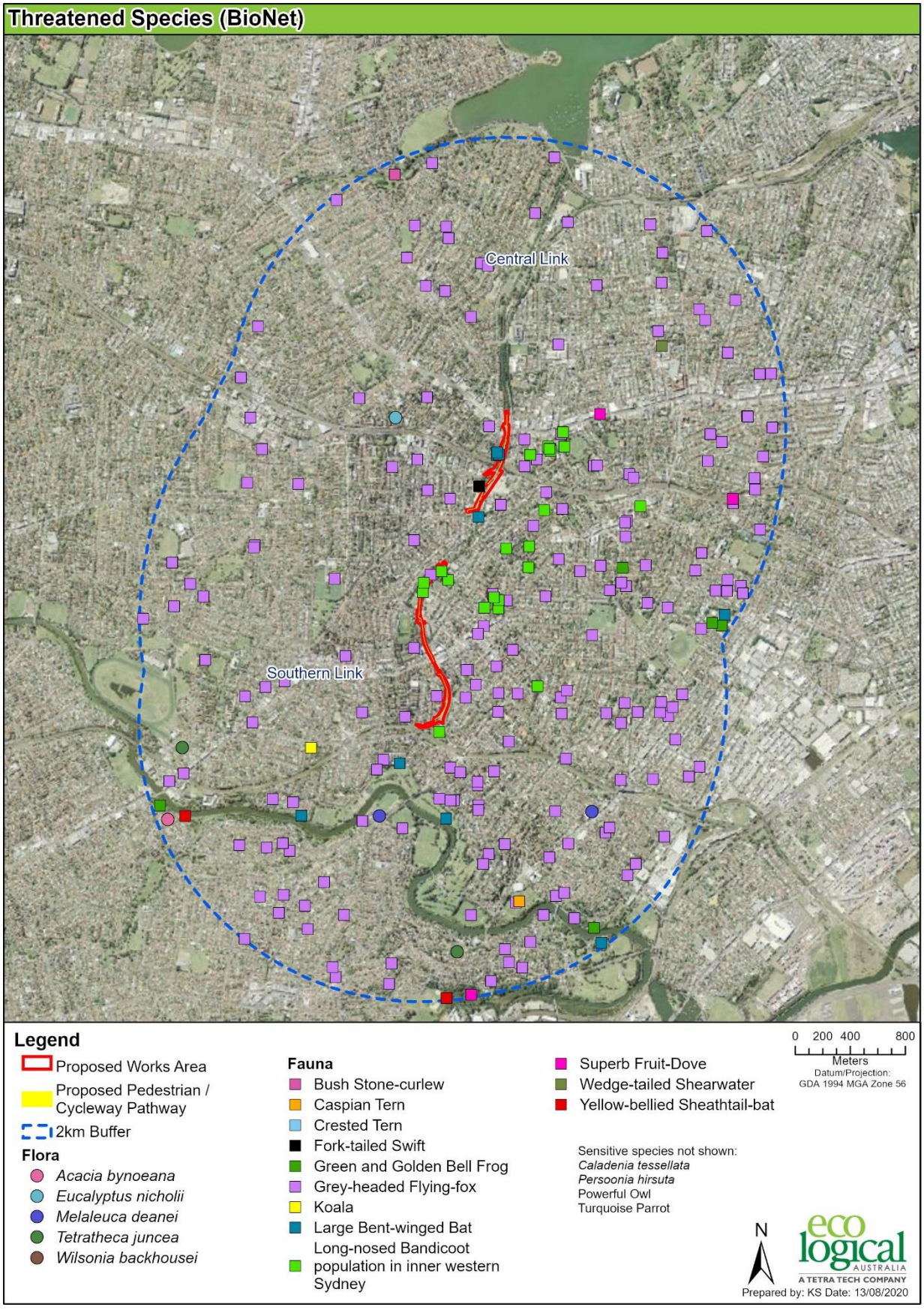


Figure 3: BioNet threatened search records (2 km buffer)

4.2 Field survey results

4.2.1 Vegetation communities

The vegetation within the study area has been substantially modified due to a long history of vegetation clearance and disturbance. The literature review identified that the study area lacks areas mapped as part of native vegetation communities. Additionally, the historic 1943 aerial photography demonstrates the vegetation has been substantially cleared and modified. The vegetation has been established through revegetation works. The selection of species for revegetation works has resembled some characteristic species of pre-European locally indigenous ecological communities.

ELA has utilised previous vegetation mapping (Cardno 2019) in the Central Links, however, changes were made regarding the presence of TECs (refer to Section 4.2.2 for justification).

The field surveys identified two PCTs which consisted of three vegetation zones mapped within the study area (Figure 4-Figure 8):

- Vegetation zone 1: PCT 1232 Coastal Freshwater Swamp Forest_planted
- Vegetation zone 2: PCT 1281 Sydney Turpentine-Ironbark Forest_planted
- Vegetation zone 3: PCT 1281 Sydney Turpentine-Ironbark Forest_highly disturbed.

A description of each vegetation zone is provided below, and a summary is provided in Table 4.

4.2.1.1 Vegetation Zone 1 PCT 1232 Coastal Freshwater Swamp Forest_Planted

One patch of vegetation zone 1 has been mapped within the study during the recent ecological surveys. This vegetation patch was located to the east and west of the existing pedestrian pathway, between Hawthorne Canal and Taverners Hill station (Photo 1). This site has not been previous identified as a bushcare site, however, literature has indicated that this site was subject to revegetation works for the GreenWay project.

The native vegetation resembles some characteristic species of PCT 1232 *Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion* including a dominant canopy of *Casuarina cunninghamiana* (River Oak), *C. glauca* (Swamp Oak) and occasional *Melaleuca styphelioides* (Prickly-leaved Tea Tree) and *Glochidion ferdinandi* (Cheese Tree). Non—locally indigenous native species to PCT 1232 have been incorporated into the GreenWay landscaping such as *Angophora costata* (Sydney Red Gum), *Pittosporum undulatum* (Sweet Pittosporum), *Ficus rubiginosa* (Port Jackson Fig), *F. fraseri* (Sandpaper Fig) and *Banksia integrifolia* (Coast Banksia). Clusters of *Lomandra* l*ongifolia* (Spikey Mat-rush) were interspersed with weeds, such as *Parietaria judaica* (Asthma Weed).

4.2.1.2 Vegetation Zone 2 PCT 1281 Sydney Turpentine-Ironbark Forest_Planted

The previous BDAR (Cardno 2019) noted the occurrence of *PCT 1281 Turpentine-Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion* within the study area. The field survey identified that areas previously mapped as PCT 1281 by Cardno (2019) corresponded to bushcare sites with established native plantings.

The field survey identified that the vegetation within the bushcare site varied from areas with an intact canopy and mixed ground layer (Photo 2) or dense weeds (*Ligustrum lucidum* (Large-leaf Privet)). This

vegetation zone was well represented within the study area and frequently included larger patches of native species. The largest patch was located between Parramatta Road to Longport Street and included Cadigal Reserve.

The vegetation within vegetation zone 2 resembles some characteristic species of *PCT 1281 Sydney-Turpentine Ironbark Forest* such as *Syncarpia glomulifera*, *Acacia parramattensis* (Parramatta Wattle)*, Breynia oblongifolia* (Coffee Bush), *Bursaria spinosa* (Blackthorn) and *Lomandra longifolia*. However, the remaining native species present in this vegetation zone did not conform to PCT 1281. These include *Eucalyptus tereticornis* (Forest Red Gum), *Melaleuca quinquenervia* (Broad-leaved Paperbark) and *M. styphelioides* (Prickly Paperbark).

A very minor patch of Vegetation zone 2 also consisted of another form of where the canopy was limited or absent, but the shrub and ground layer consisted of a highly diverse assemblage of native species, with minimal weeds. This form of vegetation zone 2 was represented in areas such as on the rock face above Dulwich Grove station. Species include; *Themeda triandra* (Kangaroo Grass)*, Kunzea ambigua* (Tick Bush)*, Acacia myrtifolia* (Red-stemmed Wattle), *A. parramattensis, A. longifolia*, *Lomandra longifolia, Hibbertia* sp*. Hardenbergia violacea* and *Tristaniopsis laurina* (Water Gum).

4.2.1.3 Vegetation Zone 3 PCT 1281 Sydney Turpentine-Ironbark Forest_highly disturbed

The best fit PCT for this vegetation was PCT 1281 Sydney Turpentine-Ironbark Forest as this PCT would have been represented in this area prior to European settlement.

This vegetation zone was present as native vegetation in highly modified environments. This includes planted native street trees (Photo 3) and opportunistic native regenerating shrubs in highly modified or weed infested habitats (Photo 4).

Planted street trees include *Lophostemon confertus* (Brush Box), *Ficus rubiginosa* and *Melaleuca* species. These areas were located within parkland or were present as overhanging canopy from street verge plantings. Planted street trees lacked a native ground cover or midstorey layer.

Opportunistic native shrubs include *Pittosporum undulatum* and regenerating *Acacia parramattensis* and *A. decurrens*. These native shrubs were often located in areas where the soil profile has been substantially modified such as rail batters. These areas contain dense weed blooms such as *Ligustrum lucidum* and *L. sinensis* (Small-leaved Privet) and lacks the presence of other native species.

4.2.2 Threatened Ecological Communities

The following PCTs mapped in the study area are associated with TECs, however, they did not meet the TEC criteria for listing under the BC Act or EPBC Act:

- *PCT 1232: Coastal Freshwater Swamp Forest*
- *PCT 1281: Sydney Turpentine-Ironbark Forest*

4.2.2.1 PCT 1232: Coastal Freshwater Swamp Forest

Components of *PCT 1232 Coastal Freshwater Swamp Forest* may represent *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* which is listed as an endangered ecological community under the BC Act and listed as part of the *Coastal Swamp*

Oak (Casuarina glauca) Forest of the South-east Queensland and New South Wales endangered ecological community under the EPBC Act.

The vegetation mapped as part of *PCT 1232 Coastal Freshwater Swamp Forest* in the study area is a landscaped environment in a narrow linear raised garden bed which is not natural habitat. The vegetation has been established for the purpose of providing native landscaping and was not conducted as part of revegetation works to re-establish this TEC into the landscape.

According to the Final determination for *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* under the BC Act this community is associated with saline environments subject to periodic flooding/ inundation. Although Hawthorne Canal is tidal, the vegetation is located above the high tide mark and the vegetation is not subject to inundation. Additionally, it is noted that the soil profile has been substantially modified. According the literature review (AWC 2012) the pre-European vegetation along Hawthorne Canal was previously present as Mangrove species and was established using some characteristic species of PCT 1232 as part of the GreenWay corridor.

The vegetation mapped as part of *PCT 1232 Coastal Freshwater Swamp Forest* within the study area does not constitute as part of a TEC under the BC Act for the following:

- The vegetation been established through landscaping works
- It does not contain remnant or regenerating native vegetation
- It contains some indicative species of the TEC from unknown source of genetic material
- It does not contribute to the extent of *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*
- It does not provide a functioning ecological community with natural regeneration.

The criteria for listing this ecological community as part of the *Coastal Swamp Oak (Casuarina glauca) Forest of the South-east Queensland and New South Wales* endangered ecological community under the EPBC Act is more stringent than the BC Act criteria for listing. Under the EPBC Act, small or degraded patches are excluded from the national protection (Department of Environment and Energy (DoEE) 2018). The vegetation within the study area does not satisfy the listing under the EPBC Act as the patch size is less than 0.5 ha, it does not meet the key diagnostic and does not have a predominantly native understorey.

4.2.2.2 PCT 1281: Sydney Turpentine-Ironbark Forest

The BioNet Vegetation Classification system identifies that PCT 1281 may conform to *Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion* listed as critically endangered under the BC Act and listed as part of the *Turpentine-Ironbark Forest in the Sydney Basin Bioregion* under the EPBC Act if it meets the criteria for listing.

Planted vegetation which resembles TECs lack the diverse assemblage of characteristic species of the TEC, they also do not function as part of an ecological community (as opposed to landscaped environments) and often do not display evidence of regeneration. The vegetation within the study area resembles some characteristic species of *Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion* however, the landscape has been substantially modified and represents a high percentage of

weeds and non-indigenous native species. As such the vegetation does not represent part of the state listing TEC.

The criteria for listing as part of the Turpentine-Ironbark Forest under the EPBC Act states that only remnant, intact patches are considered for listing under the national protection, these include (Threatened Species Scientific Committee 2005):

- Vegetation contains characteristic species in all structural layers
- Tree canopy is > 10% and remnant size is > 1 ha
- If tree canopy is less than 10% then patch is > 5 ha patch.

Although the vegetation had a canopy > 10% the patch size was not greater than 1 ha. The vegetation does not satisfy listing under the BC Act or EPBC Act.

Table 4: Summary of vegetation zones recorded within the study area

Veg Zone	PCT	Condition	Area (ha)	Description	BC Act	EPBC Act
1	*PCT 1232 Coastal Freshwater Swamp Forest*	Planted	0.02	This vegetation zone was mapped in the northern section of the Central Links along Hawthorn Canal. The vegetation was represented by a narrow corridor of planted natives canopy species *Casuarina cunninghamiana* , *C. glauca* and occasional *Melaleuca styphelioides* and *Glochidion ferdinandi*. Native groundcover species include *Lomandra longifolia* and *Dianella caerulea* (Blue Flax-lily). Exotics weeds and opportunistic species were also represented within this vegetation zone.	*	*
2	*PCT 1281 Sydney Turpentine-Ironbark Forest*	Planted	0.18	This vegetation zone was well represented throughout the study area. This vegetation zone includes the bushcare site and areas which have been subject to revegetation works. Generally, the vegetation consists of native canopy species of mixed origin with some areas more closely resembling diagnostic species of PCT 1281 than other patches. Species include *Eucalyptus amplifolia*, *E. botryoides* (Bangalay), *Corymbia maculata* (Spotted Gum) and *Syncarpia glomulifera*. Shrubs were highly diverse within this vegetation zone and represented *Breynia oblongifolia*, *Bursaria spinosa*, *Kunzea ambigua*, numerous *Acacia* and *Callistemon* species. Ground cover was a mix of native and exotic species. Natives include; *Imperata cylindrica* (Blady Grass), *Lomandra longifolia, Themeda triandra* and *Oplismenus aemulus* (Australian Basket Grass). Exotics include groundcover species; *Ehrharta erecta* (Panic Veldt Grass), *Bidens pilosa* (Cobblers Pegs) and *Sida rhombifolia* (Sida). Woody weeds *Ligustrum lucidum* and *L. sinense* were frequent in this vegetation zone.	*	*
3	*PCT 1281 Sydney Turpentine-Ironbark Forest*	Highly disturbed	0.16	This vegetation zone did not closely resemble an intact native vegetation community. Instead, the vegetation zone includes planted native street trees such as *Eucalyptus microcorys* (Tallowwood) and *Lophostemon confertus* and opportunistic native species such as *Pittosporum undulatum* in highly modified or weedy habitats.	*	*
-	Weeds / Exotics	-	0.20	Weeds and Exotics featured within the entire study area. These include horticultural landscaped gardens in Johnson Park; *Ulmus parvifolia* (Chinese Elm), *Phoenix canariensis* (Canary Island Date Palm) and linear weedy vegetation patches represented by *Ligustrum lucidum* and *L. sinense* within the rail corridor.	-	-

* PCT 1232 AND PCT 1281 DOES NOT SATISFY LISTING UNDER THE BC ACT OR EPBC ACT (REFER TO SECTION 4.2.2 FOR JUSTIFICATION)

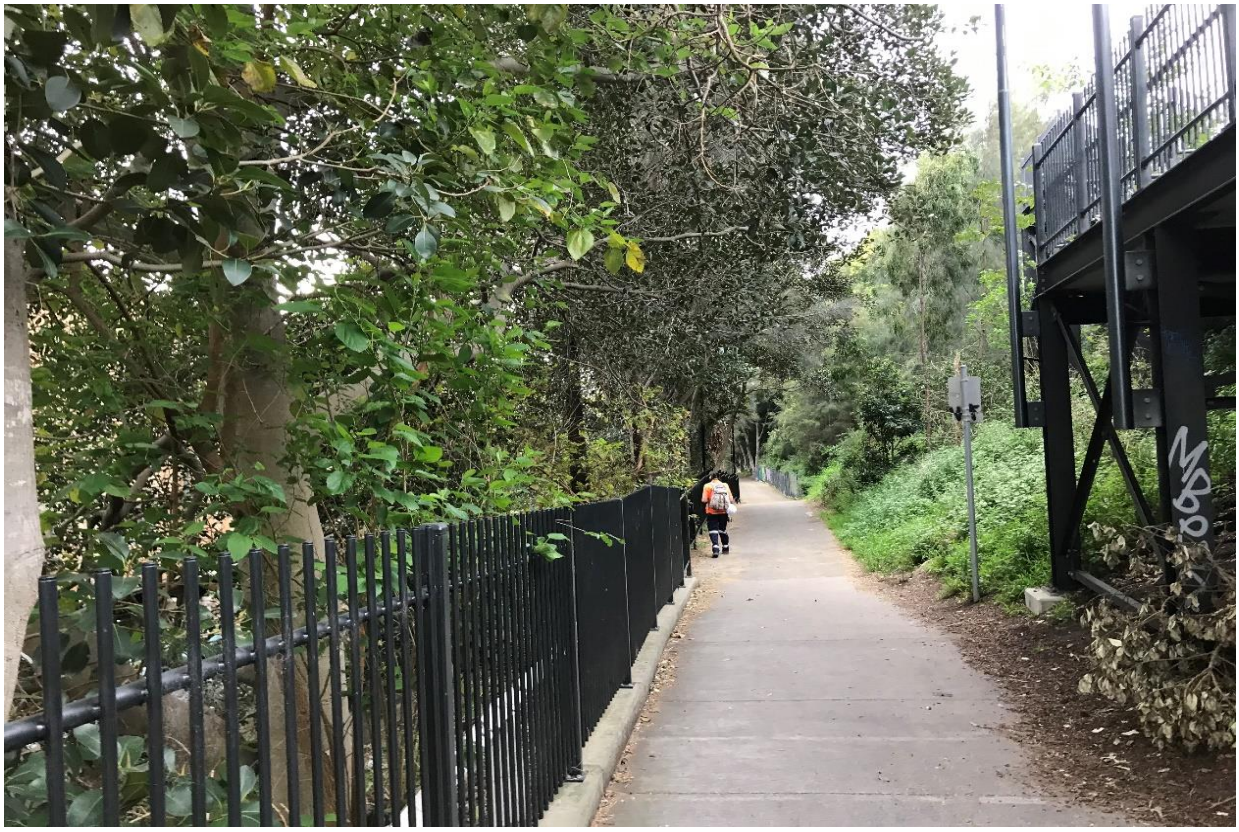


Photo 1: Vegetation Zone 1: *PCT 1232 Coastal Freshwater Swamp Forest_Planted*

Photo 2: Vegetation Zone 2: *PCT 1218 Sydney Turpentine-Ironbark Forest_Planted*

Photo 3: Vegetation zone 3: *PCT 1218 Sydney Turpentine-Ironbark Forest_highly disturbed* (showing street trees)

Photo 4: Vegetation zone 3: *PCT 1218 Sydney Turpentine-Ironbark Forest_highly disturbed* (showing weedy form)

Figure 4: Validated vegetation communities and habitat features (map 1 of 5)

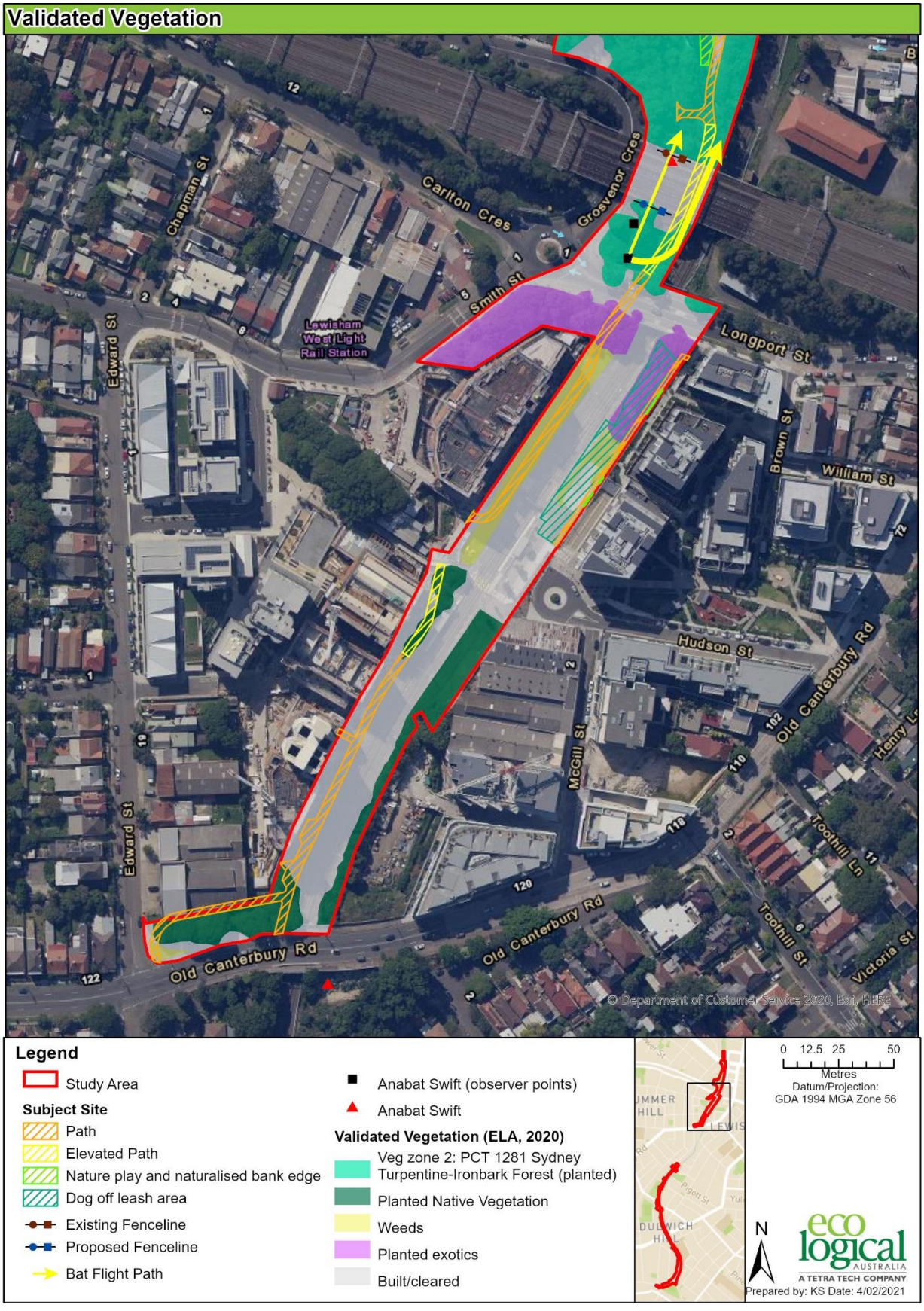


Figure 5: Validated vegetation communities and habitat features (map 2 of 5)

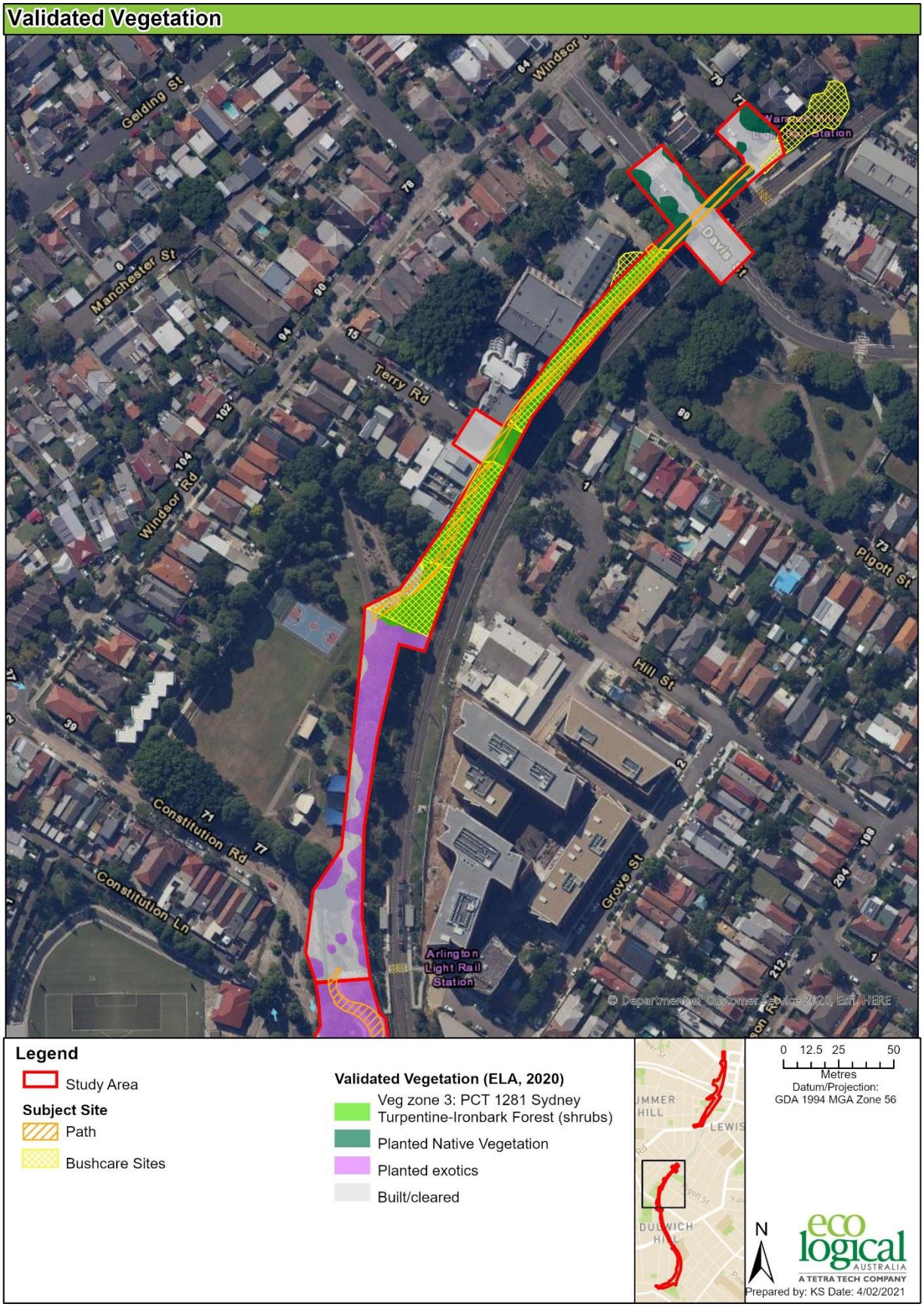


Figure 6: Validated vegetation communities and habitat features (map 3 of 5)

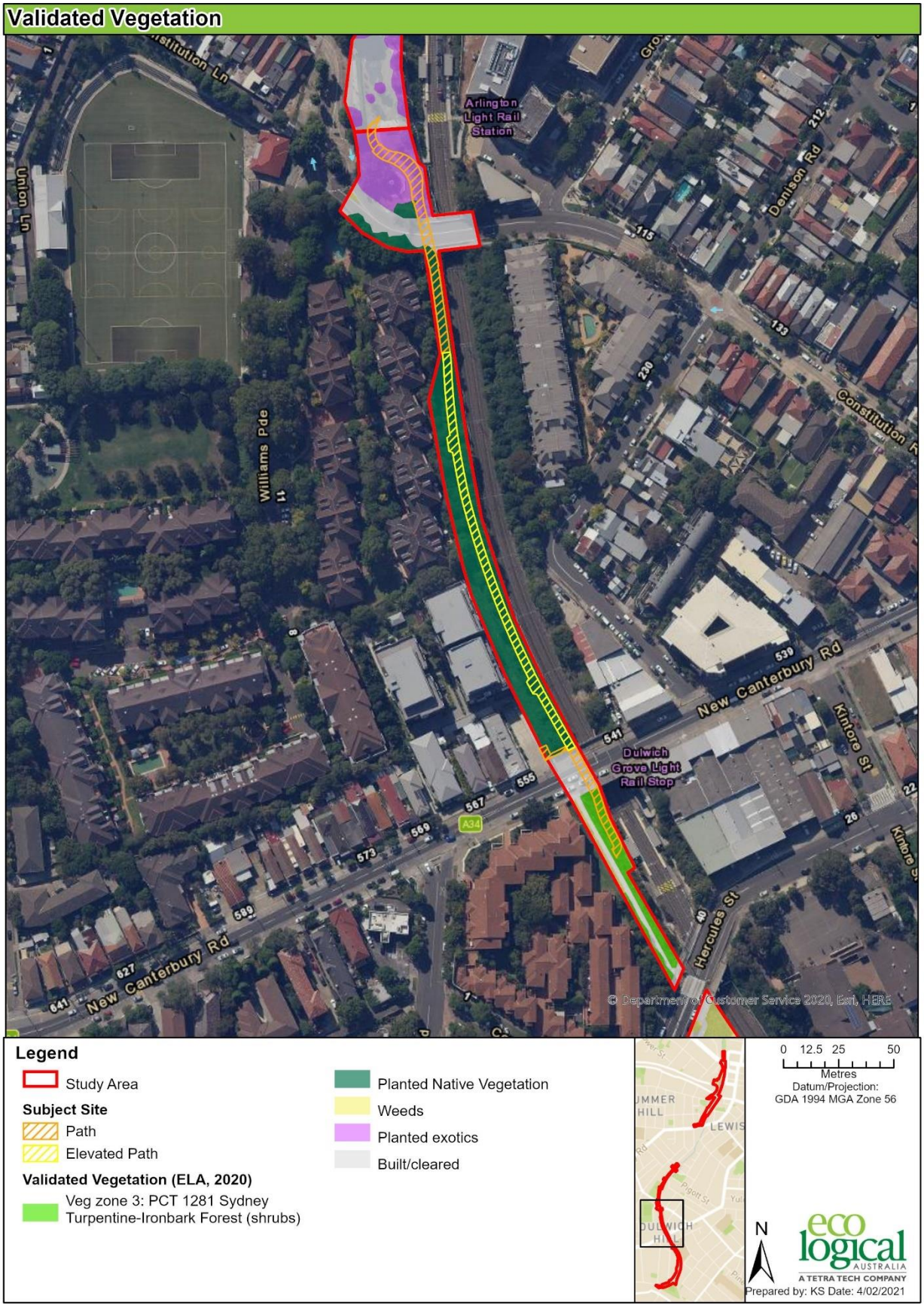


Figure 7: Validated vegetation communities and habitat features (map 4 of 5)

Figure 8: Validated vegetation communities and habitat features (map 5 of 5)

4.2.3 Flora Species

A total of 119 flora species were identified within the study area (Appendix A). Exotic species were the majority of the species recorded within the study area. A total of 63 exotic species and 56 native species were recorded opportunistically during field surveys.

4.2.4 Threatened Flora Species

No threatened flora species were recorded within the study area during field surveys. The vegetation within the study area has been significantly disturbed and is unlikely to support habitat for threatened species.

4.2.5 Priority Weeds

Of the weeds identified during field surveys, six species are listed as State priority weeds, three species are listed as regional level priority weeds and 20 are listed as other weeds of regional concern. The weeds present, their priority listing under the Act, their associated asset/value at risk and whether they are Weeds of National Significance (WoNS), are present in Table 5.

Table 5: State level determined priority weeds and other weeds of concern present

Scientific name	Common name	WONS	Priority weed obligations
State level priority weeds			
Anredera cordifolia	Madeira Vine	Yes	Asset protection[1]
Genista monspessulana	Cape Broom	Yes	Asset protection[1]
Lantana camara	Lantana	Yes	Asset protection[1]
Olea europaea subsp. cuspidata	African Olive	Yes	Containment[1]
Rubus fruticosus agg.	Blackberry	Yes	Asset protection[1]
Senecio madagascariensis	Fireweed	Yes	Asset protection[1]
Regional level priority weeds			
Arundo donax	Giant Reed	No	Asset protection[1]
Cestrum parqui	Green Cestrum	No	Asset protection[1]
Cortaderia jubata	Pampas Grass	No	Asset protection[1]
Weeds of Other Regional Concern			
Acetosa sagittata	Turkey Rhubarb	No	Environment[2]
Ageratina adenophora	Crofton Weed	No	Environment, Agriculture[2]
Araujia sericifera	Moth Vine	No	Environment[2]
Cardiospermum grandiflorum	Balloon Vine	No	Environment[2]
Cenchrus clandestinus	Kikuyu	No	Environment[2]
Celtis sinensis	Chinese Celtis	No	Environment, Agriculture[2]
Cinnamomum camphora	Camphor Laurel	No	Environment, Agriculture, Human Health[2]
Chloris gayana	Rhodes Grass	No	Environment[2]
Cotoneaster spp.	Cotoneaster spp.	No	Environment[2]
Eragrostis curvula	African Lovegrass	No	Environment[2]
Erythrina x sykesii	Coral Tree	No	Environment[2]

Scientific name	Common name	WONS	Priority weed obligations
Ipomoea indica	Blue Morning Glory	No	Environment, Human Health[2]
Ligustrum lucidum	Broad-leaf Privet	No	Environment, Human Health[2]
Ligustrum sinense	Small-leaf Privet	No	Environment, Human Health[2]
Parietaria judaica	Asthma Weed	No	Environment, Human Health[2]
Phyllostachys spp.	Bamboo	No	Environment[2]
Phoenix canariensis	Phoenix Palm	No	Environment[2]
Ochna serrulata	Ochna	No	Environment[2]
Solanum mauritianum	Wild Tobacco Bush	No	Environment/ Agriculture[2]
Tradescantia fluminensis	Trad	No	Environment[2]

[1] MANDATORY MEASURE (WHOLE OF NSW)
[2] REGIONAL STRATEGIC RESPONSE

4.2.6 Fauna Species and Their Habitat

The study area contains limited habitat features such as hollow-bearing trees (HBTs), fallen logs (apart from three piles of old wooden railway sleeper) or large patches of intact mature native vegetation. Despite the absence of most habitat features, the study area contains a number of nectar-producing species, namely Myrtaceous species. These may provide important flowering resources to arboreal mammals and birds.

A list of habitat features recorded in the study area is available in Table 6 below.

Table 6: Habitat features recorded in the study area

Habitat feature	Associated species	Presence
Large expanse of native vegetation	Birds, microchiropteran bats (microbats), megachiropteran bats (fruit bats), arboreal mammals, reptiles	Absent in the study area.
Nectar producing species	Arboreal mammals/birds and fruit bats	Present in the study area as native planted species such as; *Eucalyptus* species, *Callistemon* and *Lophostemon* sp.
Hollow-bearing trees	Microbats, birds, mammals, amphibians, reptile	Possible HBTs and nest boxes were located within Cadigal Reserve.
Subterranean (underground) cave like habitats	Microbats, birds, mammals, amphibians, reptile	Present in the study area as stormwater drains, bridges and the Cadigal Reserve Roost that is known to be occupied as an overwinter roost by Large Bent-winged Bats.
Coarse woody debris (fallen logs)	Terrestrial mammals, reptiles, invertebrates	Two disjunct piles of railway sleepers were the only examples of coarse woody debris located within the study area
Leaf litter	Reptiles, amphibians, invertebrates, and mychophagious mammals (including Long-nosed Bandicoots)	Absent
Water body	Amphibians, reptiles, microbats	Hawthorne Canal is located within the northern section of the Central Links corridor.
Rocky outcrops	Microbats, reptiles	Absent

Habitat feature	Associated species	Presence
Mistletoe	Arboreal mammals/birds and fruit bats	Absent
Winter flowering species	Winter migratory birds, arboreal mammals and megachiropteran bats (fruit bats)	Absent

4.2.6.1 Bats

The vegetation within the study area may support hollows that are of a suitable size which may provide roosting / breeding habitat for tree-roosting microchiropteran (microbat) species.

The vegetation within the study area is utilised as foraging habitat by a range of microbat species as reported during previous studies (Table 3). In addition, there are currently a number of open dark spaces present, particularly between Longport Street and Parramatta Road in Cadigal Reserve that favour those microbat species that prefer to forage in un-lit areas. These areas also provide a sheltered approach to the Large Bent-winged roost in Cadigal Reserve (Photo 5). Much of the remainder of the study area is a thin line of trees and shrubs adjacent to the light rail corridor. There are some well-lit areas also present within the study area which are more likely to suit to foraging activities of the larger and faster flying microbat species (Haddock, Threlfall, Law and Hochuli 219).

Numerous man-made structures such as stormwater drains, culverts and bridges were also identified within the study area (Photo 6). These man-made structures commonly provide potential habitat for several microbat species in an urban and peri-urban setting (Churchill 2008). The majority of structures inspected during the site visit contained some potential roosting habitat for microbats within expansion joins between culvert cells (Photo 7) and lifting holes, or within gaps and joins between bricks. Most of these structures were unlikely to support large aggregations of any microbat species for any length of time due to the risk of flooding through the culverts and stormwater drains or exposure to disturbance from humans and predators such as cats, dogs and foxes.

It must be noted that due to safety and access concerns associated with the rail corridor, it was difficult to access and inspect many of the bridges that pass over or under the light rail line within the study area. In addition to the occupied Cadigal Reserve Large Bent-winged Bat roost, two stormwater drains, one that passes beneath the Fred Street Light Rail Biodiversity Offset site and another adjacent to the southern end of Hercules Street (Photo 8, Figure 5 and Figure 8), were identified and visually inspected for evidence of the presence of roosting microbats, as was the Parramatta Road bridge over Hawthorne Canal (Photo 9, Figure 4 and Figure 5). Potential microbat habitat was identified as being present in each of these man-made structures. Consequently, it is recommended that further ultrasonic call recording surveys and / or emergence surveys be conducted at each of these structures.

Threatened microbat species which utilise the study area include:

- Little Bent-winged Bat
- Large Bent-winged Bat.

The results of the targeted microbat surveys are provided below (Section 4.2.8).

One Grey-headed Flying-fox was observed roosting within a *Cinnamomum camphora* (Camphor Laurel) during the field surveys (Figure 4). The nectar producing species are likely to provide seasonal foraging resources for Grey-headed Flying-fox. This species is likely to occasionally roost in dense vegetation

near foraging resources. The nearest nationally important camp is located at Wolli Creek within 3 km of the study area.

4.2.6.2 Mammals

The endangered population of the Long-nosed Bandicoot has been previously recorded within the study area prior to the installation of the Light Rail in 2015. There has been no credible recording of a Long-nosed Bandicoot in the inner western Sydney region despite recent targeted surveys. It has been noted during targeted surveys for the Long-nosed Bandicoot that the numbers of cats and foxes within the study area may have contributed to the reduction in bandicoots. Surveys conducted by ELA in association with the IWLR project between 2011 and 2015 failed to provide direct (living Long-nosed Bandicoots) or indirect (diggings, nests, fur, scats or a carcass) evidence of Long-nosed Bandicoots. Despite the lack of records, the study area contains native and exotic vegetation which may be used by Long-nosed Bandicoots for connectivity between foraging and sheltering habitat.

4.2.6.3 Birds

The vegetation within the study area provides marginal habitat for common peri-urban bird species. The vegetation within the study area is fragmented by urban development and major arterial roads. It lacks large intact vegetation and or other habitat features (such as HBTs) which are required by most threatened fauna species. One threatened nocturnal species, Powerful Owl, was considered to have potential to utilise the vegetation within the study area on occasion. This species requires large tree-hollows and intact vegetation which contains suitable habitat for prey items (such as possums/ gliders). The field survey did not record suitable habitat for possums within the study area. The Myrtaceae species may provide seasonal foraging for some urbanised possum species; however, the site also lacks a continuous canopy of midstorey required for these species to access the vegetation. Therefore, the vegetation is considered very marginal seasonal foraging for Powerful Owl within the study area.

4.2.6.4 Amphibians

The study area did not support suitable habitat features for threatened amphibian species. Hawthorne Canal lacks suitable pools or semi-aquatic species which may provide habitat for amphibians. Threatened amphibians are unlikely to inhabit the study area due to a lack of suitable habitat.

4.2.7 Connectivity

The GreenWay corridor provides a linear pathway which flows in a north-south direction through highly urbanised environment. Major arterial roads intersect the corridor are regular intervals. Additionally, the vegetation varies from planted street tree which lacks groundcover species to clusters of weeds or immature plantings.

In the broader landscape the vegetation within the study area is fragmented from large tracts of intact native vegetation.

Despite the poor condition of the vegetation within the study area, the GreenWay corridor provides an important connective pathway for the dispersal of highly mobile fauna species including a colony of up to 200 (Hochuli 2019, Nicole Gallahar pers.comm) of the threatened Large Bent-winged Bat known to roost within Cadigal Reserve. It also provides foraging and roosting habitat for migratory species and habitat for peri-urban species and threatened species.

4.2.8 Microbat Targeted Survey Results

Three microbat species were recorded during the ultrasonic surveys (Table 7). Of these three species, two, including the Large Bent-winged Bat and Little Bent-winged Bat are listed as being Vulnerable under the NSW BC Act. The third species recorded in the study area was the Gould's Wattled Bat, however, it is not listed under the BC or EPBC Acts.

Both Gould's Wattled Bats and Large Bent-winged Bats were recorded at Fred Street Light Rail Biodiversity Offset site (Figure 5). Given the timing that calls were recorded and the low number of calls (12 definite or potential calls over 8 survey nights) neither species was likely to be roosting within this structure at the time of the survey.

The ultrasonic surveys conducted within Cadigal Reserve recorded all three species of microbat. The recordings taken during emergence surveys of the roost generally contained 50 -150 Large Bent-winged Bat calls per night, most of which were recorded as Large Bent-winged Bats exited the roost soon after dark. The results show that up to 6 October, this roost remains occupied by Large Bent-winged Bats. There were very few calls from Gould's Wattled Bat and the Little Bent-winged Bat recorded within Cadigal Reserve, and none which suggested either species was likely to be roosting in the tunnel.

The Little Bent-winged Bat was identified as being present within the study area from just six calls that were recorded within a short five-minute burst in Cadigal Reserve near the roost entrance. The timing of these calls indicated that Little Bent-winged Bat(s) were not emerging from the Large Bent-winged Bat roost in the tunnel. No other calls, or evidence of this species using the rail corridor, or the Cadigal Reserve roost has been previously recorded. However, this species is known to occur in the Sydney basin, and it is possible that these recordings were made by a bat or bats foraging overhead or assessing whether the tunnel could form a suitable roost for individuals of this species. Little Bent-winged Bats and Large Bent-winged Bats are often found roosting together, particularly during the maternity season (Churchill 2008).

Detectors placed further away from the Cadigal Reserve roost (at 18 m and 40 m respectively) consistently recorded a reduced number of Large Bent-winged Bat calls than at the roost entrance (<30 calls per night) and only ever recorded Large Bent-winged Bat calls (Figure 4 and Figure 5).

Observations of the flight paths of bats as they exited the roost indicated that the preferred direction of travel was in a north easterly direction, flying low over the main western rail line, or under it within the Inner West Light Rail corridor (Figure 4 and Figure 5). Some bats also flew north along Hawthorne canal beneath the main western rail line (Figure 4 and Figure 5. This result is consistent with the ultrasonic results and with what is known about preferred foraging patterns for Large Bent-winged Bats, generally flying just above or in the upper sections of the canopy and along the edges of forested areas (Churchill 2008). It is also notable that the route most often chosen by the bats as they exited and returned to the roost was through the darkest portion of the air space. Street lighting from Grosvenor Ave spilled over into the space beneath the main western rail line making the airspace in this area brighter than that on the eastern side of the main western rail line pylons and the Inner West Light Rail Corridor.

Photo 5: Opening of the Cadigal Reserve Large Bent-winged Bat overwinter roost

Photo 6: General location of In-Corridor Works study area

Photo 7: Pipe join between pipe cells in a reinforced concrete pipe culvert that could provide roosting habitat for Large Bent-winged Bats and other subterranean roosting microbat species

Photo 8: Reinforced concrete pipe culvert (top) and brick culvert (bottom) adjacent to Hercules Street containing potential microbat roosting habitat

Photo 9: Parramatta Road bridge over Hawthorne Canal containing potential microbat roosting habitat

Table 7: Results of the ultrasonic surveys

Location of survey	Type of survey	Species name	Common name
Cadigal Reserve Roost	Evening emergence	*Miniopterus orianae oceanensis**	Large Bent-winged Bat
Cadigal Reserve Roost	Static passive survey	*Chalinolobus gouldii* *Miniopterus australis** *Miniopterus orianae oceanensis**	Gould's Wattled Bat Little Bent-winged Bat Large Bent-winged Bat
Fred Street Light Rail Biodiversity Offset site	Static passive survey	*Chalinolobus gouldii* *Miniopterus orianae oceanensis**	Gould's Wattled Bat Large Bent-winged Bat

* DENOTES THREATENED SPECIES

4.2.9 Threatened Fauna Species

Based on the literature review, BioNet records and field habitat assessment the following threatened species may utilise the vegetation within the study area:

- Grey-headed Flying-fox - listed as vulnerable under the BC Act and EPBC Act
- Long-nosed Bandicoot population in inner western Sydney listed under the BC Act
- Large Bent-winged Bat – listed as vulnerable under the BC Act
- Little Bent-winged Bat- listed as vulnerable under the BC Act.

5. Impact Assessment

5.1 Summary of Impacts

Both direct and indirect impacts during the construction and long-term impacts have been considered in the assessment below. The assessment has considered the proposed impacts such as the installation of the pathway and stairs, landscaping works or installation of park infrastructure such as lighting and benches.

The proposed construction will result in the removal of native and exotic vegetation within the study area. The impacts of the proposal to selected threatened species and communities listed under the BC Act and EPBC Act have been assessed.

Under the proposed works the following impacts may occur and have been assessed in the following sections:

Direct impacts:

- Clearing of vegetation
- Loss/modification of threatened fauna habitat
- Fragmentation or isolation of habitats.

Indirect impacts:

- Increased spread of weed infestations
- Shadowing of adjacent vegetation
- Increased artificial lighting
- Soil erosion or compaction of soil from heavy machinery
- Sediment flow or change in water quality
- Run-off from hard surfaces.

5.2 Direct Impacts

5.2.1 Clearing of Vegetation

The proposed works will result in the clearing of 0.66 ha of native vegetation (Table 8).

Table 8: Assessment of the vegetation impacted within the study area

Vegetation community	Direct impacts (ha)
Vegetation Zone 1: PCT 1232 Coastal Freshwater Swamp (planted)	0.04
Vegetation Zone 2: PCT 1281 Sydney Turpentine-Ironbark Forest (planted)	0.23
Vegetation Zone 3: PCT 1281 Sydney Turpentine-Ironbark Forest (highly disturbed)	0.10
Planted Native Vegetation	0.29
Weeds / exotics	0.51
TOTAL	**1.15**

5.2.2 Loss / Modification of Threatened Species Habitat

There is potential that the removal of flowering tall species may result in a marginal loss of foraging habitat for common peri-urban arboreal species. The removal of flowering species has potential to impact threatened species such as the Grey-headed Flying-fox. Tests of Significance under the BC Act and Assessments of Significance under the EPBC Act were conducted for Grey-headed Flying-fox.

Behavioural changes due to the installation of the pedestrian pathway and associated noise and lighting has the potential to negatively impact upon roosting microbat species. Currently there is no path or unauthorised human access within a 50 m radius of the roost within the Hawthorne Canal cutting (Figure 4 and Figure 5). The closest distance that unauthorised people can come to the roost is 50 m away where the current fence line stands (Figure 4). Although pedestrians and vehicles on Longport St above Hawthorne Canal are approximately 6 m above the roost entrance, they are not within visual / auditory range of the bats as they are exiting the roost and do not represent significant threat / disturbance to emerging bats. There are plans to move that fence so that it is only 25 m away from the roost and to create a publicly usable space in the area 25 – 50 m from the roost beneath the main western rail line. The addition of the elevated walkway in front of the roost will bring people to within 10-15 m of the roost entrance and directly in front of it.

Studies of the behaviour of Large Bent-winged Bats at roosts when changes have been made to the roost entrance in the form of grating or gating have largely shown that there can be persistent negative effects (Gonsalves 2018). These effects are often related to differences in flight agility among species, with bats that have low agility (high wing loading and narrow call bandwidths) such as Large Bent-winged Bats, suffering from greater difficulties with changes at the roost entrance (Tobin and Chambers 2017). These negative effects can manifest as delays in the timing of emergence, an extended amount of time taken for bats to emerge as they attempt to navigate the new dimensions of the space and, if the change presents too much of an obstacle bats may abandon the roost entirely.

These studies generally focused on changes at the roost entrance or within a few metres inside the roost entrance. Although not directly impacting the roost entrance at the mouth of the tunnel, the addition of an elevated walkway 15 m from the roost entrance may still alter emergence and flight behaviour for the colony of Large Bent-winged Bats roosting in the tunnel at Cadigal Reserve. The embankment slopes steeply upwards from the Canal beneath the elevated pathway. Although there will be approximately 3 m of space underneath the elevated walkway on the Canal side there will be less on the IWLR corridor side of the elevated walkway. Large Bent-winged Bats are less likely to fly below the elevated pathway given their relatively high wing loading and lower agility when compared to other clutter adapted bat species. There is less incentive for bats to fly beneath the elevated pathway when they can fly in a less cluttered environment above it and also because they would be more at risk of predation from foxes, rats and domestic and feral cats and dogs able to hunt on the high side of the embankment.

If the elevated pathway does cause changes to flight behaviour it could have flow on effects for daily energy expenditure of the bats throughout the winter which is a critical time for microbats, when food availability is low and fat stores are relied upon to survive the winter. Any changes to the preferred emergence and flight paths may result in an increased risk of predation, by forcing bats to fly into more brightly lit areas where nocturnal predators such as owls are known to forage (Haddock et al 2019); or an avoidance and eventual abandonment of the roost due to the increased perception of the risk of predation by the bats.

Previous ultrasonic surveys conducted by both Inner West Council (Nicole Gallahar pers com 2020), The University of Sydney (Hochouli 2019), Narawan Williams (2017) and ELA (2020) have shown that Large Bent-winged Bats forage across and beyond the boundaries of the study area. It is unclear whether the flight path of bats observed as they emerged from the roost during surveys undertaken for this report represent a consistently preferred flight path or whether flight paths change with the seasons and prevailing weather conditions. There have not been enough studies conducted on the flight paths of the Large Bent-winged Bats at this roost over multiple years and seasons to conduct a complete assessment of the impacts of installation of an elevated pathway and enclosed walkway into the space currently used by emerging and returning bats.

Two of the main threats to Large Bent-winged Bat populations are listed as disturbance to roosts and adjacent areas particularly during winter or breeding; and predation by cats (Office of Environment and Heritage 2020). Hoye (2000), Hoye and Spence (2004), Prucha and Hanzel (1989) and White (2011) have all documented negative impacts of disturbance to roosting bats. These studies include examples of periodic and complete roost abandonment caused by regular and repeated incursions into the roost and immediate surrounding area and cat predation (Hoye and Spence 2004). Whether by the presence of humans in the vicinity of the roost, the lighting of fires inside and outside the roost, collisions with trains as rail movements increased, cat predation or some other agent it is clear that Large Bent-winged Bats are sensitive to roost disturbances of this kind, several of which (movement of trains and predation) are already in operation at this roost.

Increased human presence within Cadigal Reserve brought about by the five to sevenfold increase in human usage predicted for the proposed pathway (Cardno 2019) brings about increased human and animal waste. This is likely to draw in and sustain more predators in the reserve such as foxes, rats, domestic and feral cats and dogs and is a major risk factor in the continuing presence of Large Bent-winged Bats at the Cadigal Reserve roost. Recent studies of the roost located a dead Large Bent-winged Bat on the pathway in Cadigal Reserve that had injuries consistent with cat attack (Hochuli, 2019). Cats are preying upon Large Bent-winged Bats in the Cadigal Reserve roost. Since the roost was discovered in 2014 it has been subject to disturbances in the form of commencement of operations of the Inner West Light Rail line, occasional human presence from a person camping in the first 5 m of the tunnel and completion of a mural painted on the brick wing wall supporting Longport Street adjacent to the tunnel entrance (completed in January 2019 when few or no bats were present). However, as there were no baseline surveys on the population size of the roost conducted until June 2016, it is impossible to determine whether the roost has been impacted by any of these disturbances or whether the population is stable.

Moving the existing fence line that prevents unauthorised access to the roost and increased lighting of the area beneath the main western rail line brings people and predators in closer contact with the area surrounding the roost. This will provide people and predators with increased opportunities to interact with bats as they emerge from the roost because there are more bats in the airspace closer to the roost and they are less dispersed. Increased human presence leads to increased human an animal waste which can attract predators and provide a more regular source of food leading to increased visitation or inclusion of the roost area within the core home range of local predators. In addition, there is likely to be removal of weedy vegetation occurring within the area between 25 – 50 m from the roost concentrating shelter and cover for predators into the area closer to the roost. As mentioned above, cats are already preying upon the Large bent-winged Bats in Cadigal Reserve. Cat predation on bats is

significant and has been documented as the reason for up to 30% of injuries to bats received into care by wildlife carers (Ancillotto, Tiziana Serangeli and Russo 2013 and Hoye and Spence 2004). There is a high risk that increasing the presence of humans and predators in the area surrounding the roost will lead to further pressure upon the Large Bent-winged bat population, deleterious effects on the roosting bats and may cause roost abandonment.

Lighting within the enclosed walkway will largely be prevented from spilling out into the airspace in front of the roost for the 10 – 12 m that the walkway remains enclosed on its eastern side and for 15 m on its western side. Some lighting of the whipple truss and western rail line pylons is proposed for safety and because the whipple truss is a heritage feature of cultural significance. The nearest lighting on the non-enclosed section of the pathway will be placed 25 m from the roost entrance. Final lighting designs have not been finalised and there will be opportunities to tailor light placement and type of lighting used in a way that minimises impacts to the roosting bats. Despite these proposed mitigation measures, any increase in light within the area surrounding the roost has the potential to alter bat behaviour as described below.

The effects of artificial lights on bats are mixed and studies have largely focused on impacts observed whilst bats are foraging (Haddock et al 2019, Hale, Fairbrass, Matthews, Davies and Sadler 2015). However, Fure (2006) reports some key findings including that light intensity affects bat behaviour more than noise intensity, particularly when considering increased light levels at roosts. This relates to the way bats use fading light levels at the end of the day to determine when to emerge from roosts. From studies of the structure of bats eyes, Fure (2006) also reports that bat vision works best in dim light. Fure (2006) states that certain species of bat do not have the ability to filter certain types of light (such as UV light) and their eyes would be damaged by exposure to it (if forced to fly during daylight or under artificial lighting with a UV spectrum).

Stone, Harris and Jones (2015) completed a review of the effects of artificial light on bats. The authors concluded that the introduction of artificial lighting at roosts can cause delayed emergence, lead to fewer individuals emerging, prolong the length of emergence leading to reduced time to forage and overall reduced fitness, cause alternative roost exits to be used and eventually cause abandonment of the roost. Avoidance of an artificially lit roost entrance and switching to an unlit entrance has been recorded at a Large Bent-winged Bat roost in Northern Sydney (Gareth Debney pers comm.) Furthermore Stone et al (2015) found that lighting at roosts can cause sudden declines in the number of bats present at the roost, increased predation at the roost entrance and increased mortality of bats from a roost due to reduced juvenile growth rates or avoidance of newly lit areas and the need to fly further to forage or avoid lit areas when leaving and returning to roost.

Thus, the avoidance of brightly lit areas by some species of bats can be attributed to a physiological necessity as well as a predator avoidance response. In the case of the Large-Bent-winged Bat roost at Cadigal Reserve introducing artificial lighting of any kind to the area surrounding the roost risks exposing bats to reduced overall fitness, increased risk of mortality and potential roost abandonment, particularly given there is no alternative entrance to this roost.

The current noise levels in the vicinity of the roost are high but generally dominated by lower frequency noises made by vehicular, rail and air traffic. Whilst it is a noisy site, sounds in the lower frequency

ranges are generally less disruptive to some microbat species than those at frequencies above 10 kHz, the frequency ranges associated with echolocation and social communication in bats.

Bonsen, Law and Ramp (2015) found that fast flying species such Large Bent-winged Bats tolerated traffic noise and were recorded flying close to roads in contrast to slower flying species. Similarly, Luo, Clarin-Markus, Borissov and Siemers (2014) found that torpid bats responded strongly to colony noise and vegetation but weakly to traffic noise. They also found that the response to noise increased from morning to evening, as bats approached their nightly active phase, implying that noises that cause bats to arouse may have differing effects at different times of day depending upon the level of arousal generated by the noise. These studies go some way to explaining how Large Bent-winged Bats can tolerate noise and living in close proximity to the main western rail line, IWLR and inner Sydney suburban roads. They do not however discount the possibility that bats may be injured and die from collisions with trains, light rail and cars as implicated in the demise of a significant northern Sydney Large Bent-winged Bat roost over 30 years ago (Hoye and Spence 2004). The proposed elevated pathway and enclosed walkway are unlikely to introduce significant amounts of noise in frequency ranges above 10 kHz or of increasing collision risk to bats and therefore have a low risk of impacting roosting bats over the long term.

The impacts of vibrations generated by the tunnel boring machine when excavating the tunnel under Longport Street or by heavy plant excavating the piles for the elevated walkway on roosting bats during construction were not considered in the previous studies (Cardno 2019). Bullen and Crease (2014) found that noise and vibration levels of 70 dB(A) and 0.9 mm/s at 20 m from any known internal extension of a cave would not result in bats abandoning the cave. Bullen has suggested maximum vibration levels of 10 mm/s be applied as the acceptable vibrational threshold beyond which impacts to roosting bats are likely.

IWC has reported that tunnelling for the Longport Street tunnel will be conducted from the southern side of Longport Street and will be low impact due to the risk of destabilising Longport Street and the supporting brick wing walls over Hawthorne Canal and the Inner West Light Rail Line. The machinery proposed to be used will produce lower vibrations and be very slow moving. Vibration levels have not been measured at the site. Recommended safe threshold vibration levels that could be experienced within the roost range from between 8 – 40 mm/s (Marshall Day Acoustics 2021). Without a more detailed estimate of the vibration levels expected to be generated by the tunnel boring machine and indication of background vibration levels Table it is difficult to make any firm conclusions. IWC reported that higher vibrational levels would be generated by excavations for the supporting piles of the elevated walkway. The MMP will provide suitable timeframes for these works to occur when no bats are present in the Cadigal Reserve roost.

In conclusion, ELA believes the proposed works have a high risk of causing a significant impact on the Large Bent-winged Bat roost in Cadigal Reserve for the following reasons:

- The roost is used throughout autumn, winter and spring and may be used for mating purposes (e.g. important components of reproduction including ovulation, insemination and fertilisation may occur whilst bats are present in this roost)
- Bats exiting and entering the roost are exposed to several stressors including cat predation and the risk of collision with trains, light rail and cars

- The number of known Large Bent-winged over-winter roosts in the Sydney Basin have declined drastically in the past 40 years, placing the population under pressure and remaining roosts in secure locations should be protected (Hoye and Spence 2004; Hoye pers comm)
- Large Bent-winged Bat roosts in the Sydney Basin have become smaller and less secure in the past 40 years which may be creating a population sink for Large Bent-winged Bats during the winter period spent in urban Sydney roosts which may be unsustainable for the local population over the medium to long term (Hoye and Spence 2004)
- Cumulative impacts to roosts for this species in the Sydney Basin have not been adequately addressed, and there is currently another project (Western Harbour Tunnel) which may impact a similar sized Large Bent-winged Bat roost in North Sydney. If the Greenway project and the Western Harbour Tunnel project cause bats to abandon both roosts, a significant amount of roosting habitat will be lost and there will be increased pressure on remaining roosts
- The proposed elevated pathway / enclosed tunnel intersects with the emergence and re-entry flight path of bats exiting / entering the roost
- The proposed elevated pathway / enclosed tunnel would reduce airspace used by bats when exiting and returning to roost
- The proposed pathway / enclosed tunnel could force bats to change flight paths when exiting and returning to roost or to abandon the roost altogether because of the perception of, and the increased risk of predation
- Clearing of vegetation required to construct the pathway / enclosed tunnel changes the character of the landscape at the roost entrance, making it more open and accessible to aerial predators such as owls
- Moving the fence line closer to the roost and introducing lighting into this area could also provide more opportunities for terrestrial predators such as foxes, rats, domestic and feral cats and dogs to interact with bats from the roost
- Lighting will be required along the elevated pathway and beneath the railway bridge and any increase in lighting may reduce available airspace for bats exiting and returning to roost, will spill over into dimmer / darker areas on the Light Rail corridor and may make it easier for predators to approach the roost (Hale et al 2015, Threlfall 2012)
- Although Large Bent-winged Bats will forage around artificial light sources (Haddock, et al 2019) the introduction of lighting at roost entrances has been shown to have detrimental effects (Stone et al 2015) including delayed emergence with reduced time for foraging, fewer individuals emerging, avoidance of roost entrances that are lit up and roost abandonment. There is good evidence from a Large Bent-winged Bat roost on the northern side of Sydney Harbour that lighting changes near one of the roost entrances have reduced the number of bats emerging from that entrance and forced bats to emerge from an alternative entrance
- There is also evidence that Large Bent-winged Bats abandon roosts in military emplacements at Malabar when fires are lit within or immediately outside the entrance to the structures or when there is increased human presence inside the structures (White 2011)
- The above points indicate that there is a possibility that the bats will abandon the roost in the short, medium or long term, with uncertain availability of secure roots of equal or greater capacity in proximity to the study area.

Further to the preparation of a BDAR, the following is proposed to outline actions required to minimise impacts to the Large Bent-winged Bat roost:

- Preparation of a Construction Microbat Management Plan (CMMP) to outline actions required to minimise impacts to the roost prior to and during construction. The CMMP will recommend that construction of the elevated pathway and jacked box culvert under Longport Street is scheduled for a time when no bats or very few bats are present at the roost
- Preparation of a Microbat Monitoring Plan (MMP) to outline monitoring protocols to be undertaken prior construction, during construction and at least two years into operation to identify changes in the roost's behaviour (if any).
- Preparation of an Adaptive Microbat Design Plan (AMDP), which may include carefully planned and staged investigations to quantify the effects on roosting and emerging bats to barriers (shade cloth) erected within the flight path at the location of the proposed walkway, exposure to lighting at varying distances and intensities from the roost and to lights of different types suggested as being the least disturbing to bats. The results of these investigations will aid in the detailed design of Cadigal Reserve and may include the following:
    - Installation of remote infra-red or thermal cameras and ultrasonic recording devices within the roost to record levels of arousal / activity prior to construction and during experimental disturbances of different kinds.
    - Monitoring and/or reviewing monitoring data gathered from several other Large bent-winged Bat roost sites (control sites) within the Sydney Basin that are not subject to impacts from construction to place results in context.
- All three Plans will be implemented to ensure that impacts to bats during the construction and operational phase are minimised, monitored and can be adaptively managed.

5.2.3 Modification of Fragmentation of Vegetation

Under the proposed works there will be a reduction in the extent of native species which may provide stepping-stone habitat. This may impact upon the movement of any remaining Long-nosed Bandicoots in the area. Although this species has not been recorded within the area since the installation of the Light Rail, a precautionary approach was taken to assume that species may remain. Habitat for this species may include weeds and vegetation zones 1-3. A Test of Significance was prepared for this species.

One highly mobile Grey Headed Flying-fox has been recorded in the study area and is considered to utilise the vegetation within the study area for foraging. Additional habitat resources in the form of planted street trees was recorded in the locality of the study area and may provide supplementary foraging habitat for this species.

5.3 Other Indirect Impacts

Indirect impacts are those impacts that do not directly affect habitat and individuals but that have the potential to interfere through indirect action. Indirect impacts considered for this assessment are site impacts (noise, light and weed invasion) and downwind impacts (sedimentation, dust, accidental spills and leaks).

During the construction, noise, dust and to a small degree vibration will be emitted which could have an indirect impact on local fauna (excluding impacts on microbats which will be addressed separately). These impacts result from the operation of heavy machinery to clear vegetation and construct the buildings and infrastructure. These impacts are short term only and therefore are unlikely to significantly impact fauna. Also, during the construction period there is a risk that sediment runoff may impact adjacent native vegetation and nearby tributaries if appropriate sediment and erosion measures are not in place. These impacts will be managed via an appropriate sediment and erosion control plan. The overall impacts are likely to be minor.

Possible increase in weed infestation can result if weed propagules are introduced or moved around by machinery during construction. Weed control measures are recommended below to minimise this risk.

As such, indirect impacts to threatened species (excluding microbats) and native vegetation are unlikely to be significant and will be managed.

6. Recommendations

The following measures are recommended to minimise the impacts of the proposed activity on surrounding bushland values, including habitat for threatened species and ecological processes. The measures have been designed in consideration of relevant legislation and guidelines.

Table 9: Recommendations

Species / sensitive area	Potential impact	Appropriate mitigation measure
Native vegetation	Compaction of soil Accidental damage/clearing	Pre-construction: • Install temporary barrier fencing to prevent entry into adjacent vegetation and appropriate 'no-go zone' signage. • Installation of tree protection measures around trees to be retained in the study area. Structures should be adequate to prevent machinery from entering within the drip zone. During construction: • Maintain temporary fencing to prevent access into the native vegetation Post construction: • Stabilise all disturbed areas, implement vegetation protection measures as required • Revegetation of native vegetation consistent with the relevant vegetation communities.
Water quality	Increase in sediment flow into waterways Modification of hydrological flow rate due to concrete pathways Reduction in water quality and increase in rubbish	During-construction: • No stockpiling of rubbish or storage of chemicals to occur near native vegetation or waterways. • The use of fuel, chemicals, herbicides should be limited near waterways and other sensitive areas
Sediments and erosion control	Increase in sediment flow into water control Runoff should be directed away from bushland	Pre-construction: • A Sediment and Erosion Control Plan is required prior to any on-ground work. • Soil and erosion control measures such as sediment fencing must be installed prior to on-ground works. These are to be inspected regularly (weekly), and more frequently during rain periods to ensure structures are in proper working order. Post-construction:

Species / sensitive area	Potential impact	Appropriate mitigation measure
		• Bare areas should be mulched, using on-site native vegetation if removed, following clearance works to prevent erosion or soil damage. Alternatively, erosion prone areas, when not in use, may be covered with biodegradable weed matting or similar product.
Spread of weeds and disease	Introduction or spread of weeds or disease into bushland or threatened species habitat	<u>Pre-construction</u>: • All equipment must be thoroughly cleaned of soil and weed propagules prior to entry into the study area • Priority weeds listed in **Section 4.2.5** should be removed using best management practices (including appropriate controls to prevent impacts to threatened species) prior to removal of native vegetation. Weed propagules are to be removed off site <u>During construction</u> • The use of chemical should be limited due to the indirect impacts to threatened fauna and native vegetation <u>Post construction:</u> • All equipment must be cleaned before exiting the study area • All weed propagules are to be bagged and removed offsite, preferably the same day and disposed of at designated green waste facility. • Implementation of a Weed Management Plan and revegetation works may be required following the completion of works for the adjacent riparian corridor.
Adjacent riparian corridor (Hawthorne Canal)	Overshadowing of vegetation resulting in changes in species composition Increase spread of weeds	<u>Post Construction</u> • Implementation of a Vegetation Management Plan and revegetation works may be required for the adjacent corridor following the completion of works • Any landscaping or revegetation works must consider the use provenance species.
Threatened microbats and Grey-headed Flying-fox	Impacts to known roost locations Abandonment of roost locations	<u>Preconstruction</u> • Prepare the CMMP and MMP and AMDP and begin implementation of the relevant actions of all three plans.

Species / sensitive area	Potential impact	Appropriate mitigation measure
		<u>During construction</u> • Conduct a pre-clearance survey to ensure that no Grey-headed Flying-foxes are present within the study area or adjacent vegetation prior to vegetation removal. • Contractors to be briefed on the presence of threatened species • If Grey-headed Flying-fox is located during works, works are to stop, and the Project Ecologist is notified to provide ecological advice. • Implement the CMMP and MMP and AMDP. <u>During Operation</u> • Ongoing implementation of the MMP.

7. Conclusion

Without a more current review of the status (mating or copulatory activities, age and sex ratio of bats) of the Cadigal Reserve Large Bent-winged Bat roost and other known Large Bent-winged Bat roosts in the Sydney Basin or more detailed information on regional patterns of use (how much movement of individuals occurs between roosts), it is difficult to conclude with any confidence that the population would persist despite the potential impacts of the proposed GreenWay In-Corridor works, and therefore, be able to sustain the loss of this roost that may result from those impacts.

In accordance with Section 7.8(3) of the BC Act, the preparation of a BDAR or SIS will be required. Furthermore, it is recommended that the Microbat Management Plans (CMMP, MMP and AMDP) be prepared and that further surveys are conducted to inform these Plans that focus on:

- Searches of up to 10 of the closest nearby suitable potential roost habitat locations outside the alignment to be accompanied by ultrasonic surveys
- Extensive ultrasonic surveys at the roost during autumn and early winter to determine whether mating activity could be taking place (Gonsalves and Law 2018)
- Banding of bats and harp trapping at the roost and other known roost sites to determine levels of movement between roosts
- Obtaining all survey data from Inner West Council and Sydney University throughout the next year
- Experimental trials investigating the effects on roosting bats of differing physical barriers simulating the placement of the elevated walkway, lighting levels and light spill at varying distances from the roost using different types of lights and baseline noise / vibrational measurements
- Monitoring of control sites of known Large Bent-winged Bat roosts in the Sydney region.

References

Ancillotto. L., Tiziana Serangeli. M. and Russo. D. 2013. *Curiosity killed the bat: domestic cats as bat predators*. Mammalian Biology 78(5):369-373.

Australian Museum Business Services. 2007 Fauna Study, Marrickville LGA. Prepared for Marrickville Council.

Australian Wetlands Consulting Pty Ltd (AWC). 2012. GreenWay Biodiversity Strategy prepared for the GreenWay sustainability Project.

Australian Wetlands Consulting Pty Ltd (AWC). 2018. Cooks to Cove GreenWay – Missing Links Flora and Fauna Assessment. Prepared for Inner West Council.

Biosis, 2012. Balmain Rock-cutting: Terrestrial Flora and Fauna Assessment. Prepared for John Holland Group Pty. Ltd.

Bonsen. G., Law. B. and Ramp. D. 2015. *Foraging strategies determine the effect of traffic noise on bats*. Acta Chiropterologica 17(2):347-357.

Bullen. R. and Crease. S. 2014. *A note on the impact on Pilbara Leaf-nosed And Ghost Bat activity from cave sound and vibration levels during drilling operations*. The Western Australian Naturalist 29

Chapman, G.A and Murphy, C.L. 1989. *Soil Landscapes of the Sydney 1:100 000 sheet*. Soil Conservation Service of NSW, Sydney.

Cardno 2019. Biodiversity Development Assessment Report – Greenway Central Missing Links. Prepared for Inner West Council.

Department of Environment and Energy. 2018. Conservation advice (incorporating listing advice) for the Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community. Canberra: Department of the Environment and Energy. Available: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/141-conservation-advice.pdf

Department of Agriculture, Water and the Environment (DAWE) 2020a. Protected Matters Search Tool [online]. Available: http://www.environment.gov.au/epbc/protect/index.html (Accessed: 7 October 2020.

Department of Agriculture, Water and the Environment (DAWE) 2020b. National Flying-fox monitoring viewer. Australian Government. Available: http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf (Accessed: 7 October 2019)

Department of Agriculture, Water and the Environment (DAWE) 2020c. Species Profile and Threats Database. Available http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

Department of Planning, Industry and Environment (DPI&E). 2020a. Threatened Species Database (5 km radius search). OEH Sydney, NSW. (Data viewed September 2020).

Department of Planning, Industry and Environment (DPIE). 2020b. Threatened Species Profiles. Available: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?

Department of Planning, Industry and Environment (DPIE) 2020c. Biodiversity Values Map and Threshold Tool (online). Available: https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=BOSETMap (Accessed 11 September 2020).

Dwyer. P. D. 1963. *The breeding biology of* Miniopterus schreibersii blepotis *(Termminck)(Chiroptera) in north-eastern NSW*. Australian Journal of Zoology. 11:219-240.

Eco Logical Australia Pty Ltd (ELA) 2011. GreenWay Revegetation and Bushcare Plan. Prepared for GreenWay Sustainability Project (a partnership between Ashfield, Leichhardt, Marrickville and City of Canterbury Councils).

Eco Logical Australia Pty Ltd (ELA) 2013. Microbat survey Balmain Tunnel letter. Prepared for John Holland Group Pty Ltd.

Eco Logical Australia Pty Ltd (ELA) 2018. Lewisham Light Rail upgrade threatened fauna targeted survey letter. Prepared for Coleman Rail.

Fure, A. 2006. *Bats and lighting*. The London Naturalist No. 85.Gonsalves. L. 2018. *Do bats habituate to grating at derelict mines*. Spoken presentation to the 18th Australasian Bat Society Conference. The Hawkesbury Institute for the Environment, Western Sydney University, Richmond, NSW.

Gonsalves. L. and Law. B. 2018. *Seasonal activity patterns of bats in North Sydney, New South Wales: implications for urban bat monitoring programs*. Australian Mammalogy 40: 220-229.

Haddock. J., Threlfall. C., Law. B. and Hochuli. D. F. 2019. *Light pollution at the urban forest edge negatively impacts insectivorous bats*. Biological Conservation 236: 17-28.

Hale. J. D., Fairbrass. A. J., Matthews. T. J., Davies. G. and Sadler. J. P. 2015. The ecological impact of city lighting scenario's : exploring gap crossing thresholds for urban bats. Global Change Biology. https://doi.org/10.1111/gcb.12884

Hochuli, D. Threlfall. D., Gonsalves.L. and Law. B. 2019. Monitoring of Eastern Bentwing Bats at Cadigal Reserve, Summer Hill. Report on first monitoring session (Autumn 2019) produced for Inner West Council.

Hoye. G. 2000. *Flora and fauna assessment Waverton Peninsula*. Report prepared for North Sydney Council. Fly By Night Surveys Pty. Ltd.

Hoye. G. and Spence. J. 2004. *The Large Bent-wing Bat* Miniopterus schreibersii *in Urban Environments: a survivor?* Pg 138-147 in Urban Wildlife: more than meets the eye, ed Daniel Lunney and Shelley Burgin, Royal Zoological Society of New South Wales, Mosman, NSW.

Leary. T., Kwok.A., Khan.B. and Ibbetson.P. 2010. *Yuppie bandicoots of inner western Sydney – in hiding or urban renewal?* Parks and Wildlife Division, Department of Environment, Climate Change and Water.

Luo. J., Clarin-Markus. B., Borissov. I. M. and Siemers. B. M. 2014. *Are torpid bats immune to anthropogenic noise?* The Journal of Experimental Biology 217:1072-1078.

Marshall Day Acoustics 2021. *Greenway Corridor Construction Noise and Vibration Assessment*. Prepared for Eco Logical Australia.

Parsons Brinckerhoff. 2010. Ecological assessment: Sydney Light Rail Extension – Stage 1. Prepared for NSW Government, Transport for NSW.

Price.C. and Banks.P. 2016. Inner West Light Rail Expansion – Long-nosed Bandicoot Population Research Project. University of Sydney.

Prucha. M. and Hanzal. V. 1989. *Some aspects of hibernation of bats wintering in the Bohemian karst (Central Bohemia, Czecholovakia*). Acta Universitatis Carolinae-Biologica 33:315-333.

Scientific Committee 2019. *Sydney Turpentine-Ironbark Forest – endangered ecological community*. Available: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/1996-1999/sydney-turpentine-ironbark-forest-endangered-ecological-community-listing

Stone. E. L., Harris. S. and Jones. G. 2015. *Impacts of artificial lighting on bats: a review of challenges and solutions*. Mammalian Biology 80:213-219.

Threlfall. C. 2012. *Why bats need dark skies*. Australasian Bat Society Fact Sheet.

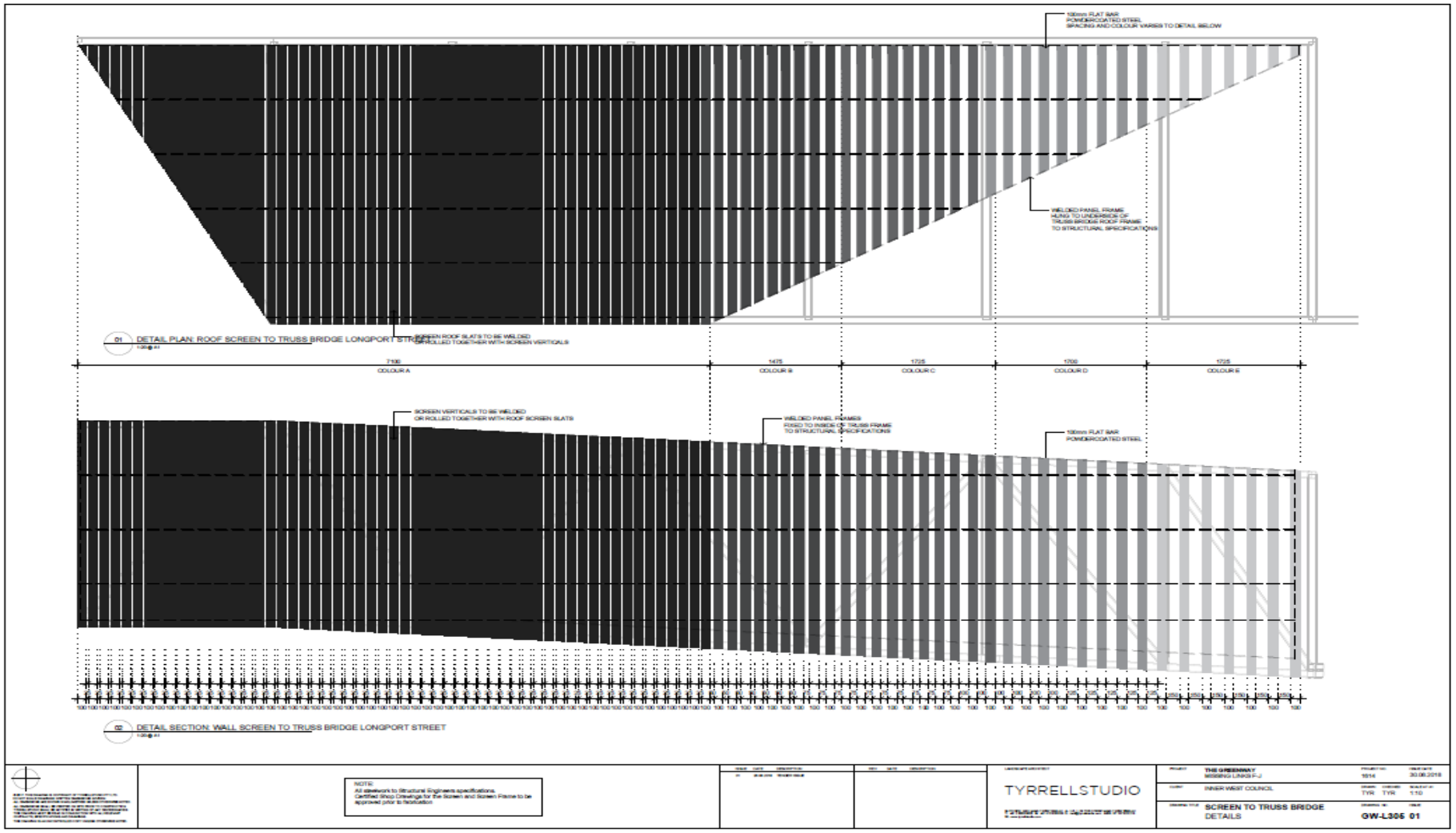
Tobin. A. and Chambers. C. L. 2017 *Mixed effects of gating subterranean habitat on bats: A review*. The Journal of Wildlife Management 81(7): 1149-1160.

White. A. W. 2011. *Roosting dynamics of Eastern Bent-wing Bats* Miniopterus schreibersii oceanensis *in disused military sites in eastern Sydney*. In The Biology and Conservation of Australasian Bats, ed. by Brad Law, Peggy Eby, Daniel Lunney and Lindy Lumsden. Royal Zoological Society of NSW, Mosman, NSW.

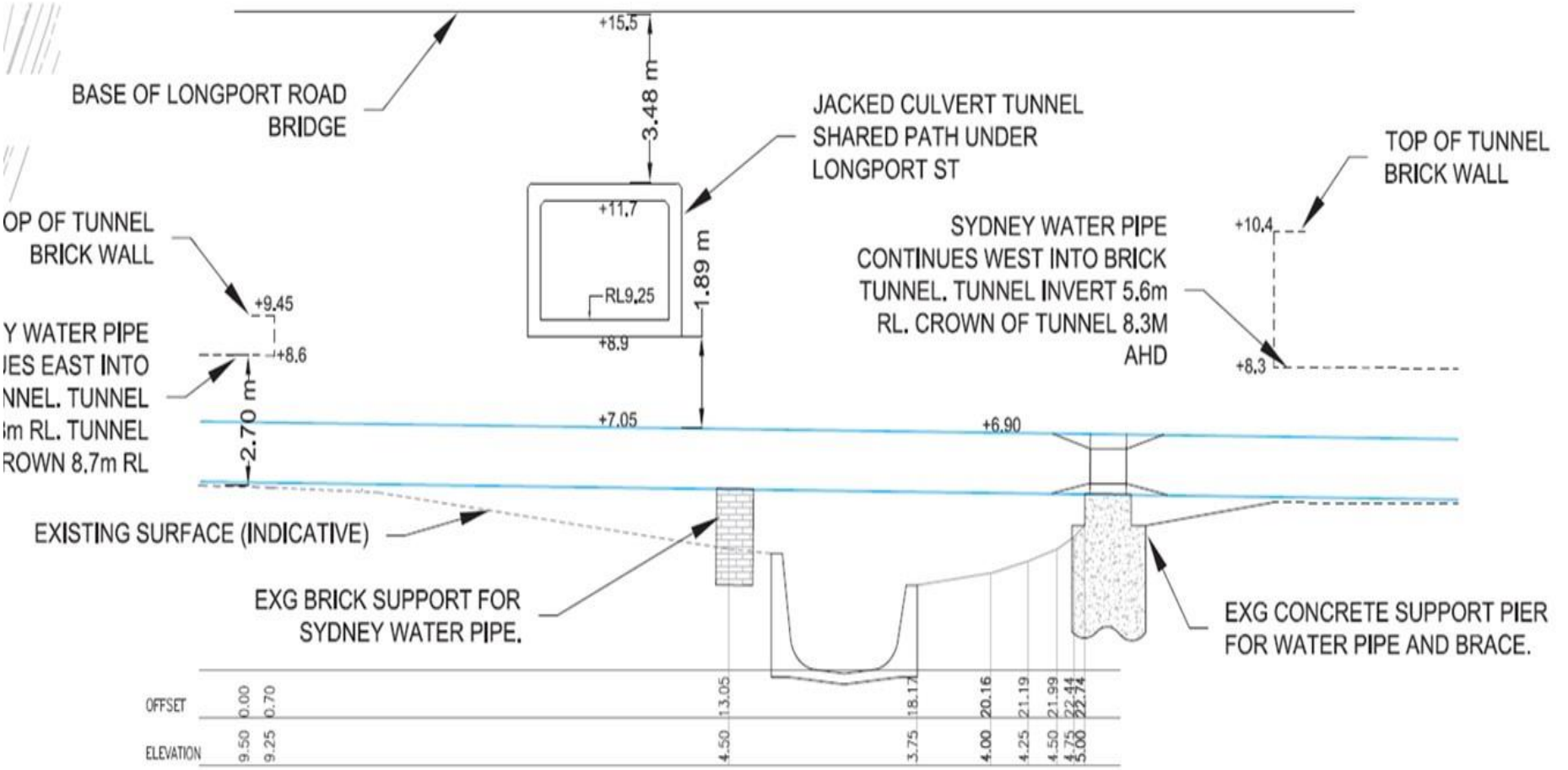
Williams. N. 2017. Cadigal Reserve, Eastern Bentwing-bat roost (tunnel), Grosvenor Crescent, Ashfield, NSW.

Appendix A Concept Engineering Plans

A1 Elevated Pathway



A2 Jacked Box Culvert Under Longport Street



SECTION O: TYPICAL SECTION
1:100 @A1

Appendix B Flora species list

Family	*Species Name*	Common Name	Exotic (*)
Altingiaceae	*Liquidambar styraciflua*	American Sweetgum	*
Apiaceae	*Foeniculum vulgare*	Fennel	*
Apocynaceae	*Araujia sericifera*	Moth Vine	*
Apocynaceae	*Nerium oleander*	Oleander	*
Araliaceae	*Hedera helix*	English Ivy	*
Arecaceae	*Phoenix canariensis*	Canary Island Date Palm	*
Asparagaceae	*Yucca* sp.		*
Asteraceae	*Ageratina adenophora*	Crofton Weed	*
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	*
Asteraceae	*Hypochaeris radicata*	Flatweed	*
Asteraceae	*Lactuca* sp.		*
Asteraceae	*Senecio madagascariensis*	Fireweed	*
Asteraceae	*Sonchus asper*	Prickly Sowthistle	*
Basellaceae	*Anredera cordifolia*	Madeira Vine	*
Binoniaceae	*Jacaranda mimosifolia*	Jacaranda	*
Brassicaceae	*Brassica* spp.		*
Cannabaceae	*Celtis sinensis*	Japanese Hackberry	*
Casuarinaceae	*Casuarina cunninghamiana* subsp. *Cunningamhiana*	River Oak	
Casuarinaceae	*Casuarina glauca*	Swamp Oak	
Chenopodiaceae	*Chenopodium album*	Fat Hen	*
Commelinaceae	*Commelina cyanea*	Scurvy Weed	
Commelinaceae	*Tradescantia fluminensis*	Trad	*
Convolvulaceae	*Dichondra repens*	Kidney Weed	
Convolvulaceae	*Ipomoea indica*	Morning Glory	*
Cunoniaceae	*Callicoma serratifolia*	Black Wattle	
Cuppressaceae	*Sequoia sempervirens*	Coastal Redwoods	*
Dilleniaceae	*Hibbertia* sp.		
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash	
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant	*
Euphorbiaceae	*Triadica sebifera*	Chinese Tallow	*
Fabaceae (Faboideae)	*Acacia implexa*	Hickory Wattle	
Fabaceae (Faboideae)	*Dillwynia retorta*		
Fabaceae (Faboideae)	*Erythrina x sykesii*	Coral Tree	*

Family	*Species Name*	Common Name	Exotic (*)
Fabaceae (Faboideae)	*Genista monspessulana*	Montpellior Broom	*
Fabaceae (Faboideae)	*Glycine clandestina*	Love Creeper	
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla	
Fabaceae (Faboideae)	*Kennedia rubicunda*	Dusky Coral Pea	
Fabaceae (Faboideae)	*Senna pendula*		*
Fabaceae (Faboideae)	*Trifolium repens*	White Clover	*
Fabaceae (Mimosoideae)	*Acacia decurrens*	Black Wattle	
Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally Wattle	
Fabaceae (Mimosoideae)	*Acacia myrtifolia*	Red-stemmed Wattle	
Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle	
Fabaceae (Mimosoideae)	*Acacia saligna*	Golden Wreath Wattle	*
Lamiaceae	*Westringia fruticosa*	Coastal Rosemary	
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	*
Liliaceae	*Lilium formasanum*	Formosan Lily	*
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	
Malvaceae	*Brachychiton populneus*	Kurrajong	
Malvaceae	*Malva parviflora*	Small-flowered Mallow	*
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	*
Moraceae	*Ficus coronata*	Sandpaper Fig	
Moraceae	*Ficus macrophylla*	Moreton Bay Fig	
Moraceae	*Morus alba*	Mulberry	*
Myrtaceae	*Acmena smithii*	Lilly Pilly	
Myrtaceae	*Angophora costata*	Smooth-barked Apple	
Myrtaceae	*Callistemon citrinus*	Crimson Bottlebrush	
Myrtaceae	*Callistemon salignus*	Willow Bottebrush	
Myrtaceae	*Corymbia eximia*	Yellow Bloodwood	
Myrtaceae	*Corymbia maculata*	Spotted Gum	
Myrtaceae	*Eucalyptus amplifolia* subsp. *amplifolia*	Cabbage Gum	
Myrtaceae	*Eucalyptus botrioydes*	Bangalay	
Myrtaceae	*Eucalyptus microcorys*	Tallowwood	
Myrtaceae	*Eucalyptus paniculata*	Grey Ironbark	
Myrtaceae	*Eucalyptus punctata*	Grey Gum	

Family	*Species Name*	Common Name	Exotic (*)
Myrtaceae	*Eucalyptus saligna*	Syndey Blue Gum	
Myrtaceae	*Eucalyptus sideroxylon*	Mugga Ironbark	
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum	
Myrtaceae	*Kunzea ambigua*	Tick Bush	
Myrtaceae	*Leptospermum parvifolium*		
Myrtaceae	*Lophostemon confertus*	Brush Box	
Myrtaceae	*Melaleuca decora*	White-feathered Honey Myrtle	
Myrtaceae	*Melaleuca quinquenervia*	Prickly-leaved Paperbark	
Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Paperbark	
Myrtaceae	*Syncarpia glomulifera*	Turpentine	
Myrtaceae	*Tristaniopsis laurina*	Water Gum	
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	*
Oleaceae	*Ligustrum lucidum*	Broad-leaf Privet	*
Oleaceae	*Ligustrum sinense*	Small-leaf Privet	*
Oleaceae	*Olea europaea subsp. cuspidata*	African Olive	*
Oxalidaceae	*Oxalis spp.*		
Phormiaceae	*Dianella caerulea*	Blue Flax-lily	
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	
Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree	
Pittosporaceae	*Bursaria spinosa* subsp. *spinosa*	Blackthorn	
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum	
Plantaginaceae	*Plantago lanceolata*	Plantain	*
Platanaceae	*Platanus x hybridus*	London Plane Tree	*
Poaceae	*Arundo* sp.		*
Poaceae	*Bromus catharticus*	Prairie Grass	*
Poaceae	*Cenchrus clandestinus*	Kikuyu	*
Poaceae	*Chloris gayana*	Rhodes Grass	*
Poaceae	*Cortaderia selloana*	Pampas Grass	*
Poaceae	*Ehrharta erecta*	Vasey Grass	*
Poaceae	*Eragrostis curvula*	African Lovegrass	*
Poaceae	*Imperata cylindrica* var. *major*	Blady Grass	
Poaceae	*Microlaena stipoides*	Weeping Meadow Grass	
Poaceae	*Oplismenus aemulus*	Australian Basket Grass	
Poaceae	*Paspalum dilatatum*		*
Poaceae	*Phyllostachys aurea*	Bamboo	*
Poaceae	*Poa annua*	Annual Poa	*

Family	*Species Name*	Common Name	Exotic (*)
Poaceae	*Setaria parviflora*	Slender Pigeon Grass	*
Poaceae	*Themeda triandra*	Kangaroo Grass	
Polygonaceae	*Acetosa sagittata*	Turkey Rhubarb	*
Primulaceae	Anagallis arvensis	Scarlet Pimpernel	*
Proteaceae	*Banksia integrifolia*	Coast Banksia	
Proteaceae	*Grevillea robusta*	Silky Oak	
Rosaceae	*Cotoneaster glaucophyllus*	Cotoneaster	*
Rosaceae	*Rubus fruticosus*	Blackberry	*
Rubiaceae	*Galium aparine*	Cleavers	*
Sapindaceae	*Cardiospermum grandiflorum*	Balloon Vine	*
Solanaceae	*Cestrum parqui*	Green Cestrum	*
Solanaceae	*Solanum mauritianum*	Wild Tobacco	*
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	*
Ulmaceae	*Ulmus parvifolia*	Chinese Elm	*
Urticaceae	*Parietaria judaica*	Asthma Weed	*
Verbenaceae	*Lantana camara*	Lantana	*
Verbenaceae	*Verbena bonariensis*	Purple Tops	*

Appendix C Likelihood of occurrence

An assessment of likelihood of occurrence was made for threatened and migratory species identified from the database search. Five terms for the likelihood of occurrence of species are used in this report. This assessment was based on database or other records, presence or absence of suitable habitat, features of the proposal site, results of the site inspection and professional judgement. Some Migratory or Marine species identified from the Commonwealth database search have been excluded from the assessment, due to lack of habitat. The terms for likelihood of occurrence are defined below:

- "known" = the species was or has been observed on the site
- "likely" = a medium to high probability that a species uses the site
- "potential" = suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur
- "unlikely" = a very low to low probability that a species uses the site
- "no" = habitat on site and in the vicinity is unsuitable for the species.

A test of significance was conducted for threatened species or ecological communities that were recorded within the study area or had a higher likelihood of occurring and would be impacted by the proposed works. It is noted that some threatened fauna species that are highly mobile, wide ranging and vagrant may use portions of the study area intermittently for foraging. For these fauna species, the habitat present and likely to be impacted is not considered to be important to the threatened species, particularly in relation to the amount of similar habitat remaining in the surrounding landscape. As such, a test of significance in reference to State or Commonwealth legislation was not considered necessary.

The records column refers to the number of records occurring within 5 km of the study area, as provided by the Atlas of NSW Wildlife (BioNet) and Protected Matters Search Tool database search.

Information provided in the habitat associations' column has primarily been extracted (and modified) from the Commonwealth Species Profile and Threats Database and the NSW Threatened Species Profiles.

Table 10: Threatened ecological communities (TECs) likelihood table

Name	BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence	Assessment of Significance required
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	V / CE	E	Occurs almost exclusively on soils derived from Tertiary alluvium, or on sites located on adjoining shale or Holocene alluvium. Often adjacent to and on slightly higher ground than Castlereagh Ironbark Forest or Shale Gravel Transition Forest in the Sydney Basin Bioregion. Dominated by *Eucalyptus parramattensis* subsp. *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 species such as *Banksia spinulosa* var. *spinulosa, Melaleuca nodosa, Hakea sericea* and *H. dactyloides* (multi-stemmed form). The ground stratum consists of a diverse range of forbs including *Themeda australis, Entolasia stricta*, *Cyathochaeta diandra, Dianella revoluta* subsp. *revoluta, Stylidium graminifolium*, *Platysace ericoides*, *Laxmannia gracilis* and *Aristida warburgii.*	Unlikely	No
Coastal Upland Swamps in the Sydney Basin Bioregion	E	E	Endemic to NSW and confined to the Sydney Basin Bioregion. It occurs in the eastern Sydney Basin from the Somersby district in the north	Unlikely	No

Name	BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence	Assessment of Significance required
			(Somersby-Hornsby plateaux) to the Robertson district in the south (n the Woronora plateau). Occurs primarily on impermeable sandstone plateaux with shallow groundwater aquifers in the headwaters and impeded drainage lines of streams, and on sandstone benches with abundant seepage moisture. Generally associated with acidic soils. May include tall open scrubs, tall closed scrubs, closed heaths, open graminoid heaths, sedgelands and fernlands. Larger examples may include a complex of these structural forms.		
Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion	E	CE	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*, *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple) and *A. subvelutina* (broad-leaved apple). *Eucalyptus baueriana* (blue box), *E. botryoides* (bangalay) and *E. elata* (river peppermint) may be common south	Unlikely	No

Name	BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence	Assessment of Significance required
			from Sydney. *E. ovata* (swamp gum) occurs on the far south coast, *E. saligna* (Sydney blue gum) and *E. grandis* (flooded gum) may occur north of Sydney, while *E. benthamii* is restricted to the Hawkesbury floodplain. A layer of small trees may be present, including *Melaleuca decora, M. styphelioides* (prickly-leaved teatree), *Backhousia myrtifolia* (grey myrtle), *Melia azadarach* (white cedar), *Casuarina cunninghamiana* (river oak) and *C. glauca* (swamp oak). Scattered shrubs include *Bursaria spinosa, Solanum prinophyllum, Rubus parvifolius, Breynia oblongifolia, Ozothamnus diosmifolius, Hymenanthera dentata, Acacia floribunda* and *Phyllanthus gunnii.* The groundcover is composed of abundant forbs, scramblers and grasses.		
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act) Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland (EPBC Act)	E	E	The ecological community occurs in coastal catchments, mostly at elevations of less than 20 m above sea-level (ASL) that are typically found within 30 km of the coast. However, this distance varies by catchment. This community typically occurs on unconsolidated sediments, including alluvium deposits, and	Unlikely	No

Name	BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence	Assessment of Significance required
			where soils formed during the Quaternary period as a result of sea-level rise during the Holocene period (Sloss et al., 2007). The ecological community can also occur on peaty soils. Occurrences of swamp oak trees on rocky headlands or other consolidated substrates are not considered to be a part of the ecological community, but areas where soils transition into unconsolidated sediments may contain the ecological community. The ecological community is typically found where groundwater is saline or brackish, but can occur in areas where groundwater is relatively fresh. It is typically found on coastal flats, floodplains, drainage lines, lake margins, wetlands and estuarine fringes where soils are at least occasionally saturated, water-logged or inundated		
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	CE	CE	Occurs at the edges of the Cumberland Plain, where clay soils from the shale rock intergrade with earthy and sandy soils from sandstone, or where shale caps overlay sandstone. The boundaries are indistinct, and the species composition varies depending on the soil influences. It typically occurs in	Unlikely	No

Name	BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence	Assessment of Significance required
			moderately wet sites, with an annual rainfall of 800-1100mm per year, and on clay soils derived from Wianamatta shale. The tree canopy is dominated by Turpentine and a variety of eucalypt species. Its distribution is mainly on the Cumberland Plain of the Sydney region. Was not recorded during the site inspection.		
Sydney Turpentine Ironbark Forest	CEEC	CEEC	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 plateaus. Open forest, with dominant canopy trees including *Syncarpia glomulifera*, *Eucalyptus punctata* (Grey Gum), *E. paniculata* (Grey Ironbark) and *E. eugenioides* (Thin-leaved Stringybark). In areas of high rainfall (over 1050 mm per annum) *E. saligna* (Sydney Blue Gum) is more dominant. The shrub stratum is usually sparse and may contain mesic species such as *Pittosporum undulatum* and *Polyscias sambucifolia* (Elderberry Panax).	Unlikely	No

Name	BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence	Assessment of Significance required
Western Sydney Dry Rainforest and Moist Woodland on Shale	E	CE	A dry vine scrub community of the Cumberland Plain, western Sydney. Canopy trees include *Melaleuca styphelioides*, Hickory Wattle (*Acacia implexa*) and Native Quince (*Alectryon subcinereus*). Many rainforest species occur in the shrub layer, such as Mock Olive (*Notelaea longifolia*), Hairy Clerodendrum (*Clerodendrum tomentosum*) and Yellow Pittosporum (*Pittosporum revolutum*). The shrub layer combines with vines, such as Gum Vine (*Aphanopetalum resinosum*), Wonga Vine (*Pandorea pandorana*) and Slender Grape (*Cayratia clematidea*) to form dense thickets in sheltered locations.	Unlikely	No

E= Endangered Ecological Community, CE = Critically Endangered Ecological Community.

Table 11: Threatened flora likelihood table

Scientific Name	Common Name	TSC Act Status	EPBC Act	Habitat Associations	Records within 5 km	Likelihood of Occurrence	Assessment of Significance required
Acacia bynoeana	Bynoe's Wattle	E1	V	Found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. Heath or dry sclerophyll forest on sandy soils.	3	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Acacia pubescens	Downy Wattle	V	V	Restricted to the Sydney region around the Bankstown-Fairfield-Rookwood and Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Open woodland and forest, including Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland. Occurs on alluviums, shales and at the intergrade between shales and sandstones.	7	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Acacia terminalis subsp. *terminalis*	Sunshine Wattle	E1	E	Limited mainly to near-coastal areas from the northern shores of Sydney Harbour south to Botany Bay. It grows in coastal scrub and dry sclerophyll woodland on sandy soils.	2	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Allocasuarina glareicola		E1	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.	0	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No

Scientific Name	Common Name	TSC Act Status	EPBC Act	Habitat Associations	Records within 5 km	Likelihood of Occurrence	Assessment of Significance required
Caladenia tessellata	Thick Lip Spider Orchid	E1	V	Currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Grassy sclerophyll woodland on clay loam or sandy soils, or low woodland with stony soil.	2	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	It is known 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 of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*).	0	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Darwinia biflora	-	V	V	Woodland, open forest or scrub-heath on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone.	0	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Eucalyptus camfieldii	Camfield's Stringybark	V	V	Narrow band from the Raymond Terrace area south to Waterfall. Grows In coastal heath on shallow sandy soils overlying Hawkesbury sandstone, mostly on exposed sandy ridges.	0	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No

Scientific Name	Common Name	TSC Act Status	EPBC Act	Habitat Associations	Records within 5 km	Likelihood of Occurrence	Assessment of Significance required
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	Grassy open forest or woodland on poor sandy loams, most commonly on gently sloping or flat sites.	2	This species does not occur locally.	No
Genoplesium baueri	Bauer's Midge Orchid	E1	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 and flowers from December to March.	0	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Melaleuca deanei	Deane's Paperbark	V	V	Ku-ring-gai/Berowra area, Holsworthy/Wedderburn area, Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas. Heath on sandstone.	8	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Melaleuca biconvexa	Biconvex Paperbark	V	V	Only found in NSW, populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Damp places, often near streams or low-lying areas on alluvial soils.	0	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Persicaria elatior	Tall Knotweed	V	V	In south-eastern NSW recorded from Mt Dromedary, Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW known from Raymond Terrace	0	Unlikely. Suitable habitat not present due to high level of	No

Scientific Name	Common Name	TSC Act Status	EPBC Act	Habitat Associations	Records within 5 km	Likelihood of Occurrence	Assessment of Significance required
				(near Newcastle) and the Grafton area (Cherry Tree and Gibberagee State Forests). Beside streams and lakes, swamp forest or disturbed areas.		modified vegetation of the study area.	
Persoonia hirsuta	Hairy Geebung	E1	E	Scattered distribution around Sydney, from Singleton in the north, along the east coast to Bargo in the south and the Blue Mountains to the west. Sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	2	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Pimelea curviflora var. curviflora	-	V	V	Confined to the coastal area of the Sydney and Illawarra regions between northern Sydney and Maroota in the north-west and Croom Reserve near Albion Park in the south. Woodland, mostly on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes.	1	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Pimelea spicata	Spiked Rice-flower	E1	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	0	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Pomaderris prunifolia	Endangered population in Parramatta, Auburn,	E2	-	This species occurs in a highly isolated population. In recent times only three plants were recorded in Rydalmere. Historical records from early 1900s include Auburn, Strathfield, Bankstown and Parramatta LGAs.	2	Unlikely. Suitable habitat not present due to high level of	

Scientific Name	Common Name	TSC Act Status	EPBC Act	Habitat Associations	Records within 5 km	Likelihood of Occurrence	Assessment of Significance required
	Strathfield and Bankstown LGA					modified vegetation of the study area.	
Prostanthera marifolia	Seaforth Mintbush	E4A,3	CE	Only known from the northern Sydney suburb of Seaforth. In or in close proximity to the endangered Duffys Forest ecological community, on deeply weathered clay-loam soils associated with ironstone and scattered shale lenses.	1	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Syzygium paniculatum	Magenta Lilly Pilly	E1	V	Only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. Subtropical and littoral rainforest on gravels, sands, silts and clays.	19	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Tetratheca juncea	Black-eyed Susan	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 (DPIE 2020b). 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 (DPIE 2020b). Flowers July to December.	15	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No
Thesium australe	Austral Toadflax	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* (DECC 2007). The preferred soil type is a fertile loam	0	Unlikely. Suitable habitat not present due to high level of modified	No

Scientific Name	Common Name	TSC Act Status	EPBC Act	Habitat Associations	Records within 5 km	Likelihood of Occurrence	Assessment of Significance required
				derived from basalt although it occasionally occurs on metasediments and granite.		vegetation of the study area.	
Wilsonia backhousei	Narrow-leafed Wilson	V	-	This species is a salt marsh specialist. It occurs in coastal regions including Parramatta River at Ermington, Clovelly, Voyager Point.	1	Unlikely. Suitable habitat not present due to high level of modified vegetation of the study area.	No

Table 12: Threatened fauna likelihood table

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Amphibia							
Crinia tinnula	Wallum Froglet	V	-	Occurs in acid swamps on coastal sand plains (DPIE 2020b). They typically occur in sedgelands and wet heathlands. They can also be found along drainage lines within other vegetation communities and disturbed areas, and occasionally in swamp sclerophyll forests (DPIE 2020b).	1	Unlikely. Suitable habitat not present.	No
Heleioporus australiacus	Giant Burrowing Frog	V	V	Forages in woodlands, wet heath, dry and wet sclerophyll forest (Ehmann 1997). Associated with semi-permanent to ephemeral sand or rock based streams, where the soil is soft and sandy so that burrows can be constructed.	0	Unlikely. Suitable habitat not present. Not known from the locality.	No
Litoria aurea	Green and Golden Bell Frog	E1,P	V	Since 1990, recorded from ~50 scattered sites within its former range in NSW, from the north coast near Brunswick Heads, south along the coast to Victoria. Records exist west to Bathurst, Tumut and the ACT region. Marshes, dams and stream-sides, particularly those containing Typha spp. (bullrushes) or *Eleocharis* spp. (spikerushes). Some populations occur in highly disturbed areas.	208	Unlikely. Suitable habitat not present due to absence of waterbodies.	No
Mixophyes balbus	Stuttering Frog	E	V	A variety of forest habitats from rainforest through wet and moist sclerophyll forest to riparian habitat in dry sclerophyll forest (DPIE 2020B) 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.	0	Unlikely. Suitable habitat not present due to absence of waterbodies.	No
Insecta							

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Synemon plana	Golden Sun Moth	E1	CE	Natural Temperate Grasslands and grassy Box-Gum Woodlands in which groundlayer is dominated by Austrodanthonia spp. (wallaby grasses).	0	Unlikely. Suitable habitat not present. Not known from the locality.	No
Aves							
Anthochaera phrygia	Regent Honeyeater	E4A	CE	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of River Oak (*C. cunninghamiana*). It primarily feeds on nectar from box and ironbark eucalypts and occasionally from Banksia's and mistletoes. It is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar. Suitable habitat likely to be present within the Precinct.	2	Unlikely. Suitable habitat not present due to lack of preferred feed trees and highly modified vegetation.	No
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	Widespread in NSW from coast to inland including the western slopes of the Great Dividing Range and farther west. Species have also been recorded in southern and southwestern Australia. Woodlands and dry open sclerophyll forest, usually eucalypts and mallee associations. Also have recordings in shrub and heathlands and various modified habitats, including regenerating forests. In western NSW, this species is primarily associated with River Red Gum/Black Box/Coolabah open forest/woodland and associated with larger river/creek systems.	4	Unlikely. Suitable habitat not present.	No
Botaurus poiciloptilus	Australasian Bittern	E1	E	Permanent freshwater wetlands with tall, dense vegetation, particularly *Typha* spp. (bullrushes) and *Eleocharis* spp. (spikerushes).	2	Unlikely. Suitable habitat not present.	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Burhinus grallarius	Bush Stone-curlew	E1		In NSW, it occurs in lowland grassy woodland and open forest.	4	Unlikely. Suitable habitat not present.	No
Calidris ferruginea	Curlew Sandpiper	E1	CE, M	Occurs along the entire coast of NSW, and sometimes in freshwater wetlands in the Murray-Darling Basin. Littoral and estuarine habitats, including intertidal mudflats, non-tidal swamps, lakes and lagoons on the coast and sometimes inland.	17	Unlikely. Suitable habitat not present due to highly modified vegetation and absence of hollows/.	No
Falco hypoleucos	Grey Falcon	E1		Shrubland, grassland and wooded watercourses, occasionally in open woodlands near the coast, and near wetlands.	0	Unlikely. Suitable habitat not present.	No
Glossopsitta pusilla	Little Lorikeet	V		Dry, open eucalypt forests and woodlands, including remnant woodland patches and roadside vegetation.	2	Unlikely. Suitable habitat not present due to highly modified vegetation and absence of hollows/.	No
Grantiella picta	Painted Honeyeater	V	V	A nomadic species that typically inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests with abundant mistletoe (DECC 2007). It is a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias, preferring *Amyema* sp mistletoe (DECC 2007).	0	Unlikely. Suitable habitat not present.	No
Haematopus fuliginosus	Sooty Oyster Catcher	V	-	A coastal species that inhabits rock coastlines, coral cays, reefs and occasionally sandy beaches.	1	Unlikely. Suitable habitat not present.	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Haematopus longirostris	Pied Oyster Catcher	E	-	Roosts and forages on sandy beaches, sand banks, mudflats and estuaries.	3	Unlikely. Suitable habitat not present.	No
Haliaeetus leucogaster	White-bellied Sea-Eagle	V		Distributed along the coastline of mainland Australia and Tasmania, extending inland along some of the larger waterways, especially in eastern Australia. Freshwater swamps, rivers, lakes, reservoirs, billabongs, saltmarsh and sewage ponds and coastal waters. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, forest and urban areas.	5	Unlikely. Suitable habitat not present due to lack of foraging or nesting habitat.	No
Hieraaetus morphnoides	Little Eagle	V	-	Throughout the Australian mainland, with the exception of the most densely forested parts of the Dividing Range escarpment. Open eucalypt forest, woodland or open woodland, including sheoak or Acacia woodlands and riparian woodlands of interior NSW.	1	Unlikely. Suitable habitat not present due to lack of foraging or nesting habitat.	No
Ixobrychus flavicollis	Black Bittern	V	-	Found in terrestrial and estuarine wetlands in areas of permanent water and dense vegetation.	2	Unlikely. Suitable habitat not present due to lack of foraging or nesting habitat.	No
Lathamus discolor	Swift Parrot	E	CE	Breeds in Tasmania between September and January. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts. Hence, in this region, autumn and winter flowering eucalypts are important for this species. Favoured feed trees include winter flowering species such as *Eucalyptus robusta* (Swamp Mahogany), *Corymbia maculata*, *C. gummifera* (Red Bloodwood), *E. sideroxylon* (Mugga Ironbark), and *E. albens* (White Box) (DPIE 2020B).		Unlikely. Suitable habitat not present due lack of suitable foraging trees.	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Melithreptus gularis gularis	Black-chinned Honeyeater	V	-	Occupies dry open forests and woodlands dominated by box or ironbark eucalypts. Vegetation is generally dominated by *Eucalyptus sideroxylon*, *E. albens* (White Box), *E. microcarpa* (Inland Grey Box), *E. melliodora* (Yellow Box), *E. blakelyi* (Blakely's Red Gum) and *E. tereticornis*.	1	Unlikely. Suitable habitat not present.	No
Neophema chrysogaster	Orange-bellied Parrot	E4A	CE	Winter habitat is mostly within 3 km of the coast in sheltered bays, lagoons, estuaries, coastal dunes and saltmarshes. Also small islands and peninsulas, saltworks, golf courses, low samphire herbland and taller coastal shrubland.	0	Unlikely. Suitable habitat not present.	No
Neophema pulchella	Turquoise Parrot	V	-	Lives on the edges of eucalypt woodlands adjoining clearings. Feeds on seeds and plant matter. Nests in tree hollows.	2	Unlikely. Suitable habitat not present.	No
Ninox strenua	Powerful Owl	V		Woodland, open sclerophyll forest, tall open wet forest and rainforest.	18	Unlikely. Suitable habitat not present.	No
Numenius minutus	Little Curlew		M	Dry grasslands, open woodlands, floodplains, margins of drying swamps, tidal mudflats, airfields, playing fields, crops, saltfields, sewage ponds.	1	Unlikely. Suitable habitat not present.	No
Petroica boodang	Scarlet Robin	V	-	Dry eucalypt forests and woodlands, and occasionally in mallee, wet forest, wetlands and tea-tree swamps.	2	Unlikely. Suitable habitat not present.	No
Petroica phoenicea	Flame Robin	V	-	Endemic to south-eastern Australia. In NSW it breeds in tall moist eucalypt forests and migrates in winter to inland slopes and plains. Prefers open understorey.	1		

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Ptilinopus superbus	Superb Fruit-Dove	V	-	Rainforest and closed forests. May also forage in eucalypt or acacia woodland where there are fruit-bearing trees.	6	Unlikely. Suitable habitat not present.	No
Rostratula australis	Australian Painted Snipe	E1	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (ibid.). Breeding is often in response to local conditions; generally occurs from September to December. Roosts during the day in dense vegetation. Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter (ibid.).	0	Unlikely. Suitable habitat not present.	No
Stagonopleura guttata	Diamond Firetail	V		Grassy eucalypt woodlands, open forest, mallee, Natural Temperate Grassland, secondary derived grassland, riparian areas and lightly wooded farmland.	1	Unlikely. Suitable habitat not present.	No
Tyto novaehollandiae	Masked Owl	V		Dry eucalypt forests and woodlands from sea level to 1100 m.	1	Unlikely. Suitable habitat not present.	No
Xenus cinereus	Terek Sandpiper	V	M	A rare migrant to the eastern and southern Australian coasts. The two main sites in NSW are the Richmond River estuary and the Hunter River estuary. Mudbanks and sandbanks near mangroves, rocky pools and reefs, and occasionally up to 10 km inland around brackish pools.	4	Unlikely. Suitable habitat not present.	No
Mammalia							

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Wet and dry sclerophyll forests, Cyprus Pine dominated forest, woodland, sub-alpine woodland, edges of rainforests and sandstone outcrop country.	0	Unlikely. Suitable habitat not present due to highly modified vegetation and lack of nearby roosting habitat	No
Dasyurus maculatus	Spotted-tailed Quoll	V	E	The Spotted-tailed Quoll 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 and in NSW within 200km of the coast. Preferred habitat is mature wet forest, especially in areas with rainfall 600 mm/year. Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable. 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.	0	Unlikely. Suitable habitat not present.	No
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E1	E	Found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River. Heath or open forest with a heathy understorey on sandy or friable soils.	0	Unlikely. Suitable habitat not present. No known local population.	No
Miniopterus australis	**Little Bent-winged Bat**	**V**	**-**	**Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub.**	**1**	**Potential**	**Yes**

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Miniopterus orianae oceanensis	**Large Bent-winged Bat**	**V**	**-**	**Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia. Breeding or roosting colonies can number from 100 to 150,000 individuals. Hunt in forested areas, catching moths and other flying insects above the tree tops.**	**24**	**Potential**	**Yes**
Myotis macropus	Southern Myotis	V		Foraging habitat is waterbodies (including streams, or lakes or reservoirs) and fringing areas of vegetation up to 20 m.	5	Potential	No individuals were recorded during recent targeted surveys or have been recorded during previous ecological surveys.
***Perameles nasuta* endangered population**	**Long-nosed Bandicoot population in inner western Sydney**	**E2**	**-**	**In 2002 an individual was trapped in Dulwich Hill in inner western Sydney. Further investigation revealed additional individuals in the suburbs of Lewisham and Dulwich Hill. Individuals appear to utilise habitat under old buildings and forage in backyards.**	**26**	**Potential**	**Yes**

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices.	0	Unlikely. Suitable habitat not present.	No
Petauroides volans	Greater Glider	-	V	Eastern Australia, from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest). Eucalypt forests and woodlands. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	0	Unlikely. Suitable habitat not present.	No
Phascolarctos cinereus	Koala	V	V	Eucalypt woodlands and forests.	2	Unlikely. Suitable habitat not present.	No
Pseudomys novaehollandiae	New Holland Mouse		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.	0	Unlikely. Suitable habitat not present.	No
Pteropus poliocephalus	**Grey-headed Flying-fox**	**V**	**V**	**Subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.**	**1299**	**Potential.**	**Yes. This species was recorded roosting within the study area**

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		Almost all habitats, including wet and dry sclerophyll forest, open woodland, open country, mallee, rainforests, heathland and waterbodies. Typically roosts in hollow-bearing trees and has been known to also roost in caves.	4	Unlikely. Suitable habitat not present	No
Listed migratory species							
Actitis hypoleucos	Common Sandpiper	-	M	Non-breeding migrant to Australia. Breeds in Europe and Asia. Inhabits coastal areas	3	Unlikely. Suitable habitat not present	No
Apus pacificus	Fork-tailed Swift		M	Sometimes travels with Needletails. Varied habitat with a possible tendency to more arid areas but also over coasts and urban areas.	1	Unlikely. Suitable habitat not present	No
Ardenna grisea	Sooty Shearwater	-	M	Breeds in on islands off New Zealand, southern Australia. Forages in deep ocean waters.	4	Unlikely. Suitable habitat not present	No
Ardenna pacifica	Wedge-tailed Shearwater	-	M	Marine species.	0	Unlikely. Suitable habitat not present	No
Ardenna tenuirostris	Short-tailed Shearwater	-	M	Marine species.	6	Unlikely. Suitable habitat not present	No
Arenaria interpres	Ruddy Turnstone			Journeys from the Artic to Australia. It breeds in Europe and Asa. Forages in rocky reefs and beaches.	4	Unlikely. Suitable habitat not present	No
Calidris acuminata	Sharp-tailed Sandpiper	-	M	Summer migrant. Widespread in most regions of NSW, especially in coastal areas, but sparse in the south-central Western Plain and east Lower Western	52	Unlikely. Suitable habitat not present	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
				Regions. Shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.			
Calidris alba	Sanderling	V	M	Breeds from North America and Russia. Migrating to Australia. Forages along shorelines.	2	Unlikely. Suitable habitat not present	No
Calidris canutus	Red Knot	-	E	A non-breeding migratory species from Siberia. Recorded along major rivers estuaries and sheltered boys especially near Hunter River estuary.	3	Unlikely. Suitable habitat not present	No
Calidris ruficollis	Red-necked Stint	-	M	Nest in Siberia and migrates to Australia. Found in sheltered inlets, bays, mudflats foraging along shorelines and wetlands.	6	Unlikely. Suitable habitat not present	No
Calidris tenuirostris	Great Knot	V	CE	Migrates to Australia during non-breeding season. Forages on sandy beaches with mudflats, exposed rock platforms or reefs.	2	Unlikely. Suitable habitat not present	No
Charadrius leschenaultii	Greater Sand Plover	V	V	Non-breeding migratory species. Restricted to coastal areas on sheltered beaches or estuaries.	3	Unlikely. Suitable habitat not present	No
Charadrius mongolus	Lesser Sand Plover	V	E	Breeds in central and north eastern Asia. Migrates to coastal Australia. Utilises beaches, harbours and estuaries.	1	Unlikely. Suitable habitat not present	No
Diomedea antipodensis	Antipodean Albatross	-	V, M	Marine forager	0	Unlikely. Suitable habitat not present	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Diomedea antipodensis gibsoni	Gibson's Albatross	V	V	Marine forager	0	Unlikely. Suitable habitat not present	No
Diomedea epomophora	Southern Royal Albatross	-	V, M	Marine forager	0	Unlikely. Suitable habitat not present	No
Diomedea exulans	Wandering Albatross	E	V, M	The Wandering Albatross is marine, pelagic and aerial	1	Unlikely. Suitable habitat not present	No
Diomedea sanfordi	Northern Royal Albatross	-	E, M	Marine forager	0	Unlikely. Suitable habitat not present	No
Gallinago hardwickii	Latham's Snipe	-	M	Migrant to east coast of Australia, extending inland west of the Great Dividing Range in NSW. Freshwater, saline or brackish wetlands up to 2000 m above sea-level; usually freshwater swamps, flooded grasslands or heathlands.	6	Unlikely. Suitable habitat not present	No
Hirundapus caudacutus	White-throated Needletail		M	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.	4	Unlikely. Suitable habitat not present	No
Hydroprogne caspia	Caspian Tern	-	M, Ma	Non-breeding, marine forager. Widespread along coastal regions in NSW (DAWE 2020b).	2	Unlikely. Suitable habitat not present	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Limicola falcinellus	Broad-billed Sandpiper	V	-	This species breeds in Siberia before migrating south to Australia in winter (DPIE 2020b). The main site for this species is within the Hunter River estuary. It prefers sheltered estuarine sandflats, mudflats, harbors, saltmarsh and lagoons.	2	Unlikely. Suitable habitat not present	No
Limicola lapponica baueri	Bar-tailed Godwit	-	M	The Bar-tailed Godwit has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria, including the offshore islands. It is found south from Cooktown to Port Phillip Bay, but is less common west of the Bellarine Peninsula. There are a few inland records from NSW and Victoria (DAWE 2020b).	21	Unlikely. Suitable habitat not present	No
Limicola lapponica menzbieri	Northern Siberian Bar-tailed Godwit	-	M	A migratory shorebird which breeds in northern Siberia and descends to coastal regions around Australia. This species forages in intertidal sandflats, mudflats, estuaries, inlets and coastal lagoons and roosts on sandy beaches or spits.	0	Unlikely. Suitable habitat not present	No
Limicola limosa	Black-tailed Godwit	V	M	Primarily found along the coast on sandspits, lagoons and mudflats (DPIE 2020B). The species has also been found to occur inland on mudflats or shallow receding waters of portions of large muddy swamps or lakes.	2	Unlikely. Suitable habitat not present	No
Macronectes giganteus	Southern Giant-Petrel	E	E, M	Over summer, the species nests in small colonies amongst open vegetation on Antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic territory (DPIE 2020B).	0	Unlikely. Suitable habitat not present	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Macronectes halli	Northern Giant-Petrel	V	V, M	The Northern Giant Petrel breeds in the sub-Antarctic, and visits areas off the Australian mainland mainly during the winter months (May-October). Immature and some adult birds are commonly seen during this period in offshore and inshore waters from around Fremantle (WA) to around Sydney (NSW).	0	Unlikely. Suitable habitat not present	No
Monarcha melanopsis	Black-faced Monarch	-	M	In NSW, occurs around the eastern slopes and tablelands of the Great Divide, inland to Coutts Crossing, Armidale, Widden Valley, Wollemi National Park and Wombeyan Caves. It is rarely recorded farther inland. Rainforest, open eucalypt forests, dry sclerophyll forests and woodlands, gullies in mountain areas or coastal foothills, Brigalow scrub, coastal scrub, mangroves, parks and gardens.	0	Unlikely. Suitable habitat not present.	No
Monarcha trivirgatus	Spectacled Monarch	-	M	Mountain / lowland rainforest, wooded gullies, riparian vegetation including mangroves.	0	Unlikely. Suitable habitat not present.	No
Motacilla flava	Yellow Wagtail	-	M	An insectivorous bird, inhabiting open country near water, such as wet meadows. It nests in tussocks.	0	Unlikely. Suitable habitat not present.	No
Myiagra cyanoleuca	Satin Flycatcher		M	Habitat typically includes wetter, denser forest, often at high elevations.	0	Unlikely. Suitable habitat not present.	No
Numenius madagascariensis	Eastern Curlew	-	CE; M	Estuaries, bays, harbors, inlets and coastal lagoons, intertidal mudflats or sandflats, ocean beaches, coral reefs, rock platforms, saltmarsh, mangroves, freshwater/brackish lakes, saltworks and sewage farms.	2	Unlikely. Suitable habitat not present.	No
Pachyptila turtur subantarctica	Fairy Prion (southern)	-	M	Breeds in small islands offshore. Hunts planktonic crustaceans by skimming over water surface at night.	0	Unlikely. Suitable habitat not present.	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Pluvialis fulva	Pacific Golden Plover	-	M	Estuaries, mudflats, saltmarshes, mangroves, rocky reefs, inland swamps, ocean shores, paddocks, sewage ponds, ploughed land, airfields, playing fields.	9	Unlikely. Suitable habitat not present.	No
Pluvialis squatarola	Grey Plover	-	M	Mudflats, saltmarsh, tidal reefs and estuaries.	1	Unlikely. Suitable habitat not present.	No
Rhipidura rufifrons	Rufous Fantail	-	M	It is a summer breeding migrant to southeastern Australia. It 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.	0	Unlikely. Suitable habitat not present.	No
Sterna hirundo	Common Tern	-	M	The species is a non-breeding migrant to Australia, where it is widespread and common on the eastern coast south to eastern Victoria, and common on parts of the northern coast, mainly east of Darwin (DAWE 2020b).	6	Unlikely. Suitable habitat not present.	No
Sternula albifrons	Little Tern	E	-	Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbors, inlets and rivers (DPIE 2020b). This species breeds along east coast from Tasmania to northern Queensland and migrates to eastern Asia (DPIE 2020b).	1	Unlikely. Suitable habitat not present.	No
Sternula nereis neresi	Australian Fairy Tern	-	V	This species breeds in Australia along coastal areas.	0	Unlikely. Suitable habitat not present.	No
Thalassarche bulleri	Buller's Albatross	-	V, M	Marine forager	0	Unlikely. Suitable habitat not present.	No
Thalassarche bulleri platei	Northern Buller's Albatross	-	M	Marine forager	0	Unlikely. Suitable habitat not present.	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
Thalassarche cauta cauta	Shy Albatross	V	V, M	Marine forager	0	Unlikely. Suitable habitat not present.	No
Thalassarche eremita	Chatham Albatross	-	E, M	Marine forager	0	Unlikely. Suitable habitat not present.	No
Thalassarche melanophris	Black-browed Albatross	-	V, M	Marine forager	0	Unlikely. Suitable habitat not present.	No
Thalassarche melanophris impavida	Campbell Albatross	-	V, M	Marine forager	0	Unlikely. Suitable habitat not present.	No
Thalassarche salvini	Salvin's Albatross		M	Marine forager	0	Unlikely. Suitable habitat not present.	No
Thalassarche steadi	White-capped Albatross		M	Marine forager	0	Unlikely. Suitable habitat not present.	No
Thalasseus bergii	Greater Crested Tern		M	Marine forager	10	Unlikely. Suitable habitat not present.	No
Thinornis cucullatus cucullatus	Hooded Plover (eastern)	CE	V	Endemic to south-coast Australia. Breeds in coastal areas.	0	Unlikely. Suitable habitat not present.	No
Tringa brevipes	Grey-tailed Tattler	-	M	Breeds in Siberia. Fly south to places like Australia. Utilises sheltered reefs, rock platforms and mudflats	3	Unlikely. Suitable habitat not present.	No
Tringa stagnatilis	Marsh Sandpiper	-	M	Breeds in east Siberia to east Europe. Forages in brackish wetlands and rivers, lagoons.	1	Unlikely. Suitable habitat not present.	No
Tringa nebularia	Common Greenshank		M	Terrestrial wetlands (swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans, saltflats, sewage farms and saltworks dams, inundated rice crops and bores) and	0	Unlikely. Suitable habitat not present.	No

Scientific Name	Common Name	BC Act	EPBC Act	Habitat Associations	Records	Likelihood of occurrence	Assessment of Significance required
				sheltered coastal habitats (mudflats, saltmarsh, mangroves, embayments, harbours, river estuaries, deltas, lagoons, tidal pools, rock-flats and rock platforms).			

M = Migratory, V= Vulnerable; E= Endangered, E2 = Endangered Population, CE = Critically Endangered, PE= Presumed extinct.

Appendix D Test of Significance (BC Act)

The Test of Significance (5-part test) is applied to species, populations and ecological communities listed on Schedules 1 and 2 of the BC Act and Schedules 4, 4A and 5 of the FM Act. The assessment sets out factors, which when considered, allow proponents to undertake a qualitative analysis of the likely impacts of an action and to determine whether further assessment is required via a BDAR, or a SIS. All factors must be considered, and an overall conclusion made based on all factors in combination.

The impact assessment was undertaken for the following threatened species, populations and ecological communities:

- Grey-headed Flying-fox
- Long-nosed Bandicoot endangered population
- Cave roosting microbats (combined)
    - Little Bent-winged Bat
    - Large Bent-winged Bat

D1 *Pteropus poliocephalus* (Grey-headed Flying-fox)

Grey-headed Flying Fox is listed as a vulnerable species under the NSW BC Act. The species is endemic to the east coast of Australia with a distribution from Bundaberg in the north to Melbourne in the south, from the western slopes of the Great Dividing Range to the coast.

Grey-headed Flying-fox is a highly mobile species whose migration patterns are determined by the availability of flowering food resources. The species is a canopy-feeding frugivore, blossom-eater and nectivore, and occurs in rainforest, woodlands, paperbark swamps and Banksia woodlands. This species feeds in particular on the nectar and pollen of native trees, especially *Eucalyptus* spp., *Melaleuca* spp. and *Banksias* spp., and fruits of rainforest trees and vines. During times when native food resources are limited, Grey-Headed Flying-foxes forage on fruit crops and cultivated gardens (DPIE 2020b).

Roosting camps are generally located next to rivers or creeks and occur in a range of vegetation communities including rainforest, wet sclerophyll forest, *Melaleuca* woodland, *Casuarina* forest or mangroves (DPIE 2020b). These sites have a dense canopy, providing them with the moist, humid microclimate they require. Campsites are critical for mating, birthing, rearing of young and as diurnal refuge from predators. Urban gardens, cultivated fruit crops and roadside verges may also provide temporary roosting habitat for this species

This species is threatened by a number of processes including loss of foraging habitat, disturbance of roosting sites, unregulated shooting, and electrocution on powerlines (DPIE 2020b).

One individual Grey-headed Flying-fox was recorded during the field survey. This species has been previously recorded within the study area from literature review and database records.

Vegetation impacted by the proposed works are likely to provide foraging resources for this species. The study area does not contain current or historic campsites. The nearest roost site or 'camp' to the study area is Wolli Creek (500 – 2,499 individuals recorded in August 2019) less than 3 km away (DAWE 2020b). One individual was observed roosting in the study area during field surveys.

Table 13: *Biodiversity Conservation Act 2016* Test of Significance – Grey-headed Flying-fox

BC Act	Question	Response
7.3.1 a)	In the case of a threatened species: whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Factors likely to have an adverse effect on the life cycle of Grey-headed Flying-fox would include a substantial loss and/or fragmentation of foraging habitat, disturbance to maternity bat 'camp' or mortality from electrocution or entanglement in fruit netting. The Grey-headed Flying-fox colony located at Wolli Creek is considered to be a viable local population. Foraging resources for this viable population includes landscaped gardens, street trees, parks and Council reserves up to 50 km from their night campsite. No modification of vegetation will occur within the maternity colony location. However, the proposed? will involve the removal of potential foraging resource in the form of *Eucalyptus* species, tall *Callistemon* and *Melaleuca* species and *Lophostemon confertus* street trees.

BC Act	Question	Response
		Given that no impacts will occur to maternity camps and that only 0.66 ha of vegetation will be removed, the works are unlikely to have an adverse effect on the life cycle of this species such that a local viable population is at risk of extinction
7.3.1 b) i	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or	Not applicable.
7.3.1 b) ii	In the case of an endangered ecological community or critically endangered ecological community: Whether the proposed development or activity is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.	Not applicable.
7.3.1 c) i	In relation to the habitat of a threatened species or ecological community: The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity	The proposed works will involve removal of planted native canopy and tall shrubs and removal of several mature street trees from within the study area for the proposed new pathway. The vegetation occurs as linear patches which equates to 0.66 ha which will require removal prior to the new pathway. Indirect impacts include shadowing, changes in species assemblages, increase in weed infestation and increase in nutrient and water flow from urban development. With careful management these indirect impacts may be mitigated
7.3.1 c) ii	In relation to the habitat of a threatened species or ecological community: Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity	The proposed works will involve removal of several clumps of planted native canopy species incorporated into revegetated areas. Although the proposed works will remove vegetation within the study area, the works will not result in fragmentation of vegetation. Connectivity will be retained along the GreenWay corridor and within the revegetated area adjacent to the study area. Due to the small scale of the proposed works and the highly mobile nature of this species it is unlikely that the proposed works would fragment or isolate or increase the fragmentation or isolation of Grey-headed Flying-fox habitat.
7.3.1 c) iii	In relation to the habitat of a threatened species or ecological community: The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The proposed works will result in the modification of urbanised landscaped gardens and revegetated areas which includes planted canopy and tall shrubs. It is noted that one individual was observed roosting in the study area. This species may not have reached the bat camp prior to dawn and utilised the vegetation within the study area as a temporary refuge. The closest

BC Act	Question	Response
		nationally listed bat camp is located at Wolli Creek approximately 3 km south-east of the study area. There is potential that the vegetation within the study area provides supplementary foraging and occasional roosting habitat. The study area does not provide breeding habitat for this species and therefore it not considered vital to the survival of this species.
7.3.1 d)	Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).	No areas of outstanding biodiversity value have been listed on or near the study area.
7.3.1 e)	Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.	The proposed works constitutes one key threatening processes of relevance to the Grey-headed Flying-fox, namely Clearing of Native Vegetation, which would result in a small loss of potential habitat. However, the scale of these impacts within the study area is not considered to be significant due to the small size of the habitat to be removed and the highly mobile nature of this species.
Conclusion	**Is there likely to be a significant impact?**	**No**

D2 *Perameles nasuta* Long-nosed Bandicoot endangered population in inner western Sydney

The Long-nosed Bandicoot was thought to be extinct within the inner-city regions of Sydney. A live individual was captured in 2003. Additional surveys were conducted to reveal several other confirmed sightings. The inner western Sydney population has been identified within the Marrickville, Canada Bay, Canterbury, Ashfield and Leichhardt local government areas. Individuals utilise old buildings during the day to shelter and forage in backyards and parklands.

The species has been previously recorded from BioNet records within the study area, however, recent targeted surveys have not recorded this species. The presence of predators and loss of habitat may have contributed to the decline of sightings in this area.

Table 14: *Biodiversity Conservation Act 2016* Test of Significance –Long-nosed Bandicoot endangered population

BC Act	Question	Response
7.3.1 a)	In the case of a threatened species: whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Factors which may lead to an adverse effect on this species may include the loss of sheltering sites from residential development, road mortality and predation. The development will result in the loss or modification of 0.66 ha of planted native vegetation and 0.51 ha of weeds which may provide habitat for this species. According to literature and data obtained from radio tracked individuals, this endangered population utilises old building for daytime sheltering habitat and open parks and backyards for foraging habitat. The vegetation within the study area is likely to provide connectivity corridor and supplementary foraging habitat for this species. As the proposed works will not result in increase in road mortality, impacts to sheltering sites or predation, the works are unlikely to result in a significant impact upon this endangered population such that the population is at risk of extinction.
7.3.1 b) i	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or	Not applicable.
7.3.1 b) ii	In the case of an endangered ecological community or critically endangered ecological community: Whether the proposed development or activity is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.	Not applicable.
7.3.1 c) i	In relation to the habitat of a threatened species or ecological community:	The proposed In-corridor works package will result in the clearing or modification of 0.66 ha of planted native vegetation and 0.51 ha of weeds which may provide

BC Act	Question	Response
	The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity	habitat for this species. The proposed works are likely to result in an increase in human activity and additional lighting.
7.3.1 c) ii	In relation to the habitat of a threatened species or ecological community: Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity	The proposed works will occur along a highly urbanised and fragmented habitat. The vegetation is currently subject to edge effects and intersected at regular intervals by major arterial roads. The proposed pathway is only 2.5 m wide and is unlikely to result in this species avoiding utilising the area, if it is still present.
7.3.1 c) iii	In relation to the habitat of a threatened species or ecological community: The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The vegetation within the study area includes native planted vegetation and weeds. It does not include suitable sheltering sites (i.e. old buildings), however, it does include open parklands which may provide foraging habitat. These parklands are currently subject to regular human activity and artificial lighting and therefore not considered important for the survival of this species.
7.3.1 d)	Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).	No areas of outstanding biodiversity value have been listed within the study area.
7.3.1 e)	Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.	The proposed works constitutes one key threatening processes of relevance, namely Clearing of Native Vegetation, which would result in a small loss of potential habitat. However, the scale of these impacts within the study area is not considered to be significant due to the small size of the habitat to be removed.
Conclusion	**Is there likely to be a significant impact?**	**No.**

D3 Cave roosting Microbats (combined)

MINIOPTERUS ORIANAE OCEANENSIS (LARGE BENT-WINGED BAT)

The Large Bent-winged Bat is listed as *Vulnerable* under the BC Act and occupies a range of forested environments (including wet and dry sclerophyll forests), along the coastal portion of eastern Australia, and through the Northern Territory and Kimberley area. It forages from just above the tree canopy, to many times the canopy height in forested areas, and will utilise open areas where it is known to forage at lower levels. This highly mobile species is capable of large regional movements in relation to seasonal differences in reproductive behaviour and winter hibernation. Although roosting primarily occurs in caves, it has also been recorded in mines, culverts, stormwater channels, buildings, and occasionally tree-hollows. This species occupies a number of roosts within specific territorial ranges usually within 300 km of the maternity cave and may travel large distances between roost sites.

The study area contains a known wintering roost site for this species. Individuals generally occupy this roost between the months of late February to October (Williams 2017, Nicole Gallahar IWC pers.comm.).

MINIOPTERUS AUSTRALIS (LITTLE BENT-WINGED BAT)

Little Bent-winged Bat is listed as *Vulnerable* under the BC Act. The species is generally found in well-timbered areas, including moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats (OEH 2018b). This species has been recorded from a total of six ultrasonic call records within the study area. There is no suggestion that this species currently roosts within the Cadigal Reserve tunnel but there is a possibility that Little Bent-winged Bats could roost in the tunnel, and are often found roosting together with Large Bent-winged Bats. Reasoning relating to disturbance and lighting changes presented below is equally relevant to Little Bent-winged Bats if they are found to be roosting within the Cadigal Reserve tunnel.

Table 15: *Biodiversity Conservation Act 2016* Test of Significance – combined cave roosting microbats

BC Act	Question	Response
7.3.1 a)	In the case of a threatened species: whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction	Factors which may lead to a risk of extinction for the local population of Large Bent-winged Bats in the Cadigal Reserve roost include changes to the environment in front of the roost including introducing lighting to the area surrounding the roost, increased disturbance from humans in close proximity to the roost, increased predation or perceived increased risk of predation which could all lead to a reduction in fitness of individuals inhabiting the roost and abandonment of the roost, placing pressure on remaining roosts across the Sydney Basin.
7.3.1 b) i	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: Is likely to have an adverse effect on the extent of the ecological community such that its local	Not applicable

BC Act	Question	Response
	occurrence is likely to be placed at risk of extinction, or	
7.3.1 b) ii	In the case of an endangered ecological community or critically endangered ecological community: Whether the proposed development or activity is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.	Not applicable
7.3.1 c) i	In relation to the habitat of a threatened species or ecological community: The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity	A portion of the airspace directly in front of the roost which is used by bats emerging from and returning to the roost will be removed from use by the installation of the elevated and enclosed walkway. Bats will have the ability to fly above this obstruction, but it may force them into more exposed air space increasing the risk of predation from aerial predators such as owls. The introduction of lighting into the area surrounding the roost which is currently unlit may cause numerous negative impacts including delayed emergence, prolonged emergence, reduced foraging times, reduced fitness and eventual abandonment of the roost. Movement of the fence restricting access to unauthorised persons to within 25 m of the roost and illuminating the area 25 – 50 m away from the roost increases opportunities for interactions between roosting and emerging bats and humans and predators.
7.3.1 c) ii	In relation to the habitat of a threatened species or ecological community: Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity	Large Bent-winged Bats are a highly mobile species capable of foraging in excess of 10 km nightly from roosts and dispersing over 300 km between winter and summer roost sites. Studies have shown that there is some movement of Large Bent-winged Bats between local and regional winter roost sites (Gonsalves and Law 2018, Hoye 2000 and Hoye pers. comm). The proposed works will not fragment or isolate areas of foraging or roosting habitat within the Sydney Basin. If the population of Large Bent-winged Bats roosting in the tunnel abandons the roost as a result of the proposed works, there are other roosts across the Sydney Basin that may have capacity to accommodate this population. However, numerous significant Large Bent-winged Bat winter roosts have been lost across the Sydney Basin in the past 40 years. There is a risk that the loss of another winter roost site may cause population level changes that are difficult to predict. In addition, there are threats from development to another significant Large Bent-winged Bat winter roost site in Northern Sydney. The cumulative impacts of this and other future developments on roosts in the Sydney Basin cannot be downplayed given the tentative status of Large Bent-winged Bat roosts across the Sydney

BC Act	Question	Response
		Basin, now being largely contained within less secure stormwater drains and culverts.
7.3.1 c) iii	In relation to the habitat of a threatened species or ecological community: The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The Cadigal Reserve tunnel is an over winter roost site for up to 200 Large Bent-winged Bats and is predominantly occupied during the months of February to October, although small numbers of bats have been recorded during the summer months. Large Bent-winged Bats copulate at winter roost sites (Dwyer 1963). It is unknown whether mating occurs at this roost. Large Bent-winged Bat roosts in the Sydney basin have reduced significantly in number, size and security over the past 40 years (Hoye and Spence 2004). Conservation and protection of existing roosts is a key component in the persistence of this species across the Sydney Basin.
7.3.1 d)	Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).	Not applicable
7.3.1 e)	Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.	Yes - The proposed works is likely to increase the impact of several key threatening processes relevant to Large Bent-winged Bats and their roosts. Predation by the European Red Fox and Predation by feral cats are both likely to be exacerbated by the proposed works due to the increased presence of humans and their waste in an area surrounding the roost and the addition of lighting to the area surrounding the roost.
Conclusion	**Is there likely to be a significant impact?**	Yes – owing to the known sensitivities of Large Bent-winged Bats to disturbances at roost sites and the uncertainties involved in how the bats will respond to changes at the roost entrance and surrounding area brought about by the proposed works**.**

Appendix E Significance Assessment (EPBC Act)

The EPBC Act Administrative Guidelines on Significance set out Significant Impact Criteria that are to be used to assist in determining whether a proposed action is likely to have a significant impact on matters of national environmental significance. Matters listed under the EPBC Act as being of national environmental significance include:

- Listed threatened species and ecological communities
- Listed migratory species
- Wetlands of International Importance
- The Commonwealth marine environment
- World Heritage properties
- National Heritage places
- Nuclear actions.

Specific Significant Impact Criteria are provided for each matter of national environmental significance except for threatened species and ecological communities in which case separate criteria are provided for species listed as endangered and vulnerable under the EPBC Act.

The relevant Significant Impact Criteria have been applied to Grey-headed Flying-fox.

Table 16: EPBC Act Assessment of Significance - Grey-headed Flying-fox

Criterion	Question	Response
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:		
1)	lead to a long-term decrease in the size of an important population of a species	The Grey-headed Flying-fox is considered one population due to the constant exchange of genetic material between individuals and its movement between camps throughout its entire geographic range (DAWE 2020c). Maternity or other roosting habitat is considered important habitat for this species. No roosting habitat (i.e. camps) have been recorded within the study area. According to the National Flying-fox Monitoring Program, no camps currently occur or have ever been recorded within the study area (DAWE 2020b). The nearest active Grey-headed Flying-fox camp occurs approximately 3 km to the south-east of the study area, within Wolli Creek (DAWE 2020b). The study area contains 0.66 ha of potential foraging habitat (vegetation zone 1-3) for the Grey-headed Flying-fox. Additional foraging habitat was recorded within the broader locality of the study area, this includes parklands and urban space. Given the proximity of more suitable habitat within the locality of the study area, the removal of this potential foraging habitat would not lead to the long-term decrease in the size of an important population of Grey-headed Flying-fox.
2)	reduce the area of occupancy of an important population	The proposed works will reduce the extent of available foraging habitat for the Grey-headed Flying-fox. About 0.66 ha of potential foraging habitat will be removed. The vegetation within the study area may provide supplementary foraging habitat for this species. The study area does not contain breeding or sheltering habitat (i.e. bat camps).

Criterion	Question	Response
		However, one individual was located roosting temporarily within the study area. The Grey-headed Flying-fox is known to fly long distances (up to 50 km per night) and move between bat camps. As such this species is likely to utilise a large extent of habitat around the Wolli Creek camp which may include some habitat within the study area. Due to the extent of habitat within a 50 km radius of the known bat camp at Wolli Creek, the removal of a small amount of native planted vegetation is unlikely to significantly reduce the extent of occupancy for this species.
3)	fragment an existing important population into two or more populations	The proposed works will result in the loss of 0.66 ha of potential foraging habitat in the form of planted native species within the study area. The proposed works will not affect camps. Additionally, due to the planted and highly urbanised nature of the vegetation within the study area, it is likely that the vegetation affected by the development is considered marginal or supplementary foraging habitat for this species. The Grey-headed Flying-fox is a highly mobile species and is considered part of one large population. As the vegetation within the study area is considered supplementary habitat for this species, it is unlikely that the proposed works will result in the fragmentation of populations for this highly mobile species.
4)	adversely affect habitat critical to the survival of a species	The Draft Recovery Plan for the Grey-headed Flying-fox 2017 identifies 'a continuous temporal sequence of productive foraging habitats, linked by migration corridors or stopover habitats, and suitable roosting habitat within nightly commuting distance of foraging areas' as habitat critical to the survival of the species. No camps will be affected by the proposed action. The proposed action will remove 0.66 ha of vegetation, some of which comprises suitable foraging habitat for the Grey-headed Flying-fox. The Grey-headed Flying-fox is recorded as travelling long distances (50 km) on feeding forays and suitable habitat is available outside of the study area.
5)	disrupt the breeding cycle of an important population	The proposed action will remove 0.66 ha of vegetation, some of which comprises suitable foraging habitat for the Grey-headed Flying-fox. The proposed action will not disrupt the breeding cycle of the Grey-headed Flying-fox given that no camps will be impacted by the proposed action and suitable foraging habitat is available adjacent to the study area.
6)	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 remove 0.66 ha of vegetation, including foraging habitat for the Grey-headed Flying-fox. Grey-headed Flying-fox camps will not be removed, or disturbed, and suitable habitat is available outside of the study area.
7)	result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The proposed action is unlikely to result in the establishment of an invasive species that is harmful to the Grey-headed Flying-fox.
8)	introduce disease that may cause the species to decline, or	Grey-headed Flying-fox are reservoirs for the Australian bat lyssavirus and can cause clinical disease and mortality in Grey-headed Flying-fox. The proposed action would not increase the incidence of this disease.
9)	interfere substantially with the recovery of the species.	A Draft National Recovery Plan for the Grey-headed Flying-fox was developed in 2017. The relatively small amount of foraging habitat to be

Criterion	Question	Response
		removed is unlikely to substantially interfere with the recovery of this species.
Conclusion	Is there likely to be a significant impact?	No. The proposed action is unlikely to have a significant impact on the Grey-headed Flying-fox for the following reasons: • No camps will be removed by the proposed action. More suitable foraging habitat for this highly mobile species is available outside of the study area.

Appendix F Call Profiles of Those Microbats Recorded During this Survey

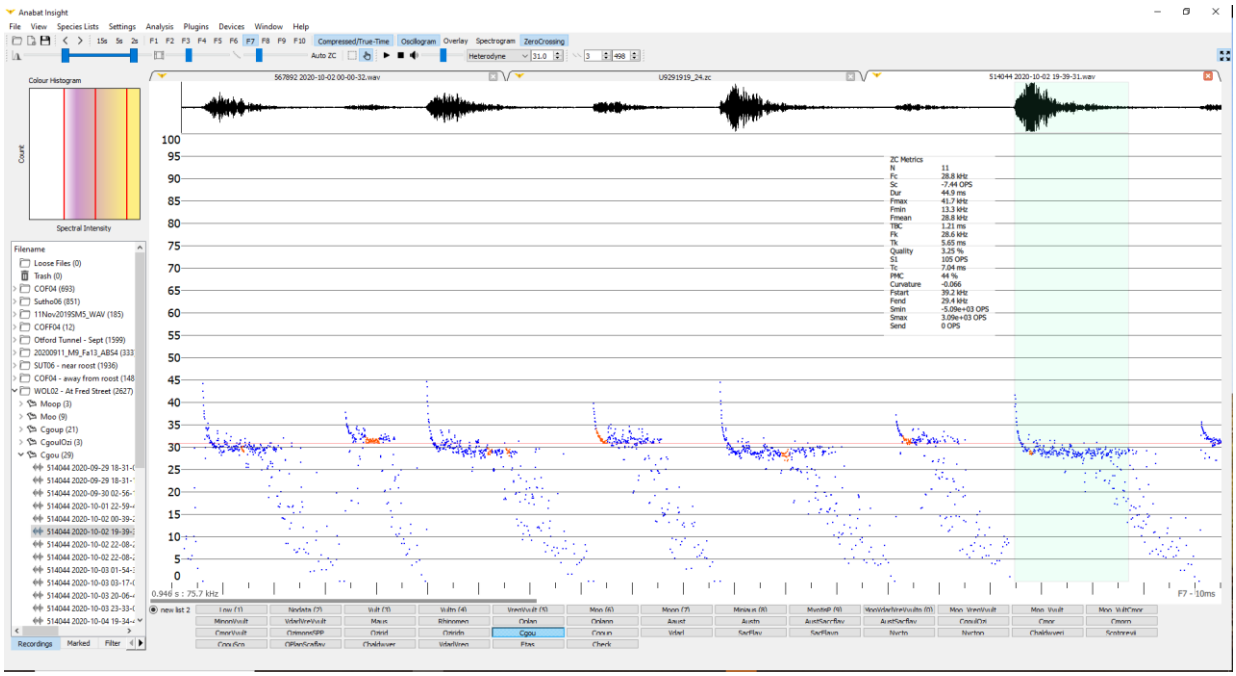


Photo 10. Call profile for *Chalinolobus gouldii* (Gould's Wattled Bat) recorded at the Fred Street Light Rail Biodiversity Offset site at 19.39 (7.39 pm) on the 2 October 2020.

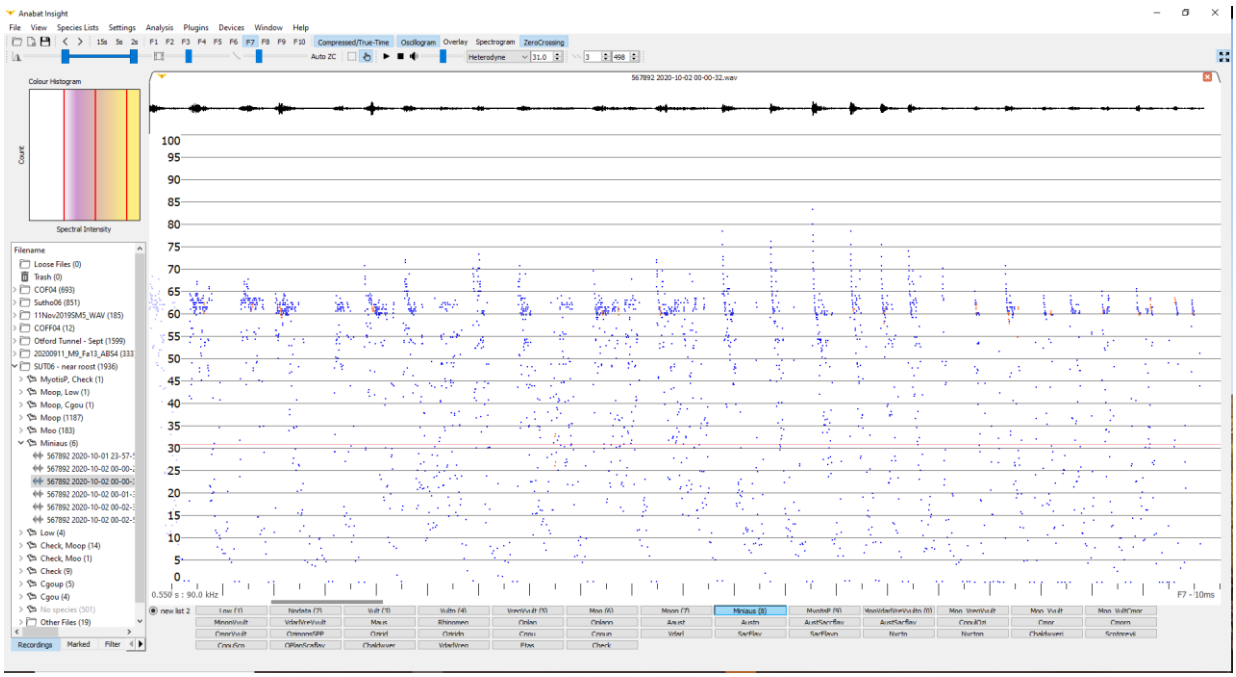


Photo 11. Call profile for *Miniopterus australis* (Little Bent-winged Bat) recorded at the opening of the Cadigal Reserve roost at 00.23 (12.23 a.m.) on the 2 October 2020.

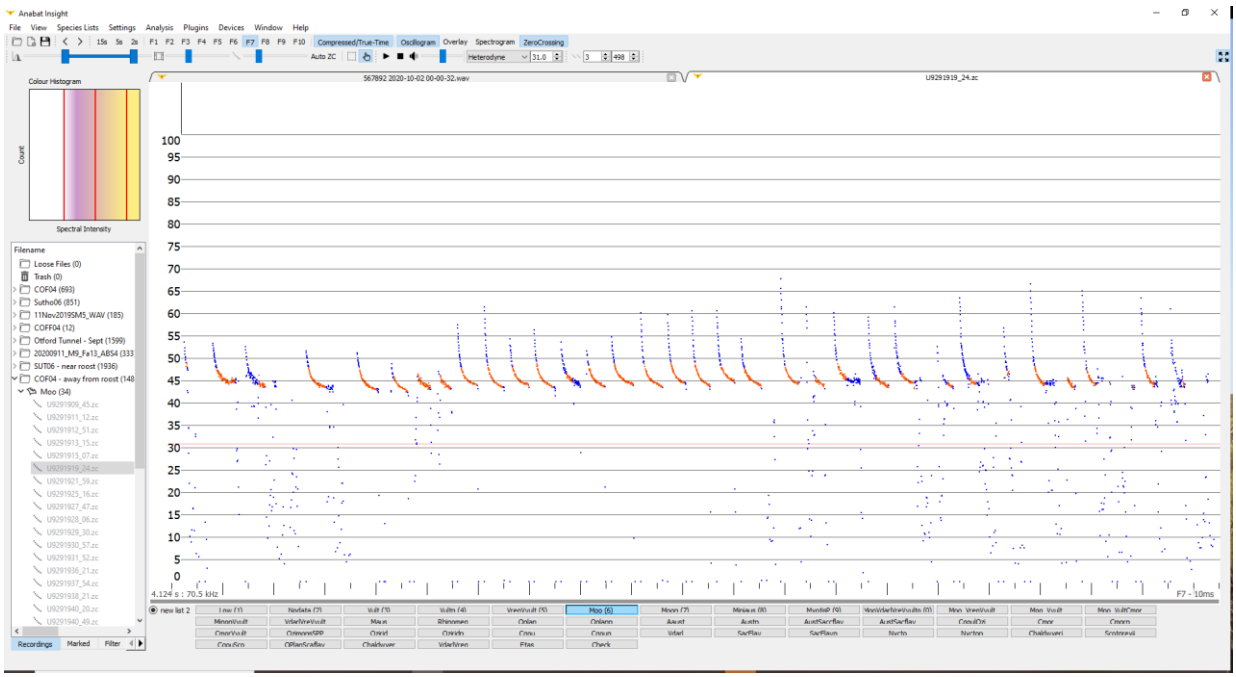


Photo 12. Call profile for *Miniopterus orianae oceanensis* (Large Bent-winged Bat) recorded at the opening of the Cadigal Reserve roost at 19.19 (19.19 p.m.) on the 29 September 2020.

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au