sydney METRO | city & southwest

SYDENHAM TO BANKSTOWN

ENVIRONMENTAL IMPACT STATEMENT

> Technical Paper 9 - Biodiversity assessment report

NSW GOVERNMENT

Transport for NSW

Sydney Metro City & Southwest

Sydenham to Bankstown upgrade

Environmental Impact Statement

Technical Paper 9 – Biodiversity Assessment Report

August 2017

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Abbreviations

Abbreviation	Description
ASL	Above sea level
BAR	Biodiversity Assessment Report
BBAM	The NSW *BioBanking Assessment Methodology* (OEH, 2014)
BOS	Biodiversity Offset Strategy
CEEC	critically endangered ecological community
DEC	Department of Environment and Conservation (NSW)
DECC	Department of Environment and Climate Change (NSW)
DEE	Department of Environment and Energy (Commonwealth)
DPE	Department of Planning and Environment (NSW)
DotE	Department of the Environment (Commonwealth), now DEE
DPI	Department of Primary Industries (NSW)
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FBA	Framework for Biodiversity Assessment
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater Dependent Ecosystem
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
MNES	Matter of National Environmental Significance
NP	National Park
NPWS	National Parks and Wildlife Service (NSW)
NW Act	*Noxious Weeds Act 1993* (NSW)
OEH	Office of Environment & Heritage (NSW)
PCT	Plant Community Type
SEARs	Secretary's environmental assessment requirements
SSD	State Significant Development
SSI	State Significant Infrastructure
TEC	threatened ecological community
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
VIS	Vegetation Information System
WoNS	Weed of National Significance

Glossary

Term	Description
Biodiversity credit	A unit of biodiversity value to measure specific development impacts or conservation gains in accordance with the FBA or the BBAM. Includes ecosystem credits or species credits.
Biodiversity offset strategy	The section of a Biodiversity Assessment Report prepared in accordance with the FBA which presents the approach to the delivery of biodiversity offsets for the project, including the quantum of offsets required, options to deliver these offsets, an estimate of the costs involved and the additional steps required to finalise their delivery.
Biodiversity values	The composition, structure and function of ecosystems, including native species, populations and ecological communities, and their habitats.
Ecosystem credit	The class of biodiversity credits created or required for the impact on EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur within a vegetation type according to the FBA and the BBAM.
Food tree	A tree species that is recognised as being of value as a foraging resource for a given fauna species.
Habitat tree	A tree that is recognised as being of value as a shelter, roosting and/or nesting resource for fauna species. Includes hollow-bearing trees, stags (standing dead trees) and trees with nests or other signs of fauna occupancy.
Project area	The area that would be directly affected by the construction or operation of the project.
Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates according to the BBAM.
Study area	The area that was subject to field survey and assessed for direct or indirect impacts that may arise from the project in this Biodiversity Assessment Report.
The locality	Land within a 10 kilometre radius of the project area.
The project	The proposed works which are the subject of this report as described in section 1.3.2.
The region	A bioregion defined in a national system of bio-regionalisation. For this study this is the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (DSEWPaC 2011).
Threatened biota	Threatened species, populations or communities listed under the EPBC Act, FM Act and/or the TSC Act.

Executive summary

Transport for NSW ('the proponent') is seeking approval to construct and operate the Sydenham to Bankstown upgrade component of Sydney Metro City & Southwest (the 'project'). The project involves upgrading the 10 existing stations from Marrickville to Bankstown (inclusive), and the 13 kilometre long section of the Sydney Trains T3 Bankstown Line between west of Sydenham Station and west of Bankstown Station, to improve accessibility for customers and enable conversion of the line to metro standards. This Biodiversity Assessment Report has been prepared in accordance with the Framework for Biodiversity Assessment (FBA) and the Secretary's Environmental Assessment Requirements to describe the biodiversity values present in the study area, assess impacts of the project and determine the number of biodiversity credits required to offset impacts of the project.

The majority of the vegetation in the project area and surrounding study area comprises exotic or planted native species on highly modified landforms. There are small isolated patches of remnant or regrowth native vegetation in small portions of the study area associated with rail cuttings with less disturbed soil profiles. Remnant Turpentine - Grey Ironbark open forest on shale in Moderate/good-medium condition in the study area comprises an occurrence of Sydney Turpentine Ironbark Forest which is listed as an endangered ecological community (EEC) under the *Threatened Species Conservation Act 1995* (TSC Act). Remnant and regrowth Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest in the study area comprises an occurrence of Shale Gravel Transition Forest, which is listed as an EEC under the TSC Act. Neither community meet the condition criteria of the communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The study area contains around 650 stems of the Downy Wattle (*Acacia pubescens*), which is listed as a vulnerable species under the EPBC Act and TSC Act. One threatened fauna species, the Grey-headed Flying-fox (*Pteropus poliocephalus*), was recorded in the study area during the site surveys. This species is listed as a vulnerable species under the TSC Act and the EPBC Act. Four other species listed as vulnerable under the TSC Act are likely to occur at least on occasion: the Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), Large-footed Myotis (*Myotis macropus*), Eastern Freetail-bat (*Mormopterus norfolkensis*) and Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*).

The majority of the project area is located within the rail corridor, which has been cleared and substantially modified through earthworks and construction. The project has been purposefully designed to avoid or further reduce impacts on biodiversity values as far as is practicable. In particular, the population of the threatened *A. pubescens* has been excluded from the project area, and there would be clear marking out of exclusion areas to avoid impacts during construction.

Despite measures taken to avoid and mitigate impacts, the project would result in some unavoidable residual adverse impacts upon some elements of the natural environment, including removal of native plants and habitat resources and imposition of edge effects on adjoining areas of native vegetation. These residual impacts are small in extent and magnitude and would comprise a minor reduction in biodiversity values in the study area.

A FBA assessment and credit calculations have been performed in accordance with the methodology and using the FBA credit calculator Version 4.0. The FBA includes thresholds for assessing and offsetting impacts of development. With reference to these thresholds the project:

- Includes a total of one hectare of impacts for which the assessor is required to determine an offset, comprising:
  - 14 ecosystem credits for impacts on Turpentine - Grey Ironbark open forest on shale (ME041).
  - 13 ecosystem credits for impacts on Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest on clay/gravel soils (ME004).
- Includes a total of 7.3 hectares of impacts for which the assessor is not required to determine an offset, comprising the removal of planted native vegetation.
- Includes a total of 60.54 hectares of impacts that do not require further assessment by the assessor, comprising construction within areas of existing infrastructure, disturbed cleared land or exotic vegetation.

Impacts that require further consideration in regards to section 9.2 of the FBA have been assessed for the Long-nosed Bandicoot population in the Inner West. No evidence of Long-nosed Bandicoots (*Perameles nasuta*) were found during surveys for this project. Similarly, no evidence of the population was found along the light rail corridor during recent targeted surveys (Price and Banks, 2016). Price and Banks (2016) concluded any residual population would be surviving in very low numbers within urban backyards and were unlikely to be resident along the light rail line that adjoins the project area.

Construction traffic and higher-frequency metro trains are a vehicle strike risk, however given the lack of evidence of a resident population along the rail corridor, and the location of the rail corridor on the edge of the mapped core habitat area (OEH, 2015), it is unlikely that this would impact the local population to a substantial degree, if at all.

Given the lack of evidence in the project area and dearth of records in the surrounding area despite recent targeted surveys, as well as the limited shelter habitat and high abundance of introduced predators, and difficulty of access to the rail corridor, the Long-nosed Bandicoot is not likely to occur. Based on these considerations, it is highly unlikely that the project would cause the extinction of the population from the Cumberland – Sydney Metro subregion or significantly reduce its viability.

The Biodiversity Offset Strategy for the project would include the purchase and retirement of biodiversity credits as calculated in accordance with the FBA. Biodiversity credits appropriate to offset the impacts of the project could be purchased from BioBanking agreement 148, owned by The Hills Shire Council, or The Little Island biobank, which has been the subject of a detailed BioBanking assessment by GHD ecologists and has a pending application for a BioBanking agreement. The proponent would consult with the vendor(s) of these biodiversity credits and arrange to purchase and retire a total of 27 biodiversity credits appropriate to offset the impacts of the project.

Assessments of the significance of impacts on *A. pubescens* and the Grey-headed Flying-fox have been prepared based on the consideration of the criteria contained in the EPBC Act *assessment of significance guidelines 1.1*. The outcome of these assessments is that the project is unlikely to have a significant impact on any Matters of National Environmental Significance (MNES). Given the minor magnitude of impacts, further assessment or approval under the EPBC Act is highly unlikely to be required and a referral is not recommended. The project would not result in any significant impacts on any threatened biota listed under the EPBC Act and so there is no requirement for biodiversity offsets under the EPBC Act and associated policy.

1. Introduction

1.1 Overview

1.1.1 Project background

The New South Wales (NSW) Government is implementing *Sydney's Rail Future* (Transport for NSW, 2012a), a plan to transform and modernise Sydney's rail network so that it can grow with the city's population and meet the needs of rail customers into the future.

Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future*, providing 66 kilometres of metro rail line and 31 metro stations. The NSW Government is currently delivering the first two stages of Sydney Metro, shown in Figure 1.1, which consist of Sydney Metro Northwest (between Rouse Hill and Chatswood) and Sydney Metro City & Southwest (between Chatswood and Bankstown).

Sydney Metro Northwest is currently under construction. Sydney Metro Northwest services will start in the first half of 2019, with a metro train running every four minutes in the peak period. Services will operate between a new station at Cudgegong Road (beyond Rouse Hill) and Chatswood Station. Sydney Metro City & Southwest will extend the Sydney Metro system beyond Chatswood to Bankstown, delivering about 30 kilometres of additional metro rail, a new crossing beneath Sydney Harbour, new railway stations in the lower North Shore and Sydney central business district (CBD), and the upgrade of existing stations from Marrickville to Bankstown. City & Southwest trains would run between Sydenham and Bankstown stations in each direction, at least every four minutes in peak periods, averaging around 15 trains per hour.

Sydney Metro City & Southwest comprises two core components (shown in Figure 1.1):

- The Chatswood to Sydenham project
- The Sydenham to Bankstown upgrade ('the project' and the subject of this document)

1.1.2 The project for which approval is sought

Transport for NSW is seeking approval to construct and operate the Sydenham to Bankstown upgrade component of Sydney Metro City & Southwest (the project).

The project involves upgrading 10 existing stations west of Sydenham (Marrickville to Bankstown inclusive), and a 13 kilometre long section of the Sydney Trains T3 Bankstown Line, between west of Sydenham Station and west of Bankstown Station, to improve accessibility for customers and meet the standards required for metro operations. The project would enable Sydney Metro to operate beyond Sydenham, to Bankstown.

A key element of the project is upgrading stations along the corridor from Marrickville to Bankstown, to allow better access for more people by providing new concourses, level platforms, and lifts at stations. These upgrades aim to provide a better, more convenient, and safer experience for public transport customers, by delivering:

- Stations that are accessible to people with a disability or limited mobility, the elderly, people with prams, and people travelling with luggage.
- Upgraded station buildings and facilities for all transport modes that meet the needs of a growing population.
- Interchanges that support an integrated transport network and allow seamless transfers between different modes for all customers.

The project is subject to assessment and approval by the NSW Minister for Planning under Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

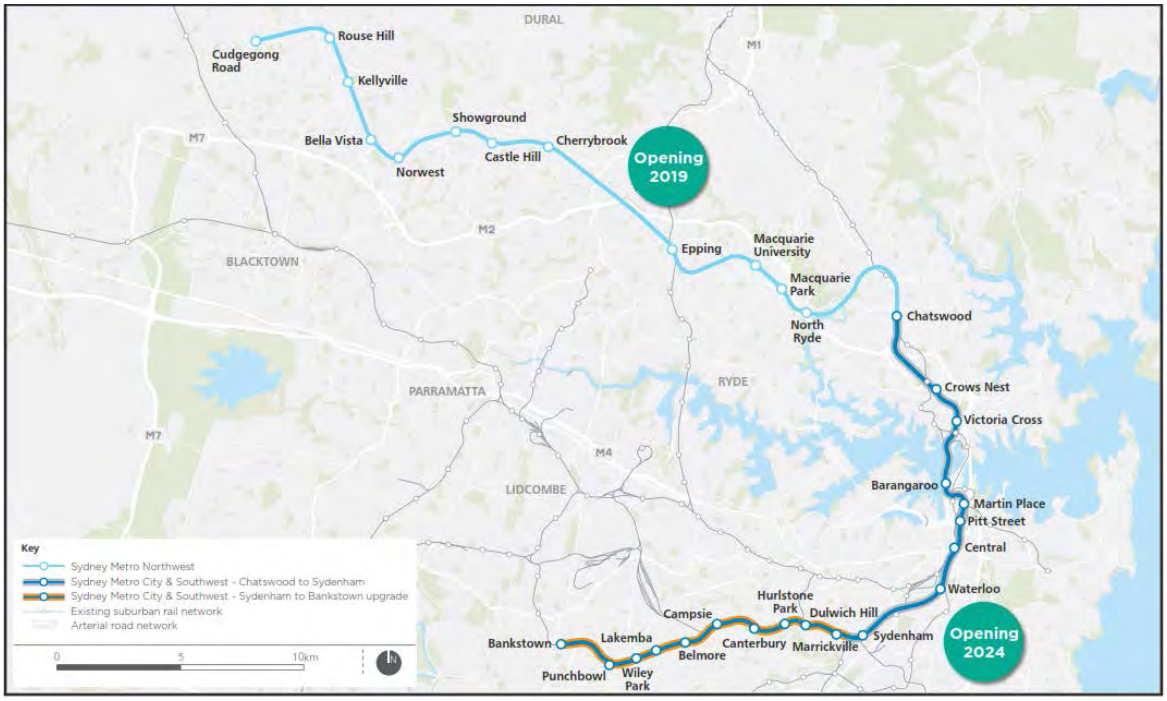


Figure 1.1 The Sydney Metro network

1.2 The project

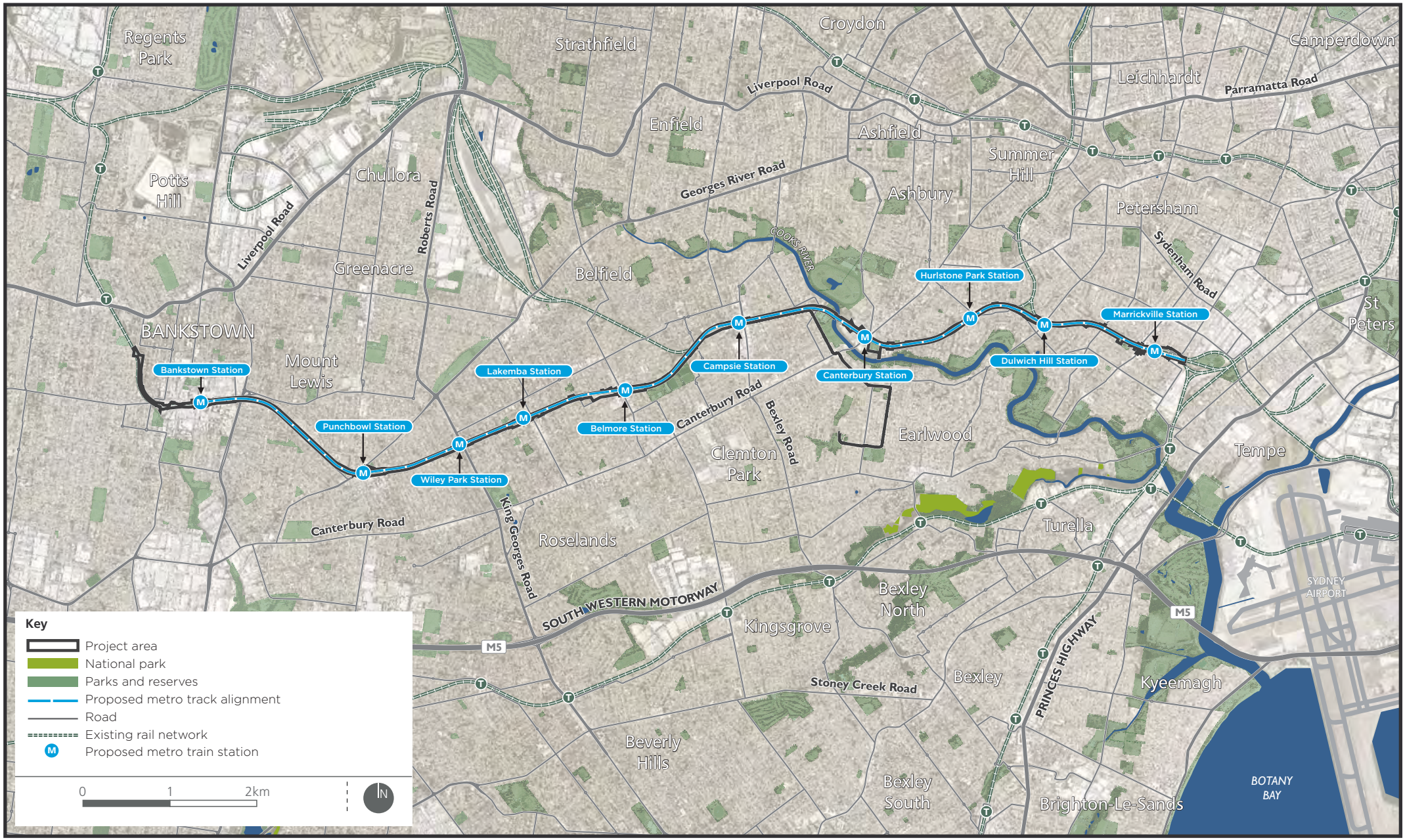
1.2.1 Location

The location of the project is shown in Figure 1.2.

The key elements of the project are located mainly within the existing rail corridor, from about 800 metres west of Sydenham Station in Marrickville, to about one kilometre west of Bankstown Station in Bankstown. The project is located in the Inner West and Canterbury-Bankstown local government areas.

The term ‘project area’ is used throughout this document to refer to the area where the physical works for the project would be undertaken. This area encompasses the existing rail corridor (as described above), the 10 existing stations within the corridor, and areas surrounding the rail corridor as shown in Figure 1.2.

The term ‘study area’ is used throughout this document to refer to the area that was subject to field survey and assessed for direct or indirect impacts to biodiversity values that may arise from the project.



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Overview of the project

FIGURE 1.2

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number	21-25273
Revision	A
Date	05 Jul 2017

Project area layout

Figure 1.3a

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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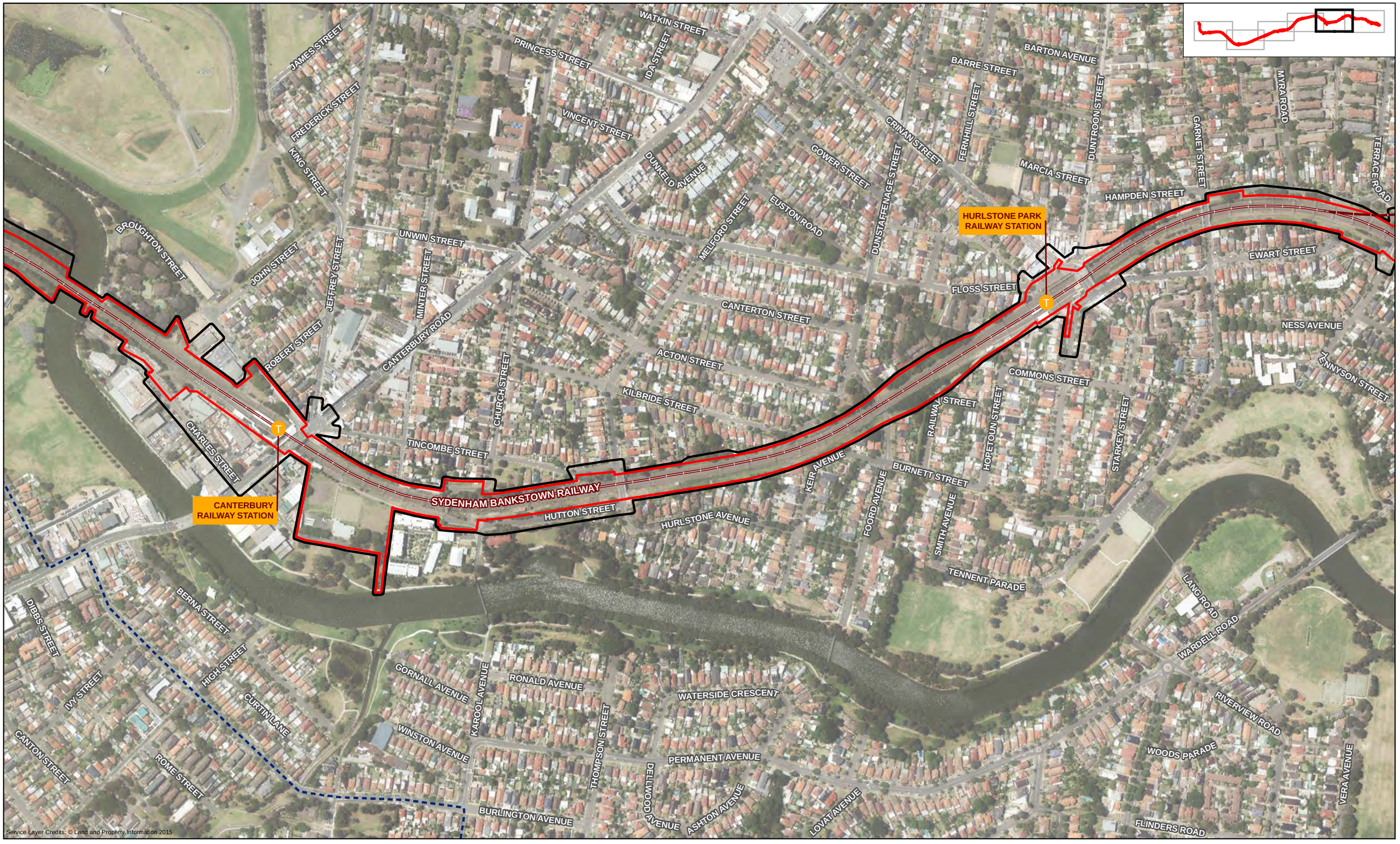

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- Canterbury feeder

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number	21-25273
Revision	A
Date	05 Jul 17

Project area layout

Figure 1.3b

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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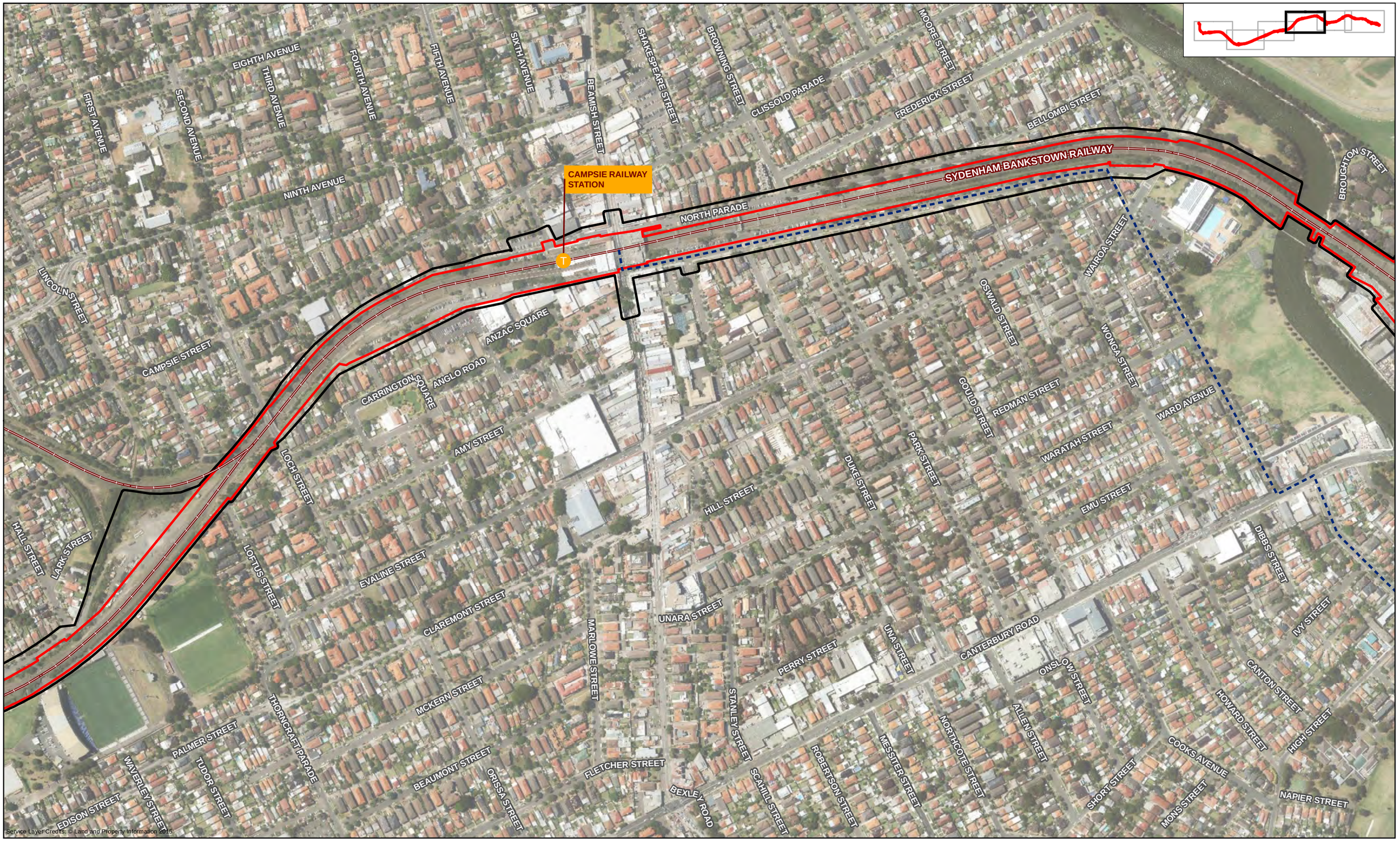

Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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LEGEND

- Study area
- Project area
- Train station
- Railway
- Canterbury feeder

Transport for NSW
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Date	05 Jul 2017

Project area layout

Figure 1.3c

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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LEGEND

- Study area
- Project area
- Train station
- Railway

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
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Job Number	21-25273
Revision	A
Date	05 Jul 2017

Project area layout

Figure 1.3d

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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LEGEND

- Study area
- Project area
- Train station
- Railway

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number	21-25273
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Date	05 Jul 2017

Project area layout

Figure 1.3e

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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LEGEND

- Study area
- Project area
- Train station
- Railway

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Revision	A
Date	05 Jul 2017

Project area layout

Figure 1.3f

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1.2.2 Key features

The key features of the project are summarised below and are shown in Figure 1.2.

Works to upgrade access at stations

The project includes upgrading the 10 stations from Marrickville to Bankstown as required, to meet legislative requirements for accessible public transport, including the requirements of the *Disability Discrimination Act 1992* and the *Disability Standard for Accessible Public Transport 2002*. The proposed works include:

- Works to platforms to address accessibility issues, including levelling and straightening platforms
- New station concourse and station entrance locations, including:
  - new stairs and ramps
  - new or relocated lifts
- Provision of additional station facilities as required, including signage and canopies

Works would also be undertaken in the areas around the stations to better integrate with other modes of transport, improve travel paths, and meet statutory accessibility requirements. This would include provision of pedestrian, cyclist, and other transport interchange facilities; as well as works to the public domain, including landscaping.

Works to convert stations and the rail line to Sydney Metro standards

Station works

In addition to the station upgrades to improve accessibility, works to meet the standards required for metro services would be carried out, including:

- Installation of platform screen doors
- Provision of operational facilities, such as station services buildings

Track and rail system facility works

Upgrading the track and rail systems to enable operation of metro services would include:

- Track works where required along the rail corridor, including upgrading tracks and adjusting alignments, between west of Sydenham Station and west of Bankstown Station
- New turnback facilities and track crossovers
- Installing Sydney Metro rail systems and adjusting existing Sydney Trains rail systems
- Overhead wiring adjustments

Other works

Other works proposed to support Sydney Metro operations include:

- Upgrading existing bridges and underpasses across the rail corridor
- Installation of security measures, including fencing
- Installation of noise barriers where required
- Modifications to corridor access gates and tracks
- Augmenting the existing power supply, including new traction substations and provision of new feeder cables
- Utility and rail system protection and relocation works

- Drainage works to reduce flooding and manage stormwater

Active transport corridor and surrounding development

The project would also provide for:

- Parts of an active transport corridor where located within the station areas or surplus rail corridor land, to facilitate walking and cycling connections to each station and between Marrickville and Bankstown
- Enabling works to support future development at Campsie Station (future development would be subject to a separate approvals process)

Temporary works during construction

During construction, the project would involve:

- Provision of temporary facilities to support construction, including construction compounds and work sites
- Implementation of alternative transport arrangements for rail customers during possession periods and/or station closures, guided by the Temporary Transport Strategy

1.2.3 Timing

Construction

Construction of the project would commence once all necessary approvals are obtained (anticipated to be in 2018), and would take about five years to complete.

The T3 Bankstown Line would remain operational for the majority of the construction period. However, to ensure the station and infrastructure upgrade works are completed as efficiently and safely as possible, and to accommodate works that cannot be undertaken when trains are operating, it would be necessary to undertake some work during rail possession periods, when trains are not operating. It is anticipated that these rail possession periods would comprise the routine weekend maintenance possessions, together with some longer possession periods during periods of reduced patronage such as school holidays.

A final, longer possession of about three to six months would also be required. This would involve full closure of the line to enable conversion to metro operations. This would include works such as the installation of new signalling, communication systems, and platform screen doors.

During each possession period, alternative transport arrangements would be implemented to ensure that customers can continue to reach their destinations.

Operation

Sydney Metro City & Southwest would be fully operational by 2024, with the opportunity of operation commencing in two phases. Initially, Sydney Metro Northwest services would be extended by the City & Southwest project, and would operate from Chatswood Station to Sydenham Station. Some months later, metro operations would extend from Sydenham Station to Bankstown Station, with both phases planned to be completed before the end of 2024. The opportunity for phased opening of the project would enable metro trains to operate from Cudgegong Road Station to Sydenham Station prior to the final conversion of the T3 Bankstown Line to metro operations.

Once the project is operational, Sydney Trains services would no longer operate along the T3 Bankstown Line between Sydenham and Bankstown stations. Customers would be able to interchange with Sydney Trains services at Sydenham and Bankstown stations. Sydney Trains services to and from Bankstown to Liverpool and Lidcombe stations would not be affected.

1.3 Purpose and scope of this report

This report has been prepared to support the Environmental Impact Statement for the project. The Environmental Impact Statement has been prepared to accompany the application for approval of the project, and addresses the environmental assessment requirements of the Secretary of the Department of Planning and Environment ('the Secretary's environmental assessment requirements').

The Secretary's environmental assessment requirements state that the Environmental Impact Statement must include a Biodiversity Assessment Report prepared in accordance with the requirements of the Framework for Biodiversity Assessment (FBA) (OEH, 2014). The purpose of this report is to describe the native biota and habitats within the study area and to assess the potential impacts of the construction and operation of the project on biodiversity values and especially threatened biota listed under the *NSW Threatened Species Conservation Act 1995* (TSC Act). This Biodiversity Assessment Report also considers the potential for the project to result in impacts on threatened biota and Key Fish Habitat listed under the *Fisheries Management Act 1994* (FM Act) and threatened biota and other biodiversity related Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The objectives of this Biodiversity Assessment Report are to:

- Outline the methods used in the biodiversity assessment
- Describe the existing environment of the study area, including the results of the desktop assessment and site surveys
- Assess the value and conservation significance of native vegetation and habitats at the study area and the potential for threatened biota and MNES to occur at the study area or be affected by the project
- Provide a description of the project, including potential impacts on biodiversity values and measures to avoid or mitigate impacts
- Assess the significance of impacts on threatened biota and MNES
- Present the data used to perform the credit calculations for the project
- Calculate the number and type of biodiversity credits that would be required to offset impacts of the project and outline a Biodiversity Offset Strategy
- Provide concluding statements to demonstrate that the project would 'improve or maintain' biodiversity values

1.4 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements relating to biodiversity, and where these requirements are addressed in this report, are outlined in Table 1-1.

Table 1-1 Secretary's environmental assessment requirements – biodiversity

Secretary's environmental assessment requirements	Where addressed
3. Assessment of key issues	
1. The level of assessment of likely impacts must be proportionate to the significance of, or degree of impact on, the issue, within the context of the proposal location and the surrounding environment. The level of assessment must be commensurate to the degree of impact and sufficient to ensure that the Department and other government agencies are able to understand and assess impacts.	Section 2
2. For each key issue the Proponent must: (a) describe the biophysical and socio-economic environment, as far as it is relevant to that issue;	Section 3
(b) describe the legislative and policy context, as far as it is relevant to the issue;	Section 1.5
(c) identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts;	Section 4, Section 5.5, Section 5, Appendix C
(d) demonstrate how potential impacts have been avoided (through design, or construction or operation methodologies);	Section 6.2
(e) detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant); and	Section 6.3
(f) detail how any residual impacts will be managed or offset, and the approach and effectiveness of these measures.	Section 7
3. Where multiple reasonable and feasible options to avoid or minimise impacts are available, they must be identified and considered and the proposed measure justified taking into account the public interest.	Section 6
6. Biodiversity	
The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity.	Section 5.4, Section 6
Offsets and/or supplementary measures are assured which are equivalent to remaining impacts of project construction and operation.	Section 7
1. The Proponent must assess biodiversity impacts in accordance with the current guidelines including the FBA.	Section 2.1, Section 5
2. The Proponent must assess any impacts on biodiversity values not covered by the FBA as specified in s2.3. .	Section 3.8, Section 3.9, Section 4, Section 5.5.5
3. The Proponent must assess impacts on the Long-nosed Bandicoot (*Peremeles nasuta*) Inner Western Sydney Population (including an assessment of vehicle strike (from more frequent trains) and a loss of threatened species and their habitat which is not associated with vegetation (e.g. building demolition, bridge reconstruction, etc.). and provide the information specified in s9.2 of the FBA.	Section 5.5.1

Secretary's environmental assessment requirements	Where addressed
4. The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the *Threatened Species Conservation Act* 1997 (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environmental Protection and Biodiversity Conservation Act* 2000 (EPBC Act).	Section 4.4, Section 6.3

1.5 Legislation and policy

1.5.1 NSW Environmental Planning and Assessment Act 1979

The EP&A Act identifies the legal requirements for project assessment and approval in NSW and aims to, inter alia, 'encourage the proper management, development and conservation of natural and artificial resources'. Sections 115U and 115V of the EP&A Act provide for the declaration of major projects, comprising State significant infrastructure and critical State significant infrastructure. Sydney Metro City & Southwest is listed as critical State significant infrastructure on Schedule 5 of the *State Environmental Planning Policy (State and Regional Development) 2011* (State and Regional Development SEPP).

The NSW Government has developed a NSW Biodiversity Offsets Policy for Major Projects (the policy) (OEH, 2014a). Major projects include State Significant Development (SSD) and State Significant Infrastructure (SSI). Further, under the policy, the Secretary's Environmental Assessment Requirements for an Environmental Impact Statement require Transport for NSW to apply the FBA to assess impacts on biodiversity values (see section 1.4). Further detail regarding the FBA is provided in section 2.1.

1.5.2 NSW Threatened Species Conservation Act 1995

The TSC Act provides the statutory framework for biota of conservation significance in NSW. The TSC Act has been addressed in this Biodiversity Assessment Report through:

- Desktop review to determine the threatened species, populations or ecological communities (threatened biota) listed under the TSC Act that have been previously recorded within the locality of the study area and consequently could occur subject to the habitats present
- Targeted field surveys for threatened biota within the study area
- Assessment of potential impacts on threatened biota
- Identification of suitable impact mitigation measures for threatened biota, where required

1.5.3 NSW Fisheries Management Act 1994

The objects of the FM Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.

The FBA does not directly address impacts on species, populations and communities listed under the FM Act (see section 2.4 of OEH, 2014).

The FM Act has been addressed in this Biodiversity Assessment Report through undertaking:

- A desktop review to determine the threatened species, populations or ecological communities listed under the FM Act that have been previously recorded within the locality of the study area and consequently could occur subject to the habitats present
- Assessment of aquatic habitats during terrestrial field surveys in the study area
- Assessment of impacts on aquatic habitats

- Identification of suitable impact mitigation measures for aquatic habitats, where required

1.5.4 NSW Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* (NW Act), provides for the declaration of noxious weeds by the Minister for Primary Industries. Noxious weeds may be considered noxious on a national, state, regional or local scale. All private landowners, occupiers, public authorities and councils are required to control noxious weeds on their land under Part 3 Division 1 of the NW Act. As such, if present, noxious weeds within the project area that may be impacted by the project should be assessed and controlled.

1.5.5 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The purpose of the Commonwealth EPBC Act is to ensure that actions likely to cause a significant impact on matters of national environmental significance undergo an assessment and approval process. Under the EPBC Act, an action includes a project, undertaking, project or activity. An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Commonwealth Minister for the Environment (the Minister).

The EPBC Act identifies MNES as:

- World heritage properties
- National heritage places
- Wetlands of international importance (Ramsar wetlands)
- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions (including uranium mining)
- A water resource, in relation to coal seam gas development and large coal mining development

The EPBC Act has been addressed in this Biodiversity Assessment Report through:

- Desktop review to determine the ecological MNES that have been previously recorded within the locality of the study area and hence could occur, subject to the habitats present
- Targeted field surveys for species and ecological communities listed under the EPBC Act in the study area
- Assessment of potential impacts on MNES
- Identification of suitable impact mitigation measures for threatened species, where required

2. Methodology

2.1 Approach

This Biodiversity Assessment Report has been prepared to describe the impacts of the project on biodiversity values using the FBA (OEH, 2014).

The main components of the methodology for the biodiversity assessment were:

- Desktop assessment to describe the existing environment and landscape features of the study area and to identify the suite of threatened biota potentially affected by the project
- Field survey to describe the biodiversity values of the project area and surrounding study area and determine the likelihood of threatened biota and their habitats occurring in the project area or being affected by the project
- FBA calculations using the credit calculator v.4.1 to quantify the biodiversity impacts of the project and to determine the biodiversity credits that would be required to offset these impacts

Under the FBA, should biodiversity credits be required to offset impacts, a Biodiversity Offset Strategy is to be prepared which outlines how the proponent intends to offset the impacts of the major project. Both reports are required to form part of the Environmental Impact Statement for the major project.

Under the policy, both assessments are to be completed by a person accredited in accordance with section 142B(1)(c) of the NSW TSC Act.

This Biodiversity Assessment Report has been prepared by accredited assessors (see section 2.4) and includes desktop assessments, site surveys, calculations and an offset strategy in accordance with the FBA.

The Biobanking Assessment Methodology (BBAM) sets out how biodiversity values will be assessed, establishes rules for calculating the number and class of biodiversity credits, and determines the trading rules that will apply. The BBAM includes a software package known as the BioBanking Credit Calculator (the credit calculator) which processes site survey and assessment data. The credit calculator is used to determine:

- The type and extent of surveys required for a biodiversity assessment
- The number and type of biodiversity credits that are required for a development site to offset impacts on biodiversity either as part of a major project biodiversity assessment or an application for a BioBanking statement
- The number and type of biodiversity credits generated through the conservation and management of a biobank site

The credit calculator has been used in this Biodiversity Assessment Report to determine the number and type of biodiversity credits required to offset the impacts of the project.

2.2 Desktop research

2.2.1 Database interrogation

A desktop database review was undertaken to identify threatened flora and fauna species, populations and ecological communities (biota) listed under the TSC Act and FM Act, and MNES listed under the EPBC Act, that could be expected to occur in the study area and surrounding locality, based on previous records, known distribution ranges, and habitats

present. These will also be used to obtain the necessary data to perform calculations under the FBA. Biodiversity resources pertaining to the study area and locality (i.e. within a 10 km radius) that were reviewed included:

- The Commonwealth Department of Environment and Energy (DEE) Protected Matters Search Tool (PMST), for MNES known or predicted to occur (DEE, 2016a)
- DEE online species profiles and threats database (DEE, 2016b)
- The NSW Office of Environment and Heritage (OEH) Wildlife Atlas database (licensed) for records of threatened species, populations and endangered ecological communities listed under the TSC Act that have been recorded (OEH, 2016a)
- OEH threatened biota profiles for descriptions of the distribution and habitat requirements of threatened biota (OEH, 2016b). This resource was used to identify the suite of threatened ecological communities (TECs) that could potentially be affected by the project and to inform habitat assessments
- The NSW Department of Primary Industries (DPI) online protected species viewer for records of threatened aquatic species (DPI, 2016a).

The threatened and migratory biota identified in the desktop assessment are presented in Appendix A. Following collation of database records and threatened species and community profiles, a 'likelihood of occurrence' assessment was prepared for threatened and migratory species and ecological communities with reference to vegetation types and habitats within the study area and the field survey results. The criteria for the various likelihood of occurrence classes are summarised in Table 2-1.

Table 2-1 Likelihood of occurrence assessment criteria

Likelihood of occurrence	Definition
Present	Biota confirmed as present within the project area and/or the study area from either previous records or field survey results.
Likely	Species previously recorded within the locality and/or suitable habitat occurs within the study area. These species are likely to occur in the study area and the project may result in direct or indirect impacts on these species, including through the removal of habitat resources that may be relied upon by local populations of these species.
Possible	Species known or predicted to occur within the locality and potentially suitable habitat occurs within the study area. These species may occur in the study area on a transitory, seasonal or opportunistic basis. The project may result in minor direct or indirect impacts on habitat for these species, but would not remove any habitat resources that are relied upon by local populations of these species for their ongoing survival in the locality.
Unlikely	Species not previously recorded within the locality. The study area is outside of the biota's known distribution and/or suitable habitat not present within the study area. The project is very unlikely to result in any direct or indirect impacts on these species or their habitats.
Nil	The study area is outside of the biota's known or potential distribution. The project would not result in any direct or indirect impacts on these species or their habitats.

2.2.2 Review of vegetation mapping

A review of aerial photographs and existing regional vegetation mapping was undertaken to stratify the study area, assist with field survey planning and match remnant native vegetation to the most appropriate plant community type (PCT) according to the FBA.

The *Vegetation Mapping – Marrickville to Sefton* (RailCorp, 2006) shows remnant and planted native vegetation in the rail corridor along with threatened plants, weed infestations and management actions. Remnant native vegetation is not further described as a particular vegetation community or type.

The *Native vegetation of the Sydney Metropolitan Area* (OEH, 2013) is the most current and finest scale vegetation mapping available for the study area. This vegetation layer was used to help match vegetation in the study area to PCTs and to map native vegetation cover as part of the landscape assessment required by the FBA (see section 5.1).

The *Vegetation of the Cumberland Plain* (NPWS, 2002) and *Native vegetation of southeast NSW* (Tozer et. al., 2010) were also reviewed to check for patches of vegetation that may have been overlooked or not formally classified by OEH (2013).

2.2.3 Literature review

A review of relevant literature describing the biodiversity values of the study area and locality was undertaken including:

- Chatswood to Sydenham technical biodiversity assessment (Arcadis, 2016)
- Soil landscapes and geology mapping (OEH, 2016d)
- *Inner West Long-nosed Bandicoot Habitat Monitoring Interim Report* (Price, 2016)
- Inner west bandicoot study website (TfNSW, 2016)
- Survey of bandicoots in the inner west (Leary et al, 2010)
- *Assessment of Significance: Rozelle Goods Line Track Maintenance and Reconstruction* (Biosis Research, 2010)
- *Atlas of Groundwater Dependent Ecosystems* (BOM, 2016a)
- *Marrickville Biodiversity Action Plan 2011-2015* (AMBS, 2011)

Consultation has also occurred with Transport for NSW and the University of Sydney (Dr Catherine Price) regarding the Inner West Bandicoot study.

2.3 Field survey

2.3.1 Survey effort

Staged surveys of the study area were conducted with reference to section 6 of the FBA and targeted survey guidelines as relevant, including DEC (2004) and Lincoln Smith (2003). This included taking into consideration the threatened biota that may possibly occur given the urban context of the study area and the modified nature of habitats present.

Site surveys included:

- BioBanking plot/transect surveys
- Vegetation mapping
- Identification of flora species
- Fauna habitat assessment

- Spotlighting (for nocturnal mammals and birds), call playback (for threatened forest owls) and anabas surveys
- Motion-activated camera surveys for ground dwelling fauna
- Opportunistic fauna surveys
- Rapid aquatic habitat assessment

Survey effort that has directly contributed to this biodiversity assessment is summarised in Table 2-2 and is described below. Survey locations are shown on the Figure 2-1 figure series. Field survey results are presented in Appendix B.

Table 2-2 Survey effort

Stage	Date	Survey technique
Preliminary FBA assessment survey	16 June 2016	Vegetation mapping, targeted threatened flora searches, one night of spotlighting and call playback, opportunistic fauna observations, fauna habitat assessment and motion-activated camera surveys (three cameras placed for seven days).
FBA assessment survey	22-23 June 2016	20 metres x 50 metres plot/transects, targeted threatened flora searches, two nights of anabat survey (one unit each night), two nights of spotlighting and call playback, opportunistic fauna observations and fauna habitat assessment.
Supplementary threatened flora survey	5 October 2016	Targeted threatened flora searches and precise mapping of the locations of threatened plants.

2.3.2 Flora surveys

Vegetation mapping

Vegetation was mapped in the field via systematic walked transects across the entire study area. Boundaries were marked by hand on aerial photographs of the study area with reference to a handheld global positioning system (GPS) enabled tablet. The study area was divided into relatively homogenous or discrete units for assessment based on observed vegetation structure, species composition, soil type, landscape position and condition. Native vegetation was divided into vegetation zones which represented a distinct PCT (listed in the NSW Vegetation Information System (OEH, 2016c)) and broad condition state. The remainder of the study area containing non-native vegetation, was divided into separate map units based on observed structure and species composition.

Plot/transect surveys

Plot and transect surveys were conducted in accordance with the FBA to confirm PCTs, assess condition and where required to calculate biodiversity credits. The value of a location was determined by assessing ten condition attributes against benchmark values. Benchmarks are quantitative measures of the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement. Growth stratum, life form, cover and abundance data were also collected for each plant species within the 20 metre x 20 metre portion of each plot/transect.

Plots were used to sample potential vegetation zones (i.e. PCTs and broad condition classes) based on the initial stratification. Plot/transects are shown on Figure 2-1b, Figure 2-1d, Figure 2-1e and Figure 2.1f and summarised in Table 3-8. Plot/transect data was compared with Tozer (2010) diagnostic species lists to help confirm the presence of native vegetation and the identity of PCTs (OEH, 2016c).

Systematic area searches (see Figure 2-1b, Figure 2-1e and Figure 2-1f) were used to supplement the plot/transect surveys and to help describe patches of 'exotic forest and scrub' and 'planted native species' in the study area. This technique was used to provide a general description and to compile species lists for these vegetation units. Plot/transects were not appropriate because these vegetation units were clearly dominated by exotic species and located on modified landforms and would not comprise any PCT. Further, these vegetation units were frequently associated with steep railway cuttings or road verges that could not be safely sampled with a plot/transect.

Targeted threatened flora searches

Threatened plant surveys were conducted throughout the study area during all time spent surveying. The suite of threatened plants potentially present was identified based on the desktop assessment results (see Appendix A) and the species credit-type species identified by the preliminary FBA Credit Calculations (see section 5.3.2). Habitat for these species was identified based on threatened species profiles (OEH, 2016b) and the experience and judgement of GHD ecologists.

The majority of the study area contains highly modified landforms such as embankments or cuttings that are dominated by exotic or planted native species. These areas feature very little native plant cover, do not contain natural soil profiles or soil seed banks and could be readily discounted as containing any threatened plant species. Areas of potential threatened plant habitat (i.e. near-intact native vegetation and areas with natural topsoil) were systematically traversed on foot and inspected for threatened plants.

A supplementary threatened flora survey was conducted over one day, including targeted threatened flora searches in areas of previously identified habitat and precise mapping of the locations of threatened plants. A professional surveyor was present and captured the precise locations (i.e. less than 10cm accuracy) of threatened plants with a total station GPS.

2.3.3 Fauna surveys

The survey methodology included relatively limited targeted fauna survey techniques (e.g. no trapping) because of the limited extent and quality of fauna habitat in the study area and because the FBA assesses the majority of threatened fauna species that could occur based on habitat surrogates.

An assessment was made of the type and quality of habitats present in the study area for native fauna. Habitat quality was based on the level of breeding, nesting, feeding and roosting resources available. The study area was searched for habitat features, such as hollow-bearing trees, feed trees for the Grey-headed Flying-fox (*Pteropus poliocephalus*), and shelter habitat for the Long-nosed Bandicoot. Culverts and bridges were inspected for signs of roosting bats (e.g. bat droppings) or bird nests.

Two anabat bat call detectors were placed between Bankstown and Punchbowl stations on the night of 22 June 2016 to target microchiropteran bats (microbats) (see Figure 2-1e and Figure 2-1f). An anabat was placed on the night of 29 June (Railway Parade Hurlstone Park) and again on the 30 June 2016 (Challis Ave bridge Dulwich Hill) (see Figure 2-1b). The anabats were deployed about one hour before sunset and collected the following morning. The area surrounding the Challis Ave bridge was also surveyed on 30 June 2016 at dusk for microbats that may be roosting under the bridge.

Spotlighting for nocturnal fauna was also carried out on the 16 and 22 June 2016 targeting the Long-nosed Bandicoot, Grey-headed Flying-fox and other nocturnal fauna. Spotlighting was conducted within the rail corridor on 16 June 2016 near Dulwich Hill and Marrickville and on 22 June 2016 between Bankstown and Punchbowl . Call playback for the Barking Owl and Powerful Owl was also conducted on these nights (see Figure 2-1a).

Three motion activated infra-red cameras were set in the rail corridor between Hurlstone Park and Marrickville (see Figure 2-1b and Figure 2-1c), particularly targeting potential habitat for the Long-nosed Bandicoot. These were left in situ between 16 and 22 June 2016. Searches for bandicoot diggings were also conducted in grassland areas between Hurlstone Park and Marrickville on 16 June 2016.

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. Casual fauna observations were made in suitable areas of habitat throughout the course of the survey and while incidentally traversing the study area. This included visual inspection of trees and woody debris, active searches for small fauna and opportunistic observation of scats, tracks, burrows or other traces.

2.4 Staff qualifications

The project was assessed according to the methodology presented in the FBA (OEH, 2014) and the *Credit Calculator for Major Projects and BioBanking Operational Manual* (OEH, 2016e). The credit calculator is a software application that is used to apply the FBA as well as BioBanking assessments. Data is entered into the credit calculator based on information collected in the desktop assessment, surveys and from using GIS mapping software.

The FBA credit calculations were performed by Ben Harrington (assessor accreditation number 0073) using credit calculator Version 4.1. The credit calculations will be submitted to OEH.

Staff involved in field surveys and report preparation are detailed in Table 2-3.

Table 2-3 Staff qualifications

Name	Position/project role	Qualifications	Relevant experience
Ben Harrington	Senior Ecologist/desktop assessment, site surveys, credit calculations and reporting	BSc, MSc (Physical Geography) BioBanking Assessor Accreditation (number 0073)	13+ years
Kirsten Crosby	Senior Ecologist/desktop assessment, site surveys, reporting	BSc, PhD (Zoology) BioBanking Assessor Accreditation (number 0160) AUSRIVAS training	13+ years
Malith Weerakoon	Graduate Ecologist/desktop assessment, data processing.	BSc, MPhil. (Zoology)	3+ years
Jayne Tipping	Principal Ecologist/Technical Review	BSc (Ecology), MEnvLaw	25+ years

The data and assumptions used to perform the FBA credit calculations are summarised in section 5 according to the structure and information requirements outlined in Appendix 7 of the FBA (OEH, 2014).

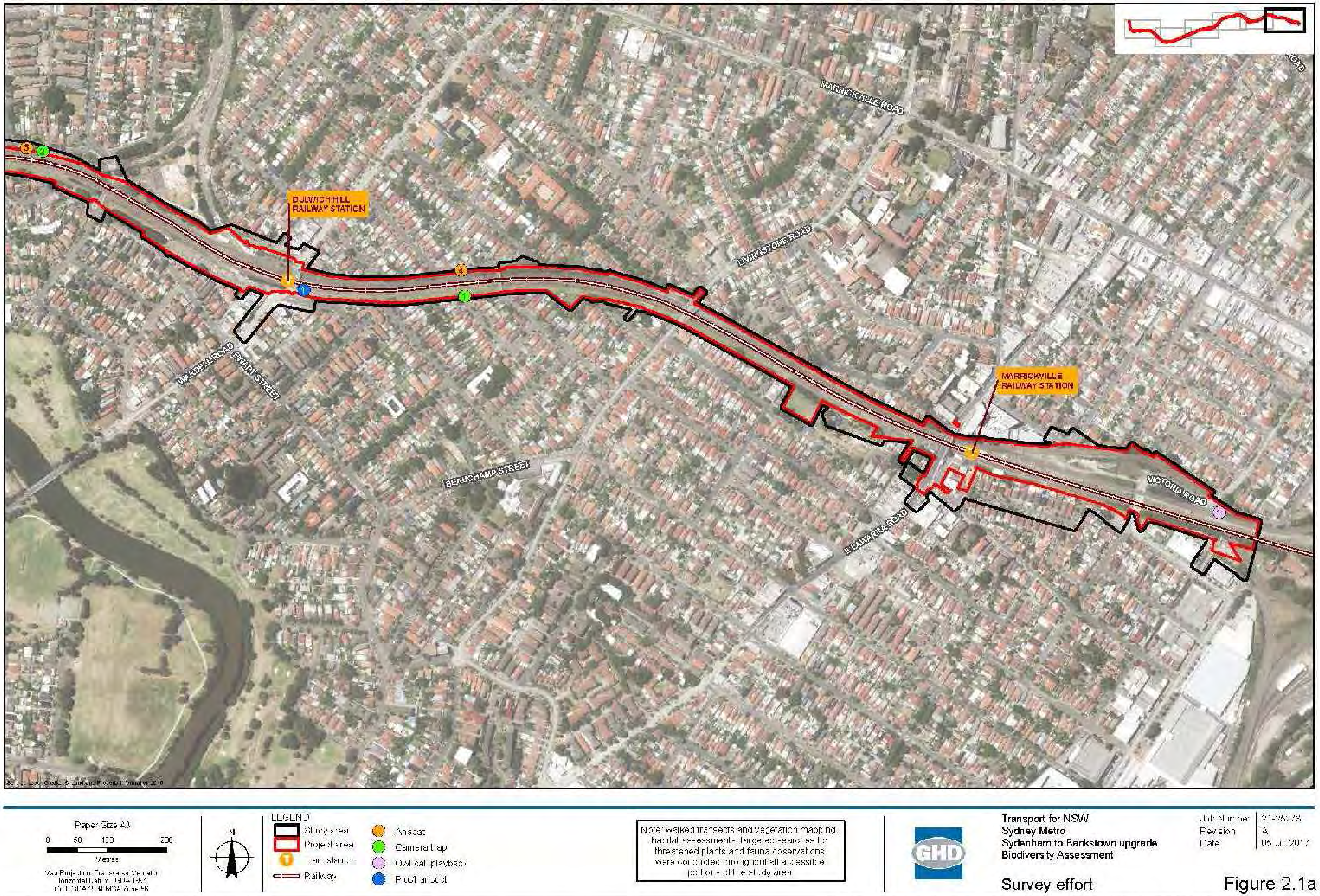
2.5 Assumptions and limitations

The majority of the study area is located in the operating rail corridor, which is subject to considerable safety and access constraints. Field survey effort was stratified across accessible portions of the study area based on the results of the initial ecological survey. Some of the vegetation and fauna habitat in the study area could not be safely accessed on foot and so was not directly sampled. These patches of vegetation were described based on data from plot/transects and habitat assessments sampled in other portions of the study area as well as visual observation from the closest available safe vantage point. No surveys were carried out along the 33kV power supply route, south of Canterbury Station as this electricity line would comprise either trenching or directional drilling within the road reserve. There would be a crossing over a concrete-lined canal (Cup and Saucer Creek) that drains to the Cooks River. This portion of the project is highly unlikely to impact any native biodiversity values.

Given the access limitations described above and the duration and timing of the field surveys (i.e. three days in mid-Winter), it is likely that some flora species that occur were not detected during the field survey. These species may include those that flower at other times of year as well as annual, ephemeral or cryptic species. Similarly, some fauna species that utilise the study area (permanently, seasonally or transiently) may not have been detected during the survey. These species may include frogs and reptiles which are active or that call at other times of year, nocturnal species and fauna species that are mobile and transient in their use of resources and may not have been present during the survey. As such, it is likely that not all species that use the study area were recorded during the survey period.

The desktop assessment provided a list of the native flora and fauna and especially threatened biota previously recorded or that could potentially occur in the study area or be affected by the project (including seasonal, transient or cryptic species). The habitat assessment conducted allows for identification of habitat resources for those species known or predicted to occur in the locality, to assist in determining their likelihood of occurrence in the study area (see section 3.7). As such, the survey was not designed to detect all species, rather to provide an overall assessment of the biodiversity values within the study area, with particular emphasis on threatened biota and their habitats.

This Biodiversity Assessment Report has been prepared based on the project description and engineering drawings provided by the proponent. A ‘project area’ polygon (i.e. disturbance footprint) was prepared for the biodiversity assessment based on these inputs and confirmed in consultation with the proponent. It is assumed that the description and spatial data accurately represent the extent of direct impacts arising from the project and so these data have been used to calculate the extent of removal of vegetation and habitat arising from the project using GIS. These calculations have in turn been relied upon in the FBA calculations and the determination of key thresholds such as whether the project would have a direct impact on a TEC, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated project design and/or spatial data.



Note: walked transects and vegetation mapping, habitat assessments, targeted searches for threatened plants and fauna observations were conducted throughout all accessible portions of the study area.

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Revision A

Survey effort

Figure 2.1a

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- Canterbury feeder
- Anabat
- Area search
- Camera trap
- Plot/transect

Note: walked transects and vegetation mapping, habitat assessments, targeted searches for threatened plants and fauna observations were conducted throughout all accessable portions of the study area.

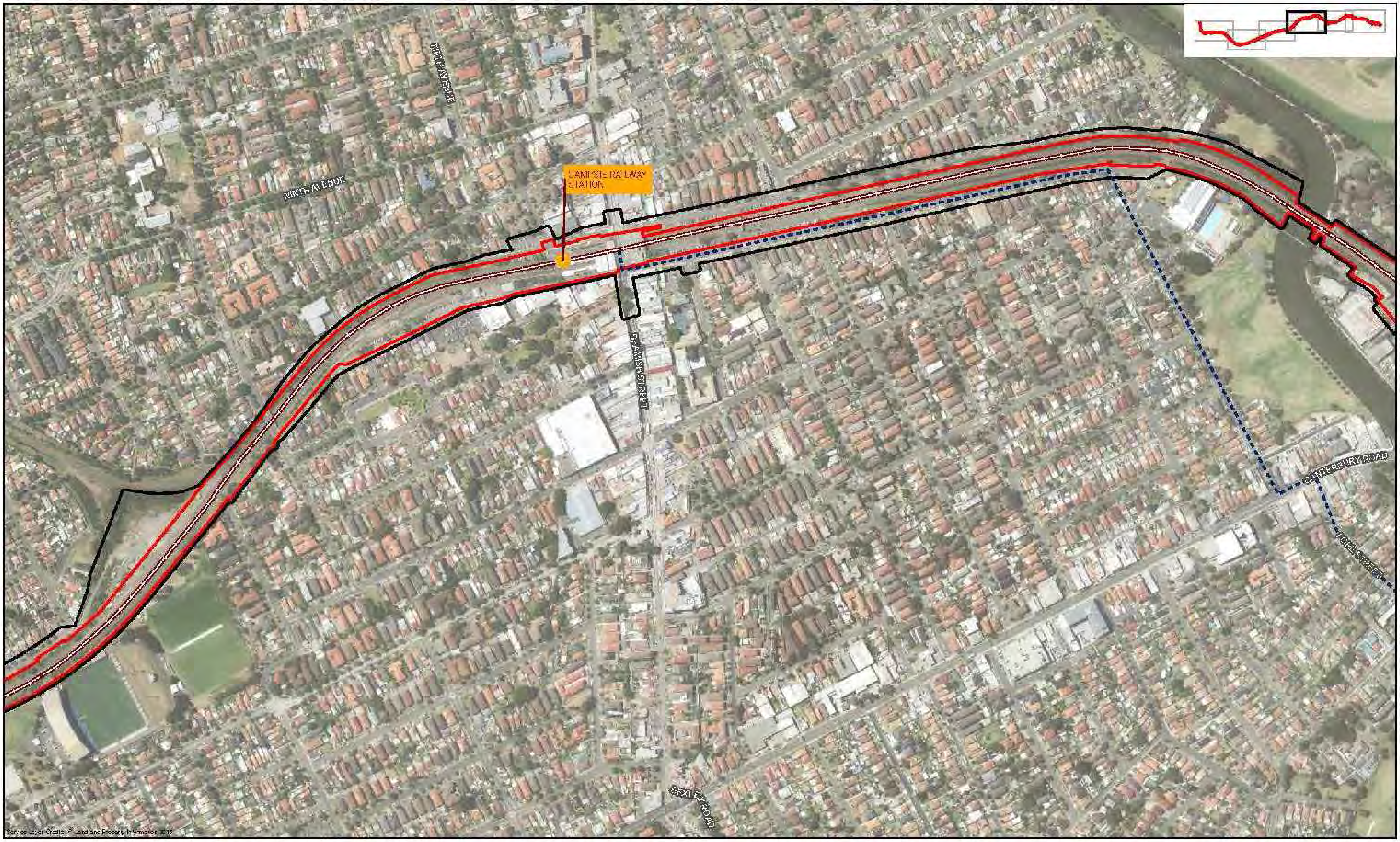
Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number 21-25273
Revision A
Date 05 Jul 2017

Survey effort

Figure 2.1b

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au



Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- Canterbury feeder

Note: walked transects and vegetation mapping, habitat assessments, targeted searches for threatened plants and fauna observations were conducted throughout all accessable portions of the study area.

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number	21-25273
Revision	A
Date	05 Jul 2017

Survey effort

Figure 2.1c

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

- Study area
- Project area
- Train station
- Railway
- Plot/transect

Note: walked transects and vegetation mapping, habitat assessments, targeted searches for threatened plants and fauna observations were conducted throughout all accessable portions of the study area.

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number	21-25273
Revision	A
Date	05 Jul 2017

Survey effort

Figure 2.1d

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- Anabat
- Area search
- Plot/transect

Note: walked transects and vegetation mapping, habitat assessments, targeted searches for threatened plants and fauna observations were conducted throughout all accessable portions of the study area.

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number	21-25273
Revision	A
Date	05 Jul 2017

Survey effort

Figure 2.1e

Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Study area
Project area
Train station
Railway
Anabat
Plot/transect

Note: walked transects and vegetation mapping, habitat assessments, targeted searches for threatened plants and fauna observations were conducted throughout all accessable portions of the study area.

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number 21-25273
Revision A
Date 05 Jul 2017

Survey effort

Figure 2.1f

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

3. Existing environment

3.1 Environmental context

3.1.1 Geology and soils

The *Sydney 1:100 000 Geological Series Sheet* (Herbert, 1983) indicates that the study area is underlain by Ashfield Shale of the Wianamatta Group comprising dark grey to black clay stone silt stone and fine grained sandstone-siltstone laminite. The underlying bedrock unit comprises Hawkesbury Sandstone consisting of medium to coarse grained quartz sandstone (Herbert, 1983).

The majority of the study area is located in the 'Blacktown' soil landscape. Smaller fragments of the 'Birrong' soil landscape are mapped within the study area adjacent to the upper Cooks River around Wiley Park, Belmore and Canterbury Stations. The 'Gymea' soil landscape is mapped as a larger patch between Canterbury and Dulwich Hill Stations in the eastern portion of the study area (OEH, 2016d).

The Blacktown soil landscape occurs in the Cumberland lowlands between the Georges and Parramatta Rivers in the south-west of Sydney. Its landscape comprises of gently undulating rises on Wianamatta Group shales with local relief to 30m and no rock outcrop. The underlying geology comprises Ashfield Shale consisting of laminite and dark grey siltstone and Bringelly Shale which consists of shale, with occasional calcareous claystone, laminite and coal. It features moderately deep (<100 cm) Red and Brown Podzolic Soils on crests, upper slopes and well-drained areas, and deep (150-300 cm) Yellow Podzolic Soils and Soloths on lower slopes and in areas of poor drainage (OEH, 2016d).

The Birrong soil landscape occurs on the level to gently undulating alluvial floodplains and watercourses draining Wianamatta Group shales, on the Cumberland Lowlands. Within the study area this landscape is associated with the upper Cooks River and feature a local relief to 5m and a slope of <3 per cent. Its geology is dominated by silt and clay sized alluvial materials derived from the Wianamatta Group and consisting mostly of shale with some carbonaceous claystone, laminite, and occasional fine to medium grain lithic sandstones. This landscape has deep (>250 cm) Yellow Podzolic Soils and Yellow Solodic Soils on older alluvial terraces, and deep (>250 cm) Solodic Soils and Yellow Solonetz on current floodplains (OEH, 2016d).

The Gymea soil landscape occurs on undulating to rolling rises and low hills on Hawkesbury Sandstone with a local relief 20-80 m and a slope between 10-25 per cent. It has some rocky outcrop (<25 per cent), with broad convex crests and moderately inclined sideslopes with wide benches. It occurs extensively throughout the Hornsby Plateau and along the foreshores of Sydney Harbour and the Parramatta and Georges Rivers. Its geology comprises Hawkesbury Sandstone, which is a medium to coarse-grained quartz sandstone with minor shale and laminite lenses. It has shallow to moderately deep (30-100 cm) Yellow Earths and Earthy Sands on crests and inside of benches; shallow (<20 cm) Siliceous Sands on leading edges of benches; localised Gleyed Podzolic Soils and Yellow Podzolic Soils on shale lenses, and shallow to moderately deep (<100 cm) Siliceous Sands and Leached Sands along drainage lines (OEH, 2016d).

The field survey confirmed that the majority of the study area falls within the Blacktown soil landscape, comprising gentle crests and gently undulating upper slopes on shale. Undisturbed areas feature shallow clay loam or loam soil, though the majority of the study area contains cuttings or fill and adjoining areas contain highly modified residential landscapes.

In the eastern portion of the study area, between Hurlstone Park and Marrickville stations, there is a gradual transition to sandstone-derived soils of the Gymea landscape. There is some sandstone rock outcrop in these areas though the soils and associated vegetation exhibit a clear shale influence reflecting the presence of soil material derived from upslope in the Blacktown soil landscape. There is a thin band of alluvial soil associated with the Birrong soil landscape on the banks of the Cook River between Canterbury and Belmore Stations.

There are substantial volumes of fill materials in the study area, including railway ballast, gravel, building debris and excavated soil material. The majority of the study area is either emplaced fill associated with railway embankments or exposed bedrock, associated with cuttings, overlain with ballast or fill.

3.1.2 Hydrology

The study area from Marrickville to approximately Punchbowl Stations drains to the Cooks River and its tributaries. The elevated corridor from approximately Punchbowl Station to Bankstown Station drains to Salt Pan Creek via the stormwater drainage network.

The Cooks River discharges to Botany Bay at Tempe adjacent to Sydney Airport. The catchment area is around 102 km^2. The watercourse is tidally influenced as far as South Enfield. The Cooks River was historically a natural watercourse but reaches were replaced with concrete lined channels or concrete side walls commencing in the 1940s. The upper reaches are concrete lined, with a mix of concrete and unlined channels further downstream. Poor water quality in the Cooks River means that it is considered unfit for contact by humans (Cooks River Alliance, 2014). Sewage overflow, illegal dumping and litter by both the public and businesses have been quoted as the main sources of pollution in the catchment. Sydney Water Corporation has undertaken progressive channel naturalisation works at three locations to restore a more natural creek in areas where the concrete sections had deteriorated. Additionally, the former Sydney Metropolitan Catchment Management Authority in consultation with local councils undertook a number of wetland remediation projects along the Cooks River between 2008 and 2012.

Salt Pan Creek is a tributary of the Georges River with a catchment area of around 26 km^2. Around 10 per cent of the total catchment area is located upstream of the study area and drains across it to reach Salt Pan Creek. The creek is partially tidally influenced. The catchment is heavily developed in the upper reaches near the study area. The upper reaches of the creek, where in open channel, is highly modified and generally concrete lined with limited vegetation until Canterbury Road. Heavy development in the catchment, including construction effects and litter, as well as other influences such as sewer overflows and a landfill operation have resulted in historically poor water quality in the creek.

3.1.3 Land use

The study area is predominately located within the existing rail corridor from Marrickville to Bankstown. Land uses adjoining the study area consist primarily of urban streetscapes and residential, commercial and industrial developments, interspersed with urban parklands.

The study area is located in the City of Canterbury Bankstown Council and Inner West Council local government areas (LGA). These two LGAs are the result of recent amalgamation of the Bankstown City Council, Canterbury Council and Marrickville Council LGAs.

3.2 Desktop studies

3.2.1 Database searches

A search of the OEH Atlas of Wildlife database and DEE protected matters search tool indicated 38 threatened flora species or populations listed under the TSC Act and 25 threatened flora species listed under the EPBC Act have been recorded or that are predicted to occur in the locality. A total of 60 threatened fauna species listed under the TSC Act, two threatened fauna species listed under the FM Act and 24 threatened fauna species listed under the EPBC Act have been recorded within 10 km of the study area or are predicted to occur.

The likelihood of occurrence of the threatened biota revealed by the data searches are detailed in Appendix A. Threatened biota that are known or likely to occur in the study area, based on the results of field surveys and habitat assessment, are presented in section 3.7.

3.2.2 Vegetation mapping

The *Native vegetation of the Sydney Metropolitan Area* (OEH, 2013) is the most current and finest scale vegetation mapping available in the study area. The most extensive vegetation map unit in the study area is 'Urban/exotic/native'. There are small, linear fragments of this vegetation map unit throughout the rail corridor and in adjoining areas of open space such as parks, gardens and median strips. There are small patches of 'Weeds and exotics' mapped at Bankstown Station and to the west of Canterbury Station (OEH, 2013).

'Weeds and exotics' and 'urban exotics and natives' are both non-native vegetation map units. The map unit 'weeds and exotics' comprises vegetation patches greater than 0.1 hectare in size with a complete cover of exotic species in the upper strata (i.e. where no visible native species could be discerned). 'Urban exotics and natives' comprise polygons greater than 0.1 hectares in size for which urban landuse covered more than 70 per cent of the polygon and there was evidence of both exotic and native species in the upper or lower strata (OEH, 2013).

No native vegetation was mapped by OEH (2013) within the study area. There is a linear strip of 'Estuarine Mangrove Forest' mapped immediately adjacent to the study area where it crosses the Cooks River. The nearest mapped patches of native vegetation occupying a similar landscape position to the study area include:

- Patches of 'shale gravel transition forest', around 800 metres south of the study area at Punchbowl, 850 metres north at Mount Lewis and 750 metres north at Campsie
- A patch of 'Sydney Turpentine-Ironbark forest' around 500 metres south of the study area at Wiley Park (OEH, 2013)

The *Vegetation of the Cumberland Plain* (NPWS, 2002) and *Native vegetation of southeast NSW* (Tozer et. al, 2010) also do not map any native vegetation in the study area.

The *Vegetation Mapping – Marrickville to Sefton* (RailCorp, 2006) shows remnant and planted native vegetation in the rail corridor (within the study area) along with threatened plants, weed infestations and management actions. The study area is split into individual management areas which are described as either 'weeds', 'remnant' or 'revegetated' and according to dominant plant species and prescribed management actions. Remnant native vegetation is not further described as a particular vegetation community or type.

The majority of the mapped vegetation in the study area is exotic and proposed for weed control and/or slashing (RailCorp, 2006). There are small, linear patches of remnant native vegetation that are proposed for bush regeneration. These patches match the distribution of native vegetation mapped by GHD on the Figure 3-1 figure series.

RailCorp (2006) identifies several patches of the threatened plant Downy Wattle (*Acacia pubescens*) near Bankstown Station and Punchbowl Station. These patches have been confirmed by the GHD field survey and are shown on Figure 3-2 a to f and described in section 3.7.2.

3.2.3 Literature review

Long-nosed Bandicoot studies

Potential habitat for the endangered Long-nosed Bandicoot population of inner western Sydney is present in parts of the study area. The exact area occupied by the population is not clearly defined, and includes the local government areas (LGA) of Marrickville and Canada Bay, with the likelihood that it also includes Canterbury, Ashfield and Leichhardt LGAs (as noted in section 3.1.3 many of these councils have recently been merged) (OEH, 2016b). The core area of records of the Long-nosed Bandicoot in the inner west is located between Lewisham and Dulwich Hill, in an area bounded by Parramatta Road, Lewisham, in the north, the Bankstown rail line in the south, an area west of the light rail line (Summer Hill and Dulwich Hill) in the west, and Palace Street (Petersham) and Wardell Road (Marrickville) in the east (OEH, 2015). Most of the records of animals, rather than possible diggings, occur in an area bounded by Constitution Road, New Canterbury Road, Old Canterbury Road and Parramatta Road in the suburbs of Petersham, Lewisham, and Dulwich Hill (Price and Banks, 2016). Constitution Road is located about 700 metres to the north of the Bankstown line.

The Long-nosed Bandicoot was thought to be extinct in inner western Sydney in the 1950's, however an individual was trapped by the NSW National Parks and Wildlife Service (NPWS) in a garden in Dulwich Hill in 2002. Further investigation found additional individuals in the area (Leary et al, 2010). NPWS also recorded bandicoots at a property in Lewisham in 2007. Radio-tracking of individuals in that study found they nest under nearby Federation houses (where they were protected from cats and dogs) and forage in gardens (Leary et al, 2010).

The Marrickville Biodiversity Strategy (AMBS, 2011) noted that the Inner West Light Rail corridor may provide shelter habitat and connectivity for the Long-nosed Bandicoot. Targeted surveys by NPWS (trapping and hair tubes) along the then proposed (now operating) light rail corridor at Dulwich Hill did not find any evidence of the species (Leary et al, 2010). Further targeted surveys for the species using remote cameras were conducted along the route for the Environmental Impact Statement for the Inner West Light Rail in 2010. No individuals were recorded (Biosis Research, 2010).

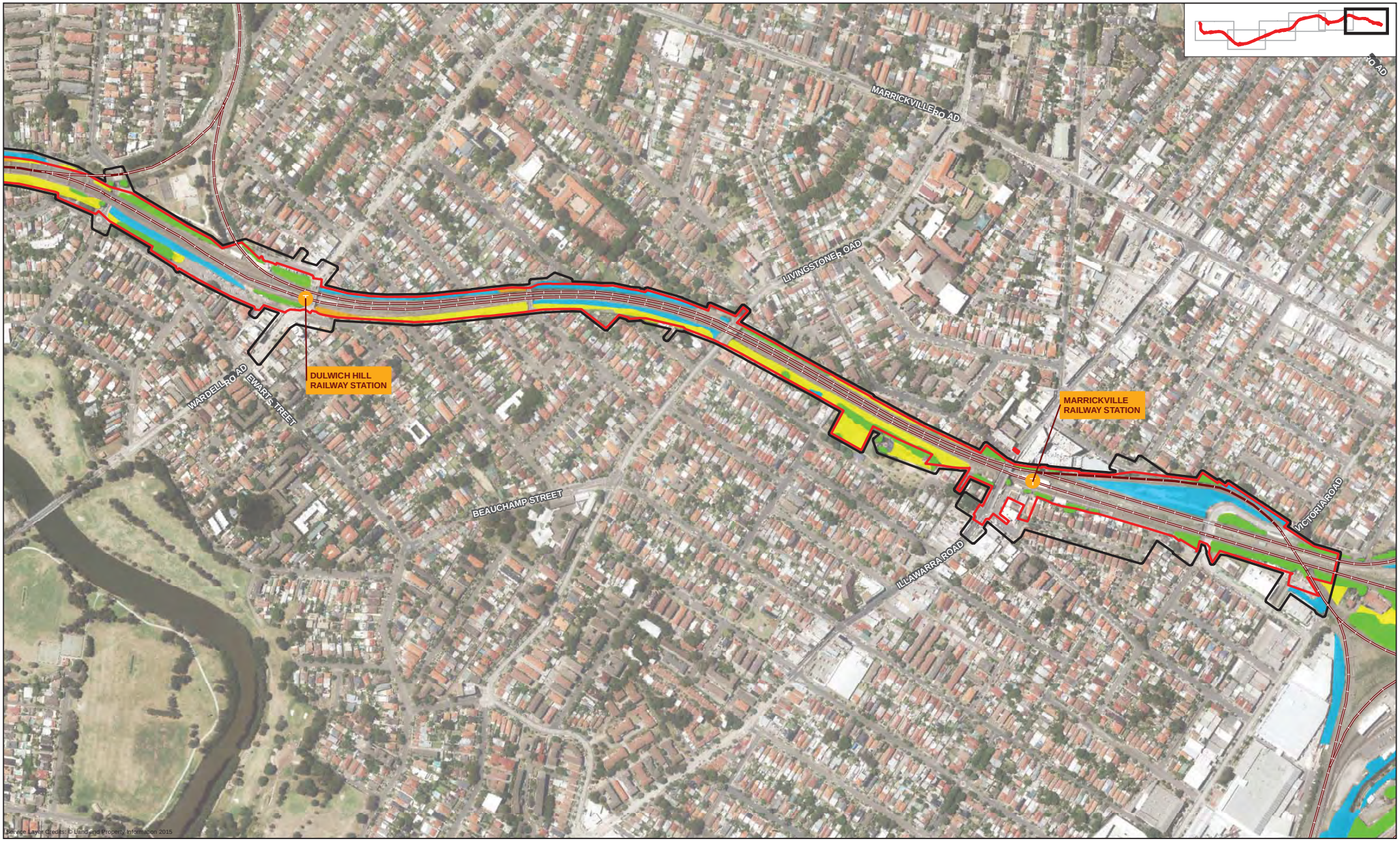
Transport for NSW recently funded a survey program targeting the Long-nosed Bandicoot along the Inner West Light Rail corridor and surrounding suburbs (Price and Banks, 2016). This comprised placement of logs for shelter and remote cameras at eight sites in the light rail corridor between Dulwich Hill and Leichhardt, and a community survey to obtain further records of the species if possible. The southern portion of the study area for the bandicoot survey intersects the study area for the metro. Cameras were installed on 3 March 2016 within the light rail corridor and checked weekly or fortnightly until 12 July 2016. No bandicoots were recorded as part of this survey program. Species recorded from the camera survey included introduced cats, foxes, and rats, as well as the native Common Brushtail Possum, Australian White Ibis and Australian Raven (Price and Banks, 2016). No recent records were identified in the community survey. The survey respondents that had observed bandicoots in the past were unable to provide any details of current observations. The most recent confirmed evidence remains an adult killed by a dog in Dulwich Hill in 2014. There was also evidence of at least one adult in Leichhardt in 2013 that was later found dead (Price and Banks, 2016). The study concluded that given the high number of introduced predators (cats, dogs and foxes) recorded within Bushcare sites and other Council reserves that were monitored along the Light Rail Line, it is unlikely that

any bandicoots are surviving in these areas. Taken together with the locations of previous records, the study indicated that it is more likely that any residual population would be surviving in very low numbers within urban backyards (Price and Banks, 2016).

Other relevant studies

The biodiversity study for the Chatswood to Sydenham component of the Sydney Metro, which included the area immediately to the east of the study area, did not identify threatened species, populations or communities (Arcadis, 2016). However, the Grey-headed Flying-fox, listed as Vulnerable under the EPBC Act and TSC Act, was considered to have a high likelihood of occurrence at the proposed Barangaroo Station and Chatswood Dive structure, which contained potential foraging habitat for the species. In addition, the Eastern Freetail-bat (*Mormopeterus norfolkensis*) and Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) were assigned a moderate likelihood of occurrence due to potential roosting habitat associated with bridges, buildings and hollow-bearing trees. Likely impacts from the construction and operation of the Chatswood to Sydenham component of the Sydney Metro were minor due to the limited removal of native vegetation and loss of fauna habitat mostly including planted trees and landscaped vegetation and buildings and bridges.

The *Marrickville Biodiversity Strategy* (AMBS, 2011) identified a wildlife corridor along the Cooks River (various parks and the Marrickville Golf Course) and the 'GreenWay'. The GreenWay is an urban green corridor in Sydney's Inner West, located along the light rail corridor (and the Hawthorn Canal) between the Cooks River and Iron Cove. The State Government has recently committed to providing $7M in funding for landscaping and walking and cycleway paths along the route (Greenway, 2016). Much of the Greenway corridor in AMBS (2011) incorporates residential and industrial areas, and is thus only indicative of a general area. The study area crosses this wildlife corridor near Dulwich Hill station. AMBS (2011) note that the urban mosaic (comprising vegetation in parks, reserves, open space, schools, church grounds, backyards and streets) provides habitat resources for a range of fauna, including Long-nosed Bandicoots, the Grey-headed Flying-fox, frogs, small reptiles, a range of birds, and microbats, and also provides low local and regional connectivity.



Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Project area
- Study area
- Train station
- Railway
- Exotic grassland
- Exotic scrub or forest
- Planted native vegetation
- Degraded Turpentine - Grey Ironbark open forest on shale (ME041, Moderate/good-poor)

Transport for NSW
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Vegetation

Figure 3.1a

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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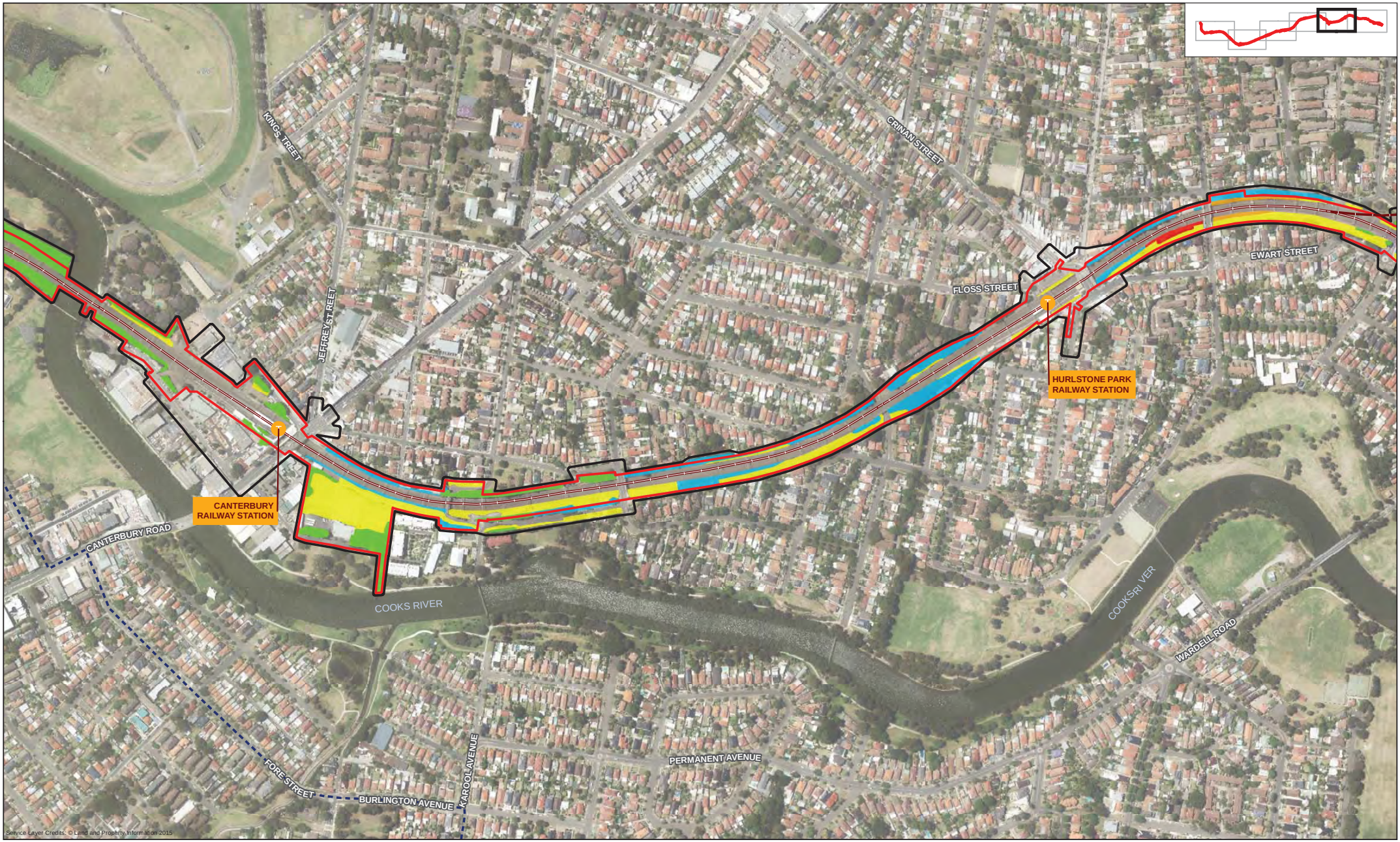

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Project area
- Study area
- Train station
- Railway
- Canterbury feeder
- Exotic grassland
- Exotic scrub or forest
- Planted native vegetation
- Turpentine - Grey Ironbark open forest on shale (ME041, Moderate/good-medium)
- Degraded Turpentine - Grey Ironbark open forest on shale (ME041, Moderate/good-poor)

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Figure 3.1b

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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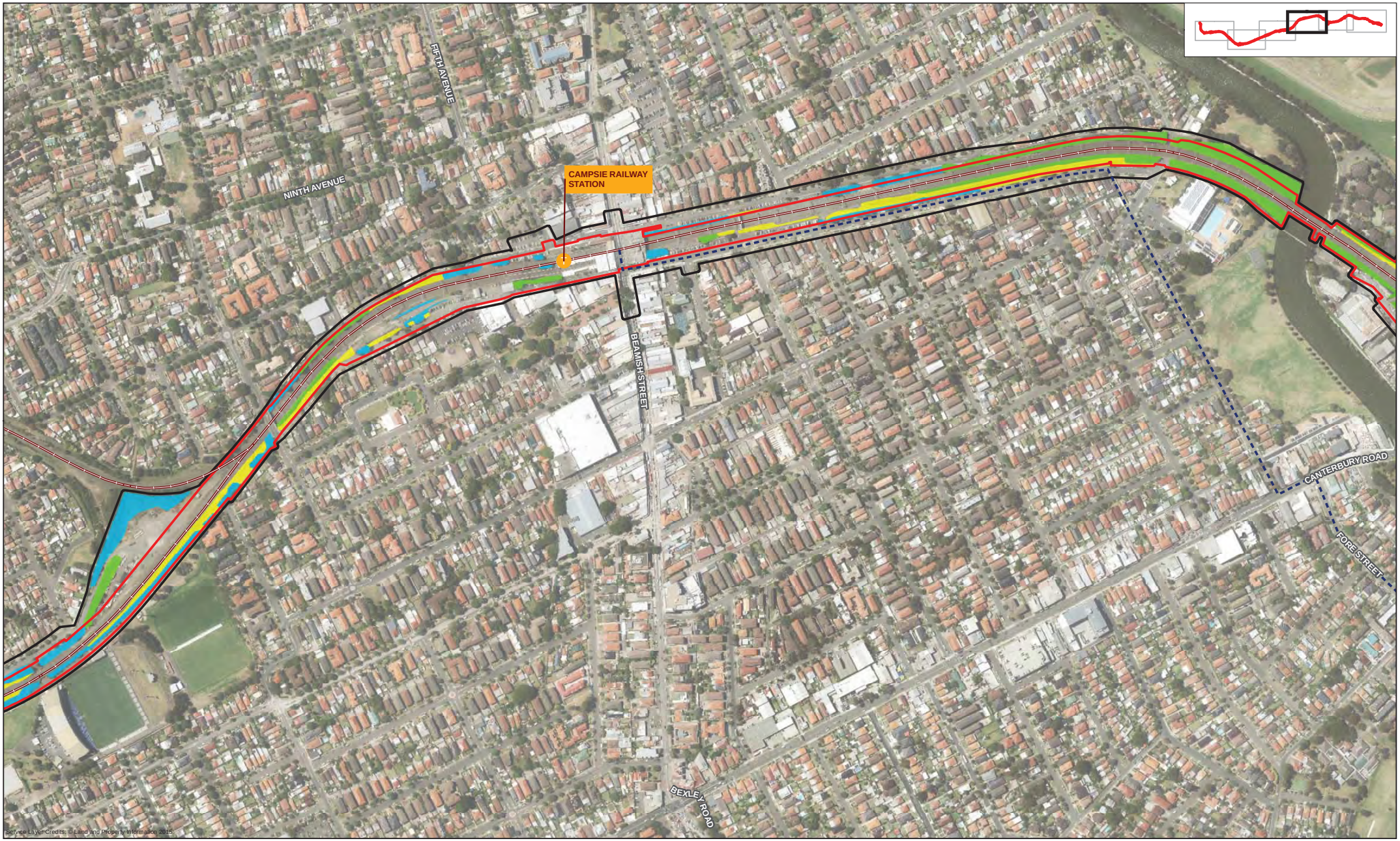

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Project area
- Study area
- Train station
- Railway
- Canterbury feeder
- Exotic grassland
- Exotic scrub or forest
- Planted native vegetation

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Figure 3.1c

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Project area
- Study area
- Train station
- Railway
- Exotic grassland
- Exotic scrub or forest
- Planted native vegetation
- Turpentine - Grey Ironbark open forest on shale (ME041, Moderate/good-medium)

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Figure 3.1d

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Project area
- Study area
- Train station
- Railway
- Exotic grassland
- Exotic scrub or forest
- Planted native vegetation
- Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest (ME004, Moderate/good)
- Degraded Turpentine - Grey Ironbark open forest on shale (ME041, Moderate/good-poor)

GHD

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Figure 3.1e

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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LEGEND

- Project area
- Study area
- Train station
- Railway
- Exotic grassland
- Exotic scrub or forest
- Planted native vegetation
- Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest (ME004, Moderate/good)

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Vegetation

Figure 3.1f

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by:jrprice

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3.3 Flora and vegetation

3.3.1 Flora species

A total of 129 flora species from 40 families were recorded within the study area, comprising 63 native and 66 exotic species. Poaceae (grasses, 22 species, 11 native), Myrtaceae (flowering shrubs and trees, 20 species, 13 native), Fabaceae (23 species, 17 native) and Asteraceae (flowering herbs, 11 species, 2 native) were the most diverse families recorded. The full list of species recorded is presented in Appendix B. Species recorded are discussed below in relation to the vegetation types occurring within the study area.

There is relatively low native species richness which confirms that the native vegetation within the study area has been extensively modified and is in moderate to poor condition. Native plant species richness was well below benchmark values in all of the plot/transects sampled. The overall plant species richness within the study area may be slightly greater than revealed by this sample given the seasonal limitations of the initial ecological survey. However, based on the small area of each patch of native vegetation, degree of disturbance and high exotic plant cover, there is unlikely to be substantially more native plant species in the study area.

The suite of plant species at the study area is representative of shale and transitional shale-gravel soils. The study area does not contain any natural sandstone outcrops, sandstone-derived soils or any shale-sandstone transition soils and would not contain any plant species that have habitat requirements specific to these soil types. Many of the threatened plant species known or predicted to occur in the locality have these specific habitat requirements and would not occur at the site (see Appendix B).

3.3.2 Vegetation

The majority of the vegetation in the project area and surrounding study area comprises exotic or planted native species on highly modified landforms. There are small isolated patches of remnant or regrowth native vegetation in small portions of the study area associated with rail cuttings with less disturbed soil profiles. Vegetation in the study area is summarised in Table 3-1, mapped on the Figure 3-1 figure series and described in Table 3-2 to Table 3-7. Threatened ecological communities are mapped on Figure 3-2.

Native vegetation in the study area matches two PCTs according to the FBA:

- Turpentine - Grey Ironbark open forest on shale (PCT ID 1281, Biometric vegetation type HN604)
- Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest (PCT ID 724, Biometric vegetation type HN512)

These PCTs were identified based on observation of vegetation structure, dominant plant species and characteristic shale-influenced soil types and geomorphology. This was partially confirmed after the site survey through comparison of plant species lists in plots with diagnostic species lists for the equivalent vegetation map unit (Tozer et al., 2010). However, the vegetation in the study area is highly modified and degraded and did not feature enough native plant species or diagnostic plant species to confidently match it to any vegetation map unit (Tozer et. al., 2010). Therefore, each vegetation map unit in the study area has been matched to the closest equivalent PCT in the Vegetation Information System (VIS) (OEH, 2016c).

There are patches of native plants in the study area that contain some species representative of Turpentine - Grey Ironbark open forest. Although they occur in a landscape position that probably previously supported this PCT, they contain planted native species on fill material and do not represent a remnant or regrowth patch of this PCT. These areas were confidently identified as ‘planted native species’ (rather than a regrowth or remnant form of this PCT) and are described separately below.

Table 3-1 Vegetation in the study area

Vegetation type	PCT/NSW Veg. Type ID (OEH, 2016c)	Condition	Survey effort[1]	Conservation significance	Extent in study area (hectares)
Turpentine - Grey Ironbark open forest on shale	1281 / ME041	Moderate/good - medium	Plot/transects 2 and 6	EEC[2] listed under the TSC Act (Sydney Turpentine Ironbark Forest in the Sydney Basin Bioregion)	0.2
Degraded Turpentine - Grey Ironbark open forest on shale	1281 / ME041	Moderate/good - poor	Plot/transects 1 and 5, area search 4	Native vegetation. Not an EEC because it does not contain characteristic canopy species listed in the Scientific Committee determination (NSWSC 2011a).	0.4
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest	724/ ME004	Moderate/good	Plot/transects 3 and 4, area search 3	EEC listed under the TSC Act (Shale Gravel Transition Forest)	0.4
Exotic grassland	n/a	Cleared/non-native vegetation	General observations		12.5
Exotic scrub or forest	n/a	Cleared/non-native vegetation	Area search 1		9
Planted native species	n/a	Cleared/non-native vegetation	Area search 2		7.3

Notes: 1. Locations of plot/transects and area searches are shown on the Figure 3-1 figure series.
2. EEC – Endangered ecological community.

Table 3-2 Turpentine – Grey Ironbark open forest on shale

Turpentine - Grey Ironbark open forest on shale		
PCT (OEH, 2016c)	Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin	
PCT ID	1281	
NSW Veg Type ID	HN604	
Survey effort	Plot/transects 2 and 6	
Condition (OEH, 2014)	Moderate/good - medium	
Conservation significance	EEC listed under the TSC Act (Sydney Turpentine Ironbark Forest in the Sydney Basin Bioregion).	
Evidence used to define vegetation unit	Forest or woodland vegetation structure. Characteristic shale-influenced soil types and geomorphology. The dominant plant species described below are consistent with OEH's vegetation information system (VIS) (OEH, 2016c) and the species list in the Scientific Committee determination for the associated EEC (NSWSC, 2011a). There are patches of this vegetation unit mapped in similar topographic positions within around 500 metres of the study area (OEH, 2013).	
Landscape position	Ridges and upper slopes on shale substrate on gently undulating terrain, mainly in the east of the study area between Canterbury and Marrickville Stations. Occasionally occurs near outcropping sandstone but is associated with a thick mantle of shale-derived soil material from upslope.	
Structure	Derived (i.e. a result of previous clearing) low open forest or woodland.	
Over storey	Occasional Turpentine (*Syncarpia glomulifera subsp. glomulifera*) to around 15 metres in height.	
Mid storey	There is a locally dense but species poor mid-storey comprising occasional patches of Black She-Oak (*Allocasuarina littoralis*), Cheese Tree (*Glochidion ferdinandii*), Sweet Pittosporum (*Pittosporum undulatum*), Parramatta Wattle (*Acacia parramattensis*), Hairy Bush-pea (*Pultenaea villosa*) or Tickbush (*Kunzea ambigua*).	
Groundcover	Patchy and variable with low native species richness. Includes: grasses such as Kangaroo Grass (Themeda triandra), Threeawn Speargrass (Aristida vagans) and Wallaby Grass (Austrodanthonia tenuior); shrubs such as native Blackthorn (Bursaria spinosa subsp. spinosa), Polyscias sambucifolia subsp. sambucifolia and Daviesia ulicifolia subsp. ulicifolia; and herbs such as Lomandra filliformis and Dianella revoluta var. revoluta; and scramblers such as Variable Glycine (*Glycine tabacina*) and Dusky Coral Pea (*Kennedia rubicunda*).	
Exotic species	A diverse mix of noxious and environmental weeds, including locally severe infestations. Includes small trees such as Jacaranda (*Jacaranda mimosifolia*), Mickey Mouse Plant (*Ochna serrulata*) and African Olive (*Olea europaea subsp. cuspidata*); tall forbs such as Narrow-leaved Cotton Bush (*Gomphocarpus fruticosus*) and Cape Daisy (*Osteospermum ecklonis*); and grasses such as Red Natal Grass (*Melinis repens*) and Kikuyu Grass (*Pennisetum clandestinum*).	

Table 3-3 Degraded Turpentine – Grey Ironbark open forest on shale

Turpentine - Grey Ironbark open forest on shale		
PCT (OEH, 2016c)	Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin	
PCT ID	1281	
NSW Veg Type ID	HN604	
Survey effort	Plot/transects 1 and 5	
Condition (OEH, 2014)	Moderate/good - poor	
Conservation significance	Does not comprise an occurrence of Sydney Turpentine Ironbark Forest EEC because it does not have a forest or woodland structure and does not include any characteristic canopy species.	
Evidence used to define vegetation unit	Vegetation structure. Characteristic shale-influenced soil types and geomorphology. The dominant plant species described below are consistent with the VIS (OEH, 2016c). There are patches of the closest equivalent vegetation unit mapped in similar topographic positions within around 500 metres of the study area (OEH, 2013).	
Landscape position	Ridges and upper slopes on shale substrate on gently undulating terrain, mainly in the east of the study area between Canterbury and Marrickville Stations. Occasionally occurs near outcropping sandstone but is associated with a thick mantle of shale-derived soil material from upslope.	
Structure	Derived (i.e. a result of previous clearing) scrub or grassland.	
Over storey	Absent.	
Mid storey	There is a locally dense but species poor mid-storey comprising occasional patches of Black She-Oak (*Allocasuarina littoralis*), *Myrsine variabilis*, Large Mock-olive (*Notelaea longifolia*), Parramatta Wattle (*Acacia parramattensis*) or Tickbush (*Kunzea ambigua*).	
Groundcover	Patchy and variable with low native species richness. Includes: grasses such as Kangaroo Grass (*Themeda triandra*), Threeawn Speargrass (*Aristida vagans*) and Wallaby Grass (*Austrodanthonia tenuior*); shrubs such as native Blackthorn (*Bursaria spinosa* subsp. *spinosa*), *Polyscias sambucifolia* subsp. *sambucifolia* and Large-leaf Hop-bush (*Dodonaea triquetra*)*;* and scramblers such as Twining glycine (*Glycine clandestina*) and Dusky Coral Pea (*Kennedia rubicunda*).	
Exotic species	A diverse mix of noxious and environmental weeds, including locally severe infestations. Includes small trees such as Mickey Mouse Plant (*Ochna serrulata*), *Cotoneaster glaucophyllus* and African Olive (*Olea europaea* subsp. *cuspidata*); herbs such as Catsear (*Hypochaeris radicata*) and Fennel (*Foeniculum vulgare*); and grasses such as Red Natal Grass (*Melinis repens*) and Panic Veldtgrass (*Ehrharta erecta*).	

Table 3-4 Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy woodland

Broad-leaved Ironark – Grey Box- *Melaleuca decora* grassy woodland		
PCT (OEH, 2016c)	Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion	
PCT ID	724	
NSW Veg Type ID	HN512	
Survey effort	Plot/transects 3 and 4 Area search 3	
Condition (OEH, 2014b)	Moderate/good	
Conservation significance	EEC listed under the TSC Act (Shale Gravel Transition Forest in the Sydney Basin Bioregion).	
Evidence used to define vegetation unit	Open forest vegetation structure in better condition patches. Characteristic shale, overlain by alluvium-influenced soil types and geomorphology. The dominant plant species described below are consistent with the VIS (OEH, 2016c) and the species list in the Scientific Committee determination for the associated EEC (NSWSC, 2011b). There are patches of this vegetation unit mapped in similar topographic positions within around 800 metres of the study area (OEH, 2013).	
Landscape position	Lower slopes and flats on gently undulating terrain, mainly in the west of the study area between Punchbowl Station and Bankstown Station.	
Structure	Open forest or derived scrub.	
Over storey	Indigenous native over storey is generally absent apart from occasional Red Ironbark (*Eucalyptus fibrosa*) to around 20 metres in height. There are also planted, non-indigenous native species such as Tallowwood (*E. microcorys*) and Brushbox (*Lophostemon confertus*).	
Mid storey	There is a locally dense but species poor mid-storey comprising occasional patches of Downy Wattle (*Acacia pubescens*), *Melaleuca nodosa* or Black Wattle (*A. decurrens*).	
Groundcover	Patchy and variable with low native species richness. Includes: grasses such as Kangaroo Grass , Barbed Wire Grass (*Cymbopogon refractus*) and Wallaby Grass; shrubs such as native Blackthorn, Prickly Beard-heath (*Leucopogon juniperinus*) and Dilwynia sieberi; herbs such as Wiry Spurge (*Phyllanthus virgatus*) and *Dianella revoluta* var. *revoluta*; and scramblers such as Variable Glycine (*Glycine tabacina*) and Pink Bindweed (*Convolvulus erubescens*).	
Exotic species	A diverse mix of noxious and environmental weeds, including some moderate infestations. Includes small trees such as African Olive; shrubs such as Boneseed (*Chrysanthemoides monilifera* subsp. *monilifera*) and Flaxleaf Broom (*Genista linifolia*); grasses such as Rhodes Grass (*Chloris gayana*) and Kikuyu Grass (*Pennisetum clandestinum*); and herbs such as Cobbler's Pegs (*Bidens pilosa*), Common Sowthistle (*Sonchus oleraceus*) and Purpletop (*Verbena bonariensis*).	

Table 3-5 Planted native species

Planted native species		
PCT (OEH, 2016c)	N/A	
PCT ID	N/A	
NSW Veg Type ID	N/A	
Survey effort	Area searches 2 and 4	
Condition (OEH, 2014)	Cleared/non-native vegetation	
Conservation significance	Low (non indigenous native vegetation).	
Evidence used to define vegetation unit	Dominance of non-indigenous native plant species. Highly modified geomorphology and unnatural soil profiles, mainly comprising imported fill. Frequent and ongoing human disturbance, such as slashing of understorey vegetation. Minimal evidence of regeneration of native plant species. There are patches of an equivalent non-native vegetation unit mapped throughout the study area (OEH, 2013).	
Landscape position	All landscape positions on gently undulating terrain throughout the study area.	
Structure	Open forest or scrub.	
Over storey	Patchy, often consisting of lines of mature trees along fences or road edges. Indigenous native over storey is generally absent apart from occasional, isolated Red Ironbark or Turpentine to around 20 metres in height. Planted, non-indigenous native species include Tallowwood, Brushbox, Lemon-scented Gum (*Corymbia citriodora*), Narrow-leaved Black Peppermint (*E. nicholii*), River Red Gum (*E. camaldulensis*) and Wallangarra White Gum (*E. scoparia*)	
Mid storey	Includes indigenous native plant species, which, judging from their age, landscape position and arrangement are probably planted such as: Swamp Paperbark (*Melaleuca ericifolia*); Prickly-leaved Tea Tree (*M. styphelioides*), Crimson Bottlebrush (*Callistemon citrinus*), Kanooka (*Tristaniopsis laurina*) and White Sally (*Acacia floribunda*). There are very occasional indigenous native plants that appear to have regenerated naturally, including Sweet Pittosporum (*Pittosporum undulatum*) and Parramatta Wattle (*A. parramattensis*).	
Groundcover	Mainly mown areas of exotic grasses such as Kikuyu (*Pennisetum clandestinum)*, bare earth, hardstand or mulch. Occasional dense, planted beds of indigenous native species such as Spiny-headed Mat-rush (*Lomandra longifolia*) or more typically commercial hybrid cultivars of native species such as *Grevillea* species, *Myoporum boninensis* or *Dianella* species.	
Exotic species	Patchy, locally dense infestations of noxious and environmental weeds such as Fennel (*Foeniculum vulgare*), Moth Vine (*Araujia sericifera*), Wandering Jew (*Tradescantia fluminensis*) and Panic Veldtgrass (*Ehrharta erecta*).	

Table 3-6 Exotic scrub or forest

Exotic forest and scrub		
PCT (OEH, 2016c)	N/A	
PCT ID	N/A	
NSW Veg Type ID	N/A	
Survey effort	Area search 1	
Condition (OEH, 2014)	Cleared/non-native vegetation	
Conservation significance	Very low (exotic vegetation).	
Evidence used to define vegetation unit	Dominance of non-indigenous native plant species. Highly modified geomorphology and unnatural soil profiles, mainly comprising imported fill on railway embankments. Minimal evidence of regeneration of native plant species. There are patches of an equivalent non-native vegetation unit mapped throughout the study area (OEH, 2013).	
Landscape position	Steeper or less accessible railway embankments and other modified landforms throughout the study area.	
Structure	Closed forest or scrub.	
Over storey	Indigenous native over storey is absent. Occasional planted non-indigenous native species such as Tallowwood (*Eucalyptus microcorys*) and Brushbox (*Lophostemon confertus*). Frequently a dense, closed canopy of exotic tree species such as Camphor Laurel (*Cinnamomum camphora*), Large-leaved Privet (*Ligustrum lucidum*), Tree of Heaven (*Ailanthus altissima*) and Honey Locust (*Gleditsia triacanthos*).	
Mid storey	Occasional indigenous native small trees such as Parramatta Wattle (*Acacia parramattensis*) and Sweet Pittosporum (*Pittosporum undulatum*). Very dense cover of native small trees that are recognised as environmental weeds such as *Acacia saligna* and Cootamundra Wattle (*A. baileyana*) and exotic small trees such as Mickey Mouse Plant (*Ochna serrulata*), African Olive (*Olea europaea* subsp*. cuspidata*), Castor Oil Plant (*Ricinus communis*), Green Cestrum (*Cestrum parqui*) and Lantana (*Lantana camara*). Exotic climbers such as Moth Vine (*Araujia sericifera*), Balloon Vine (*Cardiospermum grandiflorum*) and Morning Glory (*Ipomoea indica*) are frequently present and in places very dense and extensive.	
Groundcover	Patchy and variable including: scramblers such as Wandering Jew (*Tradescantia fluminensis*), and Bridal Creeper (*Asparagus asparagoides*); grasses such as Rhodes Grass (*Chloris gayana*) and Panic Veldtgrass (*Ehrharta erecta*); and herbs such as Lamb's Tongues (*Plantago lanceolata*), Purpletop (*Verbena bonariensis*), Mother of millions (*Bryophyllum delagoense*) and Flaxleaf Fleabane (*Conyza bonariensis*).	
Exotic species	As described above.	

Table 3-7 Exotic grassland

Exotic grassland		
PCT (OEH, 2016c	N/A	
PCT ID	N/A	
NSW Veg Type ID	N/A	
Survey effort	General observations	
Condition (OEH, 2014)	Cleared/non-native vegetation	
Conservation significance	Very low (exotic vegetation).	
Evidence used to define vegetation unit	Clear dominance of exotic plant species. Highly modified geomorphology and unnatural soil profiles, mainly comprising imported fill. Frequent and ongoing human disturbance, such as slashing. No evidence of regeneration of native plant species.	
Landscape position	All landscape positions on gently undulating terrain throughout the study area.	
Structure	Grassland.	
Over storey	Absent.	
Mid storey	Absent.	
Groundcover	Exotic grasses herbs as described below.	
Exotic species	Mown areas of exotic gasses such as Kikuyu. Herbs such as Cobbler's Pegs (*Bidens pilosa*), Burr Medic (*Medicago polymorpha*), Lamb's Tongues (*Plantago lanceolata*) and Fireweed (*Senecio madagascariensis*).	

3.3.3 Noxious and environmental weeds

Noxious weeds observed in the study area are listed in Table 3-8 along with their control category and control requirements. These noxious weed species are listed under the NW Act in the Bankstown City Council, Canterbury and Marrickville LGA control areas (recent amalgamation changes to LGAs now place the study area within the City of Canterbury Bankstown Council and Inner West Council LGAs).

These noxious weeds are broadly distributed throughout the rail corridor particularly in the 'exotic forest and scrub' vegetation map unit.

Many of these noxious weed species are also listed as 'weeds of national significance' (WoNS) which are recognised as Australia's worst invasive plants. These weeds cause negative impacts to many of Australia's natural and productive landscapes (Australian Weeds Committee, 2014).

Table 3-8 Noxious weeds and WoNS recorded in the study area

Common name	Scientific name	WoNS	NW Act control category	Formerly listed control area (LGA)	Control requirements
African Olive	*Olea europa* subsp. *cuspidata*	No	4	Bankstown	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.
Asparagus Fern	*Asparagus aethiopicus*	Yes	4	Bankstown, Canterbury, Marrickville	The plant must not be sold, propagated or knowingly distributed.
Blackberry	*Rubus fruticosus* species *aggregate*	Yes	4	Bankstown, Canterbury, Marrickville	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed This is an 'All of NSW' declaration.
Boneseed	*Chrysanthemoides monilifera* subsp. *monilifera*	Yes	1	Bankstown, Canterbury, Marrickville	The plant must be eradicated from the land and that land must be kept free of the plant.
Bridal Creeper	*Asparagus asparagoides*	Yes	4	Bankstown, Canterbury, Marrickville	The plant must not be sold, propagated or knowingly distributed.
Castor Oil Plant	*Ricinus communis*	No	4	Bankstown, Canterbury, Marrickville	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread.
Fireweed	*Senecio madagascariensis*	Yes	4	Bankstown, Canterbury, Marrickville	The plant must not be sold, propagated or knowingly distributed.
Flaxleaf Broom	*Genista linifolia*	Yes	4	Bankstown, Canterbury, Marrickville	The plant must not be sold, propagated or knowingly distributed.
Green Cestrum	*Cestrum parqui*	No	3	Bankstown, Canterbury, Marrickville	The plant must be fully and continuously suppressed and destroyed.

Common name	Scientific name	WoNS	NW Act control category	Formerly listed control area (LGA)	Control requirements
Honey Locust	*Gleditsia triacanthos*	No	3	Bankstown, Canterbury, Marrickville	The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed.
Lantana	*Lantana camara*	Yes	4	Bankstown, Canterbury, Marrickville	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread.
Mother of millions	*Bryophyllum delagoense*	No	4	Bankstown, Canterbury, Marrickville	The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed.
Pampas Grass	*Cortaderia* species	No	3	Bankstown, Canterbury, Marrickville	The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed.
Privet; broad-leaf	*Ligustrum lucidum*	No	4	Bankstown, Canterbury, Marrickville	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread.
Rhizomatous bamboo	*Phylostacca* species	No	4	Bankstown, Canterbury, Marrickville	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.

3.4 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are important elements in the landscape that require access to groundwater to maintain their health and vigour. There are many types of GDEs, but they can all be classed into one of two types. The first class of GDE relies on the surface expression of groundwater. Swamps, wetlands and rivers are ecosystems that rely on the discharge of groundwater to the surface, either into a river or into a swamp or wetland. The second class of GDEs rely on the availability of groundwater below the surface but within the rooting depth of the vegetation. The reliance on groundwater might be expressed every day of the year, or only for a few months every few years, but the reliance becomes apparent when the supply of groundwater is removed for a sufficient length of time that changes in plant function are observable. Prolonged absence of groundwater from sites that formerly had groundwater available leads to plant death and a change in ecosystem composition (Eamus, 2009).

The *Atlas of Groundwater Dependent Ecosystems* (BOM, 2016a) maps known GDEs and ecosystems that potentially use groundwater. No GDEs were identified in the study area. No vegetation in the project area is therefore likely to be a GDE. Some patches of vegetation along Wolli Creek downstream of the study area are mapped as potential GDEs (BOM, 2016a).

3.5 Fauna and fauna habitats

3.5.1 Fauna species

A low diversity of fauna species were recorded during the GHD survey, as would be expected in a highly modified urban environment. A total of 23 native species were recorded, which included 17 bird species, two mammal species, three reptile species and one frog species. No microbat species were recorded. Five introduced bird species and three introduced mammal species were also recorded. One threatened fauna species (Grey-headed Flying-fox was recorded (see Figure 3-2f). The full list of species recorded is provided in Appendix B. Additional fauna species are also likely to occur on occasion, but most of these are likely to be common and widespread fauna typical of modified urban environments and parks and gardens.

Species recorded and likely to occur are discussed in section 3.5.2 in relation to the habitats present.

3.5.2 Terrestrial fauna habitats

Exotic and native grassland

Much of the land within the study area has been previously cleared of native vegetation for the railway, roads, residential and industrial areas, and recreation. The majority of the rail corridor is cleared and vegetated with introduced grasses (e.g. *Pennisetum clandestinum*) and herbs interspersed with bare ground, ballast and other artificial substrates. Some areas with native groundcover species are present in the study area. These areas are devoid of shrubs and trees.

Exotic and native grassland contains few habitat resources of relevance to most native species. Grasses and herbs would provide foraging resources for relatively mobile and opportunistic native fauna, including birds such as the Australian Magpie (*Cracticus tibicen*) and Magpie-lark (*Grallina cyanoleuca*). Microbat species, including the threatened Eastern Bentwing Bat may forage within the study area. The endangered population of the Long-nosed Bandicoot may also forage in the study area, potentially in the Marrickville-Hurlstone Park section, as this is located within the core area of records of the population (EcoLogical undated). Small, common lizards such as the Dark-flecked Garden Sunskink (*Lampropholis delicata*) and Eastern Water Skink (*Eulamprus quoyii*) were observed, particularly in areas where shelter such as rocks and shrubs were present.

The Common Eastern Froglet (*Crinia signifera*) was heard calling from table drains in grassland areas in the study area. Other common native frog species, including the brown Striped Frog (*Limnodynastes peronii*) would also likely utilise habitats present in drains in these areas.

Exotic forest and scrub and planted native species

Patches of weeds and planted native or exotic trees and shrubs within the study area provide potential foraging habitat for a range of common bird species and mammal species. The Noisy Miner (*Manorina melanocephala*) is the most dominant and abundant species present. Other bird species recorded included the Grey Butcherbird (*Cracticus torquatus*), Red Wattlebird (*Anthochaera carunculata*) and Rainbow Lorikeet (*Trichoglossus haemotodus*). Small birds such as the Superb Fairy-wren (*Malurus supurbus*) were also observed. Three roosting colonies of the Australian White Ibis (*Threskiornis molucca*) were observed in planted trees in the rail corridor near Wiley Park Station. Prior to the 1970s, the species was rarely sighted in urban areas and did not breed in the Sydney region (OEH, 2016f). The preferred habitat of this species includes swamps, lagoons, floodplains and grasslands, but it has also become a successful inhabitant of urban parks and gardens (Birdlife Australia 2016) following extensive droughts and changes in water regimes in inland areas (OEH, 2016f).

The Common Brushtail Possum (*Trichosurus vulpecula*) was recorded in planted exotic and native species in the rail corridor at Hurlstone Park. The Common Ringtail Possum (*Pseudocheirus peregrinus*) was observed in local streets in the Dulwich Hill area and may also occur in the rail corridor on occasion. Small introduced mammals such as Black Rats (*Rattus rattus*) are also likely to occur in this habitat type. Individuals of the endangered population of the Long-nosed Bandicoot may also shelter in shrubby areas within the rail corridor, potentially in the Marrickville-Hurlstone Park section. Fencing of the rail corridor may reduce the potential for this species to access the study area.

Small common reptiles, including sunskinks (*Lampropholis* spp.) and the Eastern Water-skink (*Eulamprus quoyii*) were observed in leaf litter in this habitat type. Common frogs such as the Common Eastern Froglet (*Crinia signifera*) are also likely to be present.

The Grey-headed Flying-fox was recorded flying over the study area and one individual was recorded foraging in a planted Tallowood (*Eucalyptus microcorys)* in the rail corridor between Punchbowl and Bankstown Stations. Limited foraging habitat is present within the study area for this species. The Eastern Bentwing bat is also likely to forage above planted vegetation. Few other threatened fauna species are likely to occur in this vegetation type, except on a transient basis.

Native woodland and forest

Native woodland and forest occurs as small patches within the study area. A range of myrtaceous trees are present, including Tallowood, Sydney Blue Gum (*Eucalyptus botryoides* cross *saligna)*, Turpentine (*Syncarpia glomulifera glomulifera*) and Red Ironbark (*Eucalyptus fibrosa*), that provide foraging resources for a range of birds, including cockatoos, parrots and honeyeaters, and arboreal mammals, such as the Common Brushtail Possum (*Trichosurus vulpecula*) and Common Ringtail Possum (*Pseudocheirus peregrinus*). The small tree and shrub layer varies in floristics, structure and condition along the railway corridor. This vegetation layer provides foraging substrate but also shelter for small bird species that are reliant on dense vegetation for cover. There are a variety of acacias, *Bursaria spinosa spinosa*, Tickbush (*Kunzea ambigua*), and Sweet Pittosporum (*Pittosporum undulatum*) that would provide shelter and foraging resources. Dense patches of noxious and environmental weeds such as Lantana (*Lantana camara*) and Bonseed *(Chrysanthemoides monillifera monillifera*) are also present.

Occasional hollow-bearing trees, which could provide potential nesting habitat for arboreal mammals or birds, were recorded in the Punchbowl-Bankstown section of the study area. Around 300 vertebrate species use tree hollows and shedding bark in Australia, and the shelter provided by these habitat features is essential for the survival of many of these species (Gibbons & Lindenmayer 2002). Hollows in the study area are most likely used by the common and introduced species observed in the study area. These include bird species such as the Common Myna (*Sturnus tristis*), Common Starling (*Sturnus vulgaris*), Galah (*Eolophus roseicapillus*), and Crimson Rosella (*Platycercus elegans*) and mammal species such as the Common Brushtail Possum. A range of microbats have been recorded in the locality (OEH, 2016a), including a number of hollow-roosting species, although no microbat species were recorded during surveys. Hollows and crevices could provide roost sites for tree-dwelling threatened microchiropteran bats such as the Eastern Freetail-bat. No large hollows suitable for threatened owls are present in the rail corridor. Species such as the Powerful Owl (*Ninox strenua*) may forage for arboreal mammals such as possums on rare occasions within the rail corridor.

Culverts, bridges and buildings

Some culverts are located within the rail corridor. These drain to the Cooks River or Salt Pan Creek. Culverts provide potential temporary roosting habitat for microbat species such as the threatened Eastern Bentwing Bat and Large-footed Myotis (*Myotis macropus*). The Eastern Bentwing Bat breeds in specific maternity roosts and would not breed in these culverts. There is potential for the Large-footed Myotis to breed in these structures. No bats were observed in culverts inspected during surveys, and no bat droppings were detected. No birds nests were observed in any culverts inspected during the surveys, although it is possible species such as Welcome Swallows (*Hirundo neoxena*) and Fairy Martins (*Petrochelidon ariel*) could use these built features for nesting.

Many rail bridges are present in the project area. These provide breeding habitat for the introduced Rock Dove (*Columba livia*). No evidence of roosting bats were observed at the bridge at Challis Avenue in Dulwich Hill, which was observed at dusk on one evening. No evidence of roosting bats or bat droppings were detected at any other bridges inspected during the survey.

A number of station buildings, warehouses and residential buildings occur in the project area. These provide roosting habitat for the introduced Rock Dove and likely also native species such as Welcome Swallows and Fairy Martins. These could also provide roosting habitat for microbats, including the common Gould's Wattled Bat, recorded by Arcadis (2016) in the Marrickville area during surveys for the Chatswood to Sydenham component Environmental Impact Statement.

Federation houses and urban gardens are known to provide shelter and foraging habitat for the Long-nosed Bandicoot. The Inner West endangered population of the Long-nosed Bandicoot are known to occupy this habitat within a core area mapped by OEH (2015) that includes Dulwich Hill and the western portion of Marrickville.

No Federation houses would be demolished for the project. No evidence of bandicoots was recorded during targeted surveys for the project, and no evidence of bandicoots was recorded in 2016 during four months of infra-red camera surveys along the light rail line or from the associated community survey (Price and Banks, 2016). Diggings by cats were observed, with associated scats.

Paper Size A3

0 40 80 160

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway

Note: Point labels indicate approximate number of stems

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Figure 3.2a

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012. Created by: afoddy

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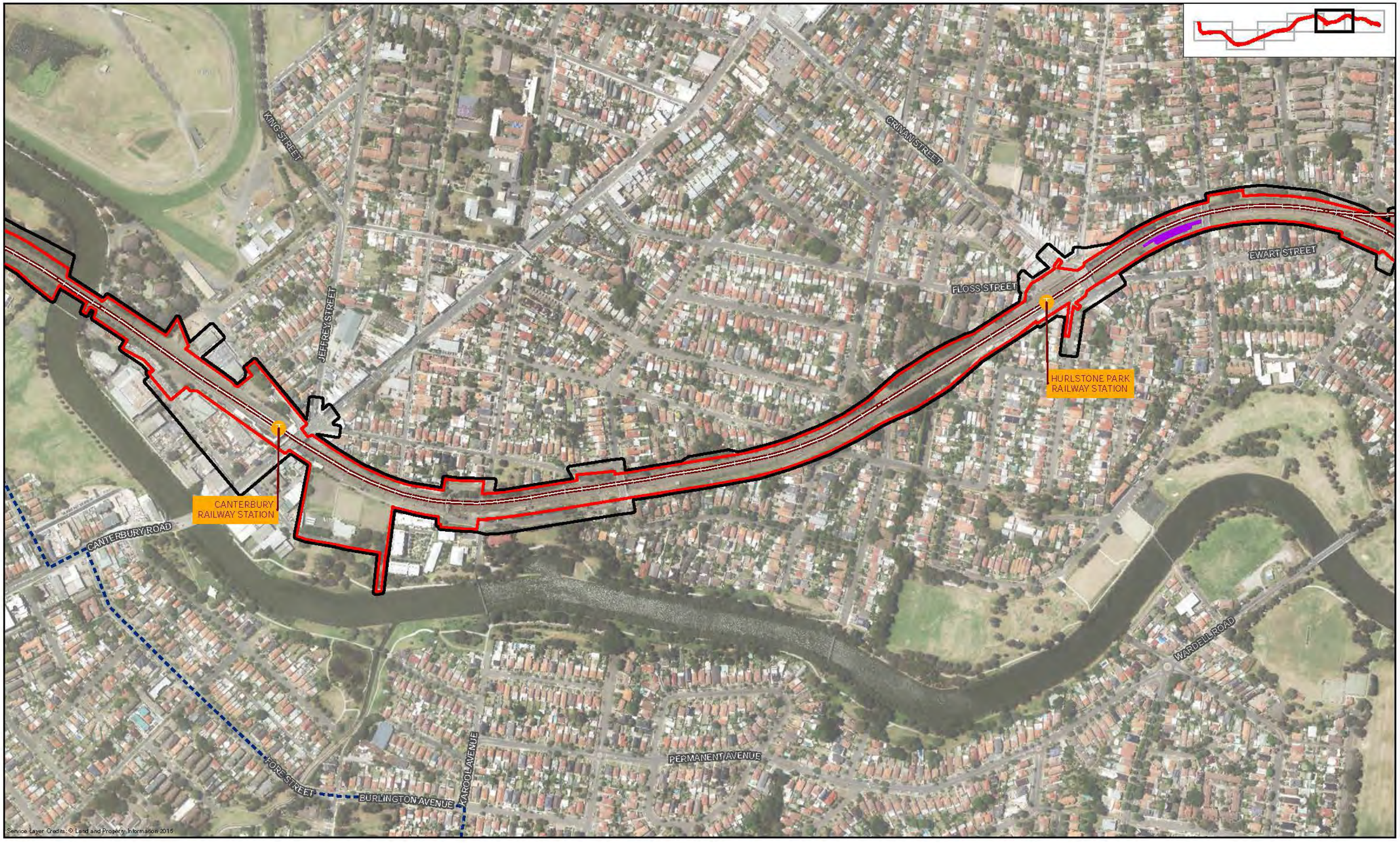

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- Canterbury feeder
- Sydney Turpentine-Ironbark Forest (EEC under the TSC Act)

Note: Point labels indicate approximate number of stems

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Figure 3.2b

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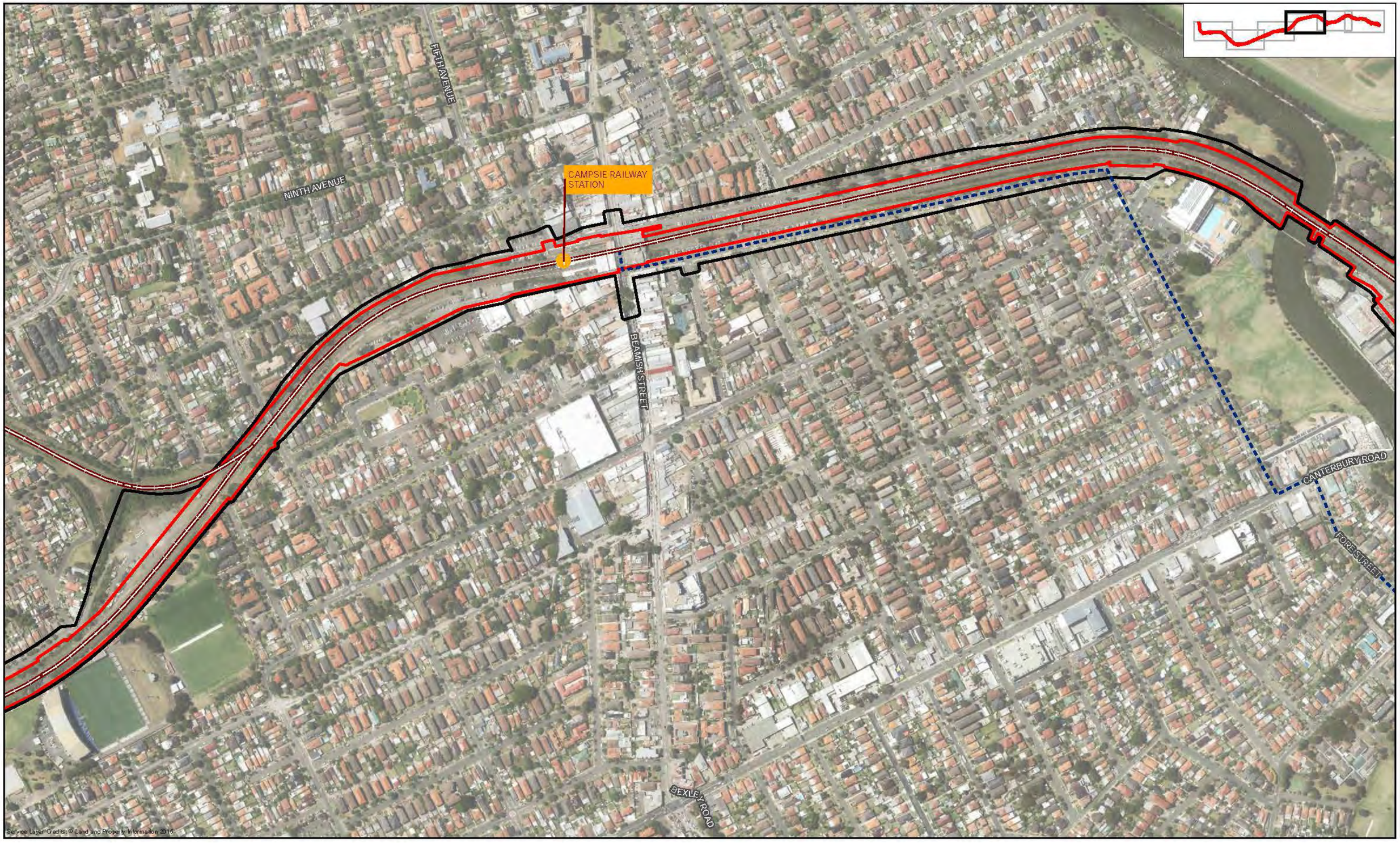

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- Canterbury feeder

Note: Point labels indicate approximate number of stems

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Figure 3.2c

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- Australian White Ibis roost colony
- Sydney Turpentine-Ironbark Forest (EEC under the TSC Act)

Note: Point labels indicate approximate number of stems

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Figure 3.2d

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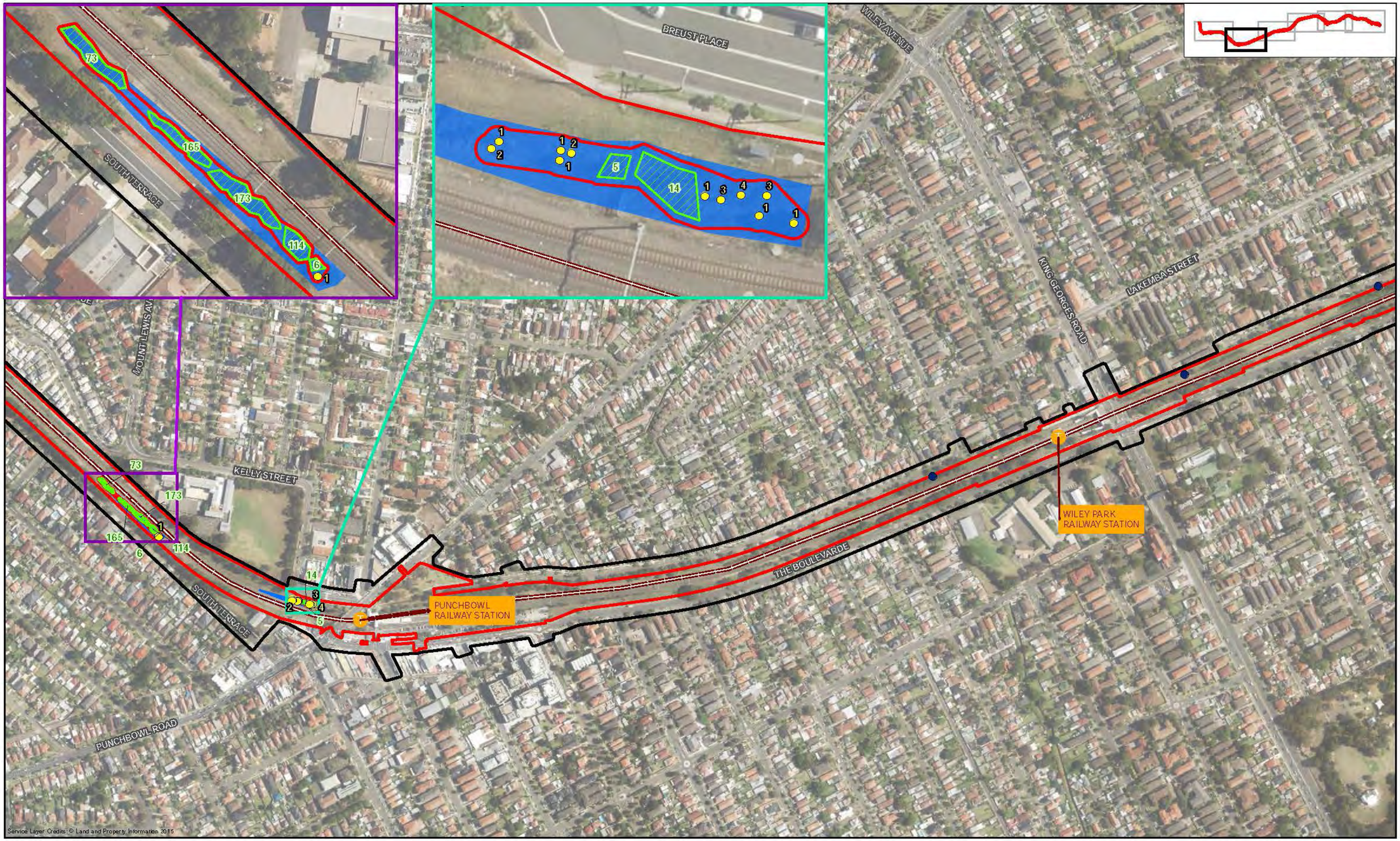

Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- Australian White Ibis roost colony
- *Acacia pubescens* (vulnerable species under the TSC Act and EPBC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Acacia pubescens* patch

Note: Point labels indicate approximate number of stems

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Figure 3.2e

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Study area
- Project area
- Train station
- Railway
- *Acacia pubescens* (vulnerable species under the TSC Act and EPBC Act)
- Grey-headed Flying-fox (vulnerable species under the TSC Act and EPBC Act)
- Hollow-bearing tree
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Acacia pubescens* patch

Note: Point labels indicate approximate number of stems

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Figure 3.2f

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3.6 Aquatic habitats

3.6.1 Cooks River

The rail corridor crosses the Cooks River to the west of Canterbury Station. It is also located downstream of the study area between Marrickville and Campsie, and table drains and culverts under the rail line would flow to the river. The Cooks River begins as a small stream near Graf Park in Yagoona and flows eastward for 23 kilometres before entering Botany Bay. The catchment covers an area of approximately 100 kilometres squared and has a population of over half a million residents, making it one of the most densely urbanised catchments in Australia. Much of the river and its tributaries are significantly modified and have suffered decades of degradation (GRCCC and Cooks River Alliance, 2013). DPI note that fish and shellfish caught in the Cooks River should not be eaten due to high levels of pollutants found in these waters (DPI, 2016b). The 2012-2013 river report card gave the Cooks River an overall poor health score, although noted that there had been some improvement since the previous report (GRCCC and Cooks River Alliance, 2013).

Seven kilometres of the highly urbanised Cooks River upstream of Canterbury were concrete lined in the 1940s in an effort to alleviate flooding and reduce water pollution. Since that time the natural values of the river declined due to pollution growth in the area and lack of riparian remnant vegetation. In 2014 Sydney Water removed sections of deteriorated concrete and undertook environmental rehabilitation of parts of the riparian zone (Cunningham 2015). Similar removal of artificial river walls and revegetation works have occurred between Canterbury and Tempe. For example, saltmarshes have been constructed at Gough Whitlam Park in Tempe (Dalby-Ball, 2015) and at Cup and Saucer Wetland in Canterbury.

The Cooks River is mapped as Key Fish Habitat (DPI, 2007). It is classified as Class 1 (major key fish habitat) as it is a permanently flowing river (DPI, 2013). At the location where the Cooks River is crossed by the rail corridor, there is limited riparian vegetation. Planted casuarinas occur along the tops of the river banks. There are limited habitat values for fauna other than some foraging and perching habitat for birds. No instream aquatic vegetation was observed at this location. The river banks at this location are vertical steel piles. No mudflats are present and there is no habitat for waders at this location. Waterbirds such as the Australian Pelican (*Pelecanus conspicillatus*) and Silver Gull (*Chroicocephalus novaehollandiae*) may forage on the river at this location on occasion.

No targeted fish surveys were conducted for this project. Sampling carried out in 2007 by the NSW DPI and the City of Canterbury in Wolli Creek, which flows into the Cooks River at Tempe, identified six native fish species in the freshwater section above the Henderson Street weir at Turella. These were Empire Gudgeon (*Hypseleotris compressa*), Flathead Gudgeon (*Philypnodon grandiceps*), Striped Gudgeon (*Gobiomorphus australis*), Firetail Gudgeon (*Hypseleotris galii*), Common Galaxia (*Galaxias maculatus*), and Long-Finned Eel (*Anguilla reinhardtii*). In the brackish to salt water immediately below the weir, the following species were collected: Sea Mullet (*Mugil cephalus*), Yellow-fin Bream (*Acanthopagrus Australia*), Port Jackson Perchlet (*Ambassis jacksoniensis*), and Toadfish (*Tetractenos* sp.) (Little et al, 2010). These latter species are likely to occur along the Cooks River also. Anecdotal evidence from online fishing forums suggest that fish such as Bream, Flathead, Trevally, Whiting, Tailor and Jewfish are regularly caught in the Cooks River. No threatened species listed under the FM Act have potential habitat in the Cooks River.

3.6.2 Table drains

Aquatic habitats within the rail corridor are mostly limited to a number of shallow table drains alongside the railway. Most ditches are shallow, with no emergent vegetation, however some display emergent rushes (*Typha*). Table drains are generally fed by seepages from embankments. Some drains ran into concrete gutters before exiting from the railway corridor. The Common Eastern Froglet was heard calling from table drains.

No threatened species listed under the FM Act have potential habitat in these table drains. Table drains do not classify as Key Fish Habitat.

3.6.3 Cup and Saucer Creek

The 33kV power supply route to Canterbury Station would cross Cup and Saucer Creek. This is a concrete-sided canal at the crossing location. It is concrete-lined to its confluence with the Cooks River, about 250 metres to the north, and for a number of kilometres upstream. A stormwater treatment wetland (Cup and Saucer Wetland) was constructed by Sydney Water in 2010 near the confluence of the creek and the river to filter some of the stormwater in Cup and Saucer Creek.

3.7 Threatened species, populations and communities

3.7.1 Threatened ecological communities

Turpentine - Grey Ironbark open forest on shale

Remnant Turpentine - Grey Ironbark open forest on shale in Moderate/good-medium condition in the study area comprises an occurrence of 'Sydney Turpentine Ironbark Forest in the Sydney Basin Bioregion' (Sydney Turpentine Ironbark Forest) which is listed as an EEC under the TSC Act. The local occurrence of this EEC is shown on Figure 3-2b, Figure 3-2d and Figure 3-2e.

The Scientific Committee determination for Sydney Turpentine Ironbark Forest describes the canopy structure as forest, woodland or remnant trees (NSWSC, 2011a). Derived grassland or scrub, without native over storey vegetation, does not comprise an occurrence of the community. Therefore patches of 'degraded Turpentine - Grey Ironbark open forest on shale' that occur in the project area that do not have any native over storey do not comprise part of the EEC.

Further, the Turpentine - Grey Ironbark open forest on shale in the study area does not comprise an occurrence of the related community 'Turpentine-Ironbark Forest of the Sydney Basin Bioregion', which is listed as a CEEC under the EPBC Act. The listing advice for the CEEC listed under the EPBC Act excludes patches where:

- Either the native mid storey and understorey or native canopy trees are absent
- Isolated single trees or shrubs characteristic of the ecological community
- All patches of the community are less than one hectare in area (TSSC, 2005)

Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest

Remnant and regrowth Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest in the study area comprises an occurrence of 'Shale Gravel Transition Forest in the Sydney Basin Bioregion' (Shale Gravel Transition Forest), which is listed as an EEC under the TSC Act. The Scientific Committee determination for the community states that disturbed remnants are considered to form part of the community, including where the vegetation would respond to assisted natural regeneration, such as where the natural soil and associated seedbank is still at least partially intact (NSWSC, 2011b). Therefore patches of derived native scrub with species representative of this community form part of the local occurrence of Shale Gravel Transition Forest. The local occurrence of this EEC is shown on Figure 3-2e and Figure 3-2f.

The Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest in the study area does not comprise an occurrence of the related community 'Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest' which is listed as a CEEC under the EPBC Act. Derived grasslands and shrub lands and small, fragmented remnants are not included as part of the CEEC listed under the EPBC Act. The Shale Gravel Transition Forest in the study area does not meet the specific condition criteria that define the EPBC Act-listed community. The listing advice for the CEEC listed under the EPBC Act excludes patches: with canopy cover of less than 10 per cent; and all patches of the community that are less than 0.5 hectares in area (TSSC 2008).

There are no other TECs present in the study area.

3.7.2 Threatened flora species and populations

One threatened plant was recorded in the study area: the A. *pubescens*.

No other threatened flora species and populations were observed in the study area.

The study area contains broadly suitable habitat for a number of additional threatened plants that are known or predicted to occur in the locality based on the desktop assessment (see Appendix A) and/or the FBA credit calculations (see section 5.3.2). Based on the small area of native vegetation and natural soil profiles that could comprise threatened plant habitat in the project area and the survey effort employed, these species can be reliably discounted from occurring in the project area or being affected by the project.

Acacia pubescens

The study area contains around 650 stems of *A. pubescens,* which is listed as a vulnerable species under the EPBC Act and TSC Act. Local populations of this species fluctuate in response to fire or other disturbance. Many stems will sprout from a common rootstock (often referred to as 'suckering'). These stems are 'ramets', or clones, rather than 'gamets', or genetically distinct individuals (NPWS, 2003). Therefore, patches of this species are best reported in terms of numbers of stems rather than numbers of individuals.

The patches of stems recorded in the local population of *A. pubescens* in the study area comprise:

- Around 40 stems on the cutting on the up side of the rail corridor, around 50 metres west of Punchbowl Station
- Around 530 stems on the embankment on the down side of the rail corridor, around 150 metres west of Punchbowl Station
- Around 60 stems on the embankment on the down side of the rail corridor, around 450 metres west of Punchbowl Station
- Around 20 stems, occurring as two patches, on the embankment on the up side of the rail corridor, around 500 metres west of Punchbowl Station
- Three stems in the rail corridor and one stem in a Council reserve around 100 metres east of the Yagoona substation

The local populations of *A. pubescens* in the study area are shown on the Figure 3-2 figure series.

The majority of the *A. pubescens* in the study area are associated with remnant and regrowth Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest, which is an occurrence of the EEC Shale Gravel Transition Forest (section 3.7.1). This vegetation type and associated *A. pubescens* habitat has been extensively modified by previous clearing and

earthworks in the rail corridor. The three stems near the Yagoona substation occur in planted native vegetation and exotic scrub. The Recovery Plan for *A. pubescens* notes that stands of the species have been recorded in open, disturbed areas, surrounded by exotic species. Although these areas are clearly not the natural habitat of *A. pubescens*, the species may survive in these situations for many years, due to its suckering nature and ability to tolerate some levels of disturbance (NPWS, 2003).

3.7.3 Threatened fauna species and populations

Few threatened fauna species would occur in the study area given the urban environment and highly modified habitats present. An assessment of the likelihood of occurrence of threatened fauna is provided in Appendix A. Only one species was positively recorded in the study area during the surveys: the Grey-headed Flying-fox. This species is listed as a vulnerable species under the TSC Act and the EPBC Act. Four other species listed as vulnerable under the TSC Act are likely to occur: the Eastern Bentwing Bat, the Large-footed Myotis, the Eastern Freetail-bat and the Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) (see Appendix A). A discussion of these species is provided below. No other species are considered likely to occur given the generally cleared nature of the study area. Some mobile species may forage on occasion in the study area on a transient basis only.

The endangered population of the Long-nosed Bandicoot may possibly occur in the study area. While this species is not considered 'likely' to occur, it is discussed here as it has a very restricted distribution in the inner west of Sydney, with most records in the Dulwich Hill area.

Grey-headed Flying-fox

The Grey-headed Flying-fox was recorded in the study area. One individual was observed foraging in a planted eucalypt in the rail corridor between Punchbowl Station and Bankstown Station and individuals would forage on occasion in large eucalypts or figs trees in the rail corridor. These occasional remnant or planted forage trees would contribute to the available foraging habitat for the Grey-headed Flying-fox but comprise only a very small component of foraging resources in the locality, and would therefore not constitute habitat critical to the survival of a local population of the species. No breeding camps are located within the study area. The eastern portion of the study area is located within two kilometres of the Wolli Creek colony. This camp would not be directly affected by the project.

Microbat species

No microbats were recorded during surveys; only poor quality data was collected by the anabats. This may suggest there is only limited habitat for these species, and that none are likely to rely on the habitats present for their foraging requirements.

Four threatened microbat species are likely to occur in the study area. The Eastern Bentwing Bat and the Large-footed Myotis are known to roost under bridges and in culverts and could roost temporarily in the study area. The Eastern Bentwing Bat is known to forage in urban areas, and the Large-footed Myotis may forage along canals in the study area. The hollow-roosting Eastern Freetail-bat and Yellow-bellied Sheathtail-bat may roost in hollow-bearing trees in the study area. A small number of hollow-bearing trees were recorded, which could provide roosting habitat for microbat species, however the presence of common parrots and starlings may limit the availability of hollows for these microbat species. These species may forage on occasion in the study area, as they are known to forage in cleared habitats, however the study area would make up a very small proportion of the foraging range of these highly mobile species.

Long-nosed Bandicoot

As discussed in section 3.2.3, the study area is located along the southern boundary of the mapped core area of records of the Long-nosed Bandicoot in the Inner West. No evidence of the population was found in the study area, either from searches for diggings or from camera surveys. As noted in section 3.2.3, there have been no recent records of the population in the core area of occupied habitat, including the adjacent light rail corridor. The most recent sighting in residential areas is from 2014 in the Dulwich Hill area (Price and Banks, 2016). The study conducted for the light rail concluded that bandicoots were not likely to be resident along the light rail line, and it is more likely that any residual population would be surviving in very low numbers within urban backyards (Price and Banks, 2016). No Federation houses occur within the project area along the southern boundary of the mapped core area of the population.

Much of the project area is cleared and contains minimal shelter habitat, which is important for this species. Fencing along the corridor is also likely to generally prevent access to the rail corridor by individuals that may reside in adjacent areas. Fencing includes cyclone fencing that is set into the ground, as well as corrugated iron and other metal sheeting at the rear of residential properties. Access to the rail corridor (if the species does access the rail corridor) would likely be via gates, which are located occasionally along the rail corridor, or small holes in fences. Predators, including cats and foxes have been recorded along the project area and the adjacent light rail line (Price and Banks, 2016).

Given the lack of evidence in the project area and dearth of records in the surrounding area despite recent targeted surveys, as well as the limited shelter habitat and high abundance of introduced predators, and difficulty of access to the rail corridor, the Long-nosed Bandicoot is not likely to occur in the project area.

3.8 Other ecological matters of national environmental significance

The protected matters search (DEE, 2016a) identified six World Heritage properties and six National Heritage places and one wetland of international importance. The World Heritage Properties and National Heritage Places are not relevant to this biodiversity assessment report. The wetland of international importance, Towra Point Wetland, is located on the southern side of Botany Bay, over four kilometres from the mouth of the Cooks River. This location is well beyond the maximum extent of potential impacts arising from the project. These additional MNES are not considered further in this report.

Three migratory species have the potential to occur within the study area, these are discussed below.

3.8.1 Migratory species

Three migratory species have the potential to occur within the study area on an occasional or transient basis, given the presence of potentially suitable habitat. These comprise the Satin Flycatcher (*Myiagra cyanoleuca*), Rufous Fantail (*Ripidura rufifrons*) and Rainbow Bee-eater (*Merops ornatus*). No potential habitat for wetland species is present.

Vegetation within the study area is highly modified, fragmented and would have only limited value for migratory species listed under the EPBC Act. Habitat in the study area is not likely to support an ecologically significant proportion of the population of any of these species, be of critical importance to the species at particular life-cycle stages, is not located at the limit of any of the species' range, and/or located within an area where the species is declining. As such, potential habitat in the study area is not 'important habitat' for any of these species, as defined in DotE (2013).

3.9 Protected and sensitive land

The Secretary's environmental assessment requirements identified a number of sensitive and protected lands that must be considered. Those that are related to biodiversity values are detailed in Table 3-9.

Table 3-9 Identification of protected and sensitive land

Protected and sensitive lands	Presence in the project area
(b) land to which State Environmental Planning Policy No.14 – Coastal Wetlands applies	No SEPP14 Coastal Wetlands are located in or adjacent to the project area.
(c) land to which State Environmental Planning Policy No.26 – Littoral Rainforest applies	No Littoral Rainforest is present in or adjacent to the project area.
(f) safe public access to coastal areas, beaches, headlands and foreshores	There are no coastal areas, beaches, headlands or foreshores that occur in the project area.
(g) protected areas (including land and water) managed by OEH and/or DPI Fisheries under the *National Parks and Wildlife Act* 1974 and the *Marine Estate Management Act* 2014	There are no protected areas managed by OEH or DPI Fisheries in the project area.
(h) Key Fish Habitat as mapped and defined in accordance with the Fisheries Management Act 1994 (FM Act)	The Cooks River is mapped as Key Fish Habitat (see section 3.6). Potential impacts on aquatic habitats are discussed in section 4.1.
(j) land or waters identified as Critical Habitat under the TSC Act, FM Act or EPBC Act	No critical habitat listed under the TSC Act, FM Act or EPBC Act is present in or adjacent to the project area.
(k) biobank sites, private conservation lands and other lands identified as offsets.	No biobank sites, private conservation lands and other lands identified as offsets are present in or adjacent to the project area.

4. Impact assessment

4.1 Construction impacts

4.1.1 Summary of direct impacts

Clearing of vegetation

As described in section 2 and section 3, the project area is characterised in general by cleared land in a rail corridor with minimal value for native biodiversity.

Construction of the project would result in direct impacts on vegetation as summarised in Table 4-1. The project and the extent of the project area has been purposefully designed to avoid vegetation removal in these areas as far as is practicable. Vegetation clearing has been calculated on a precautionary basis, with a worst-case scenario assessed. The majority of the vegetation to be removed for the project is not native vegetation and comprises exotic plants or planted, often non-indigenous, native species on fill material. Based on the worst-case scenario, the project would remove up to one hectare of native vegetation. Design and construction would aim to limit clearing of any native vegetation.

Clearing of native vegetation is listed as a Key Threatening Process (KTP) under both the NSW TSC Act and the Commonwealth EPBC Act. Under the TSC Act, native vegetation is made up of plant communities, comprising primarily indigenous species. Clearing is defined as the destruction of a sufficient proportion of one or more strata layers within a stand or stands of native vegetation so as to result in the loss, or long-term modification, of the structure, composition and ecological function of a stand or stands (NSW Scientific Committee, 2001).

The project area contains small areas of remnant and regrowth native vegetation, including small patches of two EECs (Sydney Turpentine Ironbark Forest and Shale Gravel Transition Forest) and marginal habitat for a small number of highly mobile threatened fauna species. The project would require clearing of 0.6 hectares of this listed vegetation. Native vegetation and habitat within the project area is in medium to poor condition and features impacts from existing rail corridor maintenance, edge effects, weed infestation, and exotic pests. There would be a total of one hectare of clearing of native vegetation for construction of the project, of which 0.6 hectares is EEC (see Table 4-1). Native vegetation makes up a very small proportion of the direct disturbance footprint.

The project has been purposefully designed to avoid impacts on the local population of the endangered plant species *A. pubescens*. There are no *A. pubescens* stems in the project area as the occurrences of these plants have been excluded from the project area in order to preserve the population.

Table 4-1 Proposed removal of vegetation within the project area

Vegetation community	PCT/NSW Veg. Type ID (OEH, 2016c)	Condition	Area within the project area (ha)
Turpentine - Grey Ironbark open forest on shale	1281 / ME041 (EEC)	Moderate/good - medium	0.2
Degraded Turpentine - Grey Ironbark open forest on shale (derived native forest lacking a canopy layer)	1281 / ME041 (non-EEC)	Moderate/good - poor	0.4
Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest	724 / ME004 (EEC)	Moderate/good	0.4

Vegetation community	PCT/NSW Veg. Type ID (OEH, 2016c)	Condition	Area within the project area (ha)
Total area of native vegetation			**1**
Exotic forest or scrub	N/A	Cleared/non native	9
Planted native species	N/A	Cleared/non native	7.3
Exotic grassland	N/A	Cleared/non native	12.5
Total area of vegetation			**29.8**

All of the native vegetation to be removed is in relatively poor condition and comprises fragmented patches within or adjoining the operating rail corridor.

Construction within the remainder of the project area would remove a small number of individuals of non-threatened native plants, including planted street trees, and noxious and environmental weeds within highly modified habitat that does not support a native vegetation community.

Removal of habitat resources

Construction of the project would remove a very small area of fauna habitat, as most of the project area is already cleared land. The vegetation that would be removed or modified provides limited habitat resources for native fauna species due to its existing highly modified nature and the surrounding urban environment. Fauna habitat resources that would be removed include foraging and shelter resources for mainly common native fauna typical of urban environments. It is highly unlikely that any threatened species or any fauna populations would rely on the habitat resources within the project area for their survival.

Loss of fauna habitat would be restricted to:

- The removal of a 0.6 hectares of native forest vegetation, 0.4 hectares of derived native forest (lacking a canopy layer) and a further 7.3 hectares of planted native species which would provide nesting and foraging habitat for common species of birds and possums
- The removal of 7.9 hectares of canopied foraging habitat for the threatened Grey-headed Flying-fox, Eastern Bentwing Bat and other threatened fauna species with known or potential habitat in the study area (comprised of 7.3 hectares of planted native species and 0.6 hectares of native forest vegetation)
- The removal of 21.5 hectares of exotic vegetation with a forest and scrub (12.5 hectares) or grassland (9 hectares) structure, which provides nesting and potential foraging habitat for the endangered population of the Long-nosed Bandicoot and common small birds, as well as shelter and foraging habitat for reptiles and frogs
- The removal of aquatic habitat associated with trunk drainage channels. This would lead to the removal of breeding and foraging habitat for reptiles and frogs.
- The possible removal of potential roost sites for common microbats associated with two hollow-bearing trees, bridges and culverts (see Figure 3-2a to f)
- The removal or disturbance of Australian White Ibis colonies near Wiley Park station, resulting in dispersal of individuals to other locations

Fauna injury and mortality

As described above, the project area provides limited habitat resources for native fauna species and contains mainly foraging and shelter resources for common native fauna. Brushtail Possums are present, and some common bird species may also nest in vegetation within the

rail corridor. Groundcover vegetation, leaf litter and woody debris would provide shelter and foraging substrate for reptiles, frogs and invertebrates. Construction is likely to result in the injury or mortality of some individuals of these less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the project area during clearing activities, and potentially also mortality of Australian White Ibis nestlings during removal or disturbance of colonies. Small lizards and frogs can occur throughout the entire 29.8 hectares of vegetation (native and exotic). There are few hollow-bearing trees in the project area (only two were recorded during surveys), which significantly reduces the risk of injury or mortality of arboreal mammals or hollow-nesting birds.

The potential injury or mortality of individuals within a maximum of 29.8 hectares of habitat (comprising all vegetation, including native and exotic, to be removed), is highly unlikely to affect an ecologically significant proportion of any local populations. More mobile native fauna such as native birds, bats, terrestrial and arboreal mammals that may be sheltering in vegetation in the project area are likely to evade injury during construction activities. Displaced individuals may however suffer stress, increased energy costs relating to foraging over a wider area or increased risk of predation.

Recommendations have been made in section 6 to minimise the risk of vegetation clearing activities resulting in the injury or mortality of resident fauna.

Fragmentation or isolation of habitat

Habitat fragmentation through the clearing of vegetation can increase the isolation of remnant vegetation and create barriers to the movements of small and sedentary fauna such as ground dwelling mammals, reptiles and amphibians. Furthermore, habitat fragmentation can create barriers to the movement of pollinator vectors, such as insects, or seed vectors, such as birds, and consequently affect the life cycle of both common and threatened flora.

The project would require the removal of vegetation and habitat and would create or increase small gaps in habitat that are the width of the project area. The vegetation within the study area is currently fragmented by the existing rail corridor, roads and urban development. It is unlikely that the project would create an additional barrier to the movement of pollinator and seed dispersal vectors, such as insects and birds. Therefore, the project is unlikely to affect the life cycle of either common or threatened flora species.

Vegetation in the project area comprises scattered linear fragments that together with trees in adjacent urban areas provide ‘stepping stones’ of habitat between larger areas of vegetation for mobile species such as bats and birds. Removal of these linear patches from within the rail corridor would reduce the availability of these stepping stones to a small degree.

The only remnant vegetation adjacent to the study area is a narrow, linear strip along the banks of the Cooks River. The removal of a small area of vegetation at the edge of this patch would not sever this connecting link and is unlikely to significantly increase the degree of fragmentation of native vegetation and habitat in the local area. The crossing at the Cooks River spans the river and associated aquatic and terrestrial habitat in the riparian corridor. Connectivity of terrestrial, riparian and aquatic habitat would be maintained under the railway bridge for the duration of the proposed works. There would be no impact on fish passage during construction.

Aquatic habitats

Aquatic habitats in the project area are limited. These do not provide potential habitat for threatened fish. Aquatic habitats would provide breeding and shelter resources for common frog and reptile species as discussed above. The project would remove small areas of low quality aquatic habitat associated with drainage structures and small depressions.

The project crosses the Cooks River which is mapped as Key Fish Habitat by DPI (2007). There would be no direct impacts (eg blockage of fish passage or removal of key fish habitat) on the Cooks River. No offsets in accordance with DPI (2013) are therefore required.

4.1.2 Summary of indirect impacts

Weed invasion and edge effects

Construction activities may, in general, increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via erosion (wind and water), via workers shoes and clothing or through construction vehicles. As described above, the majority of the project area is dominated by exotic species. In this context, the project would have a minor impact on the degree of weed infestation in the study area. Recommendations have been made in section 7 to minimise the spread of weeds.

'Edge effects' refer to increased noise and light or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Altered environmental conditions along new edges can allow invasion by pest animals specialising in edge habitats and/or change the behaviour of resident animals. Edge effects would result from construction activities and then continue to affect vegetation and habitats adjoining the project area.

The removal of stands of vegetation from within the rail corridor would involve widening an existing gap associated with the rail corridor and would therefore not constitute a novel impact. The project area and adjoining land has been extensively cleared for the existing rail corridor and surrounding urban development. Small, linear patches of vegetation occur at scattered locations. Due to the small size and linear arrangement of native vegetation patches in the study area, they are already severely affected by edge effects and associated negative impacts such as weed infestation. The project would not create any novel edge effects and is unlikely to result in a significant increase in the impact of existing edge effects.

Pests and pathogens

Construction activities, in general, have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into native vegetation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. The potential for impacts associated with these pathogens is low, given the disturbed nature and high visitation rates to the study area, and lack of intact native vegetation in the vicinity of the project area. As a precautionary measure a 'clean on entry, clean on exit' policy should be implemented during construction activities to prevent the introduction or spread of disease and weeds.

Noise and light impacts on fauna

The Sydney Trains network would remain operational during the majority of the construction period. During non-possession periods, the majority of works would be undertaken during recommended standard working hours. However, some construction activities, such as major station works, major earthworks and bridge works, would need to be undertaken during rail possession periods (when trains are not running) to remove the risk of affecting operations and risk to rail worker safety. These works would occur during weekends, and school holidays and three to six months at the end of the construction program and are likely be undertaken 24 hours per day during these periods.

Fauna that occupy habitats within the project area and adjacent areas are likely to be accustomed to existing noise originating from passenger trains, road traffic and the urban environment. Similarly, fauna would be used to existing light from trains, cars, street lights and residential and industrial areas. While there would be localised increases in noise and light that would temporarily create substantial disturbance, increases in noise and light above existing background levels during construction are unlikely to result in a significant impact on fauna that occur in the study area.

Aquatic disturbance and impacts on fish habitat

The potential for water quality impacts on the Cooks River is likely to be low. Much of the river and its tributaries are significantly modified and have suffered decades of degradation. The river is highly polluted, although there have been recent efforts to improve river health (see section 3.6.1). The introduction of pollutants from the project into the surrounding environment, if uncontrolled, could potentially further impact on water quality. The project has the potential to introduce pollutants and sediments into local drains which lead to the Cooks River, including Cup and Saucer Creek. Water quality impacts would be managed through implementation of water sensitive urban design measures (refer to Technical Paper 8 – Hydrology, flooding and water quality assessment) and management during construction, including the provision of sedimentation basins, silt fences and other structures. Contaminants identified during previous investigations include asbestos, heavy metals, petroleum hydrocarbons and solvents within the fill soils and groundwater. Contaminated or acid sulphate soils would be managed during construction via remediation and appropriate disposal (refer to section 20 of the Environmental Impact Statement). The provision of sedimentation basins, silt fences and other structures would intercept polluted runoff in a worst case scenario.

The project would involve some excavation works. Piling works may intercept groundwater where encountered at depth, however potential impacts can be effectively managed through the implementation of standard mitigation measures. Only negligible impacts on groundwater levels are expected, and no major dewatering activities are expected to be required. The project is therefore unlikely to result in settlement, or impact on groundwater flows (refer to Section 21 of the Environmental Impact Statement).

No endangered aquatic communities, aquatic fauna or marine vegetation listed under the FM Act or EPBC Act occur in the study area and no significant impacts on riparian vegetation or habitats downstream of the project area are anticipated as a result of the project. There would be negligible (if any) impact on Key Fish Habitat as a result of the project. No offsets in accordance with DPI (2013) are therefore required.

Impacts on groundwater dependent ecosystems

There are no GDEs located in or adjacent to the project area. The project would not directly impact any GDEs. Some patches of vegetation along Wolli Creek downstream of the study area are mapped as potential GDEs (BOM, 2016a). As discussed above, construction has the potential to result in runoff of sediments or contaminated water if not appropriately managed. The Cooks River is a highly degraded river, subject to substantial pollution as a result of its location in a highly urbanised environment. Wolli Creek is also subject to pollution from urban environments, and its interaction with the Cooks River. Runoff (including water, sediments and contaminants) as a result of the construction of the project would be managed as described above to minimise indirect impacts on downstream areas, including the GDEs present along Wolli Creek. The implementation of water sensitive urban design measures would manage surface water during operation (refer to Technical Paper 8). There are unlikely to be impacts on groundwater flows as a result of the project. As such, the project is unlikely to impact the GDEs along Wolli Creek.

4.2 Operational impacts

Impacts on biodiversity values would be largely restricted to the construction phase of the project. Some potential impacts that would occur as a result of the operation of the project include:

- Generation of additional light and noise
- Erosion and sedimentation as a result of runoff from hard stand areas
- Introduction of weed propagules by vehicles, maintenance staff or passengers
- Overshadowing of vegetation by noise walls
- Fauna mortality as a result of collision with trains

The project area is located within or immediately adjoining the existing rail corridor which is dominated by infrastructure and highly modified environments. Each of the potential operational impacts listed above would already be occurring in the project area and affecting the surrounding study area. Vegetation adjoining the project area is already subject to weed infestation and other edge effects. Fauna that occupy habitats within the project area and adjacent areas are likely to be accustomed to existing noise originating from passenger trains, road traffic and the urban environment. Additional train movements are unlikely to significantly increase the risk of collisions above current levels, given the highly modified habitats present. In this context, the project is likely to comprise only a minor increase in any of these potential negative effects. Further assessment of the risk of vehicle stike for Long-nosed Bandicoots is provided in section 5.5.1. The project is unlikely to increase the extent, duration or magnitude of any of these impacts to the extent that would result in a significant negative effect on biodiversity values.

The potential for these operational impacts can be further minimised through the implementation of appropriate mitigation measures as outlined in section 6.

4.3 Cumulative impacts

The study area is located within the centre of Sydney, and an extensive and complex road and rail network, and residential and industrial/commercial areas dominate the area.

The project would involve the removal of small patches of already highly fragmented, predominantly planted, vegetation. Additional road projects such as the New M5 and possible future M4–M5 Link, as well as further residential development along the Sydenham to Bankstown corridor associated with the project, would also result in the removal of mainly planted vegetation and associated fauna habitats. The associated Chatswood to Sydenham metro project would impact potential habitat for the Grey-headed Flying-fox and microchiropteran bats (Arcadis, 2016). Losses in biodiversity from these projects and developments are also likely to be restricted in area, given their location in a highly modified environment. Together these projects and other developments would result in the further loss of habitat from an already modified environment with only limited natural biodiversity values.

4.4 Key threatening processes

A KTP is as an action, activity or project that:

- Adversely affects two or more threatened species, populations or ecological communities
- Could cause species, populations or ecological communities that are not currently threatened to become threatened

KTPs listed under the TSC Act FM Act and EPBC Act relevant to this project are listed in Table 4-2 below. Construction of the project will comprise KTPs including clearing of native vegetation, clearing of hollow-bearing trees, removal of dead wood and dead trees, and human-induced climate change. The latter KTP will continue to occur under operation of the project. Mitigation measures to limit the impacts of these KTPs (where possible) are discussed in section 6.

Table 4-2 Key threatening process

KTP	Status	Comment
Clearing of native vegetation	TSC Act EPBC Act	The project includes the clearing of one hectare of remnant and regrowth native vegetation. This minor reduction in extent is highly unlikely to affect the viability of remnant vegetation in the study area or locality or reduce the extent of habitat below a minimum size required for any fauna species. Further, the majority of the vegetation to be removed is in relatively poor condition and on the edge of remnant patches adjacent to the operating rail corridor.
Clearing of hollow-bearing trees	TSC Act	The project would remove up to two hollow bearing trees (see Figure 3-2a to f).
Removal of dead wood and dead trees	TSC Act	The project area contains very little fallen timber. The project may result in the removal or disturbance to those small amounts that do occur within the project area, during construction of the project. The implementation of habitat management procedures is recommended to limit impacts on fauna and their habitats (see section 6).
The degradation of native riparian vegetation along NSW water courses	FM Act	Planted vegetation is present along the edges of the Cooks River (near Canterbury Station). The project is unlikely to impact this vegetation.
Human-caused climate change	TSC Act EPBC Act	Combustion of fuels associated with construction and operation of the project would contribute to anthropogenic emissions of greenhouse gases. The project does not pass through any areas mapped as coastal corridors for climate change that provide for the latitudinal movement of species. The increase in greenhouse gases as a result of the project may impact climatic habitat elsewhere in NSW over the long-term. This constribution is negligible.

4.5 Impacts on matters of national environmental significance

4.5.1 Threatened ecological communities

There are no TECs listed under the EPBC Act in the study area.

There is native vegetation in the study area which is floristically similar to 'Cumberland Plain Woodland and Shale-gravel Transition Forest' or 'Sydney Turpentine Ironbark Forest' which are both listed as CEECs under the EPBC Act. As described in section 3.7.1, the vegetation in the study area does not meet the patch size or condition criteria required to comprise occurrences of these CEECs as defined under the EPBC Act.

4.5.2 Threatened species

The study area contains around 650 stems of *A. pubescens,* which is listed as a vulnerable species under the EPBC Act and TSC Act*.* The project has been purposefully designed to avoid impacts on the population of this threatened plant. There are no *A. pubescens* stems in the project area. An assessment of the likely significance of impacts on *A. pubescens* has been prepared in accordance with the EPBC Act *significant impact guidelines 1.1* (DotE, 2013) and is provided in Appendix C. The project would remove around 0.6 hectares of potential habitat for this species. This would result in indirect effects on occupied habitat through increased fragmentation of habitat, reduction in native vegetation cover and disturbance of surface soil in the vicinity of occupied habitat. The local population of *A. pubescens* has persisted in a highly modified environment adjacent to heavy rail infrastructure. The post-construction environment of the study area would be very similar to the current situation.The project would not directly harm any individuals of this species and construction and environmental management measures are likely to significantly mitigate the risk of indirect impacts. Based on these considerations, the project is not likely to have a significant impact on *A. pubescens*.

The Grey-headed Flying-fox was recorded foraging within the project site during surveys and the project would remove foraging habitat for this species. An assessment of the likely significance of impacts on the Grey-headed Flying-fox has been prepared in accordance with the EPBC Act significant impact guidelines 1.1 (DotE, 2013) and is provided in Appendix C. The Grey-headed Flying-fox may forage on occasion in the project site, especially when figs are fruiting or eucalypts are in flower. The project would not directly or indirectly affect any roost camps. Construction for the project would remove 7.9 hectares of foraging habitat, including remnant, regrowth and planted native tree species in the project area. The habitat to be removed comprises a very minor proportion of the available habitat resources in the locality which includes many thousands of individual blossom or fruit bearing trees in street scapes, parks and gardens. Based on these considerations, the project is not likely to have a significant impact on the Grey-headed Flying-fox.

No other threatened fauna species listed under the EPBC Act are likely to be impacted by the project. Given the minor magnitude of impacts on threatened fauna and their habitats further assessment or approval under the EPBC Act is highly unlikely to be required and a referral is not recommended.

4.5.3 Migratory species

No migratory bird species listed under the EPBC Act were recorded during field surveys; however, there is potential habitat for species such as the Rufous Fantail and Rainbow Bee-eater in the project area and study area. As discussed previously, the study area is highly modified, fragmented and would have limited value for these migratory species. Any individuals that may occur would occur on a transient basis only.

The study area is not considered important habitat for any migratory species according to the significant impact criteria for migratory species (DotE, 2013) (see section 3.8). No assessments of significance have been prepared for migratory species. Based on the above considerations the project is unlikely to impose 'a significant effect' on any of the listed migratory fauna species predicted to occur within the locality.

5. Framework for biodiversity assessment

5.1 Landscape features

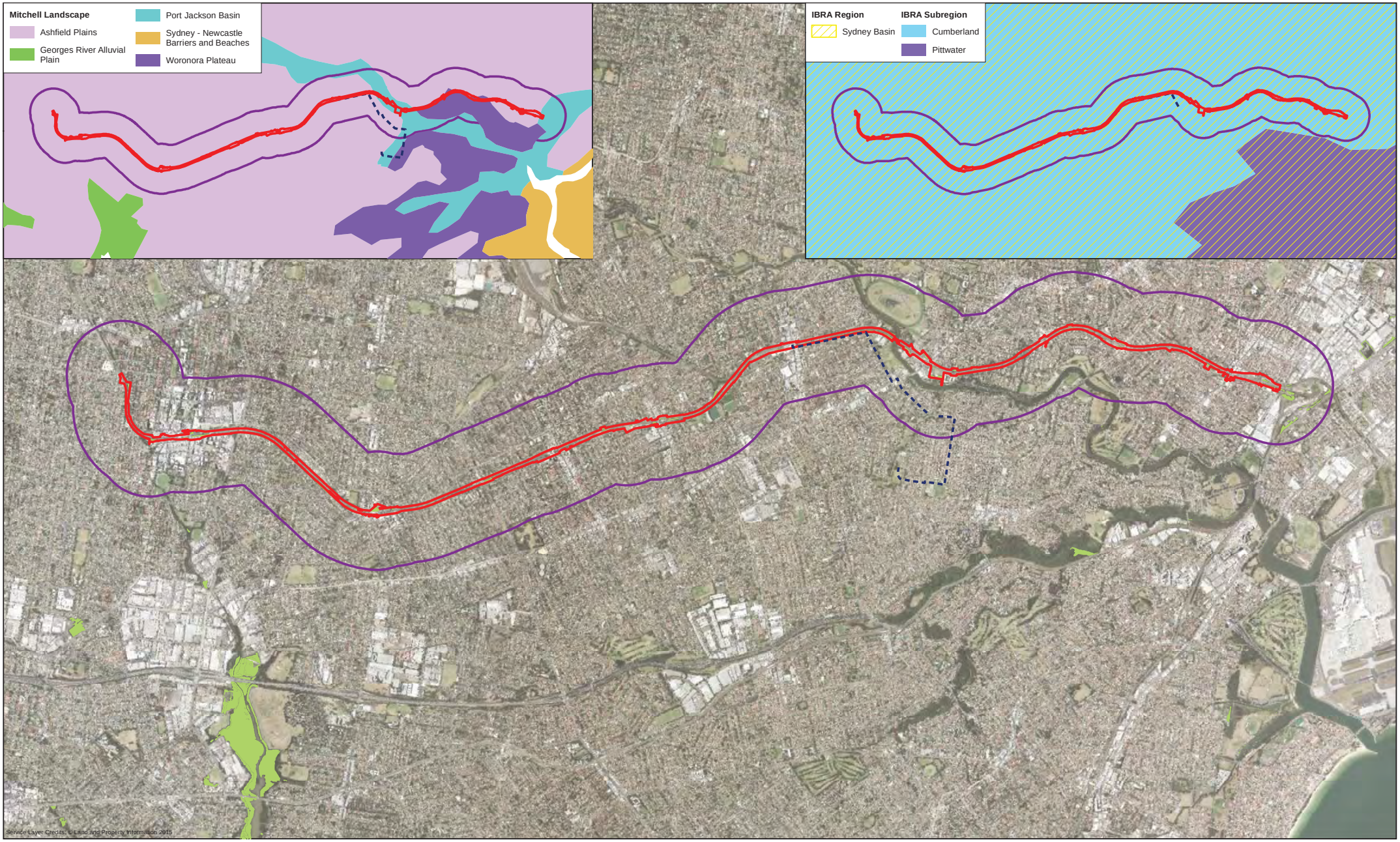
The FBA requires the assessment of landscape features to help describe the biodiversity values of the project area and assess the impacts of the project. Landscape features relevant to the FBA calculations are shown on Figure 5-1 and summarised in Table 5-1.

The project is a linear shaped development and so the landscape value has been assessed according to the methodology in Appendix 5 of the FBA (OEH, 2014b).

Table 5-1 Landscape features

Landscape feature	Project area data
Linear assessment name	Project area
Interim Biogeographic regionalisation of Australia (IBRA) bioregion and IBRA subregions	The project area is located entirely within the 'Sydney Basin' IBRA bioregion and the 'Cumberland – Sydney Metro' IBRA subregion.
Mitchell landscapes	The project area contains the Ashfield Plains, Woronora Plateau and Port Jackson Mitchell landscapes (DECC, 2008a).
Rivers, streams and estuaries	The project area crosses the Cooks River which is a third order drainage line.
Wetlands	The project area does not contain any important or local wetlands as defined in the FBA (OEH, 2014).
% Native vegetation cover	A 550 metre buffer area was created from the centre line of the project area in accordance with Appendix 5 of the FBA and as shown Figure 5-1. The buffer area is 1707 hectares.
	The current percent native vegetation cover in the landscape is <5% (1.01%, around 18.4 hectares out of the 1707 hectare buffer area). Note that this figure includes planted and/or non-indigenous vegetation cover mapped in the study area by GHD and is different to the definition of 'native vegetation' as it relates to offset calculations (OEH, 2014b).
	The future percent native vegetation cover in the landscape is <5% (0.59%), around 10.5 hectares out of the 1707 hectare buffer area) given the removal of 7.9 hectares of remnant, regrowth or planted native vegetation for the project).
Connectivity value - class	The project would affect only a local area biodiversity link, because it affects vegetation in a link that is <1000 hectare in area.
Patch size	The patch size for the Ashfield Plains Mitchell landscape is 1 hectare, comprising the largest patch of connected native vegetation in the portion of the study area located in this Mitchell landscape.
	The patch size for the Woronora Plateau Mitchell landscape is 1 hectare comprising the largest patch of connected native vegetation in the portion of the study area located in this Mitchell landscape.
	The patch size for the Port Jackson Basin Mitchell landscape is 1 hectare, comprising the largest patch of connected native vegetation in the portion of the study area located in this Mitchell landscape.

Landscape feature	Project area data
Change in area/perimeter ratio	The patches of native vegetation connected to the project area are each small (< 1 hectare) linear and highly fragmented. The current area/perimeter ratio is around 10 (one hectare patches with a perimeter of around 1000 metres). Between 0.4 hectares and 0.6 hectares of each patch falls within the project area. Therefore, the area/perimeter ratio after construction of the project would be around 5 (average 0.5 hectare patches with a perimeter of around 1000 metres).



Paper Size A3

0 250 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Updated project area
- Buffer area
- Native vegetation
- Canterbury feeder

Transport for NSW
Sydney Metro
Sydenham to Bankstown upgrade
Biodiversity Assessment

Job Number	21-25273
Revision	A
Date	05 Jul 2017

Landscape features

Figure 5.1

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Data source: Aerial imagery - sixmaps 2016, General topo - NSW LPI DTDB 2012, Sydney Metro vegetation - DECCW 2013, Mitchell Landscapes - DECCW 2008. Created by:jrprice

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5.2 Native vegetation

One vegetation zone and threatened species sub zone was created for each PCT and broad condition state in the project area. The area of each zone was calculated using GIS. Vegetation zones within the project area are summarised in Table 5-2.

Table 5-2 Vegetation zones

Veg Zone ID	PCT	Area (ha)	PCT / Veg type ID	Condition	Patch size (ha)	Extent cleared in the CMA sub region	Plot / transects required	Plot / transects completed
1	Turpentine - Grey Ironbark open forest on shale	0.2	1281/ ME041	Moderate/good - medium	1	90	1	Plot/transects 2 and 6
2	Degraded Turpentine - Grey Ironbark open forest on shale	0.4	1281/ ME041	Moderate/good - poor	1	90	1	Plot/transects 1 and 5
3	Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest	0.4	724/ ME004	Moderate/good	1	75	1	Plot/transects 3 and 4

5.3 Threatened species

5.3.1 Ecosystem credit species

The FBA credit calculator reports the suite of threatened fauna species that are predicted to be associated with ecosystem credits generated for the development. The suite of predicted threatened species for the development is shown in Table 5-3.

The 'threatened species offset multiplier' is an index of the likely response of a threatened species to improvement in habitat condition at a development site. The threatened species with the highest threatened species offset multiplier drives the ecosystem credit calculations for the entire development. The New Holland Mouse (*Pseudomys novaehollandiae*) has the highest threatened species (TS) multiplier of the predicted threatened species. There are certain circumstances where the threatened species with the highest threatened species offset multiplier and/or specific habitat attributes for that species are not likely to occur at the site or be affected by the development and the calculations can be adjusted. The New Holland Mouse has an extremely limited distribution in NSW and generally only occurs in heath vegetation which is at a specific successional stage (OEH, 2017b). There is no vegetation with these characteristics in the project area and the species has not been recorded in the Sydney Metropolitan region for many decades. The New Holland Mouse and its habitat would not be affected by the project and therefore this species has been removed from the credit calculations.

The Eastern Freetail-bat, Greater Broad-nosed Bat (*Scoteanax rueppelli*) and Yellow-bellied Sheathtail-bat are the species with the next highest TS offset multiplier. There is suitable foraging and roosting habitat for each of these threatened microbat species in the project area, including bridges, culverts and underpasses that could provide roost sites. Each of these microbat species may occur in the project area from time to time or in the future and so the offset multiplier has not been adjusted further.

Table 5-3 Predicted threatened species in the project area

Common name	Scientific name *	TS offset multiplier [1]	On site [2]
Diamond Firetail	*Stagonopleura guttata*	1.3	Yes
Eastern Freetail-bat	*Mormopterus norfolkensis*	2.2	Yes
Gang-gang Cockatoo	*Callocephalon fimbriatum*	2.0	Yes
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	1.8	Yes
Greater Broad-nosed Bat	*Scoteanax rueppellii*	2.2	Yes
Little Eagle	*Hieraaetus morphnoides*	1.4	Yes
Little Lorikeet	*Glossopsitta pusilla*	1.8	Yes
New Holland Mouse	*Pseudomys novaehollandiae*	2.6	No
Painted Honeyeater	*Grantiella picta*	1.3	Yes
Swift Parrot	*Lathamus discolor*	1.3	Yes
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	2.2	Yes

Notes:
1. The TS offset multiplier is an index of the likely response of a threatened species to improvement in habitat condition at an offset site and is proportional to the amount of offset required for impacts on habitat for that threatened species.
2. The site contains habitat resources for the threatened species and the species may occur at the site from time to time or in the future.

5.3.2 Species credit species

The FBA credit calculator references geographic, vegetation and habitat data for the project area to generate a list of the species credit-type threatened species predicted to occur in the project area and requiring targeted survey. This list was updated with reference to the desktop assessment included in Appendix A to include other species credit-type threatened species that have previously been recorded in the locality or are known to occur in similar habitat in the bioregion. These candidate species require survey and assessment according to the FBA. The candidate species credit-type threatened species list for the project area is included in Appendix D along with a 'survey time matrix' stating when targeted surveys for each species may be conducted according to the FBA and the outcome of targeted surveys and habitat assessments.

No species credit-type threatened species have been recorded at the project area, or are assumed to be present based on nearby records or the presence of suitable habitat. A number of species credit-type threatened species have been recorded in the locality, including a population of *A. pubescens* in the study area, but these biota would not be impacted by the project. No credit calculations are required for these species.

5.4 Avoid and minimise impacts

5.4.1 Impact mitigation

The majority of the project area is located within the existing rail corridor, which has been cleared and substantially modified through earthworks and construction. The project's impacts are substantially less than would be associated with an undisturbed 'green field' site. The project has been purposefully designed to avoid or further reduce impacts on biodiversity values as far as is practicable.

The study area includes land with significant biodiversity values, including around 650 stems of *A. pubescens.* The proponent recognises the value of this threatened plant population and has designed the project to avoid direct impacts on any *A. pubescens.* A detailed sub-metre survey of the *A. pubescens* stems in the study area has been undertaken, the survey data has been brought into a computer aided design (CAD) environment and the component infrastructure of the project has been designed around these threatened plants. No *A. pubescens* would be removed or otherwise directly affected by the project.

There are small patches of vegetation consistent with the EECs Sydney Turpentine Ironbark Forest and Shale-gravel Transition Forest in the rail corridor. The project area has been purposefully designed to avoid vegetation removal in these areas as far as is practicable. Vegetation clearing has been calculated on a precautionary basis, with a worst-case scenario assessed. The project would remove up to one hectare of native vegetation in total, including 0.6 hectares of Sydney Turpentine Ironbark Forest and 0.4 hectares of Shale-gravel Transition Forest. All of the vegetation to be removed is in medium or poor condition, and comprises fragmented or edge habitat adjoining rail infrastructure or access tracks. Efforts to minimise removal of native vegetation would be made during detailed design to reduce the clearing of these EECs below these values.

The remainder of the project area is cleared land, exotic vegetation or planted and degraded native vegetation with very little biodiversity value.

The project would have limited impacts on aquatic habitats. Land use in the catchments of Salt Pan Creek and the Cooks River is highly modified from its natural state through the majority of the catchment including in the project area. While the Cooks River is mapped as Key Fish Habitat (DPI, 2007) there is limited riparian vegetation and no instream vegetation at the location where the Cooks River is crossed by the rail corridor. There would be no direct impacts on aquatic habitat or fish passage at this location. No threatened species listed under the FM Act have potential habitat in the Cooks River (refer to section 4.1). As such, impacts on threatened biota and aquatic habitats have been generally avoided. Drainage measures to be implemented as part of project are predicted to provide effective mitigation of major flood impacts, and water quality impacts would be managed through implementation of water sensitive urban design measures. Further consideration of proposed changes against the design criteria would be undertaken at all stages of design to ensure that flooding, drainage and water quality impacts for a range of flood events would be managed and minimised (refer to Technical Paper 8 – Hydrology, flooding and water quality assessment).

5.4.2 Final project area

The final project area is shown on Figure 1.2 along with details of the project design. The final project area along with vegetation is shown on Figure 3-1 and along with threatened biota and habitat resources on Figure 3-2. Vegetation clearing has been calculated on a precautionary basis, with a worst-case scenario assessed.

5.4.3 Direct impacts

The project would result in direct impacts within the final project area shown on Figure 1.2 comprising:

- Disturbance of an overall construction footprint of 68.7 hectares of which 38.9 hectares is cleared land associated with the existing rail corridor or other infrastructure
- Removal or modification of 1 hectare of native vegetation and associated habitat resources for threatened species and other native biota

- Removal or modification of 7.3 hectares of planted native species, 11.6 hectares of exotic forest or scrub and 13.7 hectares of exotic grassland that is potential habitat for threatened species but has a site value score of less than 17
- Generation of noise, light, traffic and altered environmental conditions associated with the final project layout and operation of the project, which would comprise a minor impact on biodiversity values in the context of the existing heavy rail operations and the surrounding urban environment

A more detailed description of direct impacts and the likely effect on the biodiversity values of the project area is provided in section 4.

5.4.4 Indirect impacts

The impact mitigation and environmental management measures specified in section 6 are likely to ensure that construction impacts are restricted to the project area. There are unlikely to be any substantial indirect impacts associated with construction activities. As described in section 4.2 the project would not result in any substantial operational impacts beyond those associated with the existing heavy rail activities in the rail corridor. Given the proposed mitigation measures, adjoining land uses, existing activities in the project area and the extent of existing development, weed infestation and disturbance in the broader study area, the project would not result in any tangible indirect impacts.

Therefore, no additional indirect impacts have been included in the credit calculations.

5.5 Impact summary

5.5.1 Impacts on biodiversity that require further consideration

Certain impacts on biodiversity values of a major project require further consideration by the consent or approval authority. These are impacts that are particularly complicated or severe. A decision will be made by the consent or approval authority on whether it is appropriate for these impacts to occur or whether modifications to the major project are required to avoid or minimise the impact.

Impacts that require further consideration include:

- Significant impacts on landscape features
- Impacts on CEECs or impacts on EECs that are likely to significantly affect the persistence or viability of an EEC
- Impacts on critical habitat or on threatened species that are likely to significantly affect the persistence or viability of a population of a threatened species

If a major project includes an impact on biodiversity that requires further consideration it is recommended that a proponent discuss the impact with the NSW DP&E prior to lodging the Environmental Impact Statement to avoid uncertainty and potential delays to project approval (OEH, 2014b).

The project has been purposefully designed to avoid impacts on biodiversity values as far as is practicable (see section 7.5.1). The project would not remove any *A. pubescens.*

The project would result in minor impacts on Sydney Turpentine Ironbark Forest and Shale Gravel Transition Forest and would not significantly affect the persistence or viability of these EECs. It therefore does not comprise an impact that requires further consideration.

The project would not affect any critical habitat and would result in the loss of very small areas of foraging habitat and hence minor impacts on the Grey-headed Flying-fox, threatened microbats and other mobile threatened fauna that may potentially occur. The project would not threaten the persistence or viability of local populations of these threatened species.

The Secretary's Environmental Assessment Requirements identified that impacts on the Long-nosed Bandicoot endangered population require further consideration. These impacts are discussed below.

Long-nosed Bandicoot

According to section 9.2 of the FBA, impacts that require further consideration include impacts on critical habitat or on threatened species or populations that are likely to cause the extinction of the species or populations from an IBRA subregion or significantly reduce its viability (as assessed in accordance with subsection 9.2.5 of the FBA).

As described in section 3.7.3, the Long-nosed Bandicoot has a low likelihood of occurrence in the project area. It is highly unlikely that the project would cause the extinction of the population from the IBRA subregion (ie. the Cumberland – Sydney Metro subregion) or significantly reduce its viability. This is discussed further below.

(a) the size of the local population directly and indirectly impacted by the development

The exact area occupied by the Long-nosed Bandicoot population of inner western Sydney is not clearly defined, and includes the Inner West and Canada Bay LGAs (OEH, 2016b). The core area of records of the Long-nosed Bandicoot in the Inner West are located in Lewisham and Dulwich Hill, with the southern boundary mapped as the Bankstown Line (OEH, 2015). Most of the records of animals, rather than possible diggings, occur in an area bounded by Constitution Road, New Canterbury Road, Old Canterbury Road and Parramatta Road in the suburbs of Petersham, Lewisham, and Dulwich Hill (Price and Banks 2016). An animal killed by a dog in 2014 was located in Myra Road Dulwich Hill (OEH, 2015), which runs north from the Bankstown line.

The size of the Long-nosed Bandicoot population is not known, but recent information from the Price and Banks (2016) investigation suggests it may be very low given there have been no records since 2014 despite targeted surveys and community surveys. The Long-nosed Bandicoot was thought to be extinct in inner western Sydney in the 1950's, however an individual was trapped by the NSW National Parks and Wildlife Service (NPWS) in a garden in Dulwich Hill in 2002. Further investigation found additional individuals in the area, totalling seven live animals and seven dead animals (Leary et al, 2010). The most recent confirmed evidence remains an adult killed by a dog in Dulwich Hill in 2014. There was also evidence of at least one adult in Leichhardt in 2013 that was later found dead (Price and Banks, 2016). Targeted surveys by NPWS (trapping and hair tubes) along the then proposed (now operating) light rail corridor at Dulwich Hill did not find any evidence of the species (Leary et al, 2010). Further targeted surveys for the species using remote cameras were conducted along the route for the Environmental Impact Statement for the Inner West Light Rail in 2010. No individuals were recorded (Biosis Research, 2010). No Long-nosed Bandicoots were recorded in a recent survey program targeting the Long-nosed Bandicoot along the Inner West Light Rail corridor and a community survey in surrounding suburbs (Price and Banks, 2016). No Long-nosed Bandicoots were recorded during spotlighting surveys, habitat assessments or infra red camera surveys for the Bankstown to Sydenham metro project (see section 3.7.3).

Taken together with the locations of previous records, the recent study along the light rail line indicated that it is more likely that any residual population would be surviving in very low numbers within urban backyards than along the light rail line (Price and Banks, 2016).

Given the lack of evidence in the project area and dearth of records in the surrounding area despite recent targeted surveys, as well as the limited shelter habitat and high abundance of introduced predators, and difficulty of access to the rail corridor, the Long-nosed Bandicoot is not likely to occur in the project area. Based on these considerations, it is highly unlikely that the project would cause the extinction of the local population or significantly reduce its viability, if it still persists.

(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to:

(i) an estimate of the change in habitat available to the local population as a result of the proposed development

(ii) the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and

(iii) modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.

Atlas records or other documented, quantifiable means must be used by the assessor to estimate what percentage of the species' population and habitat is likely to be lost in the long term within the IBRA subregion due to the direct and indirect impacts of the development.

As described above, there has been no evidence of Long-nosed Bandicoots along either the light rail corridor or within the project area. No evidence of Long-nosed Bandicoots were found during surveys for this project. Radio-tracking of individuals by NPWS found individuals nest under Federation houses (where they were protected from cats and dogs) and forage in gardens (Leary et al, 2010) and Price and Banks (2016) also concluded any residual population would be surviving in very low numbers within urban backyards and were unlikely to be resident along the light rail line that adjoins the project area.

Much of the project area is cleared and contains minimal shelter habitat, which is important for this species. Fencing along the corridor is also likely to generally prevent access to the rail corridor by individuals that may reside in adjacent areas. Fencing includes cyclone fencing that is set into the ground, as well as corrugated iron and other metal sheeting at the rear of residential properties. Access to the rail corridor (if the species does access the rail corridor) would likely be via gates, which are located occasionally along the rail corridor, or via small holes in fences. There are no residences or backyards in the mapped core Long-nosed Bandicoots habitat area that would be removed by the project. Two bridges would be replaced in the Marrickville/Dulwich Hill area (within or adjacent to the core Long-nosed Bandicoots area): the Illawarra Road overbridge and the Abermarle Street overbridge. These provide only limited potential shelter habitat for the species. No evidence of Long-nosed Bandicoots was recorded in these areas. The undersides of these bridges are exposed to predators such as cats, which were recorded by direct observation, infra-red cameras and diggings during surveys for the project.

The presence of predators within the project area reduces habitat quality for the Long-nosed Bandicoots. As noted above, cats were recorded during surveys for the project. The infra-red camera surveys conducted over four months along the adjacent Inner West Light Rail line recorded cats at all eight monitoring sites. A minimum of 10 different cats were recorded at one of the sites and cats were recorded on many nights during the survey period (Price and Banks, 2016). Foxes were also recorded, although on fewer nights and not at all monitoring sites (Price and Banks, 2016). The project would not lead to an increase in predation risk by foxes and cats.

It would not increase their numbers or their ability to successfully prey on Long-nosed Bandicoots.

Construction traffic and higher-frequency metro trains are a vehicle strike risk, however given the lack of evidence of a resident population along the rail corridor, and the location of the rail corridor on the edge of the mapped habitat area, it is unlikely that this would cause the extinction of the population or reduce its viability. Similarly, based on these considerations, the construction and operation of the project is also unlikely to impact dispersal or movement pathways of the Long-nosed Bandicoots population.

The majority of the vegetation to be removed for the project is not native vegetation and comprises exotic plants or planted, often non-indigenous, native species on fill material. While this represents foraging habitat for the species, no evidence of the Long-nosed Bandicoots was recorded. The only diggings observed in the rail corridor during surveys were attributed to cats due to the presence of cat scats in the diggings.

Given the lack of evidence in the project area and dearth of records in the surrounding area despite recent targeted surveys, as well as the limited shelter habitat and high abundance of introduced predators, and difficulty of access to the rail corridor, the Long-nosed Bandicoot is not likely to occur. Based on these considerations, it is highly unlikely that the project would cause the extinction of the local population or significantly reduce its viability, if it still persists.

(c) the likely impact on the ecology of the local population. At a minimum, address the following:

(i) for fauna:

- ***breeding***
- ***foraging***
- ***roosting, and***
- ***dispersal and movement pathways***

The project is unlikely to impact the ecology of the population to any substantial degree, if at all. As discussed above, there is no evidence from recent or previous surveys that the Long-nosed Bandicoot occurs within the project area or the adjoining light rail line. Most of the records of animals, rather than possible diggings, occur in an area bounded by Constitution Road, New Canterbury Road, Old Canterbury Road and Parramatta Road in the suburbs of Petersham, Lewisham, and Dulwich Hill (Price and Banks, 2016). Constitution Road is located about 700 metres to the north of the project area.

Long-nosed Bandicoots are known to shelter and probably breed under Federation houses in the area (Leary et al, 2010, Price and Banks, 2016). No Federation houses would be removed as a result of the project in the area mapped as core Long-nosed Bandicoots habitat (OEH, 2015). Two bridges would be replaced in or near the core Long-nosed Bandicoots habitat area, however little shelter is present at these bridges and no evidence of the species was recorded. It is unlikely that the project would impact breeding habitat directly or indirectly. Noise and vibration from construction may disturb Long-nosed Bandicoots if any are resident under houses adjacent to the project area. Long-nosed Bandicoots (if present in adjacent areas) are likely to be accustomed to existing noise originating from passenger trains, road traffic and the urban environment. Similarly, Long-nosed Bandicoots would be used to existing light from trains, cars, street lights and residential and industrial areas.

The majority of the vegetation to be removed for the project is not native vegetation and comprises exotic plants or planted, often non-indigenous, native species on fill material. While this represents potential foraging habitat for the species, no evidence of the Long-nosed Bandicootswas recorded.

There are no known movement corridors for the Long-nosed Bandicoot population in the Inner West. No other local populations are known. The nearest populations occur on Sydney's North Shore or at the Holsworthy Army Base. In 2007, OEH wildlife officers searched 88 parks between Concord West and the Cooks River looking for a possible source population but found nothing (Leary et al, 2010).There has been supposition that Long-nosed Bandicoots may have originated in bushland in Wolli Creek, however no evidence was found there during biodiversity surveys by NPWS (Leary et al, 2010). As such, it is likely that the individuals are the remnant of the original population that occurred in the area. While it is possible that the Inner West Light Rail corridor and project area could represent movement corridors for the population, no evidence of the species has been recorded during any surveys. These corridors do, however, provide movement corridors for predators such as cats and foxes (Price and Banks, 2016). Construction and operation of the project is therefore unlikely to impact dispersal or movement pathways of the Long-nosed Bandicoots population. In addition, the project is the southern boundary of the mapped core habitat area for the species (OEH, 2015).

Vehicle strike is an existing threat to the population throughout its range, given its location in a highly urbanised environment. Construction traffic and higher-frequency metro trains are a vehicle strike risk, however given the lack of evidence of a resident population along the rail corridor, it is unlikely that this would impact the population to a substantial degree, if at all.

(d) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development

The project area is currently a substantial barrier to the movement of Long-nosed Bandicoots, both due to the presence of a wide area of cleared land, and regular train movements. Operation of the metro would further decrease the potential for individuals of the population to cross the rail corridor safely. As noted above, the rail corridor is the southern boundary of the core area of mapped habitat for the population, and there is no evidence of the species occurring in the rail corridor. The clearing of vegetation and increased train movements are unlikely to further fragment or isolate the population.

(e) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range.

As discussed above, no other local populations are known. It is likely that the Long-nosed Bandicoots are the remnant of the original population that occurred in the area (Leary et al, 2010). The rail corridor forms the southern boundary of the mapped core population area (OEH, 2016). Given the lack of evidence in the project area and dearth of records in the surrounding area despite recent targeted surveys, as well as the limited shelter habitat and high abundance of introduced predators, and difficulty of access to the rail corridor, the Long-nosed Bandicoot is not likely to occur. Based on these considerations, it is highly unlikely that the project would cause the extinction of the local population or significantly reduce its viability, if it still persists.

(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population

The Inner West population of the Long-nosed Bandicoot is threatened by mortality from vehicle strike, predation by foxes, dogs and cats, and loss of shelter sites from residential development (OEH, 2016b). No Long-nosed Bandicoots were recorded during a recent four-month infra-red camera monitoring program along the light rail corridor, and no recent records were identified in the associated community survey (Price and Banks, 2016). The most recent confirmed evidence remains an adult killed by a dog in Dulwich Hill in 2014, and an individual killed by vehicle strike in Leichhardt in 2013 (Price and Banks, 2016). The rail corridor forms the southern boundary of the mapped core area of habitat for the population (OEH, 2015). No evidence of the species was recorded along the rail corridor during the targeted surveys for the project, and, as noted above, there is no evidence of the species along the adjacent light rail corridor (Price and Banks, 2016).

Construction traffic and higher-frequency metro trains are a vehicle strike risk, however given the lack of evidence of a resident population along the rail corridor, and the location of the rail corridor on the edge of the mapped habitat area it is unlikely that this would impact the local population to a substantial degree, if at all. Similarly, based on these considerations, the construction and operation of the project is unlikely to impact dispersal or movement pathways of the Long-nosed Bandicoots population.

The project would not increase predation risk of the Long-nosed Bandicoot. No Long-nosed Bandicoots were recorded in the project area or along the light rail corridor, however surveys for this project and the light rail study (Price and Banks, 2016) did record cats and foxes. The project will not lead to an increase in predation risk by foxes and cats. It will not increase their numbers or their ability to successfully prey on Long-nosed Bandicoots.

Other studies have concluded that the Long-nosed Bandicoot is most likely to reside under Federation houses and in urban backyards (Leary et al, 2010, Price and Banks 2016). There are no residences or backyards in the core habitat area that would be removed by the project. Two bridges would be replaced along the rail corridor in the Dulwich hill and Marrickville area, however little shelter is present at these bridges and no evidence of bandicoots was recorded. It is unlikely that the project would directly impact breeding habitat. Mitigation measures are proposed to minimise the risk of impact on Long-nosed Bandicoots if any happen to be sheltering under bridges to be demolished.

Noise and vibration from construction may disturb Long-nosed Bandicoots if any are resident under houses adjacent to the project area. Long-nosed Bandicoots (if present in adjacent areas) are likely to be accustomed to existing noise originating from passenger trains, road traffic and the urban environment. Similarly, the population would be used to existing light from trains, cars, street lights and residential and industrial areas. While there would be localised increases in noise and light that would create disturbance, increases in noise and light above existing background levels during construction are unlikely to result in a significant impact on Long-nosed Bandicoots, given the location of the project at the southern boundary of the mapped core habitat area.

Construction activities may, in general, increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via erosion (wind and water), via workers shoes and clothing, construction vehicles, and edge effects. As described above, the majority of the project area is dominated by exotic species. In this context, the project would likely only have a minor impact on the degree of weed infestation in the study area. The introduction of weeds is unlikely to impact potential Long-nosed Bandicoots habitat in the rail corridor or adjacent urban backyards. Mitigation measures are proposed to minimise the spread or introduction of weeds.

Based on the above considerations, the project is unlikely to cause the extinction of the population from the Cumberland subregion or significantly reduce its viability.

(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

OEH (2016b) has identified the following management actions for this population:

- Undertake surveys to determine extent of population
- Undertake community awareness program to increase knowledge of the species, threats and reporting of sightings
- Undertake radio-tracking studies to determine habitat use
- Develop and maintain database of all records
- Monitor status of all known sub-populations

Targeted surveys were conducted for this project (including habitat assessment, infra-red camera surveys, spotlighting and searches for diggings), however no evidence of Long-nosed Bandicoots was recorded in the study area. Similarly, targeted searches conducted along the light rail line for Transport for NSW and an associated community survey also did not record any individuals or evidence to indicate their presence (Price and Banks, 2016). No additional targeted surveys are proposed as part of this project.

Other activities identified for the recovery of the species by OEH (2016b) include management of pets, and are not relevant to this project.

On the basis of survey work undertaken to date, it is unlikely that the Long-nosed Bandicoot occurs in the project area, however on a conservative approach mitigation measures are proposed for construction to minimise the potential for adverse impacts on the Long-nosed Bandicoot should it occur. These include the inspection of underbridges proposed for demolition for Long-nosed Bandicoots prior to works commencing.

5.5.2 Impacts requiring biodiversity offsets

The vegetation zones summarised in Table 5-2 are native vegetation and threatened species habitat and each have a current site value score of greater than 17. Therefore, impacts on the vegetation zones within the project area require the calculation of biodiversity offsets. There is one hectare of native vegetation and threatened species habitat requiring biodiversity offsets. The results of the biodiversity offset calculations are presented in section 5.6.

5.5.3 Areas not requiring offset determination

The majority of the native plants in the project area are contained within patches of planted native species. These areas were confidently identified as planted, rather than regrowth or remnant native vegetation, because they contain sub-mature, even aged plants arranged in straight lines and are located on cuttings or fill material associated with unnatural landforms such as embankments. Further, many of these native plant species are non-indigenous species (i.e. not associated with vegetation in the Sydney region) or are garden cultivars. All of these areas are mapped as ‘urban native/exotic’ by OEH (2013) and have not been identified as native vegetation.

Planted native species in the project area provides habitat for some threatened species, including the Grey-headed Flying-fox.

Patches of planted native species in the project area all have a site value score calculated by the credit calculator of less than 17, with some native over storey and mid storey cover but minimal native ground cover, no hollow-bearing trees, no woody debris, no natural regeneration and very low species richness (noting that species richness does not include non-indigenous species).

None of this vegetation comprises a local occurrence of a TEC or contains species credit type threatened species or their habitats. Therefore impacts on 'planted native species' in the project area do not require the calculation of offsets according to the FBA.

A more detailed description of this vegetation and justification for the decision for no further assessment under the FBA is provided in section 3.3.2.

5.5.4 Areas not requiring assessment

An assessor is not required to assess areas in a project area without native vegetation unless the Secretary's Environmental Assessment Requirements for the project specifically require it.

The majority of the project area contains exotic forest or scrub that does not comprise native vegetation within the meaning of the FBA. These areas comprise 'cleared land' according to the FBA (OEH, 2014) because they contain no native over storey or mid storey vegetation and greater than 50 per cent exotic ground cover cover or >90 per cent bare earth. Further, the majority of this vegetation is located on cuttings or fill material associated with unnatural landforms such as embankments.

These areas do not comprise native vegetation or threatened species habitat according to the FBA and so were not sampled with plot/transects. A more detailed description of this vegetation and justification for the decision for no further assessment under the FBA is provided in section 3.3.2.

The project area also includes gravel tracks, hardstand areas and other infrastructure with occasional plants associated with cracks or shallow soil deposits that clearly do not comprise native vegetation within the meaning of the FBA and do not require assessment.

5.5.5 Environmental values not assessed by the FBA

There are a number of biodiversity values that are not assessed by the FBA, but still require assessment of potential impacts. These include impacts not associated with clearing of vegetation, such as vehicle strike (as described in section 2.3 of the FBA) and impacts on aquatic biodiversity (as described in section 2.4 of the FBA). Indirect impacts associated with vehicle strike have been assessed in sections 4.2 and 5.5.1. Indirect impacts of the project on downstream areas (including GDEs) and aquatic habitats have been assessed in section 4 of this report.

5.6 Biodiversity credits

The data from the fieldwork and mapping was entered into Version 4.1 of the BioBanking credit calculator as a 'major project' assessment to determine the number and type of biodiversity credits that would be required to offset impacts at the project area. The Biodiversity Credit Report is included in Appendix D and summarised below.

Table 5-4 Ecosystem credits required to offset impacts of the project

Plant community type	Area (ha)	Loss in landscape value[1]	Loss in site value score[2]	Threatened species with highest credit requirement	Threatened species offset multiplier	Credits required
Turpentine - Grey Ironbark open forest on shale (ME041)	0.2	6.00	39.58	Greater Broad-nosed Bat	2.2	6
Turpentine - Grey Ironbark open forest on shale (ME041)	0.4	6.00	24.48	Greater Broad-nosed Bat	2.2	8
Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils (ME004)	0.4	6.00	38.54	Greater Broad-nosed Bat	2.2	13

Notes: 1. Represents the impact of the project on the surrounding landscape from development or clearing.
2. Quantified impact of the project on the vegetation condition, based on the loss in site value by calculating the difference in the condition of the vegetation in its current state, compared to its future condition state after the impacts of the project are taken into account.

6. Mitigation measures

6.1 Introduction

The general principle to minimise impacts to biodiversity, should in order of consideration, endeavour to:

- Avoid impacts on habitat, through the planning process
- Mitigate impacts on habitat, through the use of a range of mitigation measures
- Offset any residual impact that could not be avoided or mitigated

6.2 Avoidance of impacts

The project is largely contained within an existing rail corridor. The project area falls within land which has been previously modified by land clearing and development. Impacts on native flora and fauna are substantially less than would be associated with an undisturbed 'green field' site. There is no practical alternative to the location of the project. As such, there is little opportunity to further avoid impacts as part of the project other than through the micro-siting of infrastructure.

Mapping of biodiversity values, in particular threatened plants and ecological communities, early in the project has allowed some avoidance of impacts in the detail design phase. Notably the project has been purposefully designed to avoid all direct impacts to *A. pubescens.* A detailed sub-metre survey of the *A. pubescens* stems in the study area has been undertaken, the survey data has been brought into a CAD environment and the component infrastructure of the project has been designed around these threatened plants. No *A. pubescens* would be removed or otherwise directly affected by the project.

Siting of construction compounds and other construction infrastructure in already cleared areas would also avoid impacts on native biodiversity values.

6.3 Mitigation of impacts

6.3.1 Construction

In order to address the potential impacts of the project on biodiversity and to reduce the operation of KTPs as discussed in section 4, the mitigation measures outlined in Table 6-1 would be implemented. In accordance with 3.2(e) of the Secretary's Environmental Assessment Requirements Table 6-1 details how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures.

Table 6-1 Mitigation measures

Impact	Mitigation	Predicted effectiveness
General	• Ensure all workers are provided an environmental induction prior to starting work in the project area. This would include information on the ecological values of the study area, protection measures to be implemented to protect biodiversity and penalties for breaches. • Prepare a flora and fauna management plan as part of the Construction Environmental Management Plan (CEMP), incorporating recommendations below, and expanding where necessary.	• High – communication of environmental values and responsibilities to construction staff is likely to ensure that mitigation measures are implemented. Measures will meet best practice for management of construction projects. • High – the CEMP will be prepared by a qualified and experienced professional.
Vegetation clearing	• Avoid and/or mitigate impacts to *A. pubescens* • Limit disturbance of vegetation to the minimum necessary to construct works. Micrositing of infrastructure would be undertaken during detailed design where practicable to minimise or avoid impacts on native vegetation (and particularly EECs). • Where the project area adjoins native vegetation, mark the limits of clearing and install temporary fencing around the vegetated area prior to the commencement of construction activities to avoid unnecessary vegetation and habitat removal. • Restrict equipment storage and stockpiling of resources to designated areas in cleared land.	• High – a detailed survey has been undertaken, exclusion areas have been established around *A. pubescens* stems and associated native vegetation and the need to avoid impacts will be communicated to all construction staff. • High – exclusion areas will be established and maintained around native vegetation adjoining the project area. Measures will meet best practice management of flora and fauna on construction projects.
Weeds	• Develop weed management actions to manage weeds during the construction phase of the project. This would include the management and disposal of the weeds that were recorded within the project area including the noxious weeds listed in section 3.5.2 in accordance with the NW Act. • Vehicles and other equipment to be used within the rail corridor should be cleaned to minimise seeds and plant material entering the study area to prevent the introduction of further exotic plant species or disease.	• High - measures will meet best practice management of flora and fauna on construction projects. Existing road access to the project area, gentle terrain and tracks will allow relatively easy management of weed infestations. There is minimal native vegetation adjoining the project area.
Fauna habitat	• A 'bat management sub-plan' should be developed including measures for detecting and managing bats that may be roosting in bridges, culverts or hollow-bearing trees in the project area. Any potential roost sites (eg. hollow-bearing trees, disused buildings) that would be removed or modified should be checked for roosting bats immediately prior to work. Culverts must remain open on at least one side at all times to allow any roosting bats to fly in or out. • An unexpected finds procedure should be developed for any threatened biota or habitat resources detected during pre-clearing or clearing surveys or revealed by other sources.	• High - measures will meet best practice management of flora and fauna on construction projects. There is minimal native vegetation and habitat resource within the project area.

Impact	Mitigation	Predicted effectiveness
	• Protocols to prevent introduction or spread of chytrid fungus should be implemented following OEH Hygiene protocol for the control of disease in frogs (DECC, 2008b). • A trained ecologist should be present during the clearing of native vegetation or removal of potential fauna habitat to avoid impacts on resident fauna and to salvage habitat resources as far as is practicable. Clearing surveys should include: – inspections of native vegetation for resident fauna and/or nests or other signs of fauna occupancy – inspection of underbridges proposed for demolition/removal in the Marrickville to Hurlstone Park area for Long-nosed Bandicoots prior to works commencing – capture and relocation or captive rearing of less mobile fauna (such as nestling birds) by a trained fauna handler and with assistance from Wildlife Information Rescue and Education Service (WIRES) as required – inspection and identification/marking of hollow-bearing trees or other habitat resources adjacent to construction footprints to help ensure against accidental impacts – salvage of habitat features such as mature tree trunks and woody debris within the project area and placement within revegetation areas as far as is practicable (e.g. if vegetated areas are not separated by fences). • Clearing of mature, native trees should be minimised where possible and exclusion barriers set up to prevent indirect impacts.	

Impact	Mitigation	Predicted effectiveness
Water Quality	• Erosion and sediment control plans should be prepared in accordance with *Volume 2D of Managing Urban Stormwater: Soils and Construction* (DECC, 2008c). The erosion and sediment control plans would be established prior to the commencement of construction and be updated and managed throughout as relevant to the activities during the construction phase. • All water discharge into creeks would be guided by the *ANZECC Water Quality Guidelines* (2000). • Temporary scour protection and energy dissipation measures should be designed to protect receiving environments from erosion. • Erosion and sediment control measures should be established prior to construction. • Erosion and sediment control measures should be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality. • Stabilised surfaces should be reinstated as quickly as practicable after construction. • All stockpiled material should be stored in bunded areas and kept away from waterways to avoid sediment entering the waterway. • Water should be applied to exposed surfaces that are causing dust generation. Surfaces may include unpaved roads, stockpiles, hardstand areas and other exposed surfaces (for example recently graded areas). • Vehicles must follow appropriate speeds to limit dust generation.	• High - measures will meet best practice management of water quality on construction projects. Sensitive receptors for impacts are limited in extent and quality.

6.3.2 Operation

As described in section 4.2, the project would have a minor increase in existing impacts on native biodiversity values during operation. Little mitigation of the project is therefore likely to be required for biodiversity during this phase. Weeds that are present in the rail corridor would continue to be managed as per the recommendations in Table 6-1.

7. Biodiversity Offset Strategy

This section comprises the Biodiversity Offset Strategy (BOS), which outlines how the proponent intends to offset the impacts of the project in accordance with the FBA. In accordance with 3.2(f) of the Secretary's Environmental Assessment Requirements, this section details how residual impacts would be managed or offset, and the approach and effectiveness of these measures.

The FBA credit calculator has been used in this Biodiversity Assessment Report to determine the number and type of biodiversity credits required to offset the impacts of the project. The Biodiversity Credit Report is included in Appendix D.

The BOS for the project would comprise the purchase and retirement of:

- 14 Turpentine - Grey Ironbark open forest on shale (ME041) ecosystem credits (or matching equivalents)
- 13 Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest on clay/gravel soils (ME004) ecosystem credits (or matching equivalents)

A desktop assessment has been undertaken to identify matching biodiversity credits available for sale including review of the OEH credits available register and consultation with biobank site owners or their representatives. Based on this review, biodiversity credits appropriate to offset the impacts of the project could be purchased from:

- BioBanking agreement 148, owned by The Hills Shire Council, which has 40 ME041/Turpentine - Grey Ironbark open forest on shale credits available for sale at the time of publication (OEH, 2017). These credits can be traded with ME041 and ME004 credits and so could fully offset the impacts of the project.
- The Little Island biobank, which has been the subject of a detailed BioBanking assessment and has a pending application for a BioBanking agreement. The Little Island biobank will have up to 64 HN604/ME041/Turpentine - Grey Ironbark open forest on shale credits available for sale once the agreement application is approved (GHD, 2016). These credits can be traded with ME041 and ME004 credits and so could fully offset the impacts of the project.

The proponent would consult with the vendor(s) of these biodiversity credits and arrange to purchase and retire a total of 27 biodiversity credits appropriate to offset the impacts of the project.

8. Conclusion

This Biodiversity Assessment Report has been prepared in accordance with the FBA to describe the biodiversity values present at the project area, assess impacts of the project and determine the number of biodiversity credits required to offset impacts of the project.

The majority of the project area is located within the existing rail corridor, which has been cleared and substantially modified through earthworks and construction. The project's impacts are therefore substantially less than would be associated with an undisturbed 'green field' site. The project has been purposefully designed to avoid or further reduce impacts on biodiversity values as far as is practicable.

Specific mitigation measures are recommended to minimise impacts on the natural environment and threatened biota, including:

- Minimising clearing requirements during detailed design
- Exclusion of a population of the threatened plant *A. pubescens* from the project area and clear marking out of exclusion areas to avoid impacts during construction
- Erosion and sediment control measures to avoid indirect impacts on native vegetation and aquatic habitats
- Restriction of access into adjacent remnant vegetation during construction and machinery hygiene protocols, washing of vehicles and erection of appropriate barriers to reduce the risk of transmission of weeds, contaminants or pathogens
- Management of noxious and environmental weeds
- Clearing surveys and fauna management during vegetation clearing activities

Despite measures taken to avoid and mitigate impacts, the project would result in some unavoidable residual adverse impacts imposed upon some elements of the natural environment, including removal of native plants and habitat resources and imposition of edge effects on adjoining areas of native vegetation. These residual impacts are small in extent and magnitude and would comprise a minor reduction in biodiversity values in the study area.

The project would remove a very small proportion of available habitat resources for local populations of native fauna. Impacts would include the removal of foraging habitat for mobile threatened fauna species, including the Grey-headed Flying-fox, birds and microbats. The site is unlikely to contain any important breeding, roosting or nesting habitat for native fauna. No hollow-bearing trees, wetlands, permanent aquatic habitat, rock outcrops, woody debris or any other important habitat resources would be removed.

A FBA assessment and credit calculations have been performed in accordance with the methodology (OEH, 2014a) and using the FBA credit calculator Version 4.1. The FBA includes thresholds for assessing and offsetting impacts of development (see Table 4 of OEH, 2014a). With reference to these thresholds the project:

- Includes a total of one hectare of impacts for which the assessor is required to determine an offset, comprising:
  - 14 ecosystem credits for impacts on Turpentine - Grey Ironbark open forest on shale (ME041)
  - 13 ecosystem credits for impacts on Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest on clay/gravel soils (ME004)

- Includes a total of 7.3 hectares of impacts for which the assessor is not required to determine an offset, comprising the removal of planted (non-remnant) native vegetation
- Includes a total of 60.54 hectares of impacts that do not require further assessment by the assessor, comprising construction within areas of existing infrastructure, disturbed cleared land or exotic vegetation

Impacts that require further consideration in regards to section 9.2 of the FBA have been assessed for the Long-nosed Bandicoot population in the Inner West. Given the lack of evidence in the project area and dearth of records in the surrounding area despite recent targeted surveys, as well as the limited shelter habitat and high abundance of introduced predators, and difficulty of access to the rail corridor, the Long-nosed Bandicoot is not likely to occur. Based on these considerations, it is highly unlikely that the project would cause the extinction of the local population or significantly reduce its viability.

The BOS for the project would include the purchase and retirement of biodiversity credits as calculated in accordance with the FBA. Biodiversity credits appropriate to offset the impacts of the project could be purchased from: BioBanking agreement 148, owned by The Hills Shire Council; or The Little Island biobank, which has been the subject of a detailed BioBanking assessment by GHD ecologists and has a pending application for a BioBanking agreement. The proponent would consult with the vendor(s) of these biodiversity credits and arrange to purchase and retire a total of 27 biodiversity credits appropriate to offset the impacts of the project.

The desktop assessment, field surveys and habitat assessments undertaken for this biodiversity assessment report have been used to identify MNES listed under the EPBC Act that may be affected by the project, through either direct or indirect impacts. The project would result in direct impacts on MNES comprising:

- The removal of 0.6 hectares of potential habitat and potential indirect impacts on the local population of *A. pubescens*
- The removal of a small area of foraging habitat (7.9 hectares of regrowth, remnant or planted native vegetation) for the Grey-headed Flying-fox

Assessments of the significance of impacts on *A. pubescens* and the Grey-headed Flying-fox have been prepared based on the consideration of the criteria contained in the EPBC Act *assessment of significance guidelines 1.1* (DoE, 2013). The outcome of these assessments is that the project is unlikely to have a significant impact on any MNES. Given the minor magnitude of impacts, further assessment or approval under the EPBC Act is highly unlikely to be required and a referral is not recommended. The project would not result in any significant impacts on any threatened biota listed under the EPBC Act and so there is no requirement for biodiversity offsets under the EPBC Act and associated policy (DSEWPaC, 2012).

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Appendices

Appendix A – Desktop Assessment of Threatened Biota

Threatened ecological communities recorded in the study area

Common Name	TSC status	EPBC status	Source	Habitat association	Likelihood of occurrence
Cumberland Plain Woodland in the Sydney Basin Bioregion	CEEC	CEEC	Community recorded within 10km (OEH, 2016a); Likely to occur within 10km (DEE, 2016a)	Grassy woodland/forest endemic to the hills and plains of the Cumberland Plain. Canopy typically dominated by *Eucalyptus moluccana*, and *E. tereticornis*, with *E. crebra*, *Corymbia maculata* and *E. eugenoides* occurring less frequently. Shrub layer dominated by *Bursaria spinosa*, and grasses such as *Themeda australis* and *Microlaena stipoides* var *stipoides*.	Possible. Remnant vegetation has the potential to be this community.
Shale Gravel Transition Forest in the Sydney Basin Bioregion	EEC	CEEC	Community recorded within 10km (OEH, 2016a); Likely to occur within 10km (DEE, 2016a)	Occurs mainly in the north of the Cumberland Plain in Richmond, Marsden Park and Windsor districts, but is also found in Liverpool/ Holsworthy, Bankstown, Yennora, Villawood and the Kemps Creek areas. Open forest structure with canopy dominated by *Eucalyptus fibrosa*, *E. moluccana* and *E. tereticornis*, with *Melaleuca decora* also common. Shrub layer characterised by *Bursaria spinosa*, *Daviesia ulicifolia*, and *Lissanthe strigosa*.	Possible. Remnant vegetation has the potential to be this community.
Sydney Turpentine-Ironbark Forest	EEC	CEEC	Community recorded within 10km (OEH, 2016a); Likely to occur within 10km (DEE, 2016a)	Occurs on the Cumberland Plain , with most remnants in Baulkham Hills, Hawkesbury, Hornsby, Ku-ring-gai, Parramatta, Ryde, Sutherland and Wollondilly LGAs. Open forest characterised by *Syncarpia glomulifera*, *Eucalyptus punctata*, *Eucalyptus paniculata* and *E. eugenoides*. In areas of high rainfall (over 1050 mm per annum) *E. saligna* is more dominant. Sparse shrub stratum of *Pittosporum undulatum* and *Polyscias sambucifolia*.	Possible. Remnant vegetation has the potential to be this community.
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC		Community recorded within 10km (OEH, 2016a)	Occurs on flats, drainage lines and river terraces of coastal floodplains where flooding is periodic and soils generally rich in silt, lack deep humic layers and have little or no saline (salt) influence. Occurs south from Port Stephens in the NSW North Coast, Sydney Basin and South East Corner bioregions. Characterised by a tall open canopy layer of eucalypts with variable species composition.	Possible. Remnant vegetation along the Cook River has the potential to be this community.

Common Name	TSC status	EPBC status	Source	Habitat association	Likelihood of occurrence
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC		Community recorded within 10km (OEH, 2016a)	Typically occurs below 20m above sea level (asl) on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes on coastal floodplains of NSW. Associated with grey-black clay-loams and sandy loams, saline or sub-saline groundwater. Structure variable from open forests to scrubs or reedlands with scattered trees. Canopy dominated by *Casuarina glauca* (north of Bermagui) or *Melaleuca ericifolia* (south of Bermagui). Understorey characterised by frequent occurrences of vines, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.	Possible. Remnant vegetation along the Cook River has the potential to be this community.
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC		Community recorded within 10km (OEH, 2016a)	Usually occurs below 20m asl (sometimes up to 50m). Associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Characterised by open to dense tree layer of eucalypts and paperbarks, with trees up to or higher than 25 m. Includes areas of fern land and tall reed or sedge land, where trees are sparse or absent.	Possible. Remnant vegetation along the Cook River has the potential to be this community.

Notes: CEEC – Critically Endangered Ecological Community; EEC – Endangered Ecological Community; VEC -Vulnerable Ecological Community

Threatened flora recorded or predicted to occur within 10km of the study area

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Acacia bynoeana	Bynoe's Wattle	E	V	2 records within 10km (OEH, 2016a)	Endemic to central eastern NSW, currently known from only 34 locations, many of only 1-5 plants. Grows mainly in heath/ dry sclerophyll forest on sandy soils, prefers open, sometimes slightly disturbed sites such as trail margins, road edges, and in recently burnt open patches. Flowers September to March, and fruit matures in November.	Unlikely. No sandy soils present.
Acacia prominens	Gosford Wattle, Hurstville and Kogarah Local Government Areas	EP		2 records within 10km (OEH, 2016a)	Occurs at a few sites along the railway line at Penshurst, at Carss Bush Park, Carss Park and there is an unconfirmed sighting at Oatley Park, Oatley. Grows in open situations on clayey or sandy soils. Habitats mostly cleared and occurs as isolated or small groups of trees.	Nil. Outside known distribution.
Acacia pubescens	Downy Wattle	V	V	4673 records within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs mainly in Bankstown-Fairfield-Rookwood and Pitt Town areas, with outliers at Barden Ridge, Oakdale and Mountain Lagoon. Grows on alluviums, shales and shale/sandstone intergrades. Soils characteristically gravely, often with ironstone. Occurs in open woodland and forest, in communities including Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland. Flowers August to October.	Present.
Acacia terminalis subsp. terminalis	Sunshine Wattle	E	E	42 records within 10km (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Occurs in near-coastal areas from northern shores of Sydney Harbour south to the northern and western shores of Botany Bay. Occurs on sandy soil on creek banks, hillslopes of in shallow soil in rock crevices and sandstone platforms on cliffs. Grows in scrub and open eucalypt woodland or forest (Bremner and Goeth, 2010).	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.
Allocasuarina glareicola		E	E	1 record within 10km, last recorded 1996 (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Primarily restricted to small populations in and around Castlereagh NR (NW Cumberland Plain), but with an outlier population at Voyager Point, Liverpool. Also reported from Holsworthy Military Area. Grows on tertiary alluvial gravels, with yellow clayey subsoil and lateritic soil. Occurs in Castlereagh open woodland.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Asterolasia elegans		E	E	Species or species' habitat may occur within 10km (DEE, 2016a)	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs, may also occur in the western part of Gosford LGA. 7 known populations. Occurs on Hawkesbury sandstone, commonly amongst rocky outcrops and boulders in sheltered forests on mid- to lower slopes and valleys.	Nil. Outside known distribution.
Caesia parviflora var. minor	Small Pale Grass-lily	E		1 record within 10km, last recorded 2001 (OEH, 2016a)	In NSW occurs in Barcoongere State Forest between Grafton and Coffs Harbour. May be more widely distributed as not often identified to subspecies level. Grows in damp open places in open forest on sandstone.	Nil. Outside natural distribution. No suitable habitat present.
Caladenia tessellata	Thick Lip Spider Orchid	E	V	1 record within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs from Central Coast NSW to southern VIC. Mostly coastal but extends inland to Braidwood in southern NSW. In NSW grows in grassy dry sclerophyll woodland on clay loam or sandy soils, and less commonly in heathland on sandy loam soils (Duncan, 2010).	Unlikely. Potentially suitable habitat present however extensive historical disturbance in the project area makes its presence unlikely..
Callistemon linearifolius	Netted Bottle Brush	V		32 records within 10km (OEH, 2016a)	Recorded from the Georges to Hawkesbury Rivers in Sydney, and north to Nelson Bay. There is also a recent record from the northern Illawarra. In Sydney, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. Grows in dry sclerophyll forest on the coast and adjacent ranges.	Unlikely. No suitable sandstone habitat present.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with *Cryptostylis subulata* and the *Cryptostylis erecta*. Soils include moist sands, moist to dry clay loam and occasionally in accumulated eucalypt leaves. Flowers November-February.	Unlikely. No suitable light textured soils or sclerophyll forest habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Darwinia biflora		V	V	1 record within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Known from north and north-western Sydney, in the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai LGAs. Grows on the edges of weathered shale-capped ridges, at the intergrade with Hawkesbury Sandstone. Occurs in woodland, open forest and scrub/heath. Associated overstorey species include *Eucalyptus haemastoma*, *Corymbia gummifera* and/or *E. squamosa*.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.
Deyeuxia appressa		E	E	1 record within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Known only from two pre-1942 records in Sydney, at Saltpan Creek and Killara. May be extinct in the wild. Thought to occur in moist conditions.	Unlikely. Thought to be extinct.
Dillwynia tenuifolia		V		2 records within 10km (OEH, 2016a)	Bounded by Western Road, Elizabeth Drive, Devonshire Road and Cross Street, Kemps Creek in the Liverpool Local Government Area. This population occurs on a small outlier of the Berkshire Park Soil Landscape; the site supports a transition from Castlereagh Ironbark Forest to Castlereagh Scribbly Gum Woodland.	Nil. Outside known distribution.
Diuris arenaria	Sand Doubletail	E		1 record within 10km, last recorded 2001 (OEH, 2016a)	Known from Tomaree Peninsula near Newcastle, in three locations. Inhabits coastal heath and dry grassy eucalypt forest on sandy flats on clay soil.	Nil. Outside known distribution.
Epacris purpurascens var. purpurascens		V		23 records within 10km (OEH, 2016a)	Occurs from Gosford in the north, Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South. Grows in a range of sclerophyll forest, scrubs and swamps, most of which have a strong shale soil influence.	Unlikely. No suitable forest habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Eucalyptus camfieldii	Camfield's Stringybark	V	V	1 record within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs from Raymond Terrace to Waterfall, with populations known from Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai and the Royal NP. Occurs in exposed situations on sandstone plateaus, ridges and slopes near the coast, often on the boundary of tall coastal heaths or low open woodland. It grows in shallow sandy soils overlying Hawkesbury sandstone.	Unlikely. No suitable sandstone plateau habitat present.
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	9 records within 10km (OEH, 2016a)	Naturally occurs only in New England Tablelands from Nundle to north of Tenterfield. Widely planted as urban street tree. Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite.	Nil. May occur as a planted street tree. Outside natural distribution.
Eucalyptus scoparia	Wallangarra White Gum	E	V	4 records within 10km, last recorded 2003 (OEH, 2016a)	Occurs mostly in Queensland with only three known occurrences in NSW near Tenterfield. In NSW it is found on well-drained granitic hilltops, slopes and outcrops, often as scattered trees in open forest and woodland.	Nil. May occur as a planted street tree. Outside natural distribution.
Genoplesium baueri	Bauer's Midge Orchid	E	E	1 record within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs from Ulladulla to Port Stephens, with only 13 known extant populations. Grows in sparse sclerophyll forest and moss gardens over sandstone	Unlikely. No suitable forest habitat present.
Grevillea beadleana	Beadle's Grevillea	E	E	1 record within 10km, last recorded 2002 (OEH, 2016a)	Four disjunct populations in north-east NSW: Torrington west of Tenterfield, Oxley Wild Rivers NP, Guy Fawkes River NP and Shannon Creek southwest of Grafton. Grows in open eucalypt forest with shrubby understorey, usually on steep granite slopes at high altitudes.	Nil. Outside known distribution.
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	3 records within 10km (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Occurs between Moss Vale/Bargo and lower Hunter Valley, with most occurrences in Appin, Wedderburn, Picton and Bargo. Broad habitat range including heath, shrubby woodland and open forest on light clay or sandy soils, and often in disturbed areas such as on the fringes of tracks.	Nil. Sydney population is from the far south-west. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Hibbertia puberula subsp. glabrescens		CE	CE	Species or species' habitat likely to occur within 10km (DEE, 2016a); 3 records within 10km (OEH, 2016a)	Listed under EPBC Act as *Hibbertia puberula* subsp. *glabrescens*. Known only from Bankstown airport. Habitat is very heavily modified, lacks canopy species and is currently a low grass/shrub association with many pasture grasses and other introduced herbaceous weeds. Soil at the site is a sandy (Tertiary) alluvium with a high silt content.	Unlikely. No suitable sandy alluvium habitat present. Project area is outside species' known, limited distribution.
Hibbertia stricta subsp. furcatula		E		8 records within 10km (OEH, 2016a)	2 known populations: one either side of the Woronora River gorge including the Menai-Bangor, Alfords Point and Illawong areas in the north and Maandowie Reserve, Loftus on the southern side; and west and southwest of Nowra. Occurs in dry sclerophyll forest and woodland. Northern metapopulation occurs on upper slopes and above the Woronora escarpment, at or near the interface of Hawkesbury sandstone and the Lucas Heights soil landscape. Southern population appears to occur in sandy soils on sandstone,with one record from gravelly clay soil.	Unlikely. No suitable sandstone habitat present. Project area is outside species' known, limited distribution.
Hypsela sessiliflora		E	X	1 record within 10km (OEH, 2016a)	Currently known from a single location less than 10x15m on the Cumberland Plain in western Sydney. Known to grow in damp places, on the Cumberland Plain, including freshwater wetland, grassland/alluvial woodland and an alluvial woodland/shale plains woodland (Cumberland Plain Woodland) ecotone. May be an early successional species that benefits from some disturbance. Possibly out competed when overgrown by some species such as *Cynodon dactylon*.	Unlikely. Only one population known from western Sydney. Species is presumed extinct by most authors.
Leucopogon exolasius	Woronora Beard-heath	V	V	1 record within 10km (OEH 2016a)	Occurs along the upper Georges River and in Heathcote NP, Royal NP and is also known from the Blue Mountains along the Grose River. Grows in woodland on sandstone and prefers rocky hillsides along creek banks up to 100 m altitude. Associated species include *Eucalyptus piperita* and *E. sieberi* and *Pultenaea flexilis*, *Leptospermum trinervium* and *Dillwynia retorta*.	Unlikely. No suitable sandstone habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Marsdenia viridiflora subsp. viridiflora	Marsdenia viridiflora R. Br. subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	EP		334 records within 10km (OEH, 2016a)	Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range. A climber that grows in vine thickets and open shale woodland.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Species or species' habitat may occur within 10km (DEE, 2016a)	Scattered, disjunct populations in coastal areas from Jervis Bay to Port Macquarie, with most populations in the Gosford-Wyong areas. Grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	Unlikely. No suitable swamp scleorphyll habitat present.
Melaleuca deanei	Deane's Paperbark	V	V	2 records within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs from Nowra- St Albans and west to the Blue Mountains, with most records in Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. Mostly grows on broad flat ridgetops, dry ridges and slopes and strongly associated with low nutrient sandy loam soils, sometimes with ironstone. Grows in heath- open forest, often in sandstone ridgetop woodland communities.	Unlikely. No suitable sandstone habitat present.
Pelargonium sp. Striatellum	Omeo Storksbill	E	E	Species or species' habitat may occur within 10km (DEE, 2016a)	Omeo Storksbill Pelargonium sp. (G.W. Carr 10345), syn. P. striatellum, is a tufted perennial forb known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	Nil. Outside known distribution.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Persoonia hirsuta	Hairy Geebung	E	E	1 record within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs within the Blue Mountains, Southern Highlands and Sydney coastal regions from Hilltop to Glen Davis and Royal NP to Gosford. Population within the Hills Shire particularly important due to high density of plants. Grows on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone up to 600m above sea level.	Unlikely. No suitable sandy soils in the project area.
Persoonia nutans	Nodding Geebung	E	E	13 records within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs from Richmond to Macquarie Fields on the Cumberland Plain. Grows only on aeolian and alluvial sediments in sclerophyll forest and woodland vegetation communities. Largest populations occur in Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.
Pimelea curviflora var. curviflora		V	V	1 record within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Confined to area between north Sydney in the south and Maroota in the north-west. Former range extended to Parramatta River including Five Dock, Bellevue Hill and Manly. Grows on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. Often grows amongst dense grasses and sedges. Flowers October to May.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.
Pimelea spicata	Spiked Rice-flower	E	E	304 records within 10km (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Disjunct populations within the Cumberland Plain (from Mount Annan and Narellan Vale to Freemans Reach and Penrith to Georges Hall) and Illawarra (from Mt Warrigal to Gerroa) (DEC, 2005). In the Cumberland Plain region, restricted to areas which support or historically supported Cumberland Plain Woodland. Grows on well-structured clay soils derived from Wianamatta Shale. In the Illawarra, grows on variable soils in close proximity to the coast on hills or coastal headlands. Inhabits coastal woodland or grassland with emergent shrubs (DEC, 2005).	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Pomaderris prunifolia	*P. prunifolia* in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas	EP		14 records within 10km (OEH, 2016a)	Known from only 3 sites within population range: at Rydalmere, within Rookwood Cemetery and at The Crest of Bankstown. At Rydalmere occurs along a road reserve near a creek, among grass species on sandstone. At Rookwood Cemetery occurs in small gully of degraded Cooks River/Castlereagh Ironbark Forest on shale soils.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.
Pterostylis gibbosa	Illawarra Greenhood	E	E	Species or species' habitat known to occur within 10km (DEE, 2016a)	Known from a small number of populations in the Illawarra, Nowra and Hunter regions. First collected in western Sydney. Only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. Grows in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by *Eucalyptus tereticornis*, *E. longifolia* and *Melaleuca decora*. Near Nowra, the species grows in an open forest of *Corymbia maculata*, *E.tereticornis* and *E. paniculata*. In the Hunter region, the species grows in open woodland dominated by *E. crebra*, *E.tereticornis* and *Callitris endlicheri*.	Unlikely. No suitable forest habitat present.
Pterostylis saxicola	Sydney Plains Greenhood	E	E	3 records within 10km (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Occurs in western Sydney between Picton and Freemans Reach. Grows in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. Associated vegetation above these rock shelves is sclerophyll forest or woodland on shale or shale/sandstone transition soils.	Unlikely. No suitable forest habitat present.
Pultenaea parviflora		E	V	1 record within 10km, last recorded 1999 (OEH, 2016a)	Occurs on the Cumberland Plain, with core distribution from Windsor to Penrith and east to Dean Park, and outliers in Kemps Creek and Wilberforce. Grows in dry sclerophyll woodlands, forest or in grasslands on Wianamatta Shale, laterite or Tertiary alluvium, on infertile sandy to clay soils. Associated communities include Castlereagh Ironbark Forest, Shale Gravel transition Forest and intergrade with Castlereagh Scribbly Gum Woodland.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Pultenaea pedunculata	Matted Bush-pea	E		4 records within 10km (OEH, 2016a)	3 disjunct populations in NSW: in the Cumberland Plains in Sydney, the coast between Tathra and Bermagui and the Windellama area south of Goulburn (where it is locally abundant). NSW populations typically among woodland vegetation but also found on road batters and coastal cliffs. In Windellama it is largely confined to loamy soils in dry gullies.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.
Senecio spathulatus	Coast Groundsel	E		1 record within 10km, last recorded 2005 (OEH, 2016a)	Coast Groundsel occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park (with a possible occurrence at Cudmirrah). It grows on frontal dunes.	Nil. No suitable habitat present.
Syzygium paniculatum	Magenta Lilly Pilly	E	V	14 records within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs in narrow coastal strip from Bulahdelah to Conjola State Forest. Grows in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas, often in remnant littoral or gallery rainforests.	Unlikely. May occur as a planted street tree. No suitable habitat present in the study area.
Tetratheca glandulosa		V		1 record within 10km (OEH, 2016a)	Restricted to The Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong LGAs. Associated with shale-sandstone transition habitat (shale-cappings over sandstone). Occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils generally shallow, yellow, clayey/sandy loam, commonly with lateritic fragments. Vegetation varies from heath to open forest and is broadly equivalent to Sydney Sandstone Ridgetop Woodland community.	Nil. Outside known distribution.
Thelymitra kangaloonica	Kangaloon Sun Orchid	CE	CE	Species or species' habitat may occur within 10km (DEE, 2016a)	Only known from three locations near Robertson in the Southern Highlands. Grows in seasonally swampy sedgeland on grey silty clay loam at 600–700 m above sea level. Flowers in late October and early November.	Nil. Outside known distribution.
Thesium australe	Austral Toadflax	V	V	Species or species' habitat may occur within 10km (DEE, 2016a)	Found in small, scattered populations along the east coast, northern and southern tablelands. Occurs in grassland or grassy woodland, and is often found in association with *Themeda australis*.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Wahlenbergia multicaulis	Tadgell's Bluebell in the local government areas of Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield	EP		63 records within 10km (OEH, 2016a)	Found in disturbed sites and grows in a variety of habitats including forest, woodland, scrub, grassland and the edges of watercourses and wetlands. Typically occurs in damp, disturbed sites (with natural or human disturbance of various forms), typically amongst other herbs rather than in the open.	Unlikely. Potentially suitable habitat present in the project area but not detected despite targeted survey.
Wilsonia backhousei	Narrow-leafed Wilsonia	V		59 records within 10km (OEH, 2016a)	In NSW it is scattered along the coast with a northern limit of Wamberal, N of Sydney. Most extensive stands at Jervis Bay. Grows on the margins of saltmarshes and lakes.	Possible. May occur along the Cooks River.
Zannichellia palustris		E		4 records within 10km (OEH, 2016a)	Known from the Lower Hunter and Sydney Olympic Park. A submerged aquatic plant that grows in fresh or slightly saline water.	Unlikely. No suitable wetland habitat present.

Notes: CE – Critically Endangered; E – Endangered; V – Vulnerable; EP – Endangered Population

Threatened fauna recorded or predicted to occur within 10km of the study area

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Birds						
Botaurus poiciloptilus	Australasian Bittern	E	E	6 records within 10km (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Widespread but uncommon over most NSW except the northwest. Favours permanent freshwater wetlands with tall dense reedbeds particularly *Typha* spp. and *Eleocharis* spp., with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails.	Unlikely. No suitable habitat present. May occur elsewhere on the Cooks River where dense reed beds occur.
Rostratula australis	Australian Painted Snipe	E	E	3 records within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	Unlikely. No suitable wetland habitat present.
Esacus magnirostris	Beach Stone-curlew	CE		1 record within 10km, last recorded 2004 (OEH, 2016a)	In NSW occurs regularly from the Manning River north, with occasional vagrants to South-east NSW and VIC. Inhabits a range of beaches, islands, reefs and in estuaries. Often seen near mangroves. Forages in the intertidal zone of beaches and estuaries, on islands, flats, banks and spits of sand, mud, gravel or rock, and among mangroves. Nests in shallow scrapes above the littoral zone, among low vegetation of grass, scattered shrubs or low trees; also among open mangroves or on sandbanks.	Nil. No suitable habitat present.
Ixobrychus flavicollis	Black Bittern	V		1 record within 10km, last recorded 2005 (OEH, 2016a)	Occurs from southern NSW to Cape York and the Kimberley, and southwest WA. Inhabits terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. May occur in flooded grassland, forest, woodland, rainforest and mangroves as long as there is permanent water. Roosts by day in trees or within reeds on the ground. Nests in branches overhanging water and breeds from December to March.	Unlikely. No suitable habitat present. Limited potential habitat present where the rail corridor crosses the Cooks River.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V		3 records within 10km (OEH, 2016a)	Widespread in NSW, but rarely recorded east of Great Dividing Range except in Richmond and Clarence River areas and scattered sites in the Hunter, Central Coast and Illawarra regions. Mostly in upper levels of drier open forests /woodlands dominated by box and ironbark eucalypts, or less commonly smooth-barked gums, stringybarks and tea-treas. Forage over home range of >5 ha. Tend to occur within largest woodland patches in the landscape. They forage for insects, nectar and honeydew. The nest is hidden by foliage high in the crown of a tree.	Unlikely. No suitable woodland vegetation present.
Ephippiorhynchus asiaticus	Black-necked Stork	E		2 records within 10km (OEH, 2016a)	In NSW, becomes increasingly uncommon south of the Northern Rivers region, and rarely occurs south of Sydney. Breeding recorded as far south as Buladelah, though most breeding in NSW occurs in the north-east. Primarily inhabits permanent freshwater wetlands and surrounding vegetation including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters. Will also forage in inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water. Breeds during summer, nesting in or near a freshwater swamp.	Nil. No suitable habitat present.
Limosa limosa	Black-tailed Godwit	V	C,J,K	10 records within 10km, last recorded 2005 (OEH, 2016a)	The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the north and south coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. It is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. It has also been found around	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
					muddy lakes and swamps, wet fields and sewerage treatment works.	
Limicola falcinellus	Broad-billed Sandpiper	V	C,J,K	2 records within 10km, last recorded 1999 (OEH, 2016a)	Breeds in the northern hemisphere. In the non-breeding season most common in north and north west of Australia, but is a regular visitor in small numbers to the NSW coast from Ballina to Shoalhaven Heads. Occurs on sheltered parts of the coast, favouring estuarine mudflats but also occasionally in saltmarshes, freshwater lagoons, saltworks and sewerage farms. Forage on exposed mudflats or wet sand.	Nil. No suitable habitat present.
Burhinus grallarius	Bush Stone-curlew	E		7 records within 10km (OEH, 2016a)	Scattered distribution across NSW. Inhabits lowland grassy woodland and open forest and, in coastal areas, Casuarina and Melaleuca woodlands, saltmarsh and mangroves. Requires a low, sparse groundcover, some fallen timber and leaf litter, and a general lack of a shrubby understory (DEC 2006).	Unlikely. No suitable woodland vegetation present.
Calidris ferruginea	Curlew Sandpiper	E	CE,C,J,K	319 records within 10km (OEH, 2016a)	Breeds in northern hemisphere. In Australia generally occupies littoral and estuarine habitats. In NSW mainly found in intertidal mudflats on sheltered coasts. Roosts on beaches, spits or islands on the coast/in wetlands, or in saltmarsh on rocky shores.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Stagonopleura guttata	Diamond Firetail	V		2 records within 10km, last recorded 2003 (OEH, 2016a)	Typically found west of the Great Dividing Range, but populations also occur in drier coastal areas including W Sydney, Hunter, Clarence and Snowy River valleys. Occurs in grassy eucalypt woodlands including Box Gum and Snow Gum communities, as well as open forest, mallee and natural and derived grasslands. Often found in riparian areas and occasionally in lightly wooded farmland. Nests in shrubby understorey or higher up under nests of other species.	Unlikely. No suitable woodland vegetation present. Outside usual distribution.
Dasyornis brachypterus	Eastern Bristlebird	E	E	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs in three disjunct areas of south-eastern Australia: southern Queensland/northern NSW, the Illawarra Region and in the vicinity of the NSW/Victorian border. Illawarra population comprises an estimated 1600 birds, mainly from Barren Grounds Nature Reserve, Budderoo National Park and the Jervis Bay area. Habitat characterised by dense, low vegetation including heath and open woodland with a heathy understorey. The fire history of habitat is important, and the Illawarra and southern populations reach maximum densities in habitat that have not been burnt for over 15 years.	Nil. No suitable habitat present.
Numenius madagascariensis	Eastern Curlew		CE,C,J, K	45 records within 10km (OEH, 2016a); Foraging, feeding or related behaviour known to occur within 10km (DEE, 2016a)	Within Australia, the species has a primarily coastal distribution. The species is found in all states, particularly the north, east, and south-east regions including Tasmania. Breeds in Russia and north-eastern China. Most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, and sometimes use the mangroves. The birds are also found in saltworks and sewage farms.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Pezoporus wallicus wallicus	Eastern Ground Parrot	V		2 records within 10km (OEH, 2016a)	Occurs in high rainfall coastal and near coastal low heathlands and sedgelands, generally below one metre in height and very dense (up to 90% projected foliage cover). Ground Parrots can re-colonise burnt habitat after 1-2 years and reach maximum densities after 15-20 years without fire. Home ranges of adult birds is typically 10 ha and overlapping with other birds, while juveniles have a significantly larger home range. Ground Parrots feed mostly on seeds from a large range of plant species, which varies seasonally. Eggs are laid in a shallow bowl of fine sticks and grass, well hidden under overhanging tall, coarse grass, sedge or low, heathy shrubs.	Nil. No suitable habitat present.
Pandion cristatus	Eastern Osprey	V		21 records within 10km (OEH, 2016a)	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. They feed on fish over clear, open water. Breeding takes place from July to September in NSW, with nests being built high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea, though there are a handful of records from inland areas.	Possible. May forage along the Cooks River on occasion. No nests observed within the project area.
Petroica phoenicea	Flame Robin	V		1 record within 10km (OEH, 2016a)	Breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. Migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains. Forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. Fallen logs and coarse woody debris are important habitat components. An open cup nest of plant fibres and cobweb is often built near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	Unlikely. No suitable woodland vegetation present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Stictonetta naevosa	Freckled Duck	V		1 record within 10km (OEH, 2016a)	Breeds in large, ephemeral swamps in the Murray-Darling, particularly along the Paroo and Lachlan Rivers and other Riverina rivers. In drier times moves to more permanent waters. Disperses during extensive inland droughts and may be found in coastal areas during such times. Prefers freshwater swamps/ccreeks with dense Cumbungi, Lignum or tea-tree. Nests in dense vegetation at or near water level.	Unlikely. Noo suitable habitat present. May occur on the Cooks River on rare occasions.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		3 records within 10km (OEH, 2016a)	Widespread but uncommon from coast to southern tablelands and central western plains. Feeds almost exclusively on the seeds of *Allocasuarina* species. Prefers woodland and open forests, rarely away from *Allocasuarina*. Roost in leafy canopy trees, preferably eucalypts, usually <1km from feeding site. Nests in large (approx. 20cm) hollows in trees, stumps or limbs, usually in Eucalypts (Higgins, 1999).	Unlikely. No suitable woodland vegetation present.
Calidris tenuirostris	Great Knot	V	C,J,K	4 records within 10km, last recorded 2003 (OEH, 2016a)	Breeds in northern hemisphere. In Australia, prefers sheltered coastal habitats with large intertidal mud or sandflats, including inlets, bays, harbours, estuaries and lagoons. Occasionally found on exposed reefs or rock platforms, mangroves, saltwork ponds, near-coastal swamps, saltlakes and non-tidal lagoons. Rarely occurs on inland lakes and swamps. Roosts in large groups in open areas, often at the water's edge or in shallow water close to feeding areas.	Nil. No suitable habitat present.
Charadrius leschenaultii	Greater Sand-plover	V	C,J,K	2 records within 10km, last recorded 2002 (OEH, 2016a)	Does not breed in Australia. In NSW, recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries. Occurs mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores; forage on wet ground at low tide.	Nil. No suitable habitat present.
Charadrius mongolus	Lesser Sand-plover	V	C,J,K	2 records within 10km, last recorded 2002 (OEH, 2016a)	Does not breed in Australia. Found along the entire coast of Australia, most common in northern NSW, QLD and the Gulf of Carpentaria. Rarely recorded south of the Shoalhaven. In NSW almost entirely	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
					coastal, on beaches of sheltered bays, harbours and estuaries with large intertidal sand or mudflats, occasionally on sandy beaches, coral reefs and rock platforms.	
Hieraaetus morphnoides	Little Eagle	V		16 records within 10km (OEH, 2016a)	Occurs throughout NSW except most densely forested parts of the Dividing Range escarpment. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring.	Possible. May forage in the project area on occasion. Some local records. No raptor nests observed in the project area.
Glossopsitta pusilla	Little Lorikeet	V		26 records within 10km (OEH, 2016a)	Occurs from coast to western slopes of the Great Dividing Range. Inhabits dry, open eucalypt forests and woodlands. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Feed primarily on profusely-flowering eucalypts and a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands *Eucalyptus albens* and *E. melliodora* are particularly important food sources for pollen and nectar respectively. Mostly nests in small (opening approx. 3cm) hollows in living, smooth-barked eucalypts, especially *Eucalyptus viminalis*, *E. blakelyi* and *E. dealbata*. Most breeding records are from the western slopes.	Unlikely. No suitable woodland vegetation present.
Sternula albifrons	Little Tern	E	C,J,K	307 records within 10km (OEH, 2016a)	In NSW occurs mainly north of Sydney, with smaller numbers south to VIC. Almost exclusively coastal, preferring sheltered environments; may occur several kilometres from the sea in harbours, inlets and rivers. Nests in low dunes or sandy beaches just above high tide mark near estuary mouths/ adjacent to coastal lakes and islands. Forages in shallow waters of estuaries, coastal lagoons and lakes, also along open coasts, less often at sea, and usually within 50 m of shore.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Lophochroa leadbeateri	Major Mitchell's Cockatoo	V		1 record within 10km, last recorded 1998 (OEH, 2016a)	Occupies habitat in arid semi-desert scrublands, savannahs and sparse woodlands, where there is fresh surface water and large hollow trees for nesting. These birds have been recorded in forest, woodland and shrub land, including mulga, mallee, Acacia, Eucalyptus and Callitris associations. It has also been recorded in cropping areas throughout its range (Queensland Government EPA Agency, 2007). Large areas of suitable habitat are required for a viable population to exist (Webster et al undated).	Nil. Outside usual distribution.
Neophema chrysogaster	Orange-bellied Parrot	CE	CE	1 record within 10km, last recorded 2003 (OEH, 2016a); Species or species' habitat may occur within 10km (DEE, 2016a)	Breeds in Tasmania and migrates in winter to SE South Australia and southern Victoria. There are occasional reports from NSW, including Shellharbour, Maroubra and the Shoalhaven. In winter, usually found within 3 km of the coast in saltmarsh and strandline/ foredune vegetation. May also occur on golf-courses and other grassy areas, including improved pasture.	Nil. No suitable habitat present.
Grantiella picta	Painted Honeyeater	V	V	Species or species' habitat may occur within 10km (DEE, 2016a)	Nomadic, occurring in low densities across most of NSW. Highest concentrations and almost all breeding occur on inland slopes of the Great Dividing Range. Inhabits Boree, Brigalow and Box Gum woodlands and Box-Ironbark forests. Specialist forager on the fruits of mistletoes, preferably of the *Amyema* genus. Nests in outer tree canopy.	Unlikely. No suitable woodland vegetation present. Outside usual distribution.
Haematopus longirostris	Pied Oystercatcher	E		75 records within 10km (OEH, 2016a)	Scattered along NSW coast. Favours intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide. Nests mostly on coastal or estuarine beaches; occasionally saltmarsh or grassy areas.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Ninox strenua	Powerful Owl	V		149 records within 10km (OEH, 2016a)	Occurs from the coast to the western slopes. Solitary and sedentary species. Inhabits a range of habitats from woodland and open sclerophyll forest to tall open wet forest and rainforest. Prefers large tracts of vegetation. Nests in large tree hollows (> 0.5 m deep), in large eucalypts (dbh 80-240 cm) that are at least 150 years old. Pairs have high fidelity to a small number of hollow-bearing nest trees and defend a large home range of 400 - 1,450 ha. Forages within open and closed woodlands as well as open areas.	Possible. May forage in planted trees on occasion.
Anthochaera phrygia	Regent Honeyeater	CE	CE	1 record within 10km, last recorded 1996 (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	Possible. May forage in the area on rare occasions during winter migration if suitable forage trees are present.
Calidris alba	Sanderling	V	C,J,K	5 records within 10km (OEH, 2016a)	Sanderlings occur along the NSW coast, with occasional inland sightings. Often found in coastal areas on low beaches of firm sand, near reefs and inlets, along tidal mudflats and bare open coastal lagoons; individuals are rarely recorded in near-coastal wetlands. Roosts on bare sand, behind clumps of beach-cast kelp or in coastal dunes.	Nil. No suitable habitat present.
Petroica boodang	Scarlet Robin	V		3 records within 10km (OEH, 2016a)	In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs and coarse woody debris are important habitat components.	Unlikely. No suitable woodland vegetation present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Tyto tenebricosa	Sooty Owl	V		2 records within 10km (OEH, 2016a)	Occurs in the coastal, escarpment and tablelands regions of NSW. More common in the north and absent from the western tablelands and further west. Inhabits tall, moist eucalypt forests and rainforests, and are strongly associated with sheltered gullies, particularly those with tall rainforest understorey. Roosts in tree hollows, amongst dense foliage in gullies or in caves, recesses or ledges of cliffs or banks. Nests in large (>40cm wide, 100cm deep) tree hollows in unlogged/unburnt gullies within 100m of streams or in caves.	Nil. No suitable habitat present.
Haematopus fuliginosus	Sooty Oystercatcher	V		1 record within 10km, last recorded 1999 (OEH, 2016a)	Evenly distributed along NSW coast, including offshore islands. Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. Forages on exposed rock or coral at low tide. Breeds almost exclusively on offshore islands, and occasionally on isolated promontories.	Nil. No suitable habitat present.
Onychoprion fuscata	Sooty Tern	V		1 record within 10km (OEH, 2016a)	Occurs over tropical and subtropical seas and islands around northern NSW. Occasionally seen along coastal NSW, especially after cyclones. Breeds in sand or coral scrapes on offshore islands and cays including Lord Howe and Norfolk Islands.	Unlikely. Preferred habitat not present.
Circus assimilis	Spotted Harrier	V		7 records within 10km (OEH, 2016a)	Occurs throughout Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Inhabits grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods). Most commonly in native grassland, but also in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn).	Possible. May forage in the project area on occasion. Few local records. No raptor nests observed in the project area.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Lophoictinia isura	Square-tailed Kite	V		7 records within 10km (OEH, 2016a)	Occurs across NSW, resident in North, northeast and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands and open forests, with preference for timbered watercourses. Favours productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes, and Coolibah/River Red Gum on the inland plains. In Sydney area nests in mature living trees within 100m of ephemeral/permanent watercourse. Large home range > 100 km2.	Possible. May forage in the project area on occasion. Few local records. No raptor nests observed in the project area.
Ptilinopus superbus	Superb Fruit-Dove	V		2 records within 10km, last recorded 1996 (OEH, 2016a)	Occurs mainly north from NE NSW, much less common further south and largely confined to pockets of habitat south to Moruya. Vagrants occur south to VIC and TAS. Inhabits rainforest and closed forests, may also forage in eucalypt or acacia woodland with fruit-bearing trees. Nests 5-30 m above ground in rainforest/rainforest edge tree and shrub species. Part of the population migratory/nomadic.	Unlikely. No suitable wet forest habitat present.
Lathamus discolor	Swift Parrot	E	E	11 records within 10km (OEH, 2016a); Species or species' habitat likely to occur within 10km (DEE, 2016a)	Migratory, travelling to the mainland from March to October. Breeds in Tasmania from September to January. On the mainland, it mostly occurs in the southeast foraging on winter flowering eucalypts and lerps, with records of the species between Adelaide and Brisbane. Principal over-winter habitat is box-ironbark communities on the inland slopes and plains. Eucalyptus robusta, Corymbia maculata and C. gummifera dominated coastal forests are also important habitat.	Possible. May forage in the project area on rare occasions during winter migration if suitable forage trees are present.
Xenus cinereus	Terek Sandpiper	V	C,J,K	6 records within 10km (OEH, 2016a)	The two main sites for this species in NSW are the Richmond River and Hunter River estuaries. Inhabits coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks near mangroves, also observed on rocky pools and reefs and up to 10 km inland around brackish pools. Roost communally in mangroves or dead trees. Forages in open intertidal mudflats.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Neophema pulchella	Turquoise Parrot	V		1 record within 10km, last recorded 2005 (OEH, 2016a)	Occurs from coast to inland slopes. In coastal area, most common between Hunter and Northern Rivers, and further south in S Coast. Inhabits open eucalypt woodlands and forests, typically with a grassy understorey. Favours edges of woodlands adjoining grasslands or timbered creek lines and ridges. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands and open areas provide important foraging habitat for this species while woodlands provide important roosting and breeding habitat. Nests in tree hollows, logs or posts from August to December.	Unlikely. No suitable woodland vegetation present.
Daphoenositta chrysoptera	Varied Sittella	V		10 records within 10km (OEH, 2016a)	Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	Unlikely. No suitable woodland vegetation present.
Epthianura albifrons	White-fronted Chat	V		191 records within 10km (OEH, 2016a)	This species occurs from southern Queensland to Western Australia and down to Tasmania, mostly in temperate to arid climates and very rarely in sub-tropical areas. It is found in damp open habitats, particularly wetlands containing saltmarsh areas that are bordered by open grasslands. Along the coast it is found in estuarine and marshy habitats with vegetation <1m tall, and in open grasslands and areas bordering wetlands. Inland, it is often observed in grassy plains, saltlakes and saltpans along waterway margins.	Unlikely. Local records are from the southern side of Botany Bay. Limited suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Epthianura albifrons	White-fronted Chat population in the Sydney Metropolitan Catchment Management Area	EP		191 records within 10km (OEH, 2016a)	There are two isolated sub-populations of White-fronted Chats currently known from the Sydney Metropolitan CMA: at Newington Nature Reserve and at Towra Point NR. This species is unlikely to cross the 25km separating these areas, or the greater distances separating other colonies outside the CMA.	Unlikely. Local records are from the southern side of Botany Bay. Limited suitable habitat present.
Mammals						
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Species or species' habitat known to occur within 10km (DEE, 2016a)	Occurs from the Shoalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range, except in the Warrumbungles and Mt Kaputar. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Diet consists of vegetation in adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	Nil. No suitable habitat present.
Cercartetus nanus	Eastern Pygmy-possum	V		3 records within 10km (OEH, 2016a)	Occurs along the east coast of NSW, and inland to the Pillaga, Dubbo, Parkes and Wagga Wagga. Inhabits range of habitats from coastal heath and woodland though open and closed forests, subalpine heath and rainforest (Tulloch and Dickman 1995). Inhabits rainforest, sclerophyll forests and heath. Banksia spp. and myrtaceous shrubs and trees are favoured food sources and nesting subject sites in drier habitats. Diet mostly pollen and nectar from Banksia spp., Eucalyptus spp., Callistemon spp. and insects (Ward and Turner 2008). Nests in hollows in trees, under the bark of Eucalypts, forks of tea-trees, abandoned bird nests and Xanthorrhoea bases (Ward and Turner 2008, Tulloch and Dickman 2006).	Nil. No suitable habitat present.
Phascolarctos cinereus	Koala	V	V	29 records within 10km (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred hectares.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Perameles nasuta	Long-nosed Bandicoot population in inner western Sydney	EP		25 records within 10km (OEH, 2016a)	Occurs within Marrickville and Canada Bay LGAs, and may also occur in the Canterbury, Ashfield and Leichhardt LGAs. Shelters mostly under older houses and buildings, and forages in parkland and backyards.	Possible. Could occur along the rail corridor, particularly in the vicinity of Dulwich Hill Station. Limited shelter habitat present. Limited access points to the rail corridor.
Pseudomys novaehollandiae	New Holland Mouse		V	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs in disjunct, coastal populations from Tasmania to Queensland. In NSW inhabits a variety of coastal habitats including heathland, woodland, dry sclerophyll forest with a dense shrub layer and vegetated sand dunes (Wilson and Bradtke 1999). Populations may recolonise/ increase in size in regenerating native vegetation after wildfire, clearing and sandmining. Presence strongly correlated with understorey vegetation density, and high floristic diversity in regenerating heath (Lock and Wilson 1999).	Nil. No suitable habitat present.
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E	E	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs mainly in 2 areas: Ku-ring-gai Chase and Garigal National Parks N of Sydney, and far SE NSW including Ben Boyd National Park, East Boyd State Forest, Nadgee Nature Reserve, Nadgee State Forest, South East Forest and Yambulla State Forest but also occurs between these areas. Inhabits scrubby vegetation, including heath, shrubland, and heathy forest and woodland. Often associated with well-drained soils and dry heathland communities, and prefers periodically burnt areas as this increases insect abundance.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Dasyurus maculatus	Spotted-tailed Quoll	V	E	1 record within 10km, last recorded 2002 (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	Unlikely. No suitable woodland habitat present.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	411 records within 10km (OEH, 2016a); Roosting known to occur within 10km (DEE, 2016a)	Roosts in camps within 20 km of a regular food source, typically in gullies, close to water and in vegetation with a dense canopy. Forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and street trees, particularly in eucalypts, melaleucas and banksias. Highly mobile with movements largely determined by food availability (Eby and Law 2008). Will also forage in urban gardens and cultivated fruit crops.	Present. Would forage in planted trees in the project area on occasion when in flower. No breeding habitat present.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		122 records within 10km (OEH, 2016a)	Generally occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only 4 known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill 2008).	Likely. Could forage in the project area. May roost under bridges and in culverts. No breeding habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		3 records within 10km (OEH, 2016a)	Occurs on southeast coast and ranges. Prefers tall (>20m) and wet forest with dense understorey. Absent from small remnants, preferring continuous forest but can move through cleared landscapes and may forage in open areas. Roosts in hollow trunks of Eucalypts, underneath bark or in buildings. Forages in gaps and spaces within forest, with large foraging range (12km foraging movements recorded) (Churchill 2008, Law et al 2008).	Possible. May forage in the project area on occasion. No suitable tall forest present. Unlikely to breed in the project area.
Mormopterus norfolkensis	Eastern Freetail-bat	V		16 records within 10km (OEH, 2016a)	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Forages in natural and artificial openings in vegetation, typically within a few kilometres of its roost. Roosts primarily in tree hollows but also recorded from man-made structures or under bark (Churchill 2008).	Likely. Could forage in the project area. Limited potential breeding habitat present.
Scoteanax rueppellii	Greater Broad-nosed Bat	V		2 records within 10km (OEH, 2016a)	Occurs on the east coast and Great Dividing Range. Inhabits a variety of habitats from woodland to wet and dry sclerophyll forests and rainforest, also remnant paddock trees and timber-lined creeks, typically below 500m asl. Forages in relatively uncluttered areas, using natural or man-made openings in denser habitats. Usually roosts in tree hollows or fissures but also under exfoliating bark or in the roofs of old buildings. Females congregate in maternal roosts in suitable hollow trees (Hoye and Richards 2008, Churchill 2008).	Possible. Could forage in the project area. Limited potential breeding habitat present.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	1 record within 10km, last recorded 2005 (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Miniopterus australis	Little Bentwing-bat	V		2 records within 10km, last recorded 2005 (OEH, 2016a)	Occurs from Cape York to Sydney. Inhabits rainforests, wet and dry sclerophyll forests, paperbark swamps and vine thickets. Only one maternity cave known in NSW, shared with Eastern Bentwing-bats at Willi Willi, near Kempsey. Outside breeding season roosts in caves, tunnels and mines and has been recorded in a tree hollow on one occasion. Forages for insects beneath the canopy of well-timbered habitats (Churchill 2008, Hoye and Hall 2008).	Unlikely. No suitable foraging habitat present. May possibly roost on occasion under bridges or in culverts.
Myotis macropus	Southern Myotis	V		481 records within 10km (OEH, 2016a)	Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in flat/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage, typically in close proximity to water (Campbell, 2011). Breeds November or December (Churchill, 2008).	Likely. Could forage along the Cooks River. May roost under bridges and in culverts.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		4 records within 10km (OEH, 2016a)	Migrates from tropics to SE Aus in summer. Forages across a range of habitats including those with and without trees, from wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grasslands and desert. Roosts communally in large tree hollows and buildings (Churchill, 2008).	Likely. Could forage in the project area. Limited potential breeding habitat present.
Reptiles						
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter, and spring, moving to shelters in hollows of large trees within 200m of escarpments in summer. Feeds mostly on geckos and small skinks, and occasionally on frogs and small mammals.	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Varanus rosenbergi	Rosenberg's Goanna	V		1 record within 10km (OEH, 2016a)	In NSW mainly occurs on the mid coast region from Wollemi NP to Nowra; the ACT and Goulburn regions and the South-west Slopes. Inhabits coastal heathlands, wet and dry sclerophyll forests, woodlands and mallee communities. Termite mounds are an important habitat feature: eggs are laid in the mounds in summer and incubate till spring, when the young dig themselves out. Young may return to the mound as a refuge for some months, while adults shelter in burrows dug under rocks or logs, or in rock crevices, hollow logs or even rabbit burrows (Sass, 2008).	Nil. No suitable habitat present.
Frogs						
Heleioporus australiacus	Giant Burrowing Frog	V	V	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollemi National Park. Appears to exist as 2 populations with a 100km gap in records between Jervis Bay and Eden. Northern population occurs on sandy soils supporting heath, woodland or open forest. Breeds in ephemeral to intermittent streams with persistent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	Nil. No suitable habitat present.
Litoria aurea	Green and Golden Bell Frog	E	V	12226 records within 10km (OEH, 2016a); Species or species' habitat known to occur within 10km (DEE, 2016a)	Formerly occurred from Brunswick Heads to Victoria, but >80% populations now extinct. Inhabits marshes, natural and artificial freshwater to brackish wetlands, dams and in stream wetlands. Prefers sites containing cumbungi (*Typha* spp.) or spike rushes (*Eleocharis* spp.), which are unshaded and have a grassy area and/or rubble as shelter/refuge habitat nearby. Mosquitofish (*Gambusia holbrooki*) is a key threat as they feed on Green and Golden Bell Frog eggs and tadpoles.	Unlikely. Limited emergent vegetation (eg *Typha*) present in table drains. Most local records are from key populations at Homebush Bay, Greenacre, and Arncliffe.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Litoria raniformis	Growling Grass Frog	E	V	Species or species' habitat may occur within 10km (DEE, 2016a)	Currently, the species is known to exist only in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain and around Lake Victoria. Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. They are also found in irrigated rice crops, particularly where there is no available natural habitat (OEH, 2013).	Nil. No suitable habitat present.
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Species or species' habitat may occur within 10km (DEE, 2016a)	Occurs on plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground.	Nil. No suitable habitat present.
Pseudophryne australis	Red-crowned Toadlet	V		24 records within 10km (OEH, 2016a)	Restricted to Sydney Basin, from Nowra to Pokolbin and west to Mt Victoria. Inhabits heathland and open woodland on Hawkesbury and Narrabeen Sandstones, within 100m of ridgelines. Breeds in ephemeral feeder creeks or flooded depressions, requiring unpolluted water between 5.5 and 6.5 pH. Shelters under rocks, amongst masses of dense vegetation or leaf litter. Populations restricted to immediate vicinity of breeding areas.	Nil. No suitable habitat present.
Mixophyes balbus	Stuttering Frog	E	V	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs along the east coast of Australia. Has undergone a massive range reduction particularly in the south of its range: within the Sydney Basin, White (2008a) located only 3 populations south of Sydney (Macquarie Pass and Mt Werong) and Daly et al. (2002, in White 2008a) found only 2 extant populations between Macquarie Pass and Victoria. Inhabits rainforest and wet, tall, open forest. Shelter in deep leaf litter and thick understorey vegetation on the forest floor. Feeds on insects and smaller frogs, breeding in streams during summer after heavy rain. The species does not occur in areas where the riparian vegetation has been disturbed or where	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
					there have been significant upstream human impacts (Mahony et al, 1997).	
Crinia tinnula	Wallum Froglet	V		1 record within 10km, last recorded 1999 (OEH, 2016a)	Inhabits acid paperbark swamps and sedge swamps along the northern and central coast regions of NSW. It is generally not associated with disturbed habitats (Renwick, 2006).	Nil. No suitable habitat present.
Fish						
Prototroctes maraena	Australian Grayling	E	V	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Occurs in coastal rivers and streams south from the Shoalhaven River. Inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults. Most of their lives are spent in freshwater rivers and streams in cool, clear waters with a gravel substrate and alternating pool and riffle zones, however can also occur in turbid water. The species can penetrate well inland, being recorded over 100 km inland from the sea. (Backhouse et al, 2008).	Nil. Outside usual distribution.
Epinephelus daemelii	Black Rockcod	V	V	Species or species' habitat likely to occur within 10km (DEE, 2016a)	Found in warm temperate/sub-tropical parts of south-western Pacific. Naturally occur along NSW Coastincl. Lord Howe Island. Adults generally found on rocky reefs. Juveniles found in coastal rock pools and around rocky shores in estuaries. (DPI, 2013).	Nil. No suitable habitat present.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence
Gastropods						
Meridolum corneovirens	Cumberland Plain Land Snail	E		14 records within 10km (OEH, 2016a)	Occurs within a small area of the Cumberland Plain, from Richmond and Windsor to Picton.Found primarily under litter of bark, leaves and logs, or in loose soil around grass clumps within Cumberland Plain Woodland. Has also been found under rubbish. Feeds on fungus. During periods of drought can burrow into the soil to escape the dry conditions.	Unlikely. No suitable woodland habitat present.
Pommerhelix duralensis	Dural Land Snail		E	Species or species' habitat likely to occur within 10km (DEE, 2016a)	This species is a shale-influenced habitat specialist, which occurs in low densities along the northwest fringes of the Cumberland Plain on shale-sandstone transitional landscapes. The majority of confirmed records for the species occur within The Hills Shire Local Government Area. The species is also found within the Local Government Areas of Blue Mountains City, Penrith City, Hornsby Shire and Parramatta City.	Nil. No suitable habitat present.

Notes: CE – Critically Endangered; E – Endangered; V – Vulnerable; EP – Endangered Population; C - CAMBA, J-JAMBA- R-ROKAMBA

Migratory fauna recorded or predicted to occur within 10km of the study area

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Monarcha melanopsis	Black-faced Monarch			Species or species' habitat known to occur within 10km (DEE, 2016a); 43 records within 10km (OEH, 2016a)	Found along the coast of eastern Australia, becoming less common further south. Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Resident in the north of its range, but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter.	Unlikely. No suitable habitat present.
Numenius madagascariensis	Eastern Curlew	P	CE,C,J,K	611 records within 10km (OEH, 2016a)	Within Australia, the species has a primarily coastal distribution. The species is found in all states, particularly the north, east, and south-east regions including Tasmania. Breeds in Russia and north-eastern China. Most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, and sometimes use the mangroves. The birds are also found in saltworks and sewage farms.	Nil. No suitable habitat present.
Egretta sacra	Eastern Reef Egret		C	78 records within 10km (OEH, 2016a)	Occurs along most of Australia's coastline except Victoria, Tasmania and the Nullarbor. Usually inhabitat rocky shorelines, coral islands and reefs. Also occur in tidal rivers and inlets. Breed throughout the year and nests can be in trees in island woodlands or on the ground under shrubs or rock ledges (Birdlife Australia, 2014)	Unlikely. No suitable habitat present.
Apus pacificus	Fork-tailed Swift		C,J,K	4 records within 10km (OEH, 2016a)	Recorded in all regions of NSW. Non- breeding, and almost exclusively aerial while in Australia. Occurs over urban and rural areas as well as areas of native vegetation.	Unlikely. May forage high above the project area.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Plegadis falcinellus	Glossy Ibis		C	56 records within 10km (OEH, 2016a)	Occurs throughout eastern and northern Australia, east of the Kimberley and Eyre Peninsula. Largest areas of prime habitat are inland and northern floodplains, with largest numbers in the Top End and Channel Country. Preferred habitats are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. Breeds at limited locations, with most records from the Murray Darling Basin (NSW), western Riverina (VIC), south-east (SA), Channel Country (Qld/ SA) and lower Ord/Keep Rivers (WA).	Nil. No suitable habtiat present.
Numenius minutus	Little Curlew		C,J,K	1 record within 10km, last recorded 1999 (OEH, 2016a)	Generally spend the non-breeding season in northern Australia. In NSW, most records are scattered east of the Great Dividing Range, from Casino, south to Greenwell Point with a few scattered records west of the Great Dividing Range. Recorded breeding in Siberia. Most often found feeding in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of estuaries or beaches on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses and verges of roads and airstrips are also used.	Unlikely. No suitable habitat present.
Cuculus optatus	Oriental Cuckoo		C,J,K	Species or species' habitat may occur within 10km (DEE, 2016a)	This species migrates to northern and eastern Australia in the warmer months. Occurs south to the Shoalhaven area. Occurs in a range of habitats, including monsoon forest, rainforest edges, leafy trees in paddocks, river flats, roadsides and mangroves.	Unlikely. May occur along the Cooks River on occasion. Few local records.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Merops ornatus	Rainbow Bee-eater		J	Species or species' habitat may occur within 10km (DEE, 2016a); 2 records within 10km (OEH, 2016a)	Distributed across much of mainland Australia, and several near-shore islands. Occurs in a range of habitats, including open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water. It also occurs in inland and coastal sand dune systems, and in mangroves in northern Australia. Nests are made in sandy banks.	Possible. May occur in the project area on occasion.
Rhipidura rufifrons	Rufous Fantail			Species or species' habitat known to occur within 10km (DEE, 2016a); 110 records within 10km (OEH, 2016a)	Found along NSW coast and ranges. Inhabits rainforest, dense wet forests, swamp woodlands and mangroves. During migration, it may be found in more open habitats or urban areas (Birds Australia, 2008).	Possible. May occur in riparian vegetation along the Cooks River or planted trees on occasion.
Myiagra cyanoleuca	Satin Flycatcher			Species or species' habitat known to occur within 10km (DEE, 2016a); 14 records within 10km (OEH, 2016a)	In NSW widespread on and east of the Great Divide, sparsely scattered on the western slopes, very occasional records on the western plains. Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, often near wetlands and watercourses. On migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Generally not in rainforests.	Unlikely. May occur in riparian vegetation along the Cooks River or planted trees on occasion. No recent records from Sydney.
Monarcha trivirgatus	Spectacled Monarch			Species or species' habitat may occur within 10km (DEE, 2016a)	The Spectacled Monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. Prefers thick understorey in rainforest, wet gullies and waterside vegetation as well as mangroves.	Unlikely. Rarely occurs in Sydney area.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurence
Hirundapus caudacutus	White-throated Needletail		C,J,K	Species or species' habitat known to occur within 10km (DEE, 2016a); 40 records within 10km (OEH, 2016a)	Recorded along NSW coast to the western slopes and occasionally from the inland plains. Breeds in northern hemisphere. Almost exclusively aerial while in Australia. Occur above most habitat types, but are more frequently recorded above more densely vegetated habitats (rainforest, open forest and heathland) than over woodland or treeless areas.	Unlikely. May forage high above the project area.
Motacilla flava	Yellow Wagtail		C,J,K	Species or species' habitat known to occur within 10km (DEE, 2016a)	This species breeds in temperate Europe and Asia. It occurs within Australia in open country habitat with disturbed ground and some water. Recorded in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lawns.	Possible. May occur in riparian vegetation along the Cooks River or planted trees on occasion.

Notes: C – China-Australia Migratory Bird Agreement (CAMBA), J- Japan-Australia Migratory Bird Agreement (JAMBA)- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)

Appendix B – Field Survey Results

Flora species recorded Moderate/good medium condition Turpentine – Grey Ironbark open forest on shale (plots 2 and 6)

Family	Scientific name	Common name	Exotic	Plot 2 cover	Plot 2 abundance	Plot 6 cover	Plot 6 abundance
Apocynaceae	*Araujia sericifera*	Moth Vine	*	1	5		
Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	*	1	3		
Araliaceae	*Polyscias sambucifolia* subsp. *sambucifolia*					X	X
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	*	1	5	1	1
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	*	1	20	1	20
Asteraceae	*Hypochaeris radicata*	Catsear	*	1	20		
Asteraceae	*Osteospermum ecklonis*	Cape Daisy	*	2	20		
Asteraceae	*Senecio madagascariensis*	Fireweed	*			1	10
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	*	1	10		
Bignoniaceae	*Jacaranda mimosifolia*	Jacaranda	*	1	1		
Brassicaceae	*Lepidium* sp.	A Peppercress	*	1	5		
Fabaceae (Faboideae)	*Trifolium subterraneum*	Subterranean Clover	*	1	20		
Fabaceae (Mimosoideae)	*Acacia falcata*					X	X
Fabaceae (Mimosoideae)	*Acacia parramattensis*	Parramatta Wattle				X	X
Fabaceae (Mimosoideae)	*Acacia prominens*	Gosford Wattle				X	X
Fabaceae (Mimosoideae)	*Acacia saligna*	Golden Wreath Wattle	*			15	20
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	*	1	5		
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	*	1	5		
Oleaceae	*Ligustrum lucidum*	Large-leaved Privet	*	1	1		
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum				X	X
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	*	1	20	1	10
Poaceae	*Chloris gayana*	Rhodes Grass	*			1	20
Poaceae	*Ehrharta erecta*	Panic Veldtgrass	*	1	5		

Family	Scientific name	Common name	Exotic	Plot 2 cover	Plot 2 abundance	Plot 6 cover	Plot 6 abundance
Poaceae	*Eragrostis nurvula*	African Lovegrass	*	2	20		
Poaceae	*Melinis repens*	Red Natal Grass	*	20	100		
Poaceae	*Pennisetum clandestinum*	Kikuyu Grass	*	1	5	30	100
Solanaceae	*Cestrum parqui*	Green Cestrum	*	1	5		
Verbenaceae	*Lantana camara*	Lantana	*	1	10		

Notes: *exotic or non indigenous native species.
Cover – visual estimate of foliage projective cover within the plot, recorded from 1–5 per cent and then to the nearest 5 per cent.
Abundance - relative number of individuals or shoots of a species within the plot. Based on the following intervals: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, 1000. Values above 20 are estimates only
X - detected outside of survey plots, cover and abundance not recorded.

Flora species recorded in the Moderate/good poor condition Turpentine – Grey Ironbark open forest on shale (plots 1 and 5, Area search 4)

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 5 Cover	Plot 5 Abundance	Area search 4
Apiaceae	*Foeniculum vulgare*	Fennel	*	5	20			
Arecaceae	*Phoenix* sp.		*	1	1			
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	*			1	1	
Asparagaceae	*Asparagus asparagoides*	Bridal Creeper	*					X
Asteraceae	*Ageratina adenophora*	Crofton Weed	*					X
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	*	1	20	1	20	
Asteraceae	*Cirsium vulgare*	Spear Thistle	*			1	1	
Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	*	1	20			
Asteraceae	*Hypochaeris radicata*	Catsear	*	5	30	1	10	
Asteraceae	*Senecio madagascariensis*	Fireweed	*	1	20	1	10	
Brassicaceae	*Lepidium* sp.	A Peppercress	*	1	10			
Brassicaceae	*Sisymbrium* sp.		*			1	5	
Casuarinaceae	*Allocasuarina littoralis*	Bleck She-oak		X	X			
Fabaceae (Faboideae)	*Medicago polymorpha*	Burr Medic	*	1	20			
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses		X	X			
Fabaceae (Mimosoideae)	*Acacia saligna*	Golden Wreath Wattle	*					x
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	*	1	1			
Malaceae	*Cotoneaster* sp.		*					x
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	*	1	10			
Myrtaceae	*Angophora costata*	Sydney Red Gum				X	X	
Myrtaceae	*Lophostemon confertus*	Brush Box		X	X			
Myrtaceae	*Syncarpia glomulifera* subsp. *glomulifera*			X	X			

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 5 Cover	Plot 5 Abundance	Area search 4
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	*	1	3			
Oleaceae	*Ligustrum lucidum*	Large-leaved Privet	*					x
Oleaceae	*Olea europaea* subsp. *cuspidata*	African Olive	*	1	1			
Phormiaceae	*Dianella revoluta* var. *revoluta*	A Blue Flax Lily		X	X			
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	*	1	30	1	10	
Poaceae	*Aristida ramosa*	Purple Wiregrass		X	X			
Poaceae	*Briza maxima*	Quaking Grass	*			1	5	
Poaceae	*Ehrharta erecta*	Panic Veldtgrass	*					X
Poaceae	*Eragrostis curvula*	African Lovegrass	*			20	100	
Poaceae	*Melinis repens*	Red Natal Grass	*	60	500			
Poaceae	*Paspalum dilatatum*	Paspalum	*	3	30	1	10	
Poaceae	*Pennisetum clandestinum*	Kikuyu Grass	*			25	50	
Poaceae	*Rytidosperma tenuius*	A Wallaby Grass		X	X			
Poaceae	*Setaria parviflora*		*	2	50	2	50	
Verbenaceae	*Lantana camara*	Lantana	*	1	1			

Notes: *exotic or non indigenous native species.
Cover – visual estimate of foliage projective cover within the plot, recorded from 1–5 per cent and then to the nearest 5 per cent.
Abundance - relative number of individuals or shoots of a species within the plot. Based on the following intervals: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, 1000. Values above 20 are estimates only
x – detected outside of survey plots, cover and abundance not recorded.

Flora species recorded in Moderate/good condition Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest (plots 3 and 4, Area search 3)

Family	Scientific name	Common name	Exotic	Plot 3 Cover	Plot 3 abundance	Plot 4 cover	Plot 4 abundance	Area search 3
Apocynaceae	*Araujia sericifera*	Moth Vine	*			2	20	
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	*			1	3	
Asparagaceae	*Asparagus asparagoides*	Bridal Creeper	*			1	3	
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	*	1	20	1	20	X
Asteraceae	*Chrysanthemoides monilifera* subsp. *monilifera*	Boneseed	*	1	5			
Asteraceae	*Cirsium vulgare*	Spear Thistle	*			1	1	
Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	*					x
Asteraceae	*Senecio madagascariensis*	Fireweed	*			1	20	x
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	*	1	10			
Fabaceae (Faboideae)	*Genista linifolia*	Flaxleaf Broom	*					x
Fabaceae (Mimosoideae)	*Acacia saligna*	Golden Wreath Wattle	*					x
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	*	1	5			
Myrsinaceae	*Anagallis arvensis*	Scarlet Pimpernel	*	1	1			
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany		X	X			
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	*	1	10	1	10	
Poaceae	*Briza maxima*	Quaking Grass	*					X
Poaceae	*Briza subaristata*		*					X
Poaceae	*Chloris gayana*	Rhodes Grass	*	5	50	5	50	x
Poaceae	*Ehrharta erecta*	Panic Veldtgrass	*			1	20	

Family	Scientific name	Common name	Exotic	Plot 3 Cover	Plot 3 abundance	Plot 4 cover	Plot 4 abundance	Area search 3
Poaceae	*Eragrostis curvula*	African Lovegrass	*	1	20			
Poaceae	*Melinis repens*	Red Natal Grass	*	20	100			X
Poaceae	*Paspalum dilatatum*	Paspalum	*			2	20	X
Poaceae	*Pennisetum clandestinum*	Kikuyu Grass	*	1	10			X
Poaceae	*Setaria parviflora*	0	*	3	50			X
Verbenaceae	*Verbena bonariensis*	Purpletop	*					x

Notes: *exotic or non indigenous native species.
Cover – visual estimate of foliage projective cover within the plot, recorded from 1–5 per cent and then to the nearest 5 per cent.
Abundance - relative number of individuals or shoots of a species within the plot. Based on the following intervals: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, 1000. Values above 20 are estimates only
x – detected outside of survey plots, cover and abundance not recorded.

Flora species recorded in Exotic vegetation and planted native species (Area search 1 and 2)

Family	Scientific name	Common name	Exotic
Apiaceae	*Foeniculum vulgare*	Fennel	*
Apocynaceae	*Araujia sericifera*	Moth Vine	*
Araliaceae	*Hedera helix*	English Ivy	*
Asparagaceae	*Asparagus* sp.		*
Asteraceae	*Ageratina adenophora*	Crofton Weed	*
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	*
Asteraceae	*Hypochaeris radicata*	Catsear	*
Caprifoliaceae	*Lonicera japonica*	Japanese Honeysuckle	*
Commelinaceae	*Tradescantia fluminensis*	Wandering Jew	*
Convolvulaceae	*Ipomoea indica*	Morning Glory	*
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant	*
Fabaceae (Caesalpinioideae)	*Gleditsia triacanthos*	Honey Locust	*
Fabaceae (Caesalpinioideae)	*Senna pendula* var. *glabrata*		*
Fabaceae (Mimosoideae)	*Acacia saligna*	Golden Wreath Wattle	*
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	*
Malaceae	*Cotoneaster* sp.		*
Myrtaceae	*Corymbia citriodora*	Lemon-scented Gum	*
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	*
Oleaceae	*Ligustrum lucidum*	Large-leaved Privet	*
Oleaceae	*Olea europaea* subsp. *cuspidata*	African Olive	*
Platanaceae	*Platanus hispanica 'Acerifolia'*	Hybrid Plane	*
Poaceae	*Cortaderia selloana*	Pampas Grass	*
Poaceae	*Ehrharta erecta*	Panic Veldtgrass	*
Poaceae	*Phyllostachys nigra*	Black Bamboo	*
Sapindaceae	*Cardiospermum grandiflorum*	Balloon Vine	*

Family	Scientific name	Common name	Exotic
Simaroubaceae	*Ailanthus altissima*	Tree of Heaven	*
Solanaceae	*Cestrum parqui*	Green Cestrum	*
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	*
Verbenaceae	*Lantana camara*	Lantana	*

Notes: *exotic or non indigenous native species.

Fauna species recorded in the study area

Common name	Scientific name	Exotic	NSW status	EPBC status	Observation type
Birds					
Australasian Figbird	*Sphecotheres vieilloti*				O
Australian Magpie	*Cracticus tibicen*				OW
Australian Pelican	*Pelecanus conspicillatus*				O
Australian Raven	*Corvus coronoides*				OW,C
Australian White Ibis	*Threskiornis molucca*				O
Common Myna	*Sturnus tristis*	*			OW
Common Starling	*Sturnus vulgaris*	*			O
Grey Butcherbird	*Cracticus torquatus*				O
Laughing Kookaburra	*Dacelo novaeguineae*				O
Magpie-lark	*Grallina cyanoleuca*				OW
New Holland Honeyeater	*Phylidonyris novaehollandiae*				OW
Noisy Miner	*Manorina melanocephala*				OW
Rainbow Lorikeet	*Trichoglossus haematodus*				OW
Red Wattlebird	*Anthochaera carunculata*				O
Red-whiskered Bulbul	*Pycnonotus jocosus*	*			O
Rock Dove	*Columba livia*	*			O
Spotted Turtle-dove	*Streptopelia chinensis*	*			O
Superb Fairy-wren	*Malurus cyaneus*				OW
Tawny Frogmouth	*Podargus strigoides*				O
Welcome Swallow	*Hirundo neoxena*				O
Willie Wagtail	*Rhipidura leucophrys*				O
Yellow-tailed Black-cockatoo	*Calyptorhynchus funereus*				OW
Frogs					
Common eastern Froglet	*Crinia signifera*				W
Mammals					
Cat	*Felis catus*	*			O,C

Common name	Scientific name	Exotic	NSW status	EPBC status	Observation type
Common Brushtail Possum	*Trichosurus vulpecula*				C
Dog	*Canis lupus familiaris*	*			O
Grey-headed Flying-fox	*Pteropus poliocephalus*		V	V	OW
House Mouse	*Mus musculus*	*			O
Reptiles					
Cream-striped Shinning-skink	*Cryptoblepharus virgatus*				O
Dark-flecked Garden Sunskink	*Lampropholis delicata*				O
Eastern Blue-tongue	*Tiliqua scincoides*				O

Notes: Obsevation type- O=observed, W=heard, C= camera

Appendix C – Assessments of Significance

EPBC Act Assessments of Significance

Under the EPBC Act an action will require approval from the minister if the action has, will have, or is likely to have, a significant impact on a Matter of National Environmental Significance (MNES). An assessment of significance has been prepared for MNES that would be affected by the project in accordance with the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013). Assessments of significance for the vulnerable species: Downy Wattle (*Acacia pubescens*) and the Grey-headed Flying-fox are provided below.

Assessment of significance - Downy Wattle (*Acacia pubescens*)
An 'important population' of a vulnerable species is defined by DotE (2013) as '…a population that is necessary for the species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • Key source populations either for breeding or dispersal • Populations that are necessary for maintaining genetic diversity, and/or • Populations that are near the limit of the species' range'.
There are at least 650 stems of the Downy Wattle (*Acacia pubescens)* in the study area (see the Figure 3-2 series). The stems recorded in the local population occur in Shale-Gravel Transition Forest. Downy Wattle is a clonal species with clumps of tens or even hundreds of stems potentially comprising only one genetic individual (NPWS, 2003). The population of several hundred stems in an extensive patch of habitat in the study area is likely to be viable and self-sustaining and would be important in the context of the extensively cleared suburbs in the locality and the regional distribution of the species which is concentrated in the south-western suburbs of Sydney (OEH, 2016b). In this context, the population of Downy Wattle in the study area is likely to have considerable value 'to maintain genetic diversity and long term evolutionary development' and should be considered an important population (as per the definition in DotE, 2013).
According to the DotE (2013) 'significant impact criteria' for vulnerable species, an action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population
The project has been purposefully designed to avoid impacts on *A. pubescens.* There are no stems of *A. pubescens* in the project area (see the Figure 3-2 series). There are 650 stems in the near vicinity of the project area. The project includes specific work methods and mitigation measures to avoid impacts on these known stems. Temporary impact areas such as construction laydown areas and access tracks would be sited to avoid direct and indirect impacts on these *A. pubescens*. The project would remove or modify potential habitat for the species associated with around 0.6 hectares of Shale-gravel Transition Forest in the stretch of the rail corridor between Punchbowl and Bankstown stations (see the Figure 3-2 series). There is also a minor risk of harm to some *A. pubescens* through accidental impacts, if there are stems in the project area that were not detected during the field surveys. The 650 stems of the species that comprise the known population would be unharmed and would be sufficient to maintain a viable, self-sustaining population. In the long-term the size of the population would be maintained.
Reduce the area of occupancy of the species
The project would remove around 0.6 hectares of native vegetation that comprises potential habitat for the species. The project has been purposefully designed to avoid impacts to the known population of the species and areas of occupied habitat. The project would not reduce the area of occupation of the species.
Fragment an existing important population into two or more populations
The project would not permanently remove or otherwise isolate any occupied habitat for the species. The population of Downy Wattle at the site occurs as a series of disjunct patches that are separated by cleared land and rail infrastructure (see the Figure 3-2 series). The project would increase the width of gaps in potential habitat between patches of *Acacia pubescens* by removing or modifying native vegetation. The degree of habitat fragmentation will be comparable to the current condition of the study area.
Adversely affect habitat critical to the survival of a species
A. pubescens occurs at a small number of locations centred around southwestern Sydney and has specific habitat requirements related to soil type (OEH, 2016b). Given the limited range and specific habitat requirements of the species all occupied habitat is probably necessary 'for the long-term maintenance of the species' and 'to maintain genetic diversity and long term evolutionary development' and should be considered habitat critical to the survival of the species (as per the definition in DotE, 2013).

Assessment of significance - Downy Wattle (*Acacia pubescens*)
The project would not remove any occupied habitat. The project would remove potential habitat associated with around 0.6 hectares of native vegetation in the vicinity of the known population of *A. pubescens.* This would result in indirect effects on habitat critical to the survival of the species through increased fragmentation of habitat, reduction in native vegetation cover and disturbance of surface soil in the vicinity of occupied habitat. The local population of *A. pubescens* has persisted in a highly modified environment adjacent to heavy rail infrastructure. The post-construction environment of the study area will be very similar to the current situation. The fragmentation of habitat, physical disturbance and reduction in vegetation cover for the project is highly unlikely to reduce the quality of the occupied habitat that would be retained.
Disrupt the breeding cycle of an important population
The project may affect the breeding cycle of the species by reducing the extent of potential habitat and of native vegetation that may provide shelter and food for pollinator species. *A. pubescens* is a clonal species with clumps of tens or even hundreds of stems comprising potentially one genetic individual (NPWS, 2003). *A. pubescens* produces few seeds, often with low viability and/or survival and appears to have only local dispersal of seed (NPWS, 2003). It is likely the species is able to resprout from rootstock after fire. The species is likely to maintain a long-term soil-stored seedbank and germination is likely to be triggered by fire or other local disturbance (NPWS, 2003). Given the importance of clonal stems and the soil seed bank to the reproduction of the species, impacts on pollination would have a minor effect on the local population. The project would reduce the potential for expansion of *A. pubescens* into areas of potential habitat but would not disrupt the breeding cycle of the local population in occupied habitat.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The project would not remove any occupied habitat. No *A. pubescens* have been observed in the impact area. The project would remove potential habitat for *A. pubescens* in up to 0.6 hectares of native vegetation associated with around 0.6 hectares of Shale-gravel Transition Forest in the stretch of the rail corridor between Punchbowl and Bankstown stations (see the Figure 3-2 series). This would result in indirect effects on occupied habitat through increased fragmentation of habitat, reduction in native vegetation cover and disturbance of surface soil in the vicinity of occupied habitat. The local population of *A. pubescens* has persisted in a highly modified environment adjacent to heavy rail infrastructure. The post-construction environment of the study area will be very similar to the current situation. The fragmentation of habitat, physical disturbance and reduction in vegetation cover for the project is highly unlikely to substantially reduce the quality of the occupied habitat that would be retained. The project would not have an adverse effect on habitat for the species such that it is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
The project may increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via erosion (wind and water) and via visitor shoes, clothing or vehicles. Given the exclusion of works from occupied habitat and the existing extent of fragmentation and weed infestation in the study area, the project is unlikely to tangibly increase the degree of weed infestation. The project will include measures to further reduce this risk such as cleaning of construction vehicles before entering and exiting the site and exclusion of access from native vegetation outside of the immediate work area.
Introduce disease that may cause the species to decline
The project has the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*) through vegetation and soil disturbance and vehicle and foot traffic. There is little available information about the distribution of plant diseases within the locality, and no evidence of disease was observed during surveys. The potential for impacts associated with disease is low, given the disturbed nature and long term use of the study area by Sydney Trains. As a precautionary measure a 'clean on entry, clean on exit' policy should be implemented during construction to help reduce the risk of the introduction or spread of these pathogens. No diseases that may cause *A. pubescens* to decline are likely to become established in the study area as a result of the project.
Interfere with the recovery of the species
The *Downy Wattle (*A. pubescens*) Recovery Plan* (NPWS, 2003) comprises the National and NSW State Recovery Plan for the species and as such considers the conservation requirements of the species across its known range. It identifies the future actions to be taken to ensure the short and long-term viability of *A. pubescens* and the parties who will carry out these actions.

Assessment of significance - Downy Wattle (*Acacia pubescens*)
Known threats to the species include habitat loss, habitat degradation (through weed invasion, mechanical damage, rubbish dumping, illegal track creation, and inappropriate fire regimes), disease and hybridisation (NPWS, 2003). The recovery plan lists priority recovery and threat abatement actions that can be taken to support the recovery of this species. The following are relevant to the project: 'Informed environmental assessment and planning decisions are made' (NSW NPWS, 2003), which has been addressed through the preparation of this report in accordance with relevant policy and guidelines and especially the identification of the local population of *A. pubescens* and purposeful modification of the project to avoid direct impacts. The project is unlikely to directly harm any *A. pubescens*, affect the life cycle of the species, have any notable adverse effects on habitat for the species or otherwise interfere with the recovery of the species.
Conclusion
Based on the above considerations, the project is not likely to have a significant impact on the important population of *A. pubescens* that occurs in the study area as: • The project has been purposefully designed to avoid direct impacts on the species or removal of occupied habitat. • The local populations has persisted in a highly modified and edge-affected environment and is likely to be resilient to potential indirect impacts. • The post construction environment in the study area will be very similar to the current situation.

Assessment of significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)
An 'important population' of a vulnerable species is defined by DotE (2013) as '…a population that is necessary for the species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • Key source populations either for breeding or dispersal • Populations that are necessary for maintaining genetic diversity, and/or • Populations that are near the limit of the species' range'.
One individual Grey-headed Flying-fox was observed foraging in a planted eucalypt in the rail corridor between Punchbowl Station and Bankstown Station during the field investigations. It is likely that other individuals would forage on occasion in large eucalypts or figs in the rail corridor. These occasional remnant or planted forage trees would contribute to the available foraging habitat for the Grey-headed Flying-fox but comprise only a very small component of foraging resources in the locality, and would therefore not constitute habitat critical to the survival of a local population of the species. No Grey-headed Flying-fox breeding camps are located within the study area. The eastern portion of the study area is located within 2 kilometres of the Wolli Creek colony. Numbers of individuals at this camp fluctuate wildly. The highest count was 24,000 individuals in November 2016 (WCPS, 2017), whereas the colony was empty in April 2016 (WCPS, 2016). This camp would not be directly affected by the project.
According to the DotE (2013) 'significant impact criteria' for vulnerable species, an action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population
The study area does not contain any diurnal roost sites or breeding camps for the Grey-headed Flying-fox and the project will not have a direct impact on any such features in the wider locality. Life-cycle characteristics of the population that are considered pertinent to the proposed action relate to the potential loss of critical foraging habitat within a 50 kilometre radius of local camps which takes in the project study area. This is the expected maximum foraging distance of the species from roost sites (Eby, 1996). Foraging habitat for the Grey-headed Flying-fox in the project area comprises occasional remnant as well as planted trees such as eucalypts and figs. Species present include indigenous native species such as Turpentine and Red Ironbark, as well as Brush Box, Tallowwood, Lemon-scented Gum and others. No highly productive species with reliable flowering (see Eby, 1996) are present. The project would remove about 7.9 hectares of remnant and planted trees that would be used on occasion as a foraging resource by Grey-headed Flying-foxes. Individuals from various roost camps are likely to forage in the study area on an opportunistic basis when food trees are flowering or fruiting. This vegetation is similar to vegetation throughout the locality, which is predominantly scattered trees located in gardens, parks and roadsides. More dense native vegetation is present along the Wolli Creek corridor. Individuals would regularly forage in urban vegetation, as well as flying further afield to locations such as Centennial Park or the Domain. Whilst Grey-headed Flying-foxes are likely to forage in the project area on occasion, the relatively small patches of planted vegetation to be removed comprise only a small component of that available in the wider locality, and are not likely to comprise habitat critical to the survival of the local population as discussed below. The vegetation within the study area occurs as isolated patches within an already highly fragmented urban landscape and the project will not create a barrier to the movements of the Grey-headed Flying-foxes between roost camps and foraging grounds. Given the above considerations, the project is highly unlikely to result in a long-term decline in an important population of the species.
Reduce the area of occupancy of the species
The proposed action will not directly impact on any known roost camps in the locality. The impacts of construction of the proposed action on the Grey-headed Flying-fox population would be primarily confined to loss of feeding habitat caused by clearing or damage to 0.6 hectares of native vegetation and 7.3 hectares of planted trees during the construction phase. No impacts are anticipated during operation. The project would result in the loss of about 7.9 hectares of remnant and planted vegetation that contains food trees for the Grey-headed Flying-fox. This vegetation represents a minor proportion of the foraging habitat available in a 50 kilometre radius of local camp sites for the Grey-headed Flying-fox. Vegetation that would be removed is not critical to the survival of the species. No intact areas of highly productive forage trees would be removed. Similar urban foraging habitat is present throughout the locality.

Assessment of significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)
The project will not affect the ability of this highly mobile and wide-ranging species to move between local camps and foraging habitats. Extensive areas of habitat are present in the locality and wider area, including various national parks and reserves throughout Sydney, as well as planted trees in residential areas. Given the widespread nature and abundance of potential foraging habitat within the feeding range of the local population, the project is not expected to substantially reduce the area of occupancy of an important population of the Grey-headed Flying-fox.
Fragment an existing important population into two or more populations
The project will not affect a breeding camp or diurnal roost site of any local populations of the Grey-headed Flying-fox, and will not fragment the local population in any way. The project will not form a barrier to the movement of the species between any local camps or roosts and foraging habitat in the locality. The Grey-headed Flying-fox is a highly mobile species that is capable of accessing isolated patches of foraging habitat within urban areas. Any such habitat within the study area exists as small, isolated patches that are already fragmented from any large extensive patches of high-quality or important foraging habitat. Foraging habitat in the study area occurs as isolated patches or individual trees within the urban landscape. The project would result in a minor increase to existing isolation of foraging habitat in a highly urbanised landscape by impacting on patches of native vegetation and planted trees. Highly mobile species such as the Grey-headed Flying-fox are expected to be less impacted by fragmentation and this species is well-adapted to accessing widely spaced habitat resources given its mobility and preference for seasonal fruits and blossom. This species' typically exhibits very large home ranges and Grey-headed Flying-fox are known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources (Eby, 1996). The project would therefore not fragment an existing important population of the Grey-headed Flying-fox into two or more populations.
Adversely affect habitat critical to the survival of a species
Habitat in the study area consists of planted food trees and is not considered critical to the survival of the Grey-headed Flying-fox. Critical foraging habitat is identified as: • Productive during winter and spring, when food bottlenecks have been identified. • Known to support populations of >30,000 individuals, within an area of 50 kilometre radius. • Productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (Sept-May). • Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes. • Known to be continuously occupied as a camp site. The project would result in the removal of patches of native vegetation and planted trees along the edges of the existing rail line and roads from within an urban environment. No breeding camps are present in the study area. There would be no direct impact to any Grey-headed Flying-fox camp sites. Grey-headed Flying-foxes would forage in the area on an opportunistic basis when trees are flowering or fruiting. Vegetation that would be removed is not critical to the survival of the species. No intact areas of highly productive forage trees would be removed. Similar urban foraging habitat is present throughout the locality. The area of habitat loss caused by the project represents a minor proportion of available habitat present within a 50 kilometre radius of local camps. As such, the project is unlikely to adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population
The study area does not contain any Grey-headed Flying-fox camp sites and none will be affected by the project. The project will not form a barrier to the movement of Grey-headed Flying-foxes between any local camps and foraging habitat throughout the locality. The project would remove about 7.9 hectares of scattered remnant and planted trees. This total is made up of small, isolated patches of mostly planted vegetation, typically distributed in linear patches along the edges of the rail line and existing roads, which is not considered habitat critical to the survival of a local population. This represents a minor proportion of the potential foraging habitat for the Grey-headed Flying-fox within a 50

Assessment of significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)
kilometre radius of local roost camps. The loss of this foraging habitat is not likely to disrupt the breeding cycle of the local population of this highly mobile species.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The area of habitat loss associated with the project represents a minor proportion of the potential foraging habitat for the Grey-headed Flying-fox within a 50 kilometre radius of local roost camps and will not isolate areas of foraging habitat for this highly mobile species though this already highly urbanised landscape. The loss and/or modification of foraging habitat is not likely to disrupt the breeding cycle of the local population of this highly mobile species given the extent of suitable foraging habitat within a 50 kilometre radius of local camps. The proposed action will not directly impact on any local roost camps. Given the above considerations the proposed action is unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat for the Grey-headed Flying-fox to the extent that the species is like to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
The project may increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via erosion (wind and water) and via visitor shoes, clothing or vehicles. Given the limited scale and duration of works and the extent of existing disturbance in the study area the project is unlikely to tangibly increase the degree of weed infestation. The project will include measures to further reduce this risk such as cleaning of construction vehicles before entering and exiting the site and exclusion of access from native vegetation outside of the immediate work area. The project is not likely to introduce new feral animals that could harm the Grey-headed Flying-fox or encourage the spread of feral animals.
Introduce disease that may cause the species to decline
The project has the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*) through vegetation and soil disturbance and vehicle and foot traffic. There is little available information about the distribution of plant diseases within the locality, and no evidence of disease was observed during surveys. The potential for impacts associated with disease is low, given the disturbed nature and long term use of the study area as a heavy rail corridor. As a precautionary measure a 'clean on entry, clean on exit' policy should be implemented during the project as outlined under the Environment Management Plan (detailed further in section 6) to prevent the introduction or spread of these pathogens. No diseases that may cause the Grey-headed Flying-fox to decline are likely to become established in the study area as a result of the project.
Interfere with the recovery of the species
The project would not remove habitat critical to the survival of the species. The project would not directly impact on any local roost camps for the local population and no impacts on the breeding success of the local population are anticipated. The draft recovery plan for the Grey-headed Flying-fox (DECCW, 2009) identifies the protection of foraging resources as a key recovery objective. The project is located in a highly urbanised environment, and would involve the removal of small, linear patches of mostly planted trees. This habitat does not constitute habitat critical to the survival of the Grey-headed Flying-fox. This habitat loss represents a minor proportion of the potential foraging habitat for the Grey-headed Flying-fox within a 50 kilometre radius of local roost camps. As such, the removal and modification of this foraging habitat is not likely to interfere substantially with the recovery of the species.
Conclusion
The project is unlikely to have a significant impact on the Grey-headed Flying-fox as: • The project is located in a highly urbanised environment • No breeding camps would be directly impacted

Assessment of significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)
• Removal of foraging habitat would be restricted to the loss of small, linear patches of foraging habitat located along the rail corridor, existing roads and in urban areas • This habitat loss represents a minor proportion of the potential foraging habitat for the Grey-headed Flying-fox within a 50 kilometre radius of local roost camps • It would not impact movements between breeding camps and foraging grounds.

Appendix D – Framework for Biodiversity Assessment Data

Survey time matrix

Common name	Scientific name	Predicted by credit calculator[1]	BioNet records in locality[2]	Date of most BioNet recent record	Jan[3]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Habitat at site ?[4]	Recorded at site ?
Allocasuarina glareicola	*Allocasuarina glareicola*	N	1	10/09/1996	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Australasian Bittern	*Botaurus poiciloptilus*	N	6	16/09/2013	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Bauer's Midge Orchid	*Genoplesium baueri*	N	1	7/01/2011	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N
Black Bittern	*Ixobrychus flavicollis*	N	1	22/11/2005	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Bynoe's Wattle	*Acacia bynoeana*	N	2	7/01/2011	Y	Y	Y	N	N	N	N	N	Y	Y	Y	Y	N	N
Camarophyllopsis kearneyi	*Camarophyllopsis kearneyi*	Y	N/A	N/A	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	N	N
Camfield's Stringybark	*Eucalyptus camfieldii*	N	1	7/01/2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Cumberland Plain Land Snail	*Meridolum corneovirens*	Y	14	8/10/2013	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Darwinia biflora	*Darwinia biflora*	N	1	7/01/2011	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	N	N
Deane's Paperbark	*Melaleuca deanei*	N	2	19/01/2012	Y	Y	N	N	N	N	N	N	N	N	N	Y	N	N
Dillwynia tenuifolia	*Dillwynia tenuifolia*	Y	N/A	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Downy Wattle	*Acacia pubescens*	Y	4673	7/10/2015	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	N	122	28/04/2015	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	N
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	N	3	19/09/2011	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	N
Eastern Freetail-bat	*Mormopterus norfolkensis*	N	16	22/11/2010	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	N
Eastern Osprey	*Pandion cristatus*	Y	21	31/08/2015	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N

Common name	Scientific name	Predicted by credit calculator[1]	BioNet records in locality[2]	Date of most BioNet recent record	Jan[3]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Habitat at site ?[4]	Recorded at site ?
Eastern Pygmy-possum	*Cercartetus nanus*	Y	3	9/03/2012	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	N	N
Epacris purpurascens subsp. *purpurascens*	*Epacris purpurascens* subsp. *purpurascens*	Y	23	7/01/2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Green and Golden Bell Frog	*Litoria aurea*	Y	12226	11/06/2015	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	N	N
Grey-headed Flying-fox	*Pteropus poliocephalus*	N	411	25/05/2015	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
Gyrostemon thesioides	*Gyrostemon thesioides*	Y	N/A	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Hairy Geebung	*Persoonia hirsuta*	N	1	7/01/2011	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	N	N
Hibbertia puberula	*Hibbertia puberula*	Y	3	22/10/2014	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	N	N
Hibbertia stricta subsp. *furcatula*	*Hibbertia stricta* subsp. *furcatula*	N	8	7/12/2011	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y	N	N
Hibbertia superans	*Hibbertia superans*	Y	N/A	N/A	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N
Hygrocybe anomala subsp. *ianthinomarginata*	*Hygrocybe anomala* subsp. *ianthinomarginata*	Y	N/A	N/A	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N
Hygrocybe austropratensis	*Hygrocybe austropratensis*	Y	N/A	N/A	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N
Hygrocybe collucera	*Hygrocybe collucera*	Y	N/A	N/A	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N
Hygrocybe griseoramosa	*Hygrocybe griseoramosa*	Y	N/A	N/A	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N
Hygrocybe lanecovensis	*Hygrocybe lanecovensis*	Y	N/A	N/A	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N
Hygrocybe rubronivea	*Hygrocybe rubronivea*	Y	N/A	N/A	N	N	N	N	Y	Y	Y	Y	N	N	N	Y	N	N

Common name	Scientific name	Predicted by credit calculator[1]	BioNet records in locality[2]	Date of most BioNet recent record	Jan[3]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Habitat at site ?[4]	Recorded at site ?
Hypsela sessiliflora	*Hypsela sessiliflora*	N	1	7/01/2011	N	N	N	N	N	N	N	N	Y	Y	Y	N	N	N
Koala	*Phascolarctos cinereus*	Y	N/A	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Little Bentwing-bat	*Miniopterus australis*	N	2	31/03/2005	N	Y	Y	Y	N	N	N	N	N	Y	Y	Y	N	N
Large-eared Pied Bat	*Chalinolobus dwyeri*	Y	N/A	N/A	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	N	N
Long-nosed Bandicoot population in inner western Sydney	*Perameles nasuta*	N	25	31/07/2015	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Magenta Lilly Pilly	*Syzygium paniculatum*	Y	14	5/05/2015	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Marsdenia viridiflora subsp. *viridiflora*	*Marsdenia viridiflora R. Br. subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas*	N	334	6/11/2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Matted Bush-pea	*Pultenaea parviflora*	N	1	11/02/1999	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Matted Bush-pea	*Pultenaea pedunculata*	Y	4	6/12/2007	N	N	N	N	N	N	N	N	Y	Y	Y	N	N	N
Narrow-leafed Wilsonia	*Wilsonia backhousei*	N	59	27/05/2013	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Netted Bottle Brush	*Callistemon linearifolius*	Y	32	2/06/2014	Y	Y	Y	N	N	N	N	N	Y	Y	Y	Y	N	N

Common name	Scientific name	Predicted by credit calculator[1]	BioNet records in locality[2]	Date of most BioNet recent record	Jan[3]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Habitat at site ?[4]	Recorded at site ?
Nodding Geebung	*Persoonia nutans*	Y	13	18/11/2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Pimelea curviflora subsp. *curviflora*	*Pimelea curviflora* subsp. *curviflora*	Y	1	7/01/2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Plum-leaf Pomaderris population	*Pomaderris prunifolia - endangered population*	Y	14	12/10/2009	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Regent Honeyeater	*Anthochaera phrygia*	Y	1	17/06/1996	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Small-flower Grevillea	*Grevillea parviflora subsp. parviflora*	Y	N/A	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Small Pale Grass-lily	*Caesia parviflora var. minor*	N	1	21/12/2001	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	N	N
Sooty Tern	*Onychoprion fuscata*	N	1	15/02/2013	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	N	N
Southern Myotis	*Myotis macropus*	N	481	19/11/2014	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	N
Spiked Rice-flower	*Pimelea spicata*	N	304	23/09/2015	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Sydney Plains Greenhood	*Pterostylis saxicola*	N	3	7/01/2011	N	N	N	N	N	N	N	N	Y	Y	Y	N	N	N
Square-tailed Kite	*Lophoictinia isura*	N	7	21/02/2016	Y	Y	Y	N	N	N	N	N	Y	Y	Y	Y	Y	N
Squirrel Glider	*Petaurus norfolcensis*	Y	N/A	N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Sunshine Wattle	*Acacia terminalis subsp. terminalis*	N	42	26/04/2010	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Tetratheca glandulosa	*Tetratheca glandulosa*	Y	N/A	N/A	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	Y	N
Thick Lip Spider Orchid	*Caladenia tessellata*	Y	1	7/01/2011	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N
Wahlenbergia multicaulis (Tadgells	*Wahlenbergia multicaulis -*	Y	63	7/11/2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N

Common name	Scientific name	Predicted by credit calculator[1]	BioNet records in locality[2]	Date of most BioNet recent record	Jan[3]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Habitat at site ?[4]	Recorded at site ?
Bluebell) population	*endangered population*																	
White-fronted Chat	White-fronted Chat population in the Sydney Metropolitan Catchment Management Area	N	191	6/04/2010	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Woronora Beard-heath	*Leucopogon exolasius*	N	1	2/06/2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	N	4	26/01/2012	N	N	N	N	N	N	N	N	N	N	N	N	Y	N
Zannichellia palustris	*Zannichellia palustris*	N	4	18/04/2013	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N

Notes:
1. Predicted by Credit calculator – Y indicates that the species was identified by the credit calculator as a candidate species based on the Threatened Species profile database.
2. BioNet records in the locality – the number of records of the species in the BioNet database, in the locality of the study area, in the last 20 years.
3. Y indicates that targeted surveys for the candidate species may be conducted in that month according to the BBAM. Shading indicates that targeted surveys for the species were conducted in that month.
4. Habitat at site? – Y indicates that suitable habitat for the species as defined by the credit calculator and/or the threatened species profile (OEH, 2016d) and other literature is present at the site. N means that specific habitat resources are not present.

Plot/transect data

Vegetation Zone	Veg Type ID	Plot ID	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Over storey regeneration	Total length of fallen logs	Easting	Northing	Zone
1	HN604	Benchmark	39	25-35	25.5-40.5	18.9-28.9	0-10	18.9-28.9	0	> = 0	1	> = 0			
		2	20	77	6.5	30	2	8	22	0	0.33	0	327479	6246308	56
		6	15	7	6	46	0	0	48	0	0.33	0	322592	6245246	56
2	HN604	Benchmark	39	25-35	25.5-40.5	18.9-28.9	0-10	18.9-28.9	0	> = 0	1	> = 0			
		1	9	3.5	0	52	0	0	64	0	0	0	328180	6246131	56
		5	15	0.1	56	42	8	6	48	0	0	0	320836	6244510	56
3	HN512	Benchmark	38	25.6-13	30.3-14.7	24.6-0	10-14.7	24.6-0	0	> = P	1	> = 0			
		3	12	26	51	8	16	8	34	0	0	0	319932	6244542	56
		4	11	66	17	20	0	2	36	1	0	1.5	319266	6245152	56

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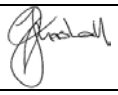
0	K. Crosby	J.Tipping		G. Marshall		25/08/2017

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