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bushfire & ecology

Biodiversity Assessment Report

Macarthur Gardens North
Goldsmith Avenue,
Campbelltown

MARCH 2017
(REF: A16113BIO)



Biodiversity Assessment Report

**Lot 1097 DP 118255
Goldsmith Avenue, Campbelltown**

March 2017

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Executive Summary

Travers Bushfire and Ecology has been engaged by *UrbanGrowth NSW* to prepare a Biodiversity Assessment Report (BAR) in accordance with the BioBanking Assessment Methodology (BBAM) (OEH 2014) for a residential development located on the southern side of Goldsmith Avenue, Campbelltown, within the local government area (LGA) of Campbelltown.

Purpose of the BAR

The aim of the BAR is to assess the potential impacts of the proposed residential development on flora and fauna with regard to the BBAM 2014.

All impacts on native vegetation on the site should be avoided wherever possible and, if not avoided, suitably offset. Potential impacts should be assessed in accordance with relevant Office of Environment and Heritage guidelines, by a person accredited in accordance with s142B(1)(c) of the Threatened Species Conservation Act 1995.

This report has been prepared by accredited BioBanking assessors - Michael Sheather-Reid No# 204 and Lindsay Holmes No# 199.

BAR assessment results

The project involves the partial removal of native vegetation within the site of just over 75%. This includes the removal of 3.60 ha of River-flat Eucalypt Forest on Coastal Floodplains (PCT 835, ME018) and 2.23 ha of Cumberland Plain Woodland (PCT 849, ME020).

The proposed works are critical stormwater drainage works for flood mitigation and urban development and modifications have been made to minimise the impacts. However significant reconstruction of the existing drainage corridor is required to manage the expected flows resulting in the loss of native vegetation and associated habitat within the site.

Avoidance of the existing native vegetation is not considered feasible and significant revegetation works can be undertaken to provide an integrated outcome. A decision has been made by *UrbanGrowth NSW* to provide BioBanking offsets for the loss of vegetation and associated habitat within the site.

The proposal will impact upon the endangered ecological communities known as Cumberland Plain Woodland and Riverflat Eucalypt Forest. The proposal will also impact upon threatened species including Little Lorikeet, Grey-headed Flying-fox, Cumberland Plain Land Snail and Eastern Bentwing-bat and associated habitat.

Potential indirect impacts could include but not be limited to:

- Sedimentation and run off;
- Noise, dust and light spill;
- Impacts to adjoining vegetation and habitat;
- Introduction of feral pests, weeds and pathogens;
- Infrequent or cumulative impacts; and
- Operations phase impacts (trampling of vegetation, rubbish dumping, noise etc).

The loss of biodiversity value has been assessed by using the BioBanking credit calculator, which considers landscape values, patch size, quality of vegetation and fauna habitat. The resulting loss in biodiversity in credits is as follows:

- 74 ecosystem credits for ME020 / PCT 849 (Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin).
- 121 ecosystem credits for ME018 / PCT 835 (Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion)
- 76 species credits would be required for Cumberland Plain Land Snail.

Species credits were not proposed for the Grey-headed Flying-fox and Eastern Bentwing-bat as there was not considered to be breeding habitat impacted by the proposal, and they would be suitably offset through the ecosystem credits.

Red Flag Variation reports

An application for a red flag determination is required for the following red flag matters:

- Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion
- 4th order stream – Bow Bowling Creek

The application for a red flag determination should address the criteria set out in the BBAM. Please note that a BioBanking statement cannot be issued unless the determination is approved.

EPBC Act referral

In respect of matters required to be considered under the *Environment Protection and Biodiversity Conservation Act 1999*, the following were recorded within the development site:

- Grey-headed Flying-fox - The proposal is not considered to have a significant impact upon matters of national environmental significance.
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest - The proposal is considered to have a significant impact upon matters of national environmental significance due to the proposed action causing impact on a NES matter, Cumberland Plain Woodland that has a patch size of greater than 0.5 ha.

A referral to DoEE is required for assessment under the EPBC Act.

Proposed offsetting strategy

The required ecosystem and species credits can be purchased from a BioBank market within the same or an adjoining IBRA sub-region. Alternatively the offsets can be provided by the identification and supply of a suitable biobank site to retire the credits.

Section 8 of the report details the findings and options for sourcing the requirements using the BioBanking Public Register.

Mitigation measures

The following mitigation measures are proposed to minimise the potential ecological impacts, address threatening processes and to create a positive ecological outcome for fauna, their habitat and endangered ecological communities. They include:

- Preclearance habitat searches and relocation of any wildlife in existing habitat trees under the supervision of a fauna ecologist in accordance with a relocation protocol.
- Sediment and erosion control measures are to be installed immediately prior to the commencement of demolition, construction and earthworks.
- Inspection and removal of any aquatic fauna from the existing dams
- Installation of protective fencing around drip zone of trees that interface with the development site to be retained.
- Sediments are to be effectively retained within the site to minimise deterioration of surface runoff during the construction works.
- Establish sediment basins to collect any sediment mobilised from the site Remove fill, stabilise and revegetate with wetland and CPW species; and
- Stabilisation of proposed restoration areas.
- Loss of vegetation compensated by the planting of EEC vegetation along the reconstructed drainage line. Revegetation will enhance or replace lost foraging trees for birds and bats.
- Aim to filter any runoff through sedge planted swales and / or bioretention basins to minimise deposition within the creek line(s).
- Target weed control should be undertaken in revegetation areas and retained vegetation areas, focussing upon invasive and noxious weed species.
- A vegetation management plan is to be prepared to identify restorations measures and to stipulate all habitat enrichment and fauna relocation protocols
- Project management plans to manage development activities on site.

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Appendix D – Biobanking Report
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List of abbreviations

AHD	Australian Height Datum
BAR	Biodiversity Assessment Report
BBAM	BioBanking Assessment Methodology (OEH 2014)
BOM	Bureau of Meteorology
BOS	Biodiversity Offset Strategy
BVTID	Biometric vegetation type identification
CEEC	Critically endangered ecological community
CPW	Cumberland Plain Woodland
DA	Development Application
DECCW	Department of Environment Climate Change and Water
Development site	The project disturbance area
DoEE	Commonwealth Department of the Environment & Energy
DP&E	NSW Department of Planning and Environment
EEC	Endangered ecological community
EIS	Environmental Impact Statement
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
FBA	Framework for Biodiversity Assessment
FFA	Flora and Fauna Assessment
FM Act	NSW <i>Fisheries Management Act 1994</i>
GDE	Groundwater Dependent Ecosystem
GIS	Geographic Information System
IBRA	Interim Biogeographic Regionalisation for Australia
Inner assessment circle	A 100 ha area surrounding the development site
LGA	Local Government Area
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	NSW Office of Environment and Heritage of the Department of Premier and Cabinet
Outer assessment circle	A 1000 ha area of the development site
PCT	Plant Community Type
TEC	Threatened Ecological Community
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i>
VIS	Vegetation Information System



Introduction

1

Travers Bushfire and Ecology has been engaged by *UrbanGrowth NSW* to prepare a Biodiversity Assessment Report (BAR) in accordance with the BioBanking Assessment Methodology (BBAM) (OEH 2014) for a residential development located on the southern side of Goldsmith Avenue, Campbelltown, within the local government area (LGA) of Campbelltown (Figure 1). The approximate size of the site is 18.32 ha.

1.1 Purpose

This report draws upon information within a recent ecological assessment undertaken by *Travers bushfire & ecology* in September 2016 and has been prepared by Accredited Biobanking Assessors - Michael Sheather-Reid No. 204 and Lindsay Holmes No. 199.



Figure 1 – Study area

1.2 Project description

The study area is the Macarthur Gardens North precinct, part of the Masterplan for the Macarthur Regional Centre. The existing Macarthur Gardens to the south of the rail line has already been completed and the proposed development outlined in this report is therefore the next and final stages of the development.

In the Masterplan, Macarthur Gardens North consists of a constructed level residential subdivision development platform in the north and a conservation area along Bow Bowing Creek in the south. The development application is staged and is to address the removal of existing vegetation and undertake bulk earthworks required to fill the development parcel and realign Bow Bowing Creek. The creek realignment is considered necessary to construct a creek corridor to manage the stormwater flows and mitigate flooding for the upstream and adjacent urban development that drains through the Bow Bowing Creek corridor.

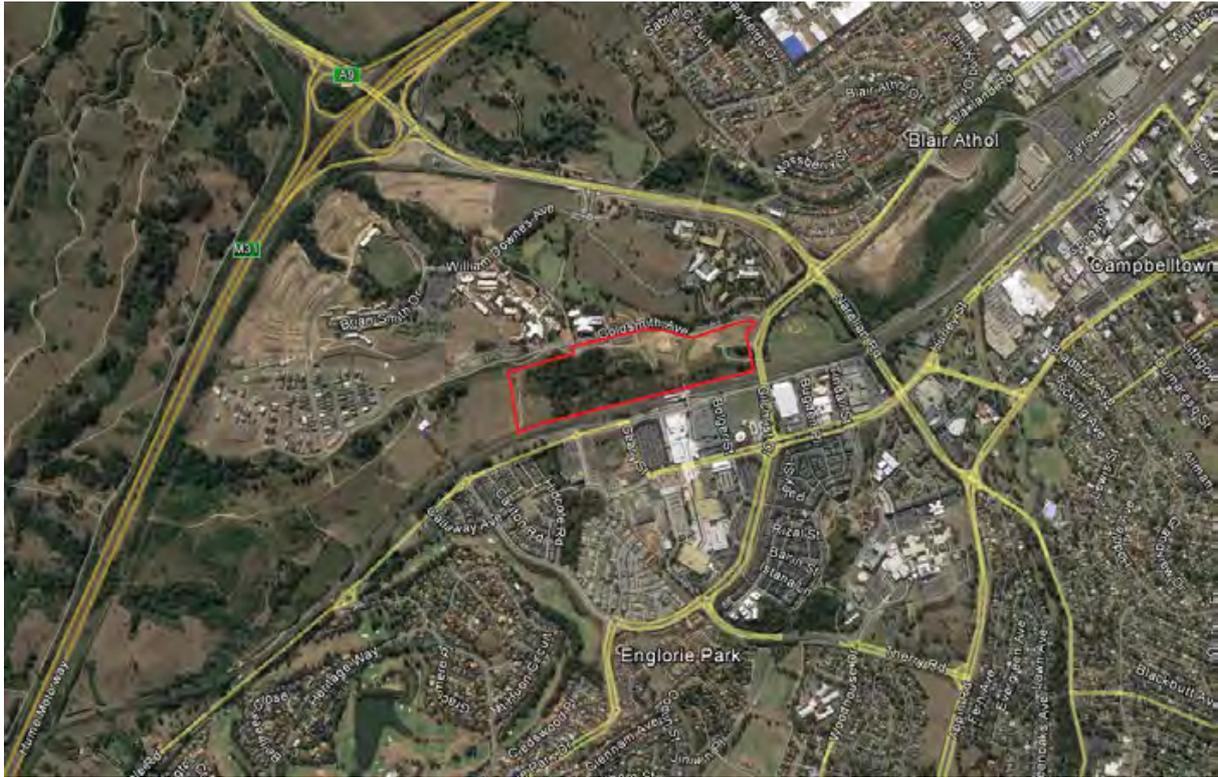


Figure 3 – Site locality

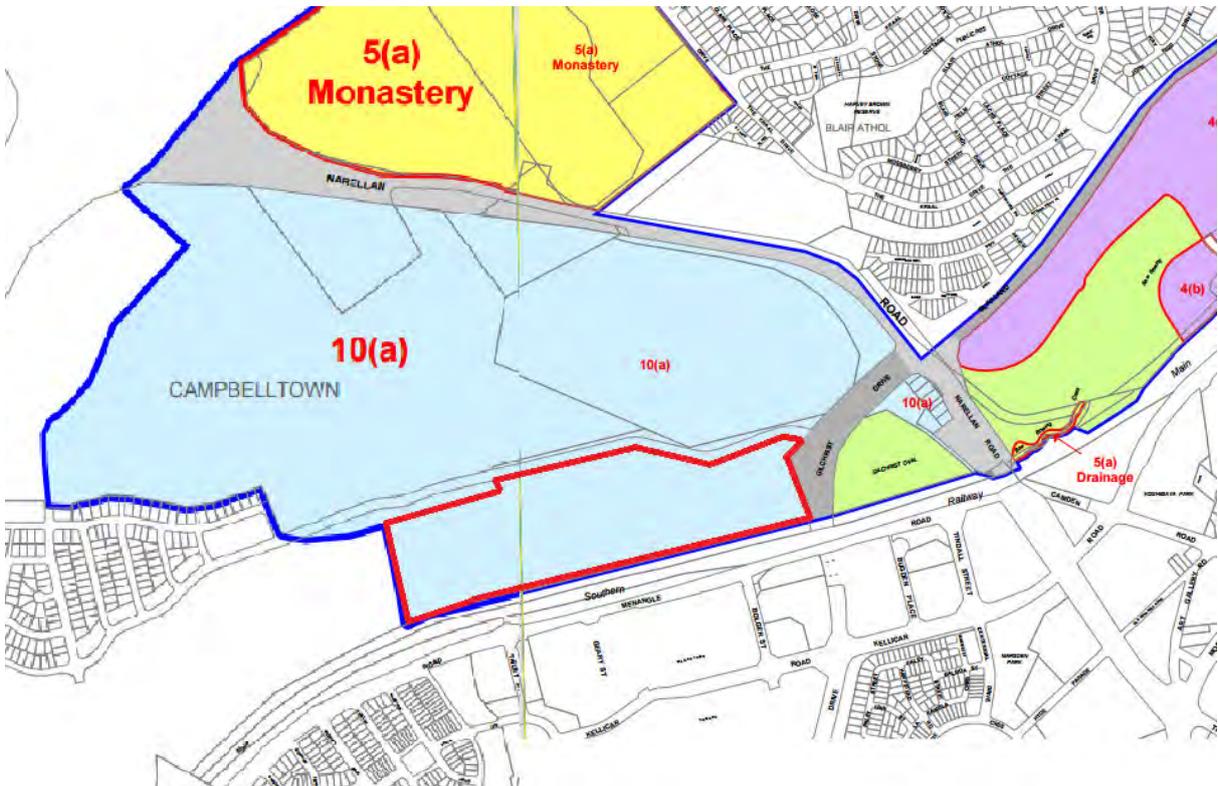


Figure 4 – Land zoning

1.2.2 Identification of development site footprint

Whilst the entire site is 18.32 ha, an estimated 5.83 ha of native vegetation will be directly impacted. Non-native vegetation or planted vegetation, along with creek lines and dams that do not relate to any PCT will also be impacted.

1.3 General description of development site

Table 1 provides a summary of the planning, cadastral, topographical, and disturbance details of the subject site.

Bow Bowling Creek bisects the site, running in a generally east-west direction. It has at least one tributary running off it to the south under the main southern railway line in the west, and there is an offshoot along the southern side of the creek which does not extend beyond the site. There are 2 dams in the eastern portion of the study area and planted vegetation along the former intersection of Gilchrist Drive and Goldsmith Avenue.

Along a portion of the northern boundary is university car parking facilities. The central northern and central eastern portions of the site have been heavily modified with cut and fill mounds, waste piles and new drainage works. There is also a walkway which is directing pedestrian traffic from Macarthur railway station to Goldsmith Avenue for university people and nearby residences. Near the western boundary is an existing track which continues on to adjoining properties.

Table 1.1 – Site features

Location	Lot 1097 DP 118255 Goldsmith Avenue, Campbelltown
Local government area	Campbelltown
Grid reference	296500E 6227700N
Elevation	70-80m AHD
Topography	Gently undulating site with the lower contours near the southern boundary (creek line) and some incised areas for drainage lines which are offshoots of Bow Bowling Creek.
Geology and soils	Geology; Quaternary Alluvium near the southern boundary of the site which relates to Bow Bowling Creek, otherwise Ashfield Shale dominates. Soils; Blacktown Soil Landscape.
Catchment and drainage	Bow Bowling Creek runs eastward through the study area and onwards into lower portions of this creek which has been subject to channel alignments and flood mitigation works. Bow Bowling Creek flows into Bunbury Curran Creek and eventually into the Georges River.
Vegetation	Where present, native vegetation has a woodland structure. Trees are around 15-25m tall in most areas, unless they are young regrowth patches. A native mid-storey is usually present with a moderate proportion of native groundcovers. Vegetation along the main creek line in the central portion of the study area is largely exotic.
Existing land use	Non-vegetated portions of the study area not subject to flora and fauna assessment are in the process of development. Vegetated portions of the study area are generally highly disturbed or regrowth areas not currently utilised.
Clearing	The majority of the study area has been previously cleared for agricultural land uses. Aerial photography from 1969 shows the site as almost totally cleared with the exception of a few large trees along the creek margins as well as two other trees.

1.4 Information sources

1.4.1 Database analysis

A number of databases were utilised as part of this assessment, including:

- Atlas of NSW Wildlife (Bionet);
- EPBC coordinate search tool;
- Threatened Species Profile Database;
- Vegetation Information System (VIS) Classification Database;
- Department of Primary Industries threatened and protected species – records viewer; and
- Bureau of Meteorology (BOM).

1.4.2 Literature review

A review of ecological literature relevant to the development site was undertaken as part of this assessment to evaluate the biodiversity values. Key documents reviewed for this BAR include:

- Flora and Fauna Assessment (*Travers bushfire & ecology*, August 2016)
- Tree Assessment (*Travers bushfire & ecology*, October 2016)
- CAD plans (*J Wyndam Prince*, 2016)
- Relevant sections of Campbelltown's LEP, 2015
- Sydney Metropolitan Catchment Management Authority vegetation mapping (2013).

1.4.3 Aerial photography

The BAR has utilised two (2) sources of aerial imagery:

- *NearMap* dated either 29/04/16 or 27/08/16.
- *Google Earth* dated 05/05/16.

The following figures 5 to 7 provide site layout and location.

Appendix E shows the site map and location map at the required scales in BBAM 2014.

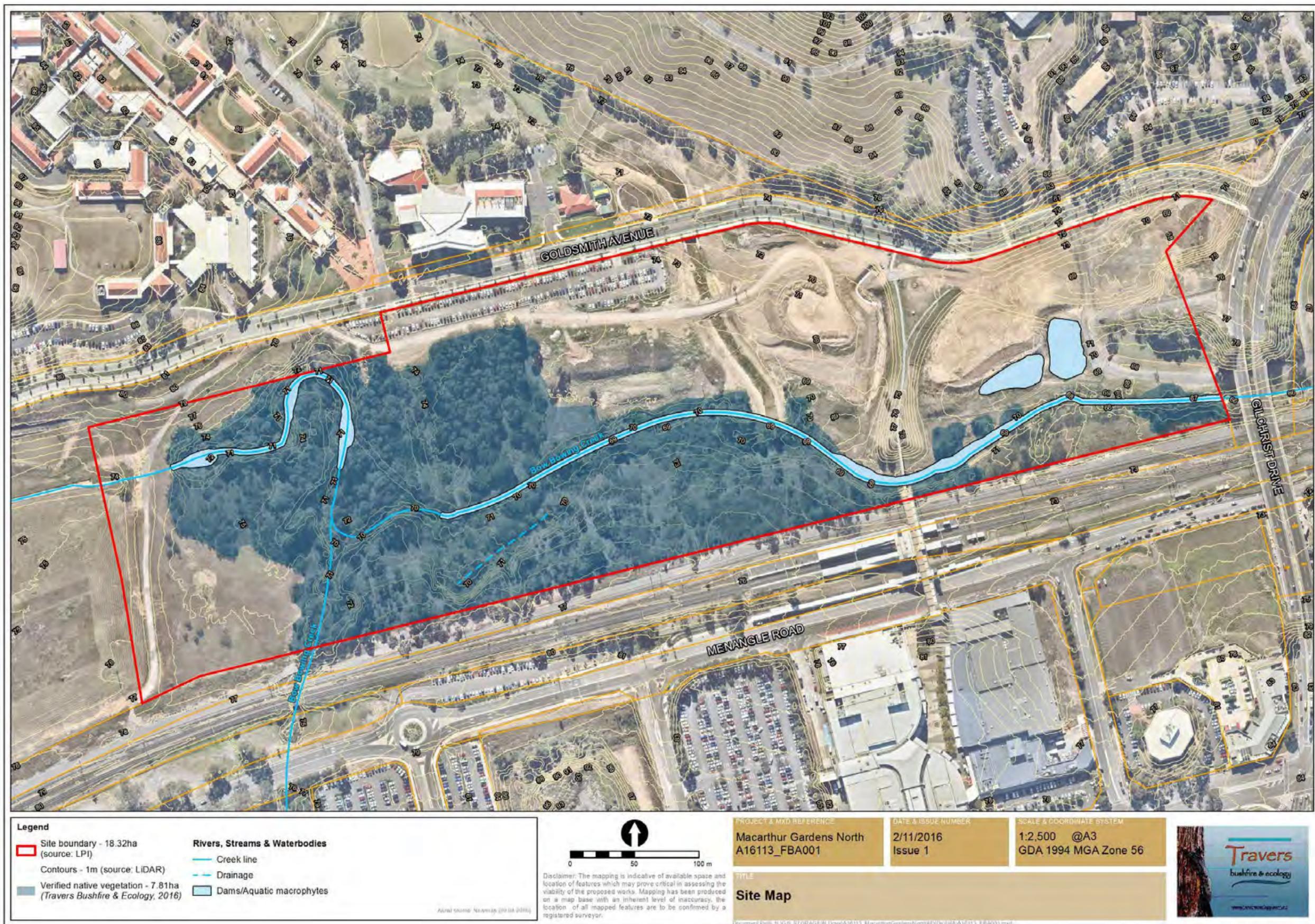


Figure 5 – Site map

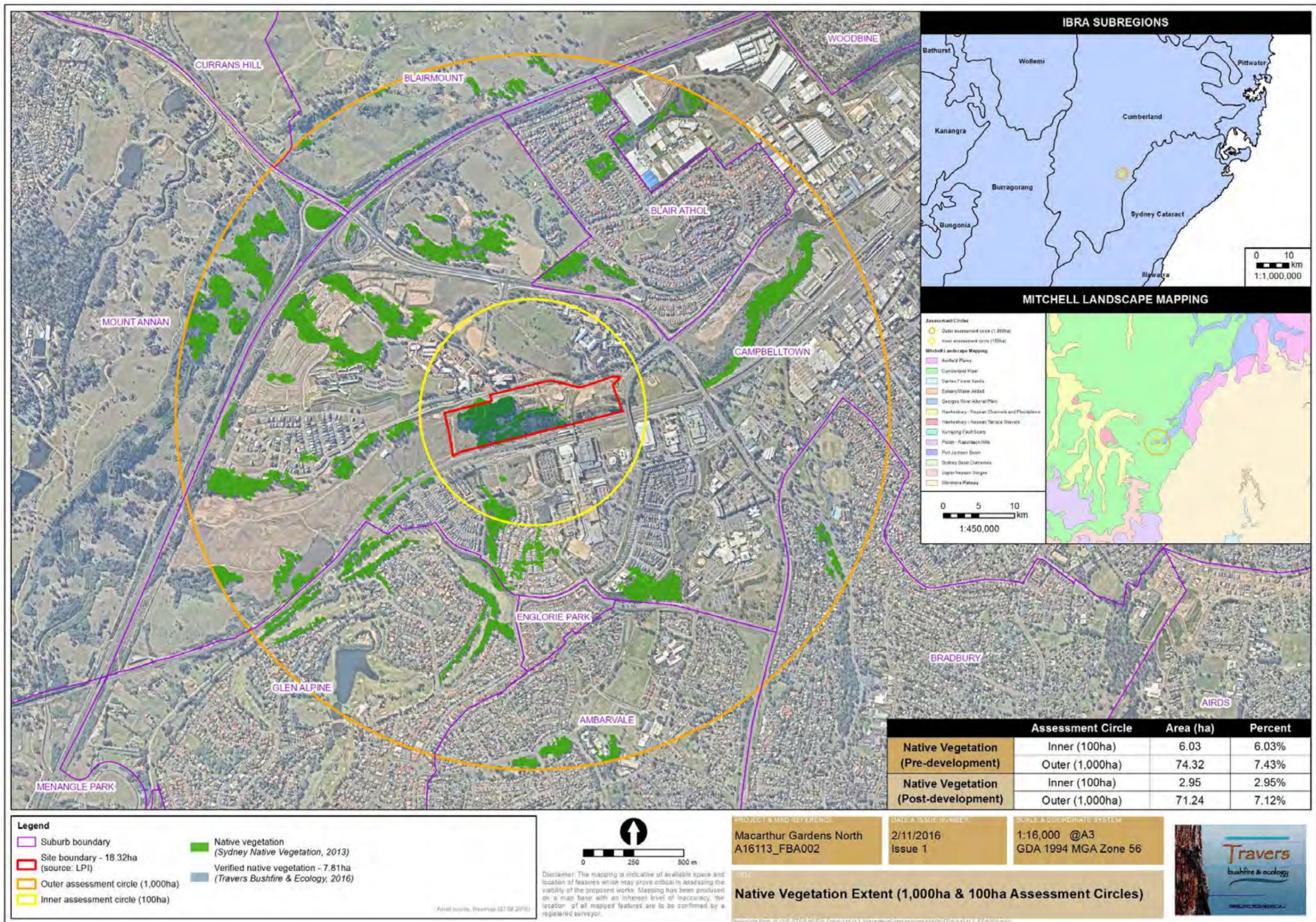


Figure 6 – Location map

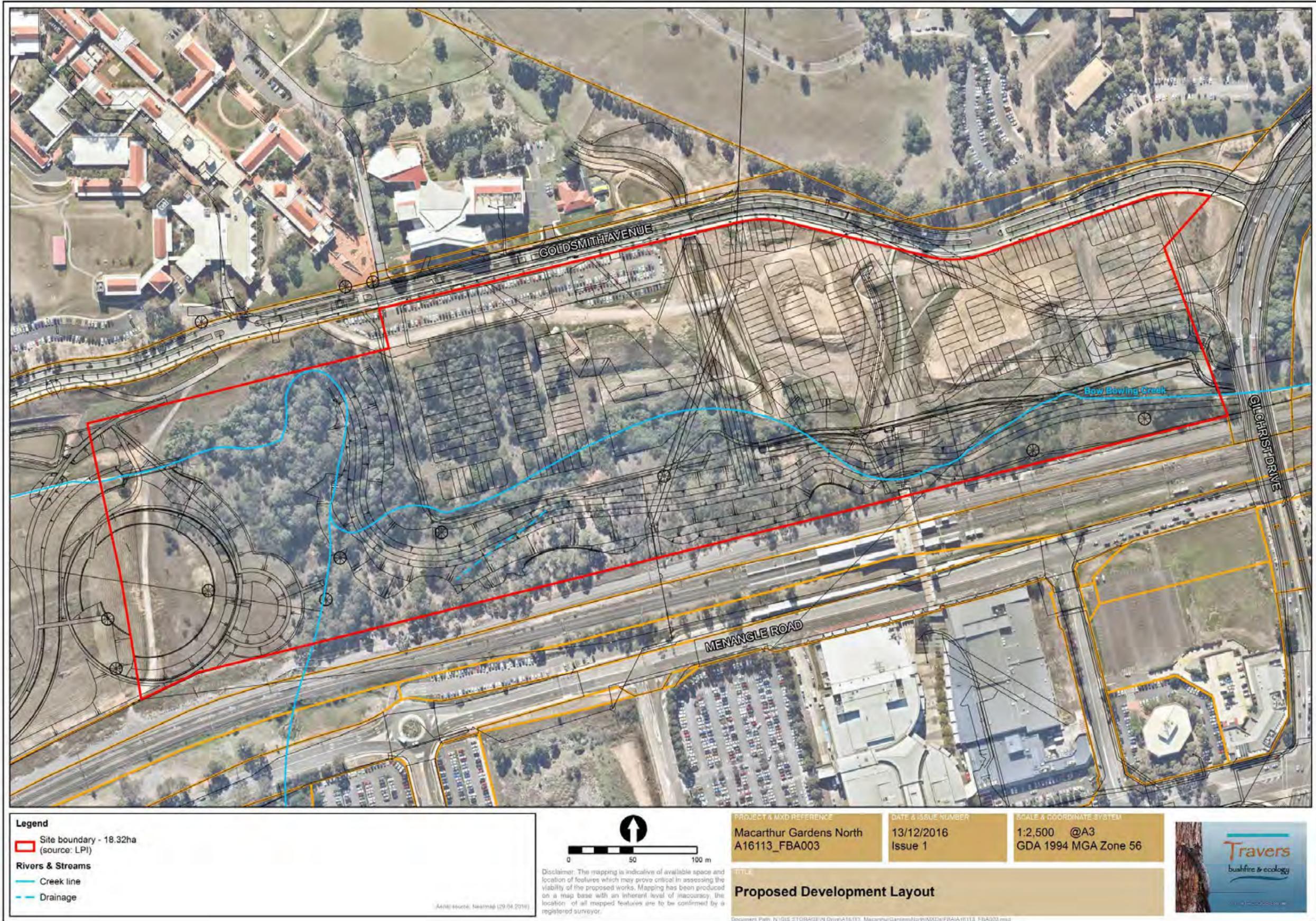


Figure 7 – Proposed development layout



Legislation and policies

2

2.1 Commonwealth

2.1.1 *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* is the Australian Government's principal piece of environmental legislation and is administered by the Commonwealth Department of the Environment & Energy (DoEE). It is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES), which include threatened species of flora and fauna, endangered ecological communities, migratory species as well as other protected matters. Among other things, it defines the categories of threat for threatened flora and fauna, identifies key threatening processes and provides for the preparation of recovery plans for threatened flora, fauna and communities.

Under the *EPBC Act*, any action (which includes a development, project or activity) that is considered likely to have a significant impact on MNES must be referred to the Commonwealth Minister for the Environment.

In respect of matters required to be considered under the *EPBC Act*, one (1) threatened fauna species Grey-headed Flying-fox (*Pteropus poliocephalus*), no protected migratory bird species, no threatened flora species, and one (1) EEC *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* listed under this Act were recorded within the study area.

Several hundred Grey-headed Flying-fox were observed in flight heading west over the study area during early nocturnal survey on 6 July 2016. Based on this observation a roost site is expected in the local region. There were no trees flowering within the study area at this time and subsequently there was no observation of this species foraging within the site, although this is expected on a seasonal basis. There is no likelihood of this species utilising the site for roosting and subsequent breeding habitat.

The Significant Impact Criteria for a vulnerable species listed under the *EPBC Act* was reviewed to assess the impacts on this species as a result of the proposed subdivision layout within the subject site. As the subject site does not contain any likely roosting or subsequent breeding habitat and foraging habitat will remain well represented in the locality, it is concluded that there will not be any significant impact on this species, or other nationally listed threatened fauna species with potential to occur, as a result of the subdivision proposal.

The proposed subdivision development is considered to have a significant impact on *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest*. Given the impact is upon a matter of national environmental significance, a referral to Department of Environment & Energy (DoEE) is required.

2.1.2 Environmental Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy

Under the *Environmental Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*, environmental offsets are actions taken to counterbalance significant residual impacts on MNES. Offsets are used as a last resort in instances where an action will give rise to residual impacts, even after the application of management measures.

The policy came into force in October 2012 and provides guidance on the role of offsets in environmental impact assessments and how DoEE considers the suitability of a proposed offset package (SEWPaC 2012). According to the policy, an offsets package is a “*suite of actions that a proponent undertakes in order to compensate for the residual significant impact of a project*” (SEWPaC 2012). It can comprise a combination of direct offsets and other compensatory measures.

The project will result in a significant impact to MNES upon Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and, as such, offsets will be required under the *EPBC Act*.

2.2 New South Wales

2.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act (EP&A Act)* is the overarching planning legislation in NSW that provides for the creation of planning instruments that guide land use. The *EP&A Act* also provides for the protection of the environment, including the protection and conservation of native animals and plants. This includes threatened species, populations and ecological communities, and their habitats of biodiversity values, as listed in the *NSW Threatened Species Conservation Act 1995 (TSC Act)* and *NSW Fisheries Management Act 1994 (FM Act)*. The protection of the environment is addressed in Section 5A of the *EP&A Act* - Significant effect on species, populations or ecological communities or their habitats.

Once the project goes down the avenue of assessment under BBAM 2014, this switches off any requirement for assessment under the *EP&A Act* provided a BioBanking Statement is approved.

An assessment of the quantum and type of impacts resulting from the project on biodiversity values and measures to avoid and mitigate these impacts is presented within this BAR.

2.2.2 Threatened Species Conservation Act 1995

The *TSC Act* is the key piece of legislation in NSW relating to the protection and management of biodiversity and threatened species. The *TSC Act* aims to protect and encourage the recovery of threatened species, populations and communities that are listed under the Act through threat abatement and species recovery programs. The *TSC Act* requires consideration of whether a development (Part 4) or an activity (Part 5) is likely to significantly impact threatened species, populations, communities or their habitat.

The preparation of a BioBanking Statement under Part 7A of the *TSC Act* is provided as this BAR and respective calculations from the tool.

2.2.3 Fisheries Management Act 1994

The *Fisheries Management Act (FM Act)* provides for the protection, conservation and recovery of fish stocks, key fish habitats, threatened species, populations and ecological communities of fish and marine vegetation as well as management of threats to threatened species, populations and ecological communities defined under the Act. In particular, the *FM Act* has mechanisms for the protection of fish, fish habitats, mangroves, seagrasses and seaweeds on public water land and foreshores. There are two (2) constructed waterbodies and one (1) permanent creek line (Bow Bowing Creek) which is proposed to be partially realigned. There has been some recent drainage works undertaken on the northern side of Bow Bowing Creek however these new areas have no potential habitat for aquatic fish or similar.

In respect of matters relative to the *FM Act*, no suitable habitat for threatened marine or aquatic species was observed within the subject site and there are no matters requiring further consideration under this Act.

2.2.4 Water Management Act 2000

The Act recognises:

- the fundamental health of our rivers and groundwater systems and associated wetlands, floodplains, estuaries has to be protected
- the management of water must be integrated with other natural resources such as vegetation, soils and land
- to be properly effective, water management must be a shared responsibility between the government and the community
- water management decisions must involve consideration of environmental, social, economic, cultural and heritage aspects
- social and economic benefits to the state will result from the sustainable and efficient use of water.

The *Water Management Act 2000* was driven by the need for NSW to secure a sustainable basis for water management for several reasons:

- NSW was at the limit of its available water resources – new licences for commercial purposes could no longer be issued across most of NSW and a limit had been placed on the total volume of water that could be extracted across the inland of NSW under the Murray–Darling Basin Cap.
- The decline in the health of our rivers, groundwater, floodplains and estuaries was evident with increasing water quality problems, loss of species, wetland decline and habitat loss.

The *Water Management Amendment Act 2014* was implemented in January 2015 which saw some changes and additions to the 2000 regulations.

The Act sets about licencing and approvals for works affecting waterways, fines and offences and special features such as water harvesting. The project will need approvals from WaterNSW and licences to undertake the proposed works for creek realignment. The licencing needs to be sourced and supplied as part of the development application works.



Landscape features

3

3.1 Landscape features

For the purposes of this BAR, a 100 ha inner assessment circle and 1,000 ha outer assessment circle was established for identifying the landscape features associated with the project.

3.1.1 IBRA bioregions and IBRA subregions

i. Bioregions

Development site: Sydney Basin Bioregion (100%)

Outer assessment circle: Sydney Basin Bioregion (100%)

The Development Site and outer assessment circle are wholly contained within the Sydney Basin Bioregion. This bioregion occupies approximately 3.6 million hectares (4.5% of NSW) and extends from just north of Batemans Bay to Nelson Bay, and almost as far west as Mudgee (NSW NPWS 2003). The Sydney Basin Bioregion is one of the most species diverse in Australia, which is the result of the variety of rock types, topography and climates in the bioregion (NSW NPWS 2003). This bioregion contains significant flora, fauna and wetlands.

The site in relation to IBRA bioregions is shown in Figure 8, and subregions in Figure 9.

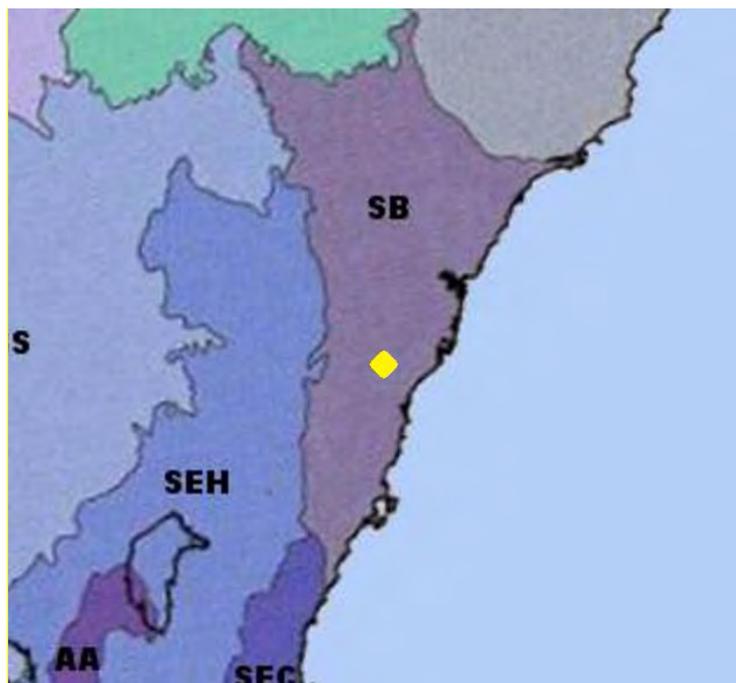


Figure 8 – IBRA bioregions

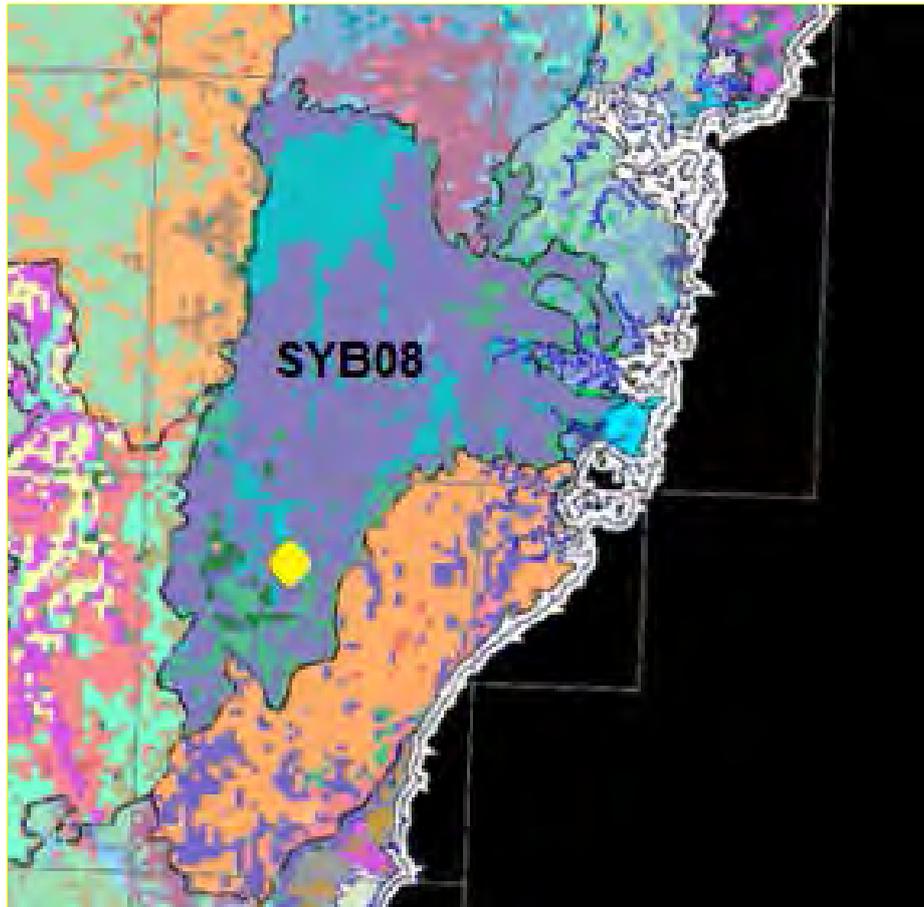


Figure 9 – Approximate location of site within IBRA subregion SYB08

ii. Subregions

Development site: Cumberland Subregion, SYB08 (100%)

Outer assessment circle: Cumberland Subregion (100%)

The development site and outer assessment circle are wholly contained within the Cumberland Subregion. This subregion is typified by low rolling hills and wide valleys in the rain shadow below the Blue Mountains (NSW NPWS 2003). The underlying geology of this subregion predominately comprises Triassic Wianamatta group shales and sandstones (NSW NPWS 2003). Vegetation communities of this subregion that occur in the vicinity of the development site include: Grey Box, Forest Red Gum, Narrow-leaved Ironbark woodland with some Spotted Gum on the shale hills; and Broad-leaved Apple, Cabbage Gum and Forest Red Gum with abundant Swamp Oak on river flats (NSW NPWS 2003).

3.1.2 Mitchell Landscapes

Development site: Cumberland Plain (52.85%) and Georges River Alluvial Plain (47.15%)

Outer assessment circle: Cumberland Plain (85.95%) and Georges River Alluvial Plain (14.05%)

The development site straddles the Cumberland Plain Mitchell Landscape and Georges River Alluvial Plain Mitchell Landscape.

Cumberland Plain Mitchell Landscape - This Mitchell Landscape is characterised by low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast on horizontal Triassic shales and lithic sandstones (DECC 2002). There are some occurrences of volcanic vents and is partly covered by Tertiary river gravels and sands with main streams containing quaternary alluvium. The general elevation of this Mitchell Landscape is between 30 and 120 m. Woodlands and open forest consist of *Eucalyptus moluccana* (Grey Box), *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus eugenioides* (Thin-leaved Stringybark), *Eucalyptus amplifolia* (Cabbage Gum) and *Angophora subvelutina* (Broad-leaved Apple) (DECC 2002). This vegetation has grassy to shrubby understorey often dominated by *Bursaria spinosa* (Australian Boxthorn), poorly drained valley floors, often salt affected with *Casuarina glauca* (Swamp Oak) and *Melaleuca* sp. (DECC 2002).

Georges River Alluvial Plain Mitchell Landscape - This Mitchell Landscape is characterised by channel, floodplain and terraces of the Georges River on Quaternary and Tertiary alluvial sediments. Mostly clayey sand and sand with limited gravel on the highest terrace, general elevation 0 to 30 m, local relief 10m. Massive uniform or gradational profiles on yellow brown to orange clayey sand. Podsolis with well-developed double pans on limited areas of deep quartz sand, stony, harsh, yellow, texture-contrast soils on higher terraces. Forest and woodland of cabbage gum (*Eucalyptus amplifolia*), rough-barked apple (*Angophora floribunda*), broad-leaved ironbark (*Eucalyptus fibrosa* ssp. *fibrosa*), scribbly gum (*Eucalyptus sclerophylla*) and narrow-leaved apple (*Angophora bakeri*). Extensive swamp oak (*Casuarina glauca*) along the riverbanks and in low-lying areas often with prickly-leaved tea-tree (*Leptospermum styphelioides*), these extend to brackish estuarine swamps with grey mangrove (*Avicennia marina*) and limited saltmarsh.

The extent of each Mitchell Landscape in relation to the development site and the outer assessment circle is shown in Figure 6.

3.1.3 Rivers and streams

The development site and outer assessment circle occurs within the Sydney Metropolitan Catchment. Bow Bowling Creek runs through the southern half of the site. It is a 4th order stream and any development or modification of it within 20m either side will require a red flag variation as they are considered to be a regionally significant biodiversity link. The realigned drainage running north in the central eastern portion of the site is a 2nd order stream, as is the stream that runs south under the train line in the western portion of the site. 2nd order streams are not red flagged.

3.1.4 Wetlands

No important or local wetlands occur within the development site. Waterbodies within the outer assessment circle are generally all dams or constructed detention basins within newer development areas.

There are no SEPP 14 wetlands located within the development site or outer assessment circle.

3.1.5 Native vegetation extent

The outer assessment circle, which is 1,000 ha in size, occurs within an area in which a number of broad-scale vegetation mapping projects have been undertaken. To map the extent of native vegetation within the outer assessment circle, the 2013 Sydney Metropolitan CMA vegetation mapping was overlain on a 2016 aerial available through NearMap. The extent of native vegetation cover was measured directly from the data available and utilised by ArcGIS.

3.1.6 State or regionally significant biodiversity links

4th order streams are considered to be red-flagged for 40m both sides of the stream edge and are part of a regionally significant biodiversity link.

Cumberland Plain Priority Conservation Lands have been mapped in the Sydney Basin Bioregion which aim to protect and to some extent, link significant patches of remnant vegetation. Priority Conservation Lands are identified within the approved Cumberland Plain Recovery Plan (DECCW 2011). The nearest Priority Conservation Lands are located 1.2 km to the west which are part of the Mount Annan Botanic Gardens. These are located on or near the outer edge of the 1,000 ha assessment circle.

3.2 Landscape value score

3.2.1 Attributes

i. Percent native vegetation cover

A 100 ha inner assessment circle and 1,000 ha assessment circle were utilised for the project in accordance with BBAM. The assessment circles were centred over the area of native vegetation that is most impacted by the project. As it was considered to be relatively even in terms of impact whether the circles were central or skewed, they were placed central to the development area. The locations of the inner and outer assessment circles are shown on Figure 6.

The current and future percentage of native vegetation cover within the inner and outer assessment circles was determined in increments of 5% using GIS. Measurements that fall half way between the score value (Table 26 of BBAM 2014) such as been 11-15 and 16-20, were rounded up if 15.5 or down if 15.49. Note that areas of native vegetation have been calculated based upon the mapped extent of the Sydney Metropolitan Catchment Area (2013).

Table 3.1 – Current and future extent of native vegetation within the assessment circles

Assessment circle	Current extent of native vegetation			Future extent of native vegetation		
	Area (ha)	% Cover	Score	Area (ha)	% Cover	Score
Inner assessment circle	6.03	6.03	1.5	2.95	2.95	0.75
Outer assessment circle	74.32	7.43	2.5	71.24	7.12	2.5

ii. Connectivity value

Native vegetation on the development site is part of a connecting link when it is linked to adjoining vegetation and native vegetation on the development site:

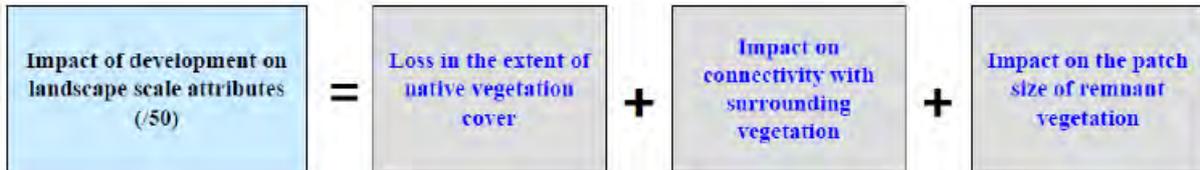
- if it is moderate to good condition, and
- has a patch size >1 ha, and
- is separated by a distance of <100m (or <30m for non-woody ecosystems), and
- is not separated by a large water body, dual carriageway, wider highway or similar hostile link.

iii. Patch size

As the project is a site-based development, patch size has been determined in accordance with BBAM 2014. The development site occurs within the Cumberland Plain Mitchell Landscape and the patch size is estimated at 18-20 ha. The patch size score was calculated as being 3.

3.2.2 Score

Using the results from the assessment of landscape attributes and Equation 4 in Appendix 1 of BBAM 2014, the landscape value score for the development site is 12.80.



Assessment circle details

Assessment circle details

Assessment circle name: 1 Status: Complete
 IBRA sub-region: Cumberland - Sydney Metro Score: 12.80

% Native vegetation cover: % Native Score: 0.75
 Before development: 06-10 After development: 06-10
 Outer assessment circle: 06-10 Inner assessment circle: <=5

Connectivity value

Connectivity value class: Riparian buffer of a 4th or 5th order st Score for connectivity value: 9

Does the development impact on any of the following connectivity value classes ?

Width: Before development: After development: *

Woody vegetation types

Over storey condition: Before development: After development: *

Mid storey/Ground cover condition: *

Non-woody vegetation types

Grassland vegetation: Before development: After development: *

Mitchell landscape: Cumberland Plain Patch size(ha): 19.00 Patch size Score: 3



Native vegetation

4

4.1 Review of existing data

The following primary sources of information were consulted as part of a desktop assessment of the native vegetation within the development site:

- VIS Classification Database;
- Sydney Metropolitan Catchment Management Authority vegetation mapping (2013); and
- Ecological assessments undertaken by this firm for the site.

4.2 Field survey

A review of the Atlas of NSW Wildlife (OEH 2016) was undertaken prior to the botanical survey to identify threatened species previously recorded within 10km of the subject site and determine whether target searches were needed to be undertaken. The most likely inhabitant considered to have potential habitat was *Pimelea spicata*.

Flora survey was undertaken on 19 and 20 July, 2016. A random meander search was undertaken in accordance with Cropper (1993) to create a broad species list. Target searches primarily for *Pimelea spicata* were also undertaken during the random meander searches and whilst undertaking transect plot surveys.

Fifteen (15) 20x20m / 50x20m floristic transect plots were assessed within vegetated portions of the study area consistent with the BioBanking Assessment methodology (BBAM) on the expectation that a BioBanking application may be required).

All observed plants are listed in Attachment B.

The following information was collected at each of the fifteen (15) 20 x 20 m full floristic plots:

- Stratum (and layer): stratum and layer in which each species occurs
- Growth form: growth form for each recorded species
- Species name: scientific name and common name
- Percent projected foliage cover of the understorey strata and exotic vegetation

The following information was collected at each of the 20 x 50 m transect sites:

- Native overstorey cover recorded at 10 points along a 50 m transect
- Native midstorey cover recorded at 10 points along a 50 m transect
- Native ground cover recorded at 50 points along a 50 m transect for three life forms (shrubs, grasses and other)
- Number of trees with hollows visible from the ground within the 20 m x 50 m plot
- The total length of fallen logs >10 cm in diameter within the 20 m x 50 m plot
- The proportion of regenerating overstorey species within the vegetation zone

Stratification based on vegetation type and condition was taken into consideration when locating the plots and transects. Table 4.1 indicates that the minimum number of plot and transect sites required has been sampled for this assessment. The biometric vegetation type identification code (BVTID) used in table 4.1 refers to ME018 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney basin Bioregion. This is part of the EEC, River-flat Eucalypt Forest on Coastal Floodplains and part of PCT 835. ME020 is Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion. This is part of the CEEC, Cumberland Plain Woodland and part of PCT 849.

Table 4.1 – Plot and transect survey effort

Veg zone no.	BVTID	Condition	Area (Ha)	Minimum plot transect sites required	Plot transect sites sampled
1	ME018	Moderate/Good	2.26	2	3
2	ME018	Moderate/Good_Poor	1.32	1	1
3	ME020	Moderate/Good	1.43	1	2
4	ME020	Moderate/Good_Poor	0.25	1	1
5	ME020	Moderate/Good_Derived grassland	0.33	1	1

Fauna survey effort on site is provided in Table 4.2.

Table 4.2 – Fauna survey effort

Fauna group	Date	Weather conditions	Survey technique(s)	Survey effort / time (24hr)
Diurnal birds	6/7/16	3/8 cloud, mod NW wind, no rain, temp 15°C	Diurnal opportunistic	4hrs 55min 1205 - 1700
	7/7/16	8-5/8 cloud, no wind, showers, temp 12-15°C	Diurnal opportunistic	5hrs 20min 0830 - 1350
	29/7/16	0/8 cloud, no wind, no rain, temp 7-18°C	Diurnal opportunistic (target Little Lorikeet hollows)	2hrs 0715 - 09155
Nocturnal birds	6/7/16	5/8 cloud, no wind, no rain, temp 13°C	Spotlighting Call playback	2hrs 50min 1700 - 1950 Commenced @ 1800
Arboreal mammals	6/7/16	5/8 cloud, no wind, no rain, temp 13°C	Spotlighting	2hrs 50min 1700 - 1950
Terrestrial mammals	6/7/16	5/8 cloud, no wind, no rain, temp 13°C	Spotlighting	2hrs 50min 1700 - 1950
Bats	6/7/16	5/8 cloud, no wind, no rain, temp 13°C	Spotlighting Anabat SD-2 & SM4BAT (Passive monitoring) x2	2hrs 50min 1700 - 1950 Overnight from 1700
Reptiles	6/7/16	3/8 cloud, mod NW wind, no rain, temp 15°C	Habitat search, opportunistic	4hrs 55min 1205 - 1700
	7/7/16	8-5/8 cloud, no wind, showers, temp 12-15°C	Habitat search, opportunistic	5hrs 20min 0830 - 1350
Amphibians	6/7/16	5/8 cloud, no wind, no rain, temp 13°C	Spotlighting & call identification	2hrs 50min 1700 - 1950
Molluscs	6/7/16	3/8 cloud, mod NW wind, no rain, temp 15°C	Habitat search	4hrs 55min 1205 - 1700
	7/7/16	8-5/8 cloud, no wind, showers, temp 12-15°C	Habitat search	5hrs 20min 0830 - 1350

4.3 Native vegetation extent within the development site

The development site total area is 18.32 ha, which includes 7.81 ha of native vegetation and approximately 0.49 ha of planted or exotic vegetation which has some value for fauna refuge. Aquatic macrophytes make up a further 0.76 ha while the remaining 9.27 ha is cleared or managed land which cannot be attributed to any veg type code. The native vegetation extent within the development site is shown in Figure 5 and has been determined through aerial photograph interpretation and field surveys.

4.3.1 Vegetation communities within the development site

The following vegetation communities were identified within the subject site through ground trothing:

- Vegetation Community 1 – Cumberland Plain Woodland
- Vegetation Community 2 – River-flat Eucalypt Forest on Coastal Floodplains
- Vegetation Community 3 – Aquatic Macrophytes
- Vegetation Community 4 – Exotic Vegetation
- Vegetation Community 5 – Planted Vegetation
- Vegetation Community 6 – Cleared / Managed Land

Cumberland Plain Woodland

The estimated extent of this vegetation community is 3.09 ha, and it occurs on higher contours of the site, generally outside of the core riparian area of Bow Bowing Creek. The vegetation community is recognised as the critically endangered ecological community (CEEC) Cumberland Plain Woodland by the same name under the TSC Act, and the CEEC Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest under the EPBC Act.



Photo 1 – Good quality vegetation near Quadrat (plot/transect) 7

There are three main patches across the site, as mapped on Figure 2, and they have been divided into the following variants:

- Moderate – Good quality (1.91 ha)
- Derived Native Grassland (0.33 ha)
- Regrowth (0.85 ha)



Photo 2 – Regrowth vegetation comprising largely Acacia trees to 5m tall (Quadrat 2)

Canopy – *Eucalyptus tereticornis*, *Eucalyptus moluccana* and *Eucalyptus crebra* 15-25m tall and average projected foliage cover of 20-25%.

Mid - storey – *Acacia parramattensis*, *Acacia implexa*, *Bursaria spinosa*, *Acacia decurrens*, *Dodonaea viscosa* and *Allocasuarina littoralis* up to 15m tall and with a projected foliage cover of 10-25%. Within the regrowth areas, there are generally no Eucalypts and the presence of Acacia species dominate, with a higher than average projected foliage cover (~40%).

Groundcovers – *Microlaena stipoides*, *Themeda triandra*, *Austrostipa pubescens*, *Aristida vagans*, *Brunoniella pumilio*, *Clematis glycinoides*, *Daviesia ulicifolia*, *Dichondra repens*, *Cheilanthes sieberi*, *Lomandra longifolia*, *Cyperus gracilis*, *Dianella revoluta*, *Oxalis perennans*, *Glycine clandestina*, *Goodenia hederacea* and *Einadia hastata* are the more dominant species observed.

River-flat Eucalypt Forest on Coastal Floodplains

The estimated extent of this community is 4.72 ha, and it occurs predominately within the riparian areas of the site. The vegetation community is recognised as an endangered ecological community (EEC) under the TSC Act.

Canopy – *Angophora floribunda*, *Eucalyptus tereticornis* and *Eucalyptus moluccana* 15-25m tall and with a projected foliage cover of 20-35%. The small remnant adjacent to Gilchrist Drive is dominated by *Casuarina glauca* 12-20m tall and with a projected foliage cover of 40-50%.

Mid-storey - *Acacia parramattensis*, *Acacia implexa*, *Bursaria spinosa*, *Acacia decurrens*, *Dodonaea viscosa* and *Allocasuarina littoralis* up to 15m tall and with a projected foliage cover of 10-25%.

Groundcovers – *Microlaena stipoides*, *Themeda triandra*, *Oplismenus imbecillis*, *Austrostipa pubescens*, *Aristida vagans*, *Veronica plebeia*, *Brunoniella pumilio*, *Clematis glycinoides*, *Daviesia ulicifolia*, *Dichondra repens*, *Cheilanthes sieberi*, *Plectranthus parviflorus*, *Lomandra filiformis*, *Lomandra multiflora*, *Dianella revoluta*, *Oxalis perennans*, *Solanum prinophyllum*, *Glycine clandestina*, *Goodenia hederacea* and *Einadia hastata* are the more dominant species observed.



Photo 3 – River-flat Eucalypt Forest near Quadrat 3 and 4 showing a moderately impacted understorey by young privets and exotic vines



Photo 4 – Impacted vegetation adjacent to Bow Bowing Creek just to the north of Macarthur Station



Photo 5 – Swamp Oak dominated vegetation along Bow Bowing Creek at the eastern end of the site

Aquatic Macrophytes

This describes the narrow vegetation community which runs along the heart of Bow Bowing Creek line. *Typha orientalis*, *Phragmites australis* and *Cyperus gracilis* are the most common native plant species that occur. The creek line tends to be dominated by non-native species such as Privets or may be narrow portions of open water.



Photo 6 – Aquatic macrophytes adjacent to soil mounds in the eastern portion of the site



Photo 7 – Phragmites along the core of Bow Bowing Creek, close to Quadrat 9

Exotic Vegetation

There is a patch of heavily weed induced vegetation along Bow Bowing Creek embankment just to the north-east of Macarthur train station where native vegetation is almost redundant. This area is heavily invaded with Privets, Green Cestrum, Blackberry and Bridal Creeper.



Photo 8 – Exotic vegetation located along and adjacent to Bow Bowing Creek in the eastern portion of the site

The proportion of native vegetation within this vegetation community is generally less than 15% and is not considered to be a part of the River-flat Eucalypt Forest on Coastal Floodplains any longer.

Planted Vegetation

Planted vegetation occurs on the slope adjacent to Gilchrist Drive. The main canopy species planted is *Eucalyptus microcorys*. The understorey is very poor quality comprising almost a full cover of exotic species such as Privet, African Boxthorn, African Olive, Madeira Vine and Panic Veldt Grass with a swathe of annuals and perennials in the ground layer.



Photo 9 – Planted vegetation adjacent to Gilchrist Drive

Cleared / Managed Land

This describes the grassland vegetation in the western portion of the study area and any cleared parts of the site, particular in the north-east. There is very little ecological value of these areas and no real ecological constraints. There is approximately 9.27 ha of cleared or managed land within the site.



Photo 10 – Cleared and managed area in the central eastern portion of the site

4.4 Identification of PCTs in accordance with biobanking nomenclature

Identification of the PCTs occurring within the development site was guided by the results of the review of surveys and transect plot data. The data collected during surveys of the development site was analysed in conjunction with a review of the PCTs held within the VIS Classification Database. Consideration was given to the following:

- Occurrence within the Cumberland IBRA subregion
- Vegetation formation
- Landscape position
- Dominant upper, mid and ground strata species

The analysis determined that the vegetation within the development site aligned with PCT 849 and 835 held within the VIS Classification Database.

Justification of choice

IBRA Subregion: Occurs within the Cumberland IBRA subregion

Vegetation formation: Coastal Valley Grassy Woodlands

Landscape position: For PCT 849 - Occurs on clay/loam soils derived from Wianamatta Shales on the Cumberland Plain at low altitudes (mainly below 150m). For PCT 835 – Occurs on stream banks and alluvial flats on the Cumberland Plain.

The full description of the PCTs are shown as Table 4.3 and 4.4, taken directly from the VIS Classification Database. The PCT occurs within the Sydney Metropolitan CMA as ME020, as well as the Hawkesbury-Nepean CMA as HN528.

Table 4.3 – PCT 849 description

PlantCommunity Type ID	849
Biometric Vegetation Type ID List	HN528; ME020;
Common Community Name	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion
Scientific Community Name	Eucalyptus moluccana , Eucalyptus crebra , Eucalyptus eugenioides / Bursaria spinosa subsp. spinosa / Aristida vagans , Brunoniella australis , Cheilanthes sieberi subsp. sieberi , Desmodium gunnii
Dominant Canopy Species	Eucalyptus moluccana (Grey Box); Eucalyptus crebra (Narrow-leaved Ironbark); Eucalyptus eugenioides (Thin-leaved Stringybark);
Main Associated Species	Eucalyptus crebra (Narrow-leaved Ironbark); Eucalyptus eugenioides (Thin-leaved Stringybark);
Landscape Position	Occurs on clay/loam soils derived from Wianamatta Shales on the Cumberland Plain at low altitudes (mainly below 150m).
Mid Stratum Species	Bursaria spinosa subsp. spinosa (Native Blackthorn);
Ground Stratum Species	Eragrostis leptostachya (Paddock Lovegrass); Microlaena stipoides var. stipoides (Weeping Grass); Opercularia diphylla (Stinkweed); Paspalidium distans; Themeda australis (Kangaroo Grass); Wahlenbergia gracilis (Sprawling Bluebell); Lomandra filiformis (Wattle Matt-rush); Aristida vagans (Threeawn Speargrass); Brunoniella australis (Blue Trumpet); Cheilanthes sieberi subsp. sieberi (Rock Fern); Desmodium gunnii (Slender Tick-trefoil); Dichelachne micrantha (Shorthair Plumegrass); Dichondra repens (Kidney Weed);
Other Diagnostic Features	Woodland with an open shrub layer and a grassy groundcover.
Profile Source	Tozer M. et al., 2006;
Full Reference Details	Tozer, M.G., Turner, K., Simpson, C., Keith, D.A., Beukers, P., MacKenzie, B., Tindall, D. & Pennay, C., 2006 Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0;
Vegetation Formation	Grassy Woodlands;
Vegetation Class	Coastal Valley Grassy Woodlands;
Percent cleared	ME020 - 85%; HN528 - 95%;
Occurs As Original Vegetation Type	No

Table 4.4 – PCT 835 description

PlantCommunity Type ID	835
Biometric Vegetation Type ID List	HN526; ME018;
Common Community Name	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
Scientific Community Name	Eucalyptus elata , Angophora floribunda , Eucalyptus amplifolia subsp. amplifolia , Eucalyptus eugenioides / Acacia parramattensis , Bursaria spinosa subsp. spinosa , Sigesbeckia orientalis / Commelina cyanea , Desmodium gunnii , Dichondra repens , Echinopogon ovatus
Dominant Canopy Species	Eucalyptus tereticornis (Forest Red Gum); Angophora floribunda (Rough-barked Apple); Eucalyptus amplifolia subsp. amplifolia; Eucalyptus eugenioides (Thin-leaved Stringybark); Eucalyptus elata (River Peppermint);
Main Associated Species	Eucalyptus eugenioides (Thin-leaved Stringybark); Eucalyptus elata (River Peppermint);
Landscape Position	Occurs on stream banks and alluvial flats on the Cumberland Plain.
Mid Stratum Species	Sigesbeckia orientalis (Indian Weed); Acacia parramattensis (Parramatta Wattle); Bursaria spinosa subsp. spinosa (Native Blackthorn);
Ground Stratum Species	Microlaena stipoides var. stipoides (Weeping Grass); Oplismenus aemulus; Pratia purpurascens (Whiteroot); Solanum prinophyllum (Forest Nightshade); Veronica plebeia (Trailing Speedwell); Commelina cyanea (Native Wandering Jew); Desmodium gunnii (Slender Tick-trefoil); Dichondra repens (Kidney Weed); Echinopogon ovatus (Forest Hedgehog Grass); Entolasia marginata (Bordered Panic);
Other Diagnostic Features	Restricted to the Hawkesbury-Nepean and Georges River systems on alluvial soils derived from Wianamatta Shale. Woodland with an open shrub layer and a continuous groundcover of grasses and forbs.
Profile Source	Tindall D. et al., 2004; Tozer M. et al., 2006;
Full Reference Details	Tindall, D., Pennay, C., Tozer, M., Turner, K. and Keith, D., 2004 , Native vegetation map report series No. 4. The Araluen, Balemans Bay, Braidwood, Burrigorang, Goulburn, Jervis Bay, Katoomba, Kiama, Moss Vale, Penrith, Port Hacking, Sydney, Taralga; Tozer, M.G., Turner, K., Simpson, C., Keith, D.A., Beukers, P., MacKenzie, B., Tindall, D. & Pennay, C., 2006 Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0;
Vegetation Formation	Forested wetlands ;
Vegetation Class	Coastal Floodplain Wetlands;
Percent cleared	ME018 - 87%; HN526 - 95%;
Occurs As Original Vegetation Type	No

Table 4.5 provides a summary of the PCT occurring within the development site, including vegetation formation, percent cleared within the Sydney Metropolitan catchment and extent within the development site.

Table 4.5 – Summary of PCT occurring within the development site

PCT code / BVTID code	PCT name	Vegetation formation	Vegetation class	% Cleared within catchment	Area within development site (ha)
849 ME020	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Grassy Woodlands	Coastal Valley Grassy Woodlands	85	3.09 on site, 2.23 to be impacted
835 ME018	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Grassy Woodlands	Coastal Valley Grassy Woodlands	87	4.72 on site, 3.60 to be impacted

The macrophyte vegetation occurring along the creek lines and in dams do not conform to any approved PCT (including PCTs representing derived or secondary communities) nor does it conform to an endangered ecological community encompassing freshwater wetlands.

The exotic and planted vegetation in the eastern portion of the site also does not conform to any approved PCT nor endangered ecological community.

Figure 10 shows the PCT within the development site.

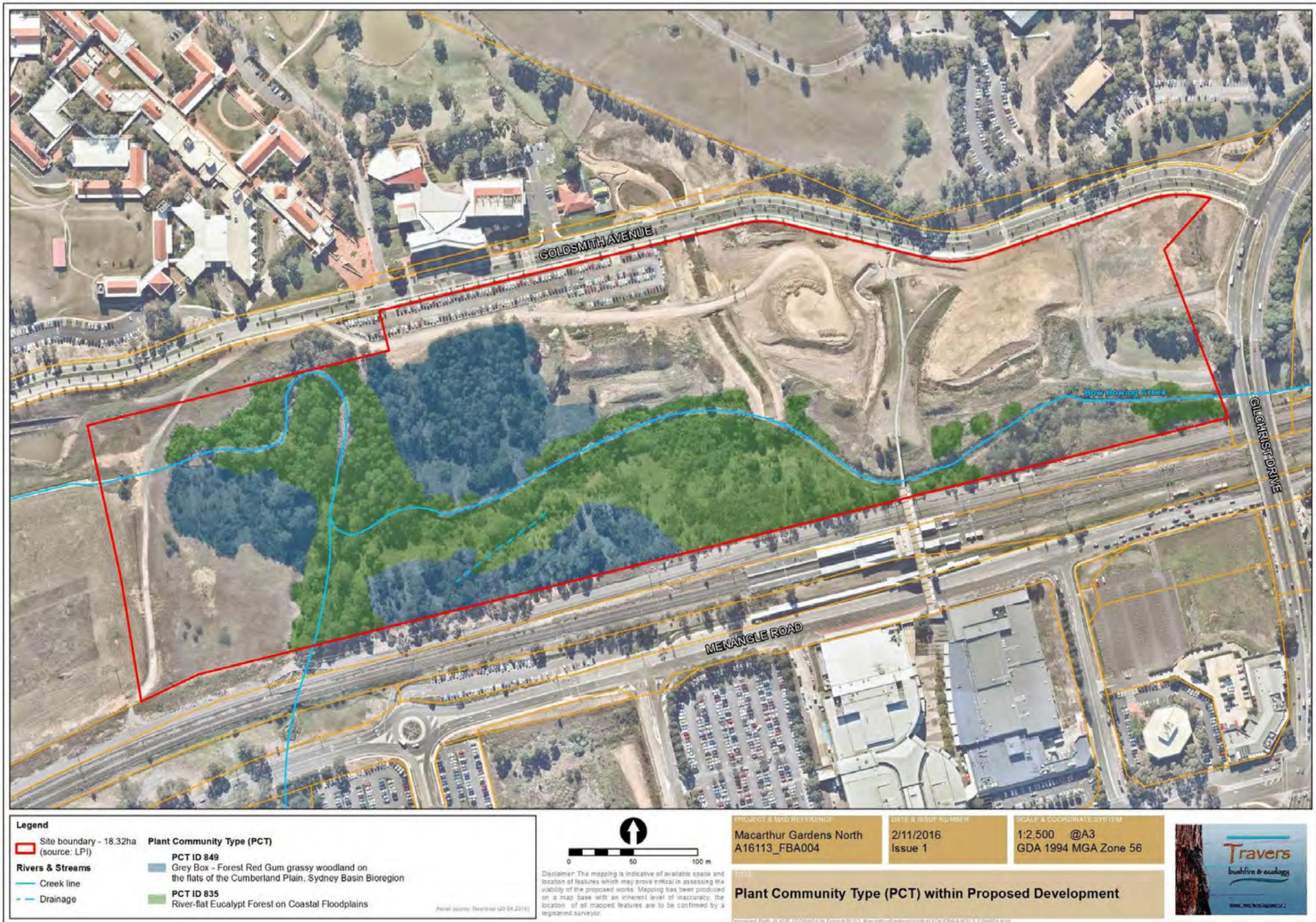


Figure 10 – PCTs within the development site

Note: the naming of the PCT refers to the respective EEC or CEEC.

4.4.1 Threatened ecological communities

PCT 849 and 835 identified within the development site are associated with a Threatened Ecological Community (TEC) according to the VIS Classification Database as shown in Table 4.6.

Table 4.6 – TECs associated with PCT occurring within the development site

PCT code	PCT name	TEC name	TEC status	Assessed or associated TEC?
ME020	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically Endangered	Yes
ME018	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-flat Eucalypt Forest on Coastal Floodplains in the NSW North Coast, Sydney Basin and South-east Corner Bioregions	Endangered	Yes

The vegetation condition for ME020 at the development site was assessed against the listing advice for Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest under the *EPBC Act* (Table 4.7). The vegetation meets the criteria to be listed under this Act.

Table 4.7 – Evaluation of ME020 at the development site against EPBC Act listing advice thresholds

Category and rationale	Threshold	Development site details
Core thresholds that apply under most circumstances: patches with an understorey dominated by natives and consistent with the minimum mapping unit size applied in NSW.	Minimum patch size is ≥ 0.5 ha; AND $\geq 50\%$ of the perennial understorey vegetation cover is made up of native species	The patch size is almost 20 ha, and of that, the CEEC occupies 3.09 ha within the site. An estimated 2.23 ha will be directly impacted. The perennial understorey often contains a vegetation cover of $>50\%$ native species.
OR Larger patches which are inherently valuable due to their rarity.	The patch size is ≥ 5 ha; AND $\geq 30\%$ of the perennial understorey vegetation cover is made up of native species.	The patch size at the development site is greater than 5 ha. Greater than 30% of the perennial understorey vegetation cover is made up of native species.

Category and rationale	Threshold	Development site details
<p>OR</p> <p>Patches with connectivity to other larger native vegetation remnants in the landscape.</p>	<p>The patch size is ≥ 0.5 ha;</p> <p>AND</p> <p>$\geq 30\%$ of the perennial understorey vegetation cover is made up of native species;</p> <p>AND</p> <p>The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥ 5ha in area.</p>	<p>The patch includes mostly River-flat Eucalypt Forest on Coastal Floodplains EEC or Swamp Oak Floodplain Forest to almost 20 ha for adjoining native vegetation within 100m.</p> <p>Greater than 30% of the perennial understorey vegetation cover is made up of native species.</p> <p>The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥ 5ha in area.</p>
<p>OR</p> <p>Patches that have large mature trees or trees with hollows (habitat) that are very scarce on the Cumberland Plain.</p>	<p>The patch size is ≥ 0.5 ha in size;</p> <p>AND</p> <p>$\geq 30\%$ of the perennial understorey vegetation cover is made up of native species;</p> <p>AND</p> <p>The patch has at least one tree with hollows per hectare or at least one large tree (≥ 80 cm dbh) per hectare from the upper tree layer species outlined in the Description and Appendix A (of the EPBC listing advice: Threatened Species Scientific Committee 2008)</p>	<p>The patch size at the development site is not ≥ 5 ha.</p> <p>Greater than 30% of the perennial understorey vegetation cover is made up of native species.</p> <p>The patch does have tree hollows and some with a DBH of 80cm or greater.</p>

Figure 11 shows the TECs across the development site.

All Cumberland Plain Woodland as mapped, fulfils the definitions under both the *TSC Act* and *EPBC Act*.

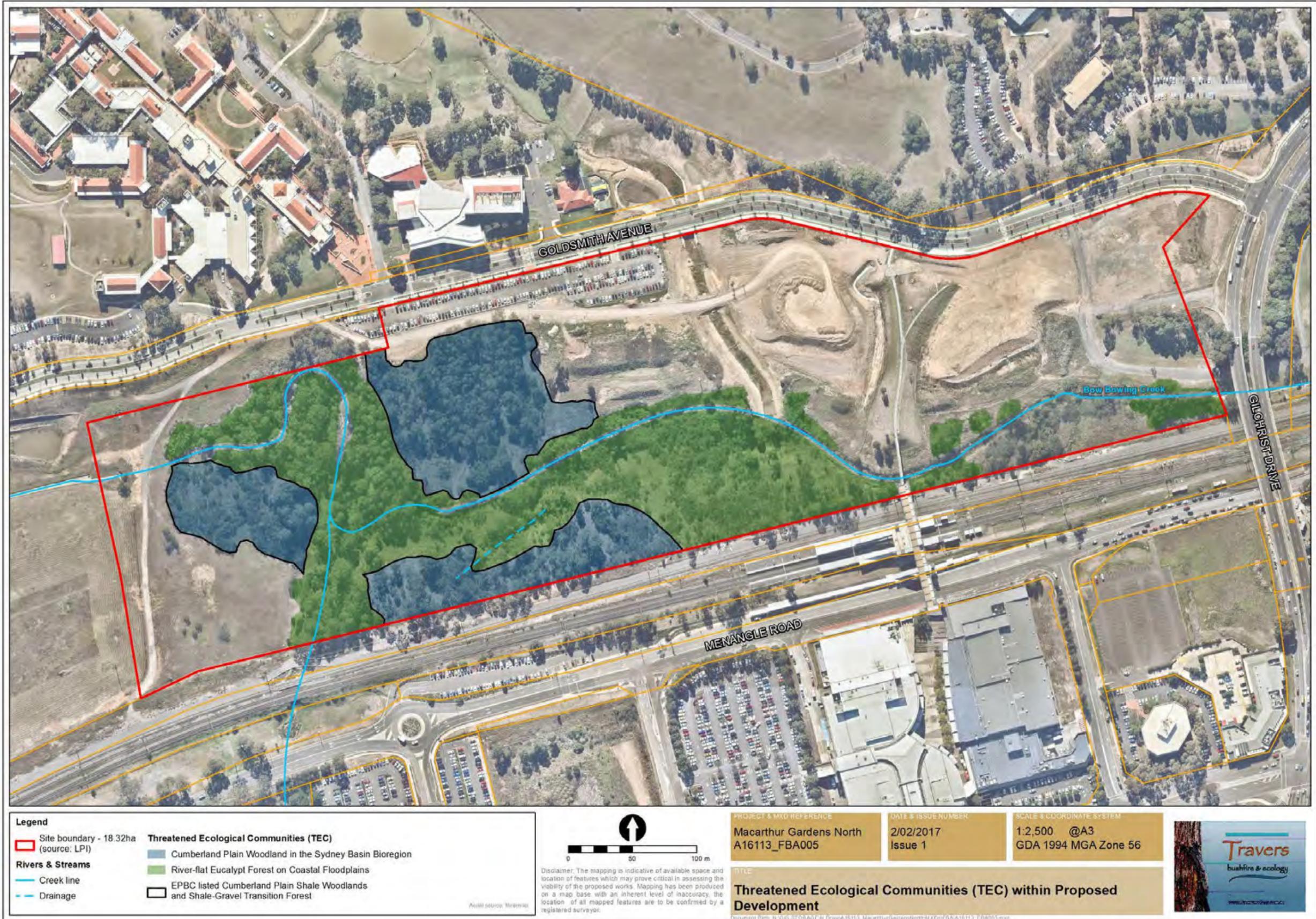


Figure 11 – TECs within the development site

4.5 Vegetation zones

PCTs occurring within the development site was stratified into areas by condition. PCT 849 (ME020) was separated into three vegetation zones on the basis of the vegetation condition, regrowth and derived native grasslands. The regenerative capacity appeared to be moderate to good and did not meet the criteria to be classed as low condition.

A summary of the vegetation zones within the development site is provided in Table 4.8 and their distribution is shown in Figure 12.

Each vegetation zone was assessed using plot transect surveys to determine the site value score. Summary plot transect data collected from the vegetation zones are provided in Appendix A.

Any vegetation zone with a site value score less than or equal to 34 which is an EEC or CEEC is not red-flagged. All zones on site are an EEC or CEEC, however zone 2, 4 and 5 will not require any red-flag variation to be undertaken.

Table 4.8 – Vegetation zones within the development site

Zone	PCT / BVTID	EEC or CEEC	Condition class	Area (ha)	Site value score	Red-flagged
1	835 - ME018 - Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	yes	Moderate to good	2.28	48.96	yes
2	835 - ME018 - Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	yes	Moderate to good_ poor (regrowth)	1.32	25.69	no
3	849 - ME020: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	yes	Moderate to good	1.43	52.08	yes
4	849 - ME020: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	yes	Moderate to good_ poor (regrowth)	0.47	22.92	no
5	849 - ME020: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	yes	Moderate to good_ derived grassland	0.33	11.98	no

4.6 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) were initially assessed by reviewing the Groundwater Dependent Ecosystem Atlas (BOM 2015) for the site.

No GDE was identified within the development site.

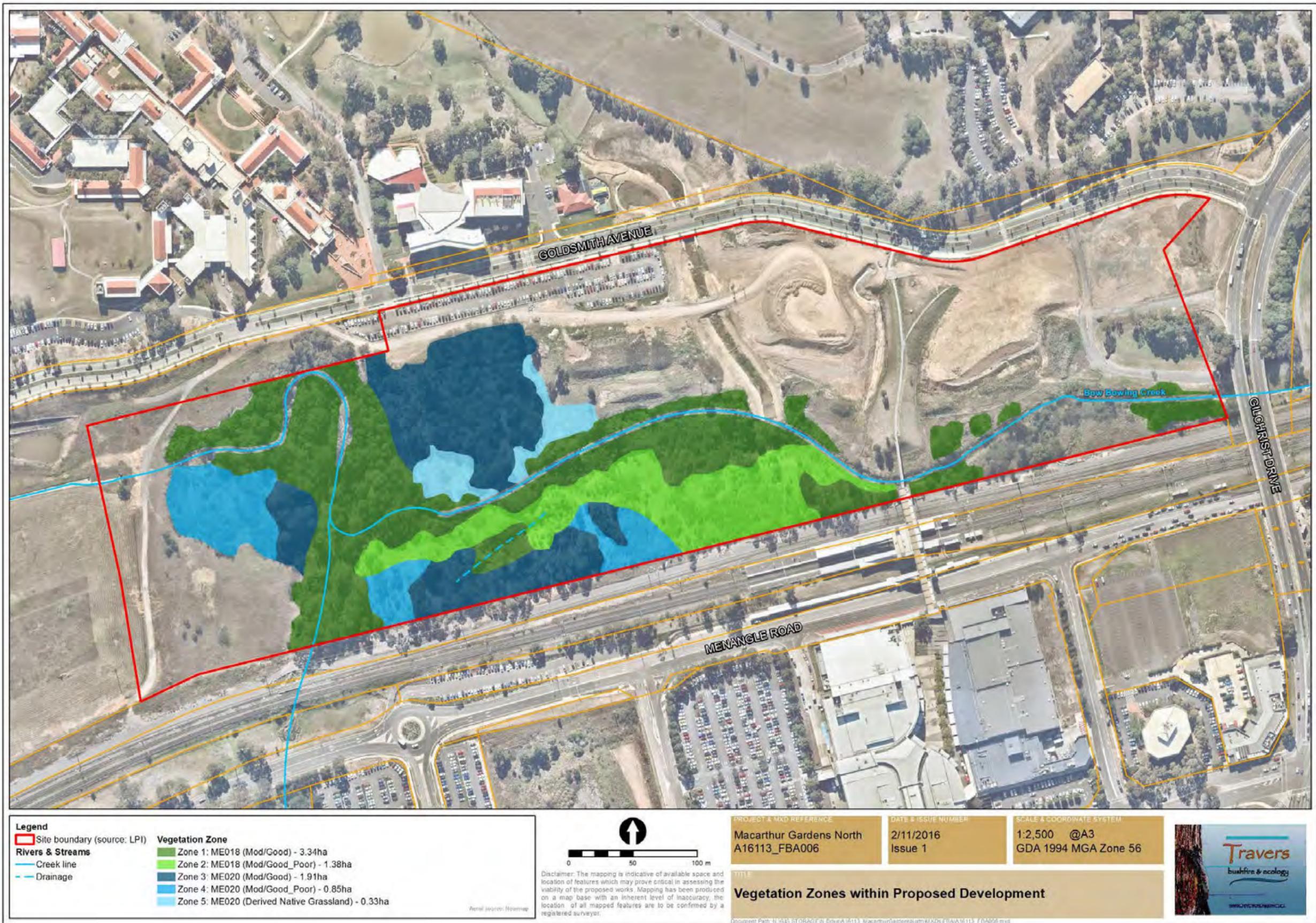


Figure 12 – Vegetation zones in the development site



Threatened species and populations

5

5.1 Review of existing data

The following primary sources of information were consulted as part of a desktop assessment of potentially occurring threatened species and populations within the development site:

- Flora and fauna assessment undertaken by *Travers Bushfire and Ecology*, August 2016;
- OEH Atlas of NSW Wildlife (OEH 2016); and
- Threatened Species Profile Database.

Information obtained during the review of existing data was utilised in determining candidate ecosystem credits species and species credit species.

5.2 Field survey

5.2.1 Habitat assessment

Botanical survey effort was undertaken over two (2) dates in July 2016 and fauna survey was undertaken over three (3) dates in July 2016. The details of the survey methodology are described in section 4.2 and Tables 4.1 and 4.2.

Searches of relevant databases and vegetation mapping were undertaken prior to field surveys to determine likely habitats and undertake the relevant target threatened species searches.

A detailed description of the habitat values (primarily for fauna) are shown in Table 5.1.

5.2.2 Targeted threatened species surveys

i. Flora

A review of the OEH Atlas of NSW Wildlife (OEH 2016 - July) was undertaken prior to the botanical survey to identify threatened species previously recorded within 10km of the development site and identify the targeted species searches that were required.

Target threatened species surveys were undertaken primarily for *Pimelea spicata* and *Pomaderris brunnea*. Survey effort is shown in Table 4.1.

Targeted surveys were conducted within areas of suitable habitat for each threatened flora species assessed as a candidate species credit species (for list of candidate species credit species, see Section 5.5).

The location of the transect plots (quadrats) is shown on Figure 13. Target species survey locations are shown on Figure 14.

Pimelea spicata

There are many records of the species within the Campbelltown LGA, with a good reserved population located within Mt Annan Botanic Gardens, 2.5-3km to the west. There may be specimens located a bit closer to the site but these are pre 1995 and not with a high degree of accuracy. There is potential habitat present across the site, more likely to be within Cumberland Plain Woodland or within River-flat Eucalypt Forest on Coastal Floodplains within good quality habitat not impacted by Privets and vines, and likely to be outside of regrowth areas. Most of the site was devoid of vegetation in the 1960s with the exception of a few remnant trees at that time, otherwise the vegetation is in a state of regrowth, hence the number of young trees and areas of Acacia regrowth with occasional Eucalypt seedlings. These attributes significantly reduce the likelihood of *Pimelea spicata* being present within the study area. Whilst currently there appears to be some areas of moderate-good potential for the species to occur, considering that almost the entire site is up to 50 years of regrowth, and recent records are >2.5km away, this significantly reduces the likelihood. Despite searches for this species, no specimens were observed.

Pomaderris brunnea

The species is known to occur along creeks and in vegetation that supports River-flat Eucalypt Forest on Coastal Floodplains, and as such, there may be some potential habitat present within the study area. The likelihood of occurrence is considered very low as the nearest record is 5km away, and most records are located along Nepean River embankment rather than lesser tributaries such as Bow Bowing Creek. No specimens were observed during the surveys.

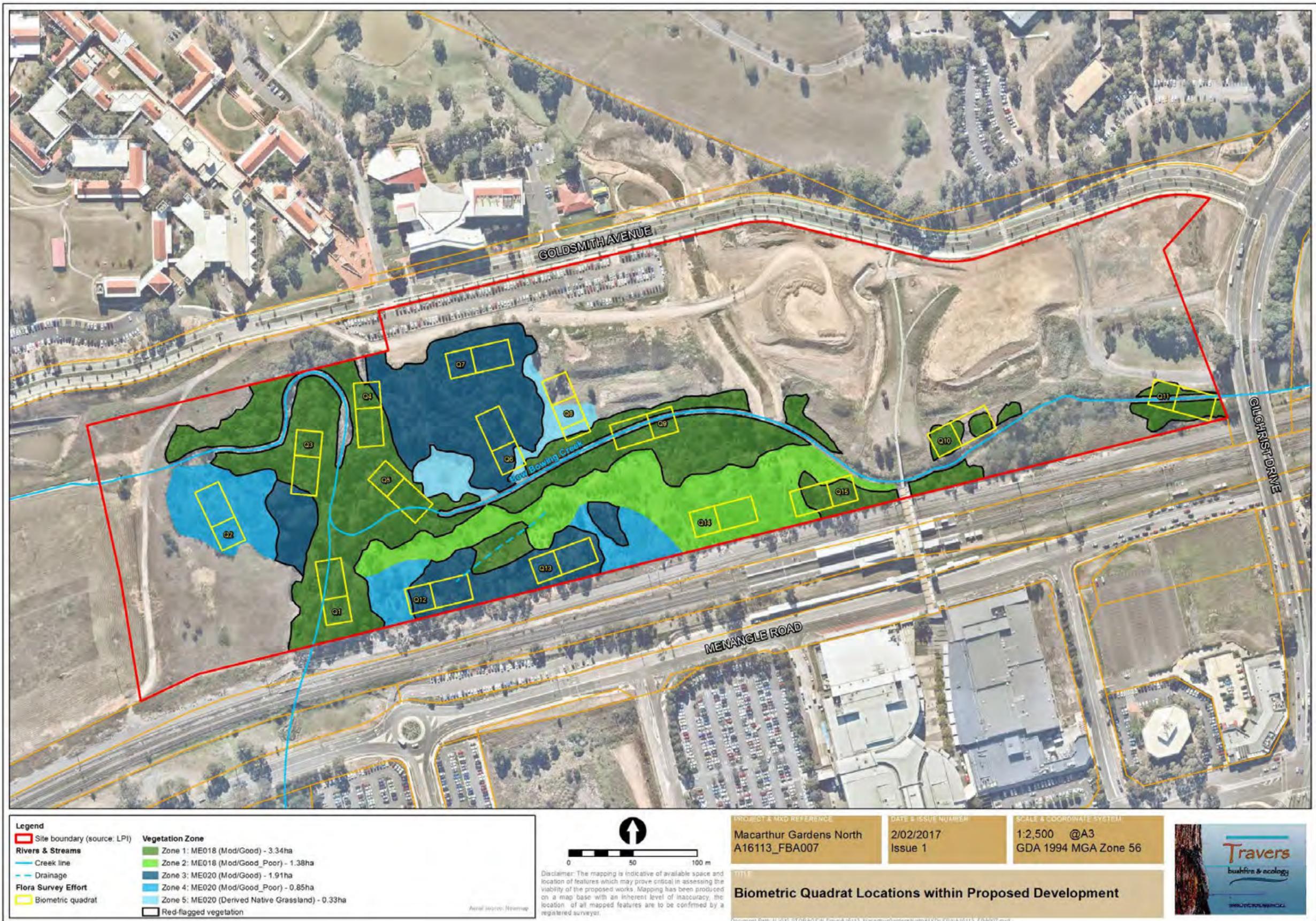


Figure 13 – Plot transect locations in the development site and red-flagged areas

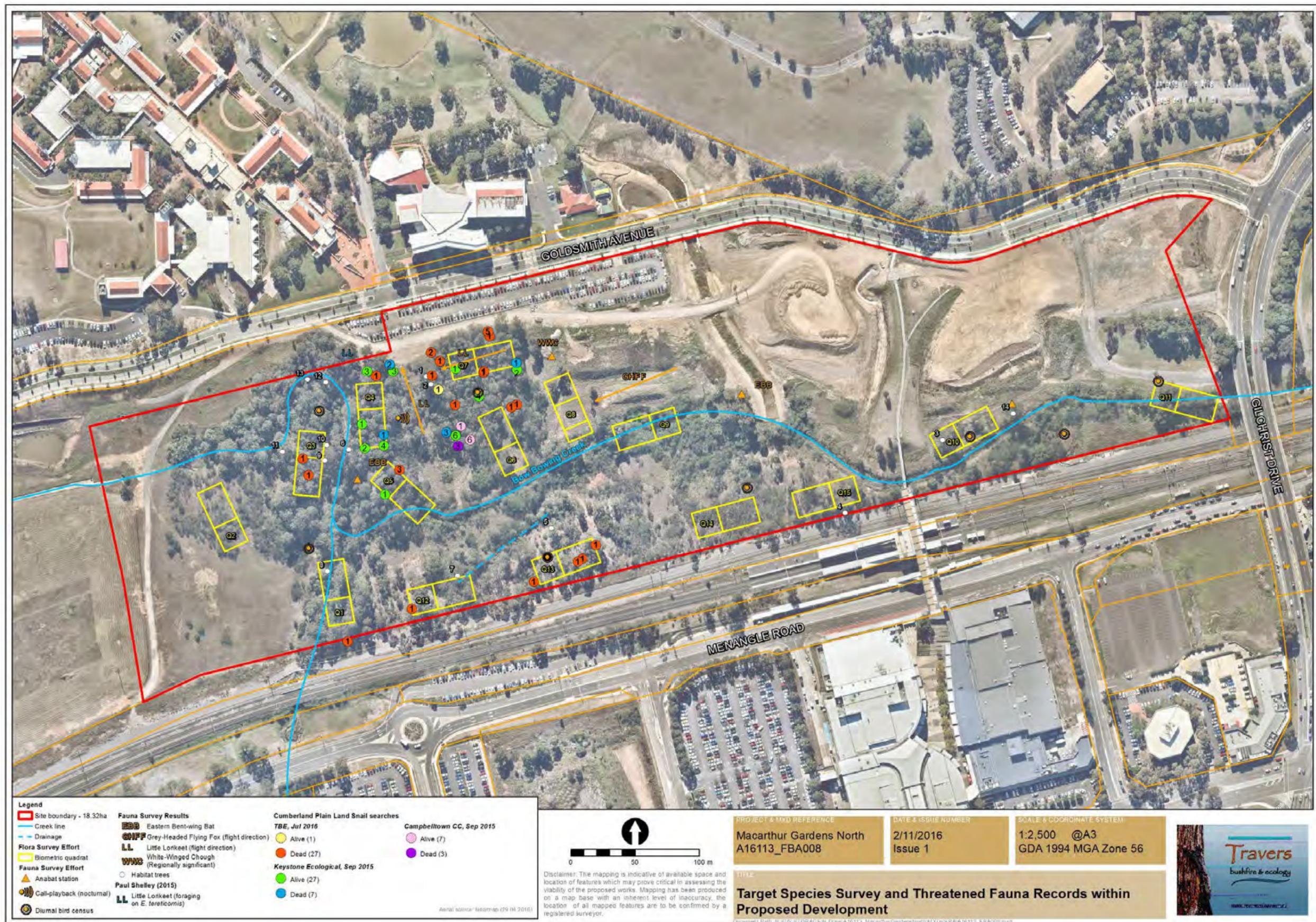


Figure 14 – Target species survey within the development site

ii. Fauna

TSC Act – A search of the *Atlas of NSW Wildlife* (OEH, July 2016) provided a list of threatened fauna species previously recorded within a 10km radius of the subject site. Strictly estuarine and oceanic threatened species found within 10km have not been included as no marine / estuarine habitats occur within the subject site. A summary of the survey effort is shown in Table 4.2.

a. Green and Golden Bell Frog and other amphibian surveys

Travers bushfire & ecology conducted targeted Green and Golden Bell Frog surveys that involved diurnal habitat searches, listening for calling males after dark, spotlighting and call-playback techniques. An assessment of potential habitat for threatened frog species on the site was also carried out primarily along the drainage line and dam area near the eastern boundary of the development site.

Breeding call imitation and sound stimulation was used in each of the potential habitat areas of the Green and Golden Bell Frog to try to evoke calling by sheltering frogs. A listening period followed each calling session.

It is noted that the breeding season for the species generally lies between September and December. Surveys were undertaken during winter outside of the breeding season. Whilst not expected to occur, further survey for Green and Golden Bell Frog should be undertaken during the upcoming breeding period (September-January) when the species is most easily recorded by call. Despite the lack of survey for this species, *EcoLogical Australia* (October 2016) in the review felt that the survey effort was appropriate.

b. Cumberland Plain Land Snail surveys

Habitat searches were undertaken by *Travers bushfire & ecology* within the Cumberland Plain Woodland and adjoining River-flat Eucalypt Forest on Coastal Floodplains across the development site. Areas of dense leaf litter with likely moisture retaining properties were scraped using a three pronged rake. Logs were also turned over.

Records from Campbelltown City Council (2015) and Keystone Ecological (2015) have been placed on Figure 14. The combined data indicates a population size of up to 30 individuals within the study area, and occupies approximately 6 ha of potential habitat.

c. Bird and owl surveys

Visual observation and call identification of diurnal birds was carried out during survey within the development site. Diurnal birds were identified and recorded as they were encountered throughout the development site. Spotlighting and call playback techniques were deployed for the threatened owl species and Australasian Bittern.

d. Microchiropteran bat surveys

Ultrasonic call detection surveys for microchiropteran bats were undertaken at several locations within the development site. The Anabat units were set up and activated before dusk and continued after dark. Ultrasonic calls collected from the Anabat were then analysed. Given that surveys were undertaken in winter when activity is generally lower than other seasons, further survey in warmer months is preferred.

e. Incidental observations

Any incidental vertebrate fauna species that was observed, heard calling, or otherwise detected on the basis of tracks or signs were recorded and listed in the total species list for the development site.

5.2.3 Survey limitations

It is important to note that field survey data collected during the survey period is representative of species occurring within the subject site for that occasion. Due to effects of fire, breeding cycles, migratory patterns, camouflage, weather conditions, time of day, visibility, predatory and / or feeding patterns, increased species frequency or richness may be observed within the subject site outside the nominated survey period. Habitat assessments based on the identification of micro-habitat features for various species of interest, including regionally significant and threatened species, have been used to minimise the implications of this survey limitation.

Flora survey limitations

Flora survey has been undertaken in the middle of winter which is typically a time when the least number of flowering plants would be expected, thus missing seasonal or repeated survey.

This limitation is not considered to be large because the threatened species with potential habitat can be detected at any time of the year, although for some it may be preferable during their flowering period. Also, given the extensive disturbance and rather isolated quality patches of vegetation on site, the site has a low likelihood of hosting potential threatened species habitat.

Fauna survey limitations

Nocturnal survey was undertaken during winter when microbat activity is typically low and also unsuitable for Green and Golden Bell Frog activity. Further survey, particularly for the Green and Golden Bell Frog is recommended after rains within the calling period (September - January).

No living Cumberland Plain Land Snails have yet been recorded within the proposed retention areas to the south and west of Bow Bowing Creek. This may be undertaken at the same time as the Green and Golden Bell Frog survey, also with benefit following rainfall as this is when snails come to the surface.

The study area is not considered suitable for any threatened reptiles, terrestrial mammals, owl species or Koalas therefore no specific target survey measures for these were deployed.

5.3 Fauna habitats within the development site

The natural vegetation throughout almost the entire site is a result of regrowth since the 1960s where historic aerials depict an almost cleared site. Thus, many of the existing trees on site have a smaller girth than a mature forest. The current vegetation is of mixed aged with several stands of Acacia only vegetation or juvenile Eucalypts less than 10m in height.

Although most natural vegetation on site is a result of some form of regrowth, the vegetation on and adjacent to the creek line embankment contains a moderate affiliation to River-flat Eucalypt Forest on Coastal Floodplains, whilst the remaining vegetation on the flats above the embankment fits more closely to Cumberland Plain Woodland. Both communities are

EECs, with Cumberland Plain Woodland listed as critically endangered. Cumberland Plain Woodland is also listed under the *EPBC Act* as the critically endangered ecological community, Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

The native vegetation that is currently present is moderate to good quality and contains several attributes which are suitable for fauna habitat, although given that there is not a lot of mature to over-mature vegetation, the number of hollow-bearing trees across the site is low.

The fauna habitats present within the site are identified within Table 5.1.

Table 5.1 – Observed fauna habitat

Topography									
Flat	✓	Gentle	✓	Moderate	Steep	Drop-offs			
Vegetation structure									
Closed Forest	Open Forest	Woodland	✓	Heath	Grassland	✓			
Disturbance history									
Fire	Under-scrubbing	✓	Cut and fill works	✓					
Tree clearing	✓	Grazing	✓						
Soil landscape									
DEPTH:	Deep	✓	Moderate	✓	Shallow	Skeletal			
TYPE:	Clay	✓	Loam	✓	Sand	Organic			
VALUE:	Surface foraging	✓	Sub-surface foraging	Denning/burrowing	✓				
WATER RETENTION:	Well Drained	✓	Damp / Moist	Water logged	Swamp / Soak				
Rock habitat									
No natural rock features of habitat value is present									
Feed resources									
FLOWERING TREES:	Eucalypts	✓	Corymbias	Melaleucas					
	Banksias		Acacias	✓					
SEEDING TREES:	Allocasuarinas	✓	Conifers						
WINTER FLOWERING EUCALYPTS:	C. maculata		E. crebra	✓	E. globoidea	E. sideroxylon			
	E. squamosa		E. grandis		E. multicaulis	E. scias			
	E. robusta		E. tereticornis	✓	E. agglomerata	E. siderophloia			
FLOWERING PERIODS:	Autumn	✓	Winter	✓	Spring	✓	Summer	✓	
OTHER:	Mistletoe	Figs / Fruit	Sap / Manna	Termites					
Foliage protection									
UPPER STRATA:	Dense	Moderate	✓	Sparse	✓				
MID STRATA:	Dense	Moderate	Sparse	✓					
PLANT / SHRUB LAYER:	Dense	Moderate	✓	Sparse	✓				
GROUNDCOVERS:	Dense	✓	Moderate	✓	Sparse	✓			
Hollows / logs									
TREE HOLLOWES:	Large	Medium	✓	Small	✓				
TEE HOLLOW TYPES	Spouts / branch	✓	Trunk	✓	Broken Trunk	✓	Basal Cavities	Stags	✓
GROUND HOLLOWES:	Large	Medium	Small	✓					
Vegetation debris									
FALLEN TREES:	Large	Medium	✓	Small	✓				
FALLEN BRANCHES:	Large	✓	Medium	✓	Small	✓			
LITTER:	Deep	✓	Moderate	✓	Shallow	✓			
HUMUS:	Deep	✓	Moderate	✓	Shallow	✓			
Drainage catchment									
WATER BODIES	Wetland(s)	Soak(s)	Dam(s)	Drainage line(s)	Creek(s)	✓	River(s)		
RATE OF FLOW:	Still	✓	Slow	✓	Rapid				
CONSISTENCY:	Permanent	✓	Perennial	✓	Ephemeral				
RUNOFF SOURCE:	Urban / Industrial	Parkland	✓	Grazing	Natural				
RIPARIAN HABITAT:	High quality	Moderate quality	✓	Low quality	✓	Poor quality	✓		

Artificial habitat			
STRUCTURES:	Sheds	Infrastructure	Equipment
SUB-SURFACE	Pipe / culvert(s) ✓	Tunnel(s)	Shaft(s)
FOREIGN MATERIALS:	Sheet ✓	Pile / refuse ✓	

A complete assessment of the location of habitat trees and the size of hollows within was undertaken as part of flora and fauna surveys. Table 5.2 provides hollow-bearing tree data.

Table 5.2 – Habitat tree data

Tree No	Scientific name	DBH (cm)	BD (cm)	Height (m)	Spread (m)	Vigour (%)	Hollows & other habitat features recorded
HT1	<i>E tereticornis</i>	100	140	34	22	80	2x 5-10cm branch spout, 1x 10-15cm branch (Rainbow Lorikeets)
HT2	<i>E tereticornis</i>	100	180	35	18	70	1x 5-10cm branch spout, 1x 15-20cm trunk spout, 1x 20-30cm low trunk (Red-rumped Parrot)
HT3	<i>E tereticornis</i>	80	100	20	12	80	1x 0-5cm branch spout
HT4	<i>E tereticornis</i>	75	100	22	12	70	1x 0-5cm branch spout
HT5	<i>E tereticornis</i>	80	140	18	17	55	3x 0-5cm branch spout, 2x 5-10cm branch spout
HT6	<i>E tereticornis</i>	70	85	41	22	80	2x 0-5cm trunk
HT7	<i>E tereticornis</i>	85	110	28	18	75	2x 0-5cm branch spout, 1x 5-10cm trunk (chew marks around)
HT8	stag	45	60	21	7	0	2x 0-5cm branch spout
HT9	<i>E tereticornis</i>	140	190	28	19	80	3x 0-5cm branch spout, 1x 5-10cm branch spout
HT10	stag	47	60	16	7	0	1x 5-10cm trunk
HT11	<i>A subvelutina</i>	75	180	24	16	80	1x 5-10cm branch spout
HT12	<i>E tereticornis</i>	70	90	27	19	75	1x 5-10cm trunk (good quality with wear), 1x 10-15cm broken trunk (Rainbow Lorikeets), 1x 20-30cm branch (good quality)
HT13	<i>E eugenioides</i>	80	120	30	13	65	1x 40-50cm trunk (good quality)
HT14	<i>E tereticornis</i>	116		25	14	80	2x potential 0-5cm branch hollows 1x 5-10cm Branch hollows

Based on the proposed layout it is expected that Habitat trees HT1, 2, 3, 5, 7, 14 and possibly 6 will be removed as part of the proposal. The combined total of hollows within these trees is nineteen (19) and these include some of good quality including recorded nesting hollows for Rainbow Lorikeets and Red-rumped Parrots.

One (1) hollow-dependent threatened species Little Lorikeet was recorded during surveys. Some hollows observed are considered suitable for this species including one notable hollow with chew marks around the entry in HT7 and possibly also in HT6. Specific observations of these trees during the morning and afternoon period did not record any use. The other hollow-dependent threatened species with varying potential to occur and with suitable hollows present include five microbats, East-coast Freetail Bat, Large-footed Myotis, Yellow-bellied Sheath-tail-bat, Greater Broad-nosed Bat and Eastern Falsistrelle.

Two (2) large hollows were recorded present however their use by large-hollow-dependent threatened cockatoos and owls is not likely in such a fragmented landscape.

Some other hollow-dependent fauna species recorded during survey include Australian King Parrot, Australian Wood Duck, Eastern Rosella, Galah, Little Corella, Musk Lorikeet, Rainbow Lorikeet, Red-rumped Parrot, Striated Pardalote, Sulphur Crested Cockatoo, Chocolate Wattled Bat, Little Forest Bat and Whistling Tree Frog.

It is recommended that all hollows are inspected for use at the time of removal and any hollows of good quality or with resident fauna are sectionally cut and relocated into the retained bushland area. All other hollows removed should be replaced with appropriately sized nest boxes. These measures should be covered in a Nest Box Management Plan as recommended by council.

5.4 Ecosystem credit species

5.4.1 Predicted ecosystem credit species

The credit calculator generates a list of predicted species utilising a number of variables. Table 5.3 lists the predicted species for the development site, which has been based on the following:

- IBRA subregion: Cumberland;
- Associated PCT(s): 835 (ME020) and 849 (ME018);
- Percent native vegetation in outer assessment circle: 6-10%;
- Condition of vegetation: moderate to good (all vegetation zones);
- Patch size: 11-20 ha; and
- Credit type: Ecosystem

Table 5.3 – Predicted ecosystem credit species

Predicted threatened species				
Common name	Scientific name *	TS offset multiplier	On site *	
Little Lorikeet	Glossopsitta pusilla	1.8	Yes	Edit
Swift Parrot	Lathamus discolor	1.3	No	Edit

5.5 Species credit species

5.5.1 Candidate species credit species

The credit calculator generates a list of candidate species credit species utilising a number of variables including classification of the species as a species credit species, the distribution of the species within the same IBRA subregion as the development site and the presence of habitat features or components associated with the species.

The habitat features that have been assessed as present within the development site are as follows:

Table 5.4 – Assessment of specific geographic / habitat features

Impact?	Common name	Scientific name	Feature
<input type="checkbox"/>	Wahlenbergia multicaulis (Tadgells Bluebell) population, Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield local government areas	Wahlenbergia multicaulis - endangered population	land situated in damp, disturbed sites
<input checked="" type="checkbox"/>	Cumberland Plain Land Snail	Meridolum corneovirens	land containing bark or leaf litter accumulation
<input type="checkbox"/>	Large-eared Pied Bat	Chalinolobus dwyeri	land containing escarpments, cliffs, caves, deep crevices, old mine shafts or tunnels
<input type="checkbox"/>	Eastern Osprey	Pandion cristatus	land within 40 m of fresh/brackish/saline waters of larger rivers or creeks; estuaries, coastal lagoons, lakes and/or inshore marine waters
<input checked="" type="checkbox"/>	Green and Golden Bell Frog	Litoria aurea	land within 100 m of emergent aquatic or riparian vegetation
<input checked="" type="checkbox"/>	Hypsela sessiliflora	Hypsela sessiliflora	Wet and damp areas only.
<input type="checkbox"/>	Matted Bush-pea	Pultenaea pedunculata	land within 5 km of coast in South East Coastal Plains CMA subregion

5.5.2 Candidate species for further assessment

Table 5.5 lists the candidate species generated within the credit calculator and an assessment of their potential presence within the development site based on habitat components. The following threatened flora and fauna species have been considered as potentially occurring and are required to be further assessed:

Table 5.5 – Species for consideration from the credit calculator tool

Common name	Scientific name *	Impacted by development?	Id method	Loss	UOM	Survey date	Negl loss	TS offset multiplier value		
Cumberland Plain Land Snail	Meridolum corneovirens	Yes	Survey	5.83	ha	07/7/2016	9999999.00	1.3	Edit	Remove
Dillwynia tenuifolia	Dillwynia tenuifolia	No	Survey	0.00	indiv	20/7/2016	50.00	1.8	Edit	Remove
Downy Wattle	Acacia pubescens	No	Survey	0.00	indiv	20/7/2016	0.00	1.9	Edit	Remove
Eastern Pygmy-possum	Cercartetus nanus	No	Survey	0.00	ha	07/7/2016	9999999.00	2.0	Edit	Remove
Green and Golden Bell Frog	Litoria aurea	No	Survey	0.00	ha	07/7/2016	9999999.00	2.6	Edit	Remove
Hairy Geebung	Persoonia hirsuta	No		0.00	indiv	01/1/1901	0.00	7.7	Edit	Remove
Hibbertia sp. Bankstown	Hibbertia sp. Bankstown	No	Survey	0.00	indiv	20/7/2016	0.00	7.7	Edit	Remove
Hypsela sessiliflora	Hypsela sessiliflora	No	Survey	0.00	indiv	20/7/2016	0.00	7.7	Edit	Remove
Koala	Phascolarctos cinereus	No	Survey	0.00	ha	07/7/2016	9999999.00	2.6	Edit	Remove
Little Lorikeet	Glossopsitta pusilla	Yes	Survey	5.83	ha	07/7/2016	9999999.00	1.8	Edit	Remove
Matted Bush-pea	Pultenaea pedunculata	No		0.00	indiv	01/1/1901	3.00	1.5	Edit	Remove
Netted Bottle Brush	Callistemon linearifolius	No	Survey	0.00	indiv	20/7/2016	5.00	1.4	Edit	Remove
Regent Honeyeater	Anthochaera phrygia	No	Survey	0.00	ha	07/7/2016	9999999.00	7.7	Edit	Remove
Spiked Rice-flower	Pimelea spicata	No	Survey	0.00	indiv	20/7/2016	2.00	2.6	Edit	Remove
Squirrel Glider	Petaurus norfolcensis	No	Survey	0.00	ha	07/7/2016	9999999.00	2.2	Edit	Remove
Sydney Plains Greenhood	Pterostylis saxicola	No	Survey	0.00	indiv	20/7/2016	0.00	4.0	Edit	Remove
Thick Lip Spider Orchid	Caladenia tessellata	No	Survey	0.00	indiv	20/7/2016	0.00	1.3	Edit	Remove
White-flowered Wax Plant	Cynanchum elegans	No	Survey	0.00	indiv	20/7/2016	2.00	1.4	Edit	Remove

Table 5.6 – Assessment of potential presence of threatened species

Note: the list of species assessed relates to Table 5.5 which were predicted in the BioBanking calculator.

Common name	Scientific name	Required habitat components	Assessment of habitat within the development site	Requires further assessment?
Cumberland Plain Land Snail	<i>Meridolum corneovirens</i>	Bark or leaf litter accumulation. Primarily inhabits Cumberland Plain Woodland, and also known from Shale Gravel Transition Forests, Castlereagh Swamp Woodlands and the margins of River-flat Eucalypt Forest.	Suitable habitat is present across most of the site which contains native vegetation. Found to occur on site.	Yes
Dillwynia tenuifolia	<i>Dillwynia tenuifolia</i>	May be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland.	No suitable habitat is present within the development site, and furthermore, there are no records of the species within a 10km radius.	No
Downy Wattle	<i>Acacia pubescens</i>	Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravelly soils, often with ironstone. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/ Castlereagh Ironbark Forest, Shale / Gravel Transition Forest and Cumberland Plain Woodland.	Low potential habitat with only 3 records within 10km, the nearest being more than 5km away. Considered unlikely to occur.	No
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	Associated PCTs with an understorey containing heath, banksias or myrtaceous shrubs including <i>Leptospermum</i> spp. Trees with hollows >2cm, loose bark of eucalypts or accumulations of shredded bark in tree forks for nesting. As per breeding and abandoned bird-nests, Ringtail Possum (<i>Pseudocheirus peregrinus</i>) drays or thickets of vegetation, (e.g. grass-tree	Unlikely to occur. No suitable habitat in the form of heath, banksias or myrtaceous shrubs. No records of the species within a 10 km radius of the development site.	No

Common name	Scientific name	Required habitat components	Assessment of habitat within the development site	Requires further assessment?
		skirts) for shelter.		
Green and Golden Bell Frog	<i>Litoria aurea</i>	Amongst emergent aquatic or riparian vegetation and amongst vegetation, fallen timber adjacent to and within 500m of breeding habitat, including grassland, cropland and modified pastures. Still or slow-flowing natural water bodies with some aquatic emergent vegetation such as <i>Typha</i> spp. or <i>Eleocharis</i> spp. Will use artificial water bodies and non-native emergent vegetation. Vegetation, rocks and fallen timber, leaf litter, manmade ground cover, debris and in soil cracks up to 1km from breeding habitat.	The suitability of the riparian area and dams was considered low. There are only 2 records within a 10km radius of the development site but one of the records is relatively recent. Survey has not been undertaken during the breeding period of September to January therefore it is difficult to rule out as being absent until those surveys are undertaken.	Yes
Hibbertia Bankstown sp.	<i>Hibbertia Bankstown</i> sp.	Small prostrate shrub known only from Bankstown airport. Occurs on tertiary alluvium floodplain communities of the Georges River.	Highly unlikely to occur given the geographic range of the species to date is so restricted. No expected to occur.	No
Hypsela sessiliflora	<i>Hypsela sessiliflora</i>	Known to grow in damp places, on the Cumberland Plain, including freshwater wetland, grassland/alluvial woodland and an alluvial woodland/shale plains woodland ecotone.	Potential habitat may be available on site however there are no records within a 10km radius of the site. Not expected to occur.	No
Koala	<i>Phascolarctos cinereus</i>	As per Koala Food Tree Species listed in Appendix 2 of the NSW State Koala Recovery Plan.	Unlikely to occur. Although one primary feed tree occurs within the development site (<i>Eucalyptus tereticornis</i>), the habitat is significantly fragmented from any nearby connecting habitat. There are 980 records of the species within a 10 km radius of the development site, however most are on the eastern edge of Airds, Kentlyn and adjoining suburbs where the substrate changes from shale to sandstone.	No
Little Lorikeet	<i>Glossopsitta pusilla</i>	Inhabits forests, woodlands; large trees in open country; timbered watercourses,	Observed on site.	No. It is covered under

Common name	Scientific name	Required habitat components	Assessment of habitat within the development site	Requires further assessment?
		shelterbeds, and street trees. <i>Distribution Limit: N-Tweed Heads. S-South of Eden.</i>		ecosystem credits.
Nettled Bottle Brush	<i>Callistemon linearifolius</i>	Shrub to 4m high. Dry sclerophyll forest on coast and adjacent ranges. Distribution limits N-Nelson Bay S-Georges River.	The development site is located at the southern end of known range of the species. There are only 2 records within 10km of the development site and the species is not typically associated with the vegetation types present.	No
Regent Honeyeater	<i>Anthochaera phrygia</i>	The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: <i>Eucalyptus microcarpa</i> , <i>E. punctata</i> , <i>E. polyanthemus</i> , <i>E. moluccana</i> , <i>Corymbia robusta</i> , <i>E. crebra</i> , <i>E. caleyi</i> , <i>C. maculata</i> , <i>E. mckieana</i> , <i>E. macrorhyncha</i> , <i>E. laevopinea</i> , and <i>Angophora floribunda</i> . Nectar and fruit from the mistletoes <i>Amyema miquelii</i> , <i>A. pendula</i> and <i>A. cambagei</i> are also eaten during the breeding season.	Potential to occur but unlikely. Occurrences of <i>E. tereticornis</i> may provide habitat for this species. No recent records of the species within a 10 km radius of the development site and only 1 in total.	Yes
Spiked Rice-flower	<i>Pimelea spicata</i>	On the Cumberland Plain sites it is associated with Grey Box communities (particularly Cumberland Plain Woodland variants and Moist Shale Woodland) and in areas of ironbark.	Potential to occur. A grey box community is present on the site. 457 records of the species within a 10 km radius of the development site and there are records just over 1km away.	Yes
Squirrel Glider	<i>Petaurus norfolcensis</i>	Mixed aged stands of eucalypt forest & woodlands including gum barked & high nectar producing species & hollow bearing trees. <i>Distribution Limit: N-Tweed Heads. S-Albury.</i>	Unlikely to occur. There are limited habitat attributes present across the development site however only 3 records within a 10km radius.	No
Swift Parrot	<i>Lathamus discolor</i>	Inhabits eucalypt forests and woodlands with winter flowering eucalypts. <i>Distribution</i>	The site does contain winter flowering Eucalypts. Surveys were undertaken during	No. It is covered under

Common name	Scientific name	Required habitat components	Assessment of habitat within the development site	Requires further assessment?
		<i>Limit: N-Border Ranges National Park. S-South of Eden.</i>	winter.	ecosystem credits.
Sydney Plains Greenhood	<i>Pterostylis saxicola</i>	Typically in shallow /skeletal soils on rock shelves and platforms. The vegetation communities above the shelves where <i>Pterostylis saxicola</i> occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	Unlikely to occur. Site does not contain rock platforms, or associated skeletal soils. There are 4 records of the species within a 10 km radius of the development site but not since 1990.	No
Thick Lip Spider Orchid	<i>Caladenia tessellata</i>	Terrestrial orchid. Clay-loam or sandy soils. LHCCREMS guidelines suggest the species grows in Map Unit 34 – Coastal Sand Wallum Woodland - Heath. Flowers in September – November. Distribution limits N-Swansea S-south of Eden. Is known to favour low, dry sclerophyll woodland (for example open <i>Kunzea</i> woodland) with a heathy or sometimes grassy understorey.	No suitability for occurrence within the development site. No records exist within a 10km radius of the development site.	No
White-flowered Wax Flower	<i>Cynanchum elegans</i>	Climber or twiner to 1m. Grows in rainforest gullies, scrub & scree slopes. Distribution limits N-Gloucester S-Wollongong.	Poor habitat attributes may be present across parts of the development site, however there are only 4 records within a 10km radius. There are no records in close proximity. Unlikely to occur.	No

5.5.3 Presence of candidate species

Table 5.7 outlines the surveys that were undertaken for each of the candidate species that were assessed as requiring further assessment.

A list of flora and fauna species recorded during surveys is provided in Appendix B and Appendix C, respectively.

Table 5.7 – Summary of surveys undertaken for candidate species

Common name	Scientific name	Survey type	Survey timing	Further loss in CMA
Cumberland Plain Land Snail**	<i>Meridolum corneovirens</i>	Targeted searches in woodland areas with leaf litter and on-ground refugia	July 2016	Acceptable
Green and Golden Bell Frog*	<i>Litoria aurea</i>	Habitat searches and nocturnal survey	July 2016	No loss to natural breeding habitat, no loss of foraging habitat within 250m of natural waterbodies, up to 10% loss of foraging habitat greater than 250m from natural waterbodies.
Regent Honeyeater	<i>Anthochaera phrygia</i>	Diurnal bird survey	July 2016	No loss of breeding in Capertee sub-catchment, up to 5% of habitat excluding Swamp Mahogany
Spiked Rice-flower	<i>Pimelea spicata</i>	Target threatened flora survey	July 2016	No

* denotes species survey not undertaken within main season

** denotes species recorded

Little Lorikeet is not a candidate species as it is an ecosystem credit species, however the species was surveyed and noted as being present during diurnal bird surveys in July 2016.

Figure 14 shows specific search areas / types and the location where there was any occurrences of the species.

It was considered that the proposal will impact on breeding or potential breeding habitat for Cumberland Plain Land Snail and thus species credits would be required. There is no impact to breeding habitat for Grey-headed Flying-fox (and no nearby camps) and Eastern Bentwing-bat, therefore species credits should not be applied for these species as they are considered for offsetting in the ecosystem credits. Little Lorikeet will be impacted but this is an ecosystem species credit.



Avoid and minimise impacts

6

This chapter outlines the extent of proposed actions to avoid the potential direct and indirect impacts of the development on biodiversity values. It also summarises proposals to minimise the potential direct and indirect impacts to biodiversity values by implementing mitigation measures.

6.1 Avoidance measures

Some specific design measures have been incorporated in an attempt to limit impacts, however the majority of vegetation is impacted upon by the proposed development.

The proposal seeks to realign a large portion of Bow Bowing Creek to provide more future room for development of the central and eastern portions of the site. Post construction the creek corridor will be regenerated.

The site is in a key location, adjacent to commercial development, adjacent to main roads and railway, adjacent to a university, and less than 2km to the freeway heading in and out of Sydney metropolitan area.

Indirect impacts to offsite areas are limited to mostly hydrological changes to Bow Bowing Creek and its tributaries. There may also be some impacts to adjoining vegetation on the northern edge of the site towards the western end which is adjacent to an existing carpark. This vegetation is contiguous with vegetation within the development site.

Indirect impacts are primarily associated with construction activities on the surrounding land such as:

- Sedimentation and run off
- Noise, dust and light spill
- Impacts to adjoining vegetation and habitat
- Introduction of feral pests, weeds and pathogens
- Infrequent or cumulative impacts
- Operations phase impacts (trampling of vegetation, rubbish dumping, noise, etc.)

The project will include measures designed to minimise the impacts on retained vegetation as set out in Section 6.2.

6.2 Mitigation measures

The following mitigation measures are proposed to minimise the potential ecological impacts, address threatening processes and to create a positive ecological outcome for fauna, their habitat and endangered ecological communities. They include:

- Preclearance habitat searches and relocation of any wildlife in existing habitat trees under the supervision of a fauna ecologist in accordance with a relocation protocol (pre-construction)
- Sediment and erosion control measures are to be installed immediately prior to the commencement of demolition, construction and earthworks (pre-construction)
- Inspection and removal of any aquatic fauna from the existing dams (pre-construction)
- Installation of protective fencing around drip zone of trees that interface with the development site to be retained (pre-construction)
- Sediments are to be effectively retained within the site to minimise deterioration of surface runoff during the construction works (construction phase)
- Establish sediment basins to collect any sediment mobilised from the site (pre-construction)
- Remove fill, stabilise and revegetate with wetland and CPW species (pre-construction and construction phase)
- Stabilisation of proposed restoration areas (pre-construction and construction phase)
- Loss of vegetation compensated by the planting of EEC vegetation along the reconstructed drainage line. Revegetation will enhance or replace lost foraging trees for birds and bats (construction phase)
- Aim to filter any runoff through sedge planted swales and / or bioretention basins to minimise deposition within the creek line(s) (pre-construction)
- Target weed control should be undertaken in revegetation areas and retained vegetation areas, focussing upon invasive and noxious weed species (all phases of work)
- A vegetation management plan is to be prepared to identify restorations measures and to stipulate all habitat enrichment and fauna relocation protocols (all phases of work)
- Monitoring protocol for environmental controls (all phases)
- Ongoing management (post-construction)
- Project management plan to manage construction activities

There has been some minor redesigns of the development to retain a little bit extra of Cumberland Plain Woodland.

Mitigation measures need to be fully explored and detailed within a management plan.

6.3 Impacts that cannot be avoided or mitigated

A summary of the direct impacts and how they will be addressed is provided in Table 6.1. These impacts have been assessed using the BioBanking Credit Calculator and are discussed in Chapter 7.

The scale and extent of the indirect impacts are summarised in Table 6.2.

6.4 Summary

Potential for avoidance measures

The potential to avoid impacts on EECs and other biodiversity matters is difficult in this situation because of the way Bow Bowling Creek bisects the site, and the social / economic values of the land in relation to major shopping centres, education areas, and transport hubs. The proposal seeks a strategy to make a red flag variation request for the impacts on biodiversity values.

Table 6.1 – Summary of direct impacts

Impact	How it is addressed	Outcome	Timing	Responsibility
<p>River-flat Eucalypt Forest on Coastal Floodplains</p> <ul style="list-style-type: none"> • The proposal will see a large reduction of this EEC throughout the study area (76%) • Much of the existing area will be removed or highly modified for future realignment of Bow Bowing Creek. 	<p>Vegetation being retained is generally within the western portion of the development site and along the western end of Bow Bowing Creek or along part of the southern boundary.</p> <p>Remnant areas of vegetation are to be protected via fencing that restricts vehicular and pedestrian access, as well as sediment fencing.</p> <p>Remnant vegetation is to be weeded.</p> <p>Post construction, most of the realigned creek is to be restored with River-flat Eucalypt Forest species.</p> <p>Non-development areas may be secured by covenant and managed in accordance with an approved vegetation management plan in perpetuity.</p>	<p>Improvements to native species diversity through regulated weed control and access control, but still a shortfall on required offsets. External sources would be required to offset EEC values.</p> <p>The listing of vegetation communities to be cleared is accounted for in the biobanking calculations. The purchase of biodiversity credits includes a "punishment" for this direct impact.</p>	<p>Sourcing of credits will be commenced once approval is obtained.</p> <p>Retirement of credits will occur according to biobanking rules.</p>	<p>Property owner</p>
<p>Cumberland Plain Woodland</p> <ul style="list-style-type: none"> • The proposal will see a large reduction of this CEEC throughout the study area (72%) • The proposal will remove a high amount of the remnant 	<p>Vegetation being retained is generally within the western portion of the development site or along part of the southern boundary.</p> <p>Remnant areas of vegetation are to be protected via fencing that restricts vehicular and pedestrian access, as well as sediment fencing.</p> <p>Remnant vegetation is to be weeded.</p> <p>Post construction, parts of the realigned</p>	<p>Improvements to native species diversity through regulated weed control and access control, but still a shortfall on required offsets. External sources would be required to offset EEC values.</p> <p>The listing of vegetation communities to be cleared is accounted for in the biobanking calculations. The purchase of biodiversity credits includes a "punishment" for this direct impact.</p>	<p>Sourcing of credits will be commenced once approval is obtained.</p> <p>Retirement of credits will occur according to biobanking rules.</p>	<p>Property owner</p>

Impact	How it is addressed	Outcome	Timing	Responsibility
<p>vegetation on site, leaving only a very small portion which would be subjected to edge effects, weed invasion and possible erosion from adjoining cut and fill. The indirect impacts have the capacity to be large and likely.</p>	<p>creek may be restored with CPW species.</p> <p>Non-development areas may be secured by covenant and managed in accordance with an approved vegetation management plan in perpetuity.</p>			
<p>Loss of fauna habitat</p>	<p>Replacement of disturbed or removed vegetation post creek realignment, weed control to improve native flora species diversity, and replacement of hollows and ground refugia. Cumberland Plain Land Snail may be translocated to retained vegetation areas or to nearby bushland further west along Goldsmith Avenue.</p> <p>Incorporation of a nest box management plan, and an approved vegetation management plan in perpetuity.</p>	<p>Cumulative loss of localised fauna habitat to be minimised through restoration measures post creek realignment, translocation and nest box installation.</p>	<p>Same as above</p>	<p>Property owner</p>
<p>Loss of tree hollows</p>	<p>It is estimated that 6 or 7 of the 14 hollow-bearing trees are likely to be removed. All hollows will be inspected before removal using a camera probe under the inspection of a fauna ecologist. Artificial hollows are proposed for re-installation on retained trees. This is to be addressed under a nest box management plan. The number of hollows to be replaced with next boxes is to exceed the number being removed.</p>	<p>The tree hollows to be removed is accounted for in the biobanking site attribute data (Appendix A, Table A.1). Its loss is therefore included in the credit calculation and the offset requirements.</p>	<p>Same as above</p>	<p>Property owner</p>

Impact	How it is addressed	Outcome	Timing	Responsibility
Loss of threatened fauna species	<p>The proposal will see a cumulative loss of foraging values for threatened species as opposed to likely breeding opportunities, except for the Cumberland Plain Land Snail.</p> <p>Foraging values may be partly replaced through restoration and / or revegetation works.</p> <p>Cumberland Plain Land Snail may be translocated to retained vegetation areas or suitable bushland in close proximity to the site.</p>	The presence of threatened fauna is considered in the biobanking calculations. Some species are assessed as species credits and some as ecosystem credits. The purchase of biodiversity credits includes a "compensation" for this direct impact.	Same as above	Property owner
Loss of threatened flora species	No threatened flora species were found within the development site during the surveys.	The proposed development is unlikely to have an impact on any threatened flora species.	N/A	N/A
Degradation of aquatic habitats and removal of dams	<p>Mitigated by recreation of Bow Bowing Creek and reestablishment of vegetation along the creek line, followed up by regular weed control maintenance. The site does not contain species that require assessment under the Fisheries Act.</p> <p>Dewatering of dams can be undertaken in the presence of a fauna ecologist who will relocate fauna as required (such as eels, turtles, etc).</p>	Fully stabilised sedgeland / drainage system integrated with the stormwater system.	Construction <18 months	Property owner

Table 6.2 – Extent and scale of indirect impacts

Likely impact	Details	Extent/scale
Flora fragmentation	There will be no fragmentation of flora habitat, just a reduction in area.	N/A
Fauna fragmentation	May reduce the capacity of some less mobile fauna to move within and between patches of remaining habitat.	Proposal will not sever fauna habitat corridors but will have a short term impact during realignment of Bow Bowing Creek.
Fauna mortality	May result from collisions with vehicles or plant, or accidental entrapment in plant, trenches or other earthworks.	Most likely to occur during vegetation clearance and in a post development landscape.
Degradation of aquatic habitats	Potentially caused by loss of dams and short term interruption to Bow Bowing Creek during the realignment process.	No offsite impacts expected
Impacts on fish passage	Short term impacts during the realignment process.	Loss of corridor function of the water flow into and out of the development site for a short period.
Edge effects and weed invasion	Vehicles and plant may transport weed propagules into the land. Creation of new edges will increase fragmentation and vulnerability of native vegetation to weed incursions.	No offsite impacts expected
Alteration to air quality and noise	May impact upon the roosting, breeding and foraging activities of locally occurring fauna.	No offsite impacts expected

Figure 15 shows the potential direct impacts, and Figure 16 shows the potential indirect impacts.

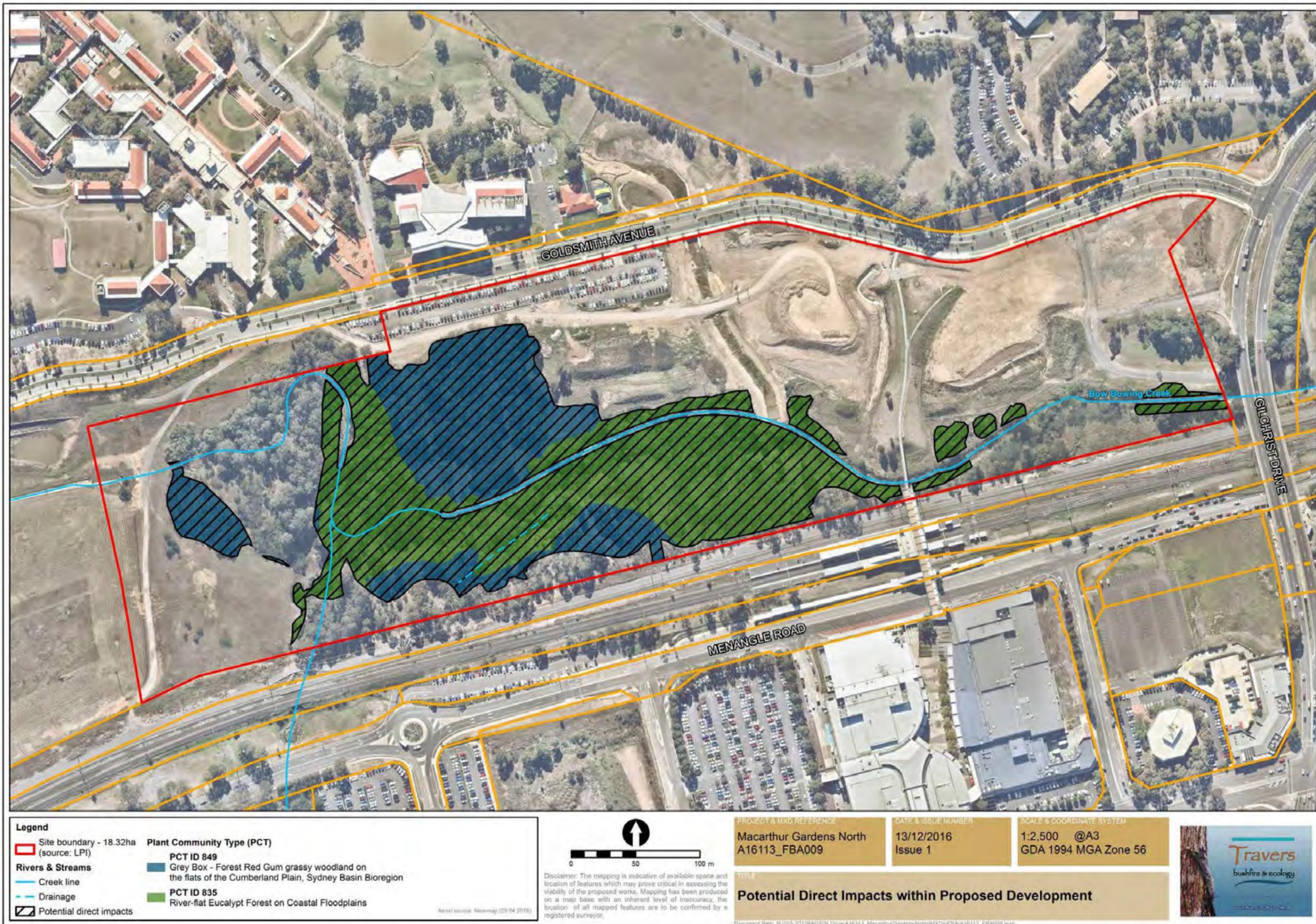


Figure 15 – Potential direct impacts within the development site

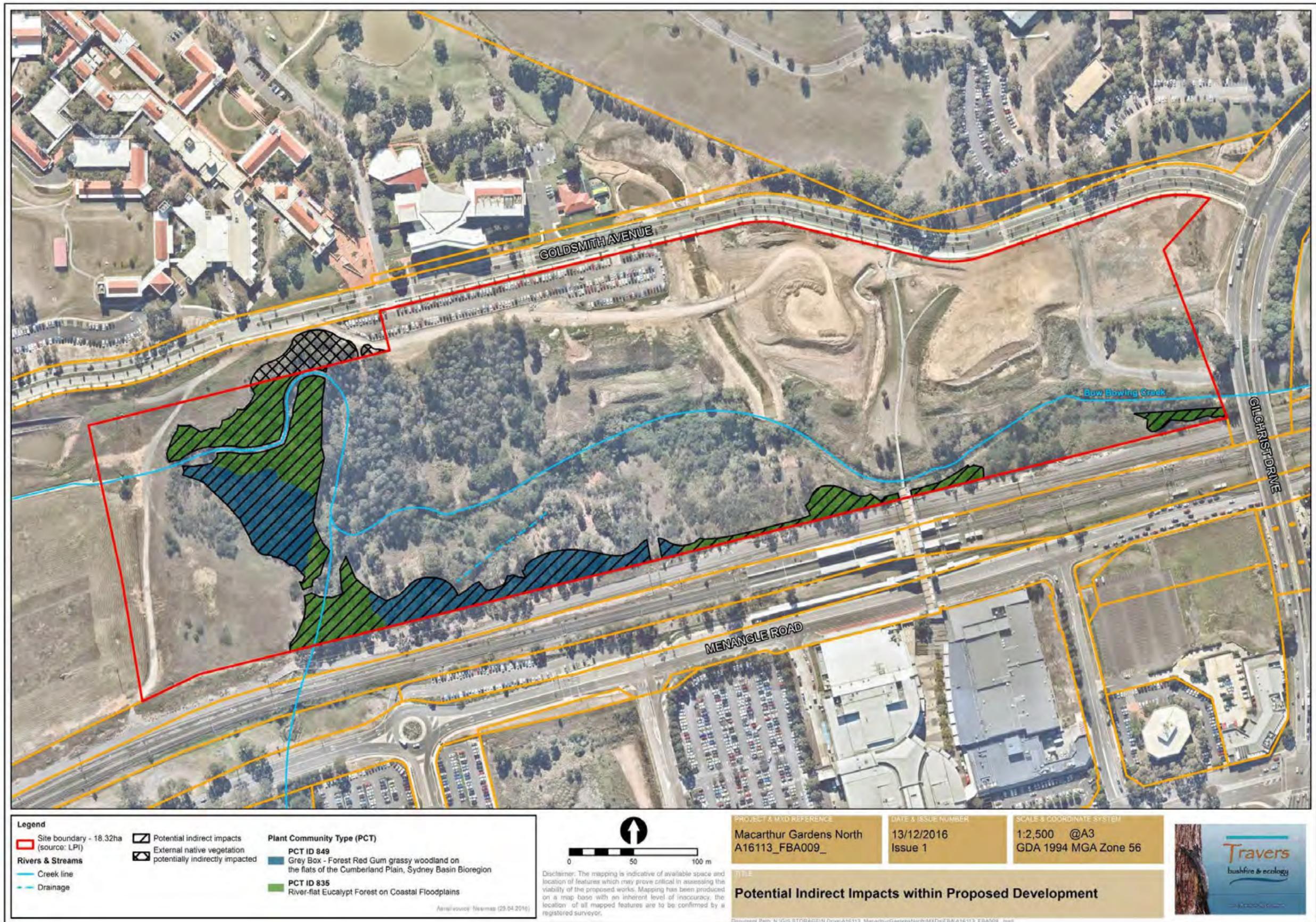


Figure 16 – Potential indirect impacts within the development site



Impact summary

7

7.1 Introduction

The project will involve some direct and indirect impacts on native vegetation and fauna habitat. Direct impacts include the loss of EEC and CEEC vegetation, loss of approximately half of the hollow-bearing trees, foraging habitat for threatened fauna, habitat for Cumberland Plain Land Snail, loss of dams and impacts to aquatic areas, due to clearing of 0.48 ha of native vegetation and minor indirect effects of construction and operation of the proposed facilities upon adjacent vegetation.

The development site comprises a total of 18.32 ha. 76% of River-flat Eucalypt Forest on Coastal Floodplains and 72% Cumberland Plain Woodland will be directly impacted by the proposal.

A summary of impacts is provided in Tables 6.1 and 6.2.

7.1.1 Direct loss of native vegetation

The proposal will remove 2.23 ha of Cumberland Plain Woodland and 3.60 ha of River-flat Eucalypt Forest on Coastal Floodplains. A summary of ecosystem credits required to offset these areas to be cleared within the development site is shown in Table 7.1.

Table 7.1 – Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits required	Red flag
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	1.32	29.66	No
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	2.28	91.02	Yes
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.80	13.60	No
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	1.43	60.43	Yes
Total	5.83	195	

The breakdown of the ecosystem credits for each PCT is shown below.

1. Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (ME020)

Number of ecosystem credits created 74
 IBRA sub-region Cumberland - Sydney Metro

Offset options - vegetation types	Offset options - CMA sub-regions
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (ME020)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (ME018)

Number of ecosystem credits created 121
 IBRA sub-region Cumberland - Sydney Metro

Offset options - vegetation types	Offset options - CMA sub-regions
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (ME018)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

We are not aware of the plans for revegetation and the exact widths of the future creek line, therefore cannot provide management scores to show the future site value and landscape value scores. It would be possible that the future site value score would be close to the original score. For the more intact vegetation that was approximately 50.

7.1.2 Direct loss of fauna habitat

The credit calculator not only calculates loss of native vegetation, but it also includes loss of connectivity to vegetation outside the impact area and loss of fauna habitat, such as fallen logs, tree hollows, exotic species and regeneration of canopy species. Species credits are required for this proposed development due to the presence of Cumberland Plain Land Snail (Table 7.2). A summary of all direct impacts by the proposed development is provided in Table 7.3.

Table 7.2 – Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits required
Cumberland Plain Land Snail	Meridolum corneovirens	5.83	76

7.2 Thresholds for assessing unavoidable impacts

Unavoidable impacts of the project have been considered and a determination made of the assessment and offsetting requirements of such impacts. Table 7.3 summarises these requirements which include:

- Impacts that require further consideration by consent authority
- Impacts for which the assessor is required to determine an offset
- Impacts for which the assessor is not required to determine an offset
- Impacts that do not require further assessment by the assessor

Table 7.3 – Thresholds for the assessment and offsetting of unavoidable impacts of the project

Threshold	Biodiversity value	Criteria	Applicable to the project?
I. Impacts that require further consideration by consent authority	Landscape features	Impacts that will substantially reduce the width of vegetation in the riparian buffer zone bordering rivers and streams 4th order or greater	Yes – although short term
		Impacts in state biodiversity links	No
		Impacts on important wetlands and their buffers	No
		Impacts in the buffer zone along estuaries	No
	Native vegetation	Any impact on a CEEC because it is likely to: <ul style="list-style-type: none"> • cause the extinction of the CEEC from the IBRA subregion, or • significantly reduce the viability of the CEEC 	Yes, but possibly short term if future management (restoration works) are applied
	Species and populations	Impacts on areas of land that the Minister for Environment has declared as critical habitat in accordance with section 46 of the TSC Act and which is listed on the Register of Critical Habitat in NSW	No
		Any impact on a critically endangered species	No
		Any impact on a threatened species or population because it is likely to: <ul style="list-style-type: none"> • cause the extinction of a species or population from an IBRA subregion, or • significantly reduce the viability of a species or population 	No
Any impact on a threatened species or population that has not previously been recorded in the IBRA subregion according to records in the NSW Wildlife Atlas		No	
II. Impacts for which the assessor is required to determine an offset	Native vegetation	The assessor is required to determine an offset for all impacts of development on PCTs.	Undertaken for all areas that will be directly impacted using the BioBanking calculator
		The offset requirement for impacts on native vegetation is determined in accordance with Chapter 10.	Undertaken for all areas that will be directly impacted using the BioBanking calculator
	Species and populations	The assessor is required to determine an offset for the impacts of development on threatened species, populations and threatened species habitat.	Species credits required for Cumberland Plain Land Snail. All other species fall into ecosystem

Table 7.3 – Thresholds for the assessment and offsetting of unavoidable impacts of the project

Threshold	Biodiversity value	Criteria	Applicable to the project?
		The offset requirement for impacts on threatened species, populations and threatened species habitat is determined in accordance with Chapter 10.	credits Species credits required for Cumberland Plain Land Snail. All other species fall into ecosystem credits
III. Impacts for which the assessor is not required to determine an offset	Native vegetation	An assessor is not required to assess areas of land on the development site without native vegetation under Chapter 4 or Chapter 5.	Cleared areas, exotic vegetation and dams which do not fit any PCT have not been assessed.

A red-flag variation report is proposed to be submitted with the application. It is acknowledged that Bow Bowing Creek being a 4th order stream is also red-flagged.

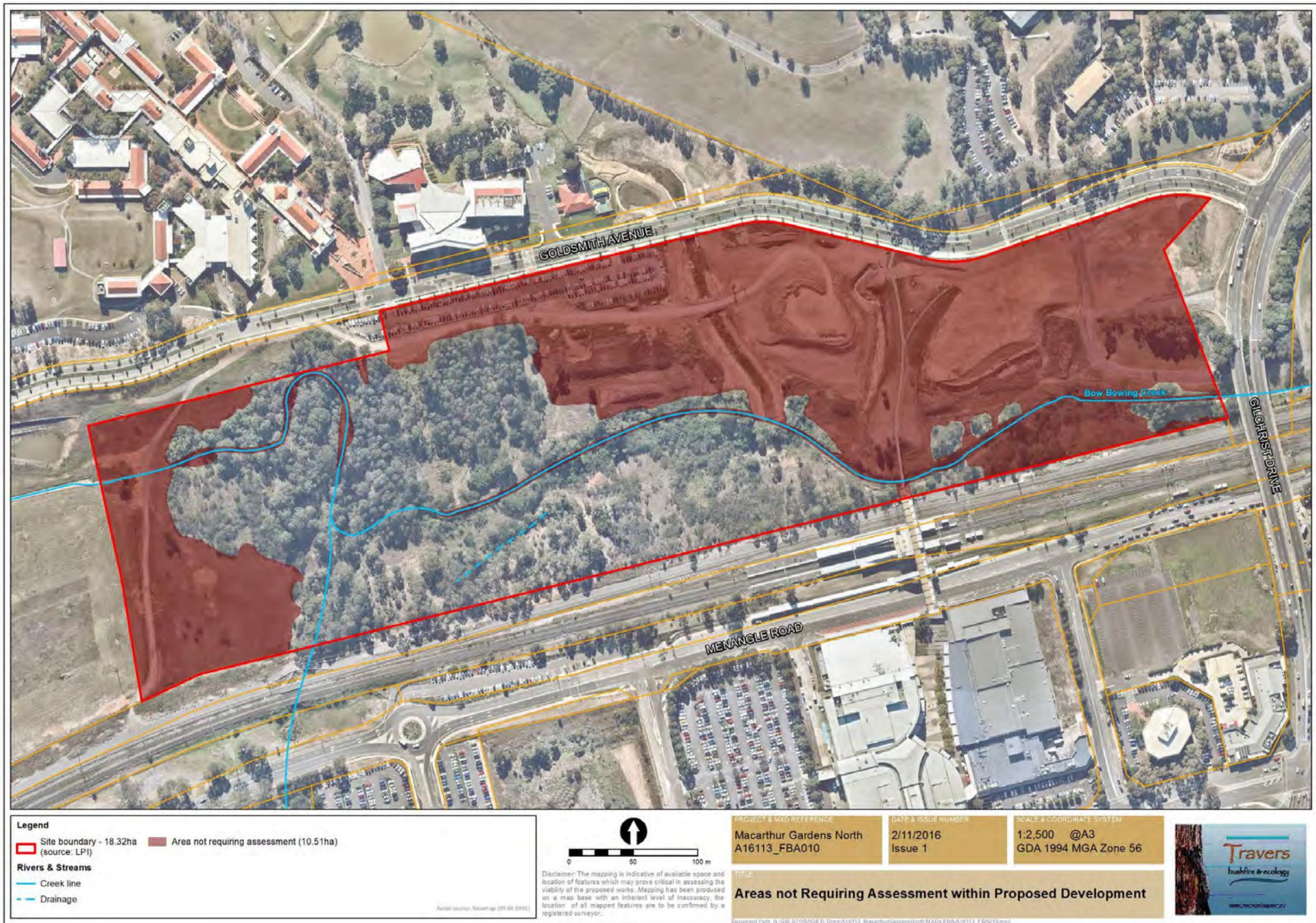


Figure 17 – Areas not requiring assessment within the development site

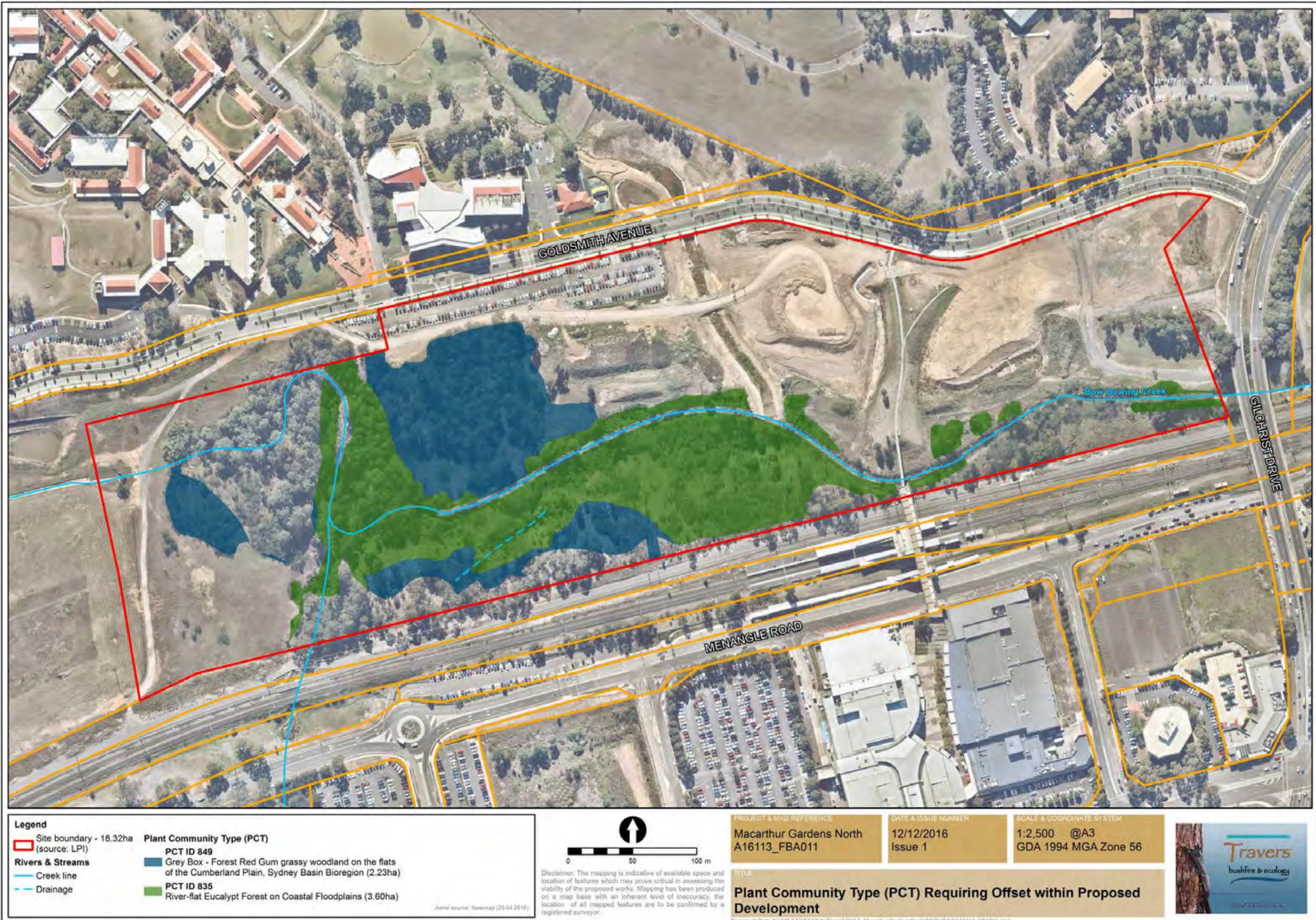


Figure 18 – PCTs requiring offsetting within the development site

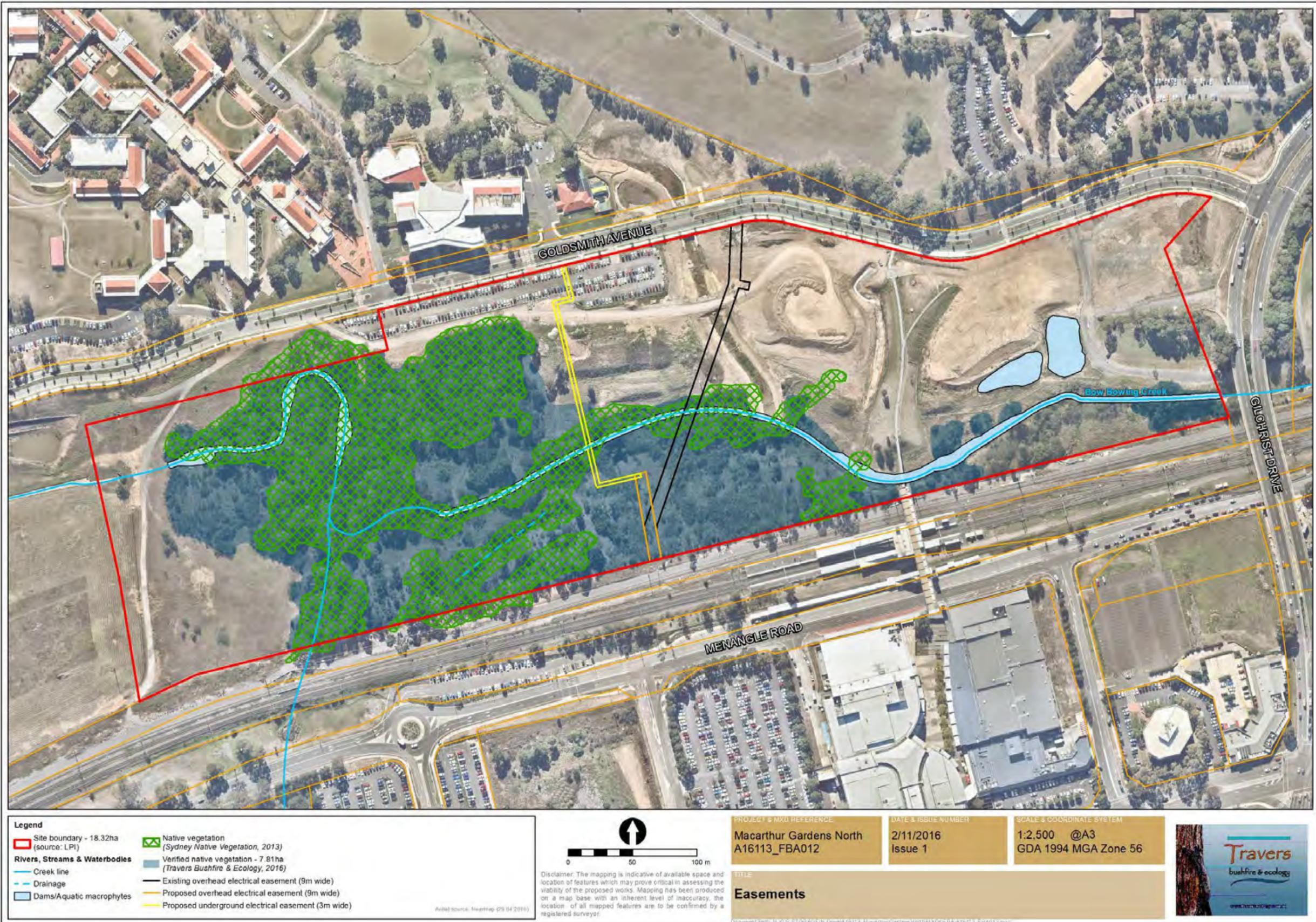


Figure 19 – Easements



Conclusion & Offset Strategy

8

8.1 Purpose of the BAR

This BAR has been prepared to inform of the offset requirements for proposed development at Goldsmith Avenue, Campbelltown, referred to as Macarthur Gardens North. It has assessed the direct and indirect impacts of the proposal and has been prepared in accordance with BBAM 2014 (OEH).

The BAR assesses the ecological impacts of the project as they relate to flora and fauna:

All impacts on native vegetation on the site should be avoided wherever possible and, if not avoided, suitably offset. Potential impacts should be assessed in accordance with relevant Office of Environment and Heritage guidelines, by a person accredited in accordance with s142B(1)(c) of the Threatened Species Conservation Act 1995.

8.2 Land use history and context of the land

The natural vegetation throughout almost the entire site is a result of regrowth since the 1960s where historic aerials depict an almost cleared site. Thus, many of the existing trees on site have a smaller girth than a mature forest. The current vegetation is of mixed aged with several stands of Acacia only vegetation or juvenile Eucalypts less than 10m in height.

Although most natural vegetation on site is a result of some form of regrowth, the vegetation on and adjacent to the creek line embankment contains a moderate affiliation to River-flat Eucalypt Forest on Coastal Floodplains, whilst the remaining vegetation on the flats above the embankment fits more closely to Cumberland Plain Woodland. Both communities are EECs, with Cumberland Plain Woodland listed as critically endangered. Cumberland Plain Woodland is also listed under the *EPBC Act* as the critically endangered ecological community, Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.

The site is currently not in use for residential purposes, commercial or industrial but is subject to ongoing residential development in accordance with the Macarthur North Masterplan permissible under the current LEP. The eastern portion of the site has been heavily modified for drainage management and handling of excess. The far western end of the site has mown grass that may be occasionally used for recreational pursuits but is the proposed location of the proposed flood detention basin. A car park for the adjoining university occurs along a portion of the northern boundary.

8.3 Summary of scale and extent of impacts

The site is 18.32 ha. The development proposal will involve the removal of approximately 75% of both EECs which are present (Cumberland Plain Woodland and River-flat Eucalypt Forest on Coastal Floodplains), representing a total estimated loss of 5.83 ha of native vegetation.

Avoidance of impacts has been given some thought with the retention of some vegetation along the southern boundary and around a portion of the riparian zone (western end), however the site is located in an area central to shopping facilities, university, main roads and freeway, and a major train line.

There is one (1) dam and two (2) basins on site which will be removed as part of the proposal, and the central and eastern end of Bow Bowing Creek is proposed to be realigned. The impacts of realignment works will be short term as it is proposed to restore vegetation in these areas. Vegetation along the creek line is highly disturbed with a high proportion of exotics. The two (2) basins will be future playing fields.

Approximately half of the hollow-bearing trees will be removed, most of which occur in the central-west, northern part of the site.

The proposal seeks the removal of two (2) EEC / CEECs and recorded habitat by the threatened fauna species, Little Lorikeet, Grey-headed Flying-fox, Eastern Bentwing-bat and Cumberland Plain Land Snail.

The impact on biodiversity has been assessed by using the BioBanking credit calculator, which considers landscape values, patch size, quality of vegetation and fauna habitat. The resulting ecosystem credits are:

- 74 ecosystem credits for ME020 (Cumberland Plain Woodland)
- 121 ecosystem credits for ME018 (River-flat Eucalypt Forest on Coastal Floodplains)

The resulting species credits are:

- 76 credits for Cumberland Plain Land Snail

The proposal will impact on red flagged areas and a separate red flag variation report will be required to support the application.

Subject to approval of the alternative offset arrangements, these ecosystem credits are to be acquired from a BioBank site within the same or an adjoining IBRA sub-region.

There is potential for indirect impacts to surrounding lands but they are expected to be relatively well filtered given the proposed restoration works of the realigned creek and weed control works. Indirect impacts could include but not be limited to:

- Sedimentation and run off;
- Noise, dust and light spill;
- Impacts to adjoining vegetation and habitat;
- Introduction of feral pests, weeds and pathogens;
- Infrequent or cumulative impacts; and
- Operations phase impacts (trampling of vegetation, rubbish dumping, noise, etc).

8.4 Summary of state matters – terrestrial biodiversity

In respect of matters required to be considered under the *Environmental Planning and Assessment Act 1979* and relating to the species / provisions of the *Threatened Species Conservation Act 1995*, the following were recorded within development site:

- Cumberland Plain Woodland, assigned to PCT 849, ME020.
- River-flat Eucalypt Forest on Coastal Floodplains, assigned to PCT 835, ME018.
- Cumberland Plain Land Snail (*Meridolum corneovirens*) was recorded on site.
- No threatened flora species.

8.5 Summary of state matters – aquatic biodiversity

In respect of matters relative to the *Fisheries Management Act 1994*, no suitable habitat for threatened marine or aquatic species was observed within the development site and there are no matters requiring further consideration under this Act.

8.6 Summary of Commonwealth matters

In respect of matters required to be considered under the *Environment Protection and Biodiversity Conservation Act 1999*, the following were recorded within the development site:

- Grey-headed Flying-fox - The proposal is not considered to have a significant impact upon matters of national environmental significance.
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest - The proposal is considered to have a significant impact upon matters of national environmental significance due to the proposed action causing impact on a NES matter, Cumberland Plain Woodland that has a patch size of greater than 0.5ha.

A referral to DoEE is required for assessment under the *EPBC Act*.

8.7 Biodiversity offset strategy

The required ecosystem and species credits can be purchased from a BioBank market within the same or an adjoining IBRA sub-region. Alternatively the offsets can be provided by the identification and supply of a suitable biobank site to retire the credits.

Section 8 of the report details the findings and options for sourcing the requirements using the BioBanking Public Register.

8.7.1 Sourcing required ecosystem end species credits from the BioBank market

With respect to locating suitable offsets, the BioBanking Public Register was utilised to gain an appreciation of the availability of the required ecosystem credits.

As at 2/11/16, there were no ME020 (PCT 849) or ME018 (PCT 835) ecosystem credits available on the BioBanking Public Register.

There are currently no PCTs on the BioBanking Public Register that have an exact match. A supplementary or alternate offset needs to be acquired.

Typically, the alternative should use the same PCT in the neighbouring IBRA sub-region. This is usually supported by OEH and DP&E. The alternative for PCT 849 is HN526 and for PCT 835 is HN 528.

In addition to this, the equivalent vegetation type in the adjoining IBRA sub-region is PCT 849 (HN528). Purchasing these credits in lieu of ME020 may be acceptable but require concurrence with DP&E. If these credits are acceptable then Western Sydney Parklands Trust currently have a number available.

There are no similar PCTs in the IBRA sub-region for PCT 835 (ME018) in the BioBanking Public Register and there are not enough credits available, only 11 and 121 are required. It may be possible with the acceptance from DP&E to acquire further ME019 credits as they relate to a vegetation type which is more threatened than ME018 (critically endangered versus endangered).

The BioBanking Public Register contains a series of offset sites which related to ME019 or PCT 850, Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion. This PCT has many of the same species recorded in PCT 849, however the main difference is the topographic value; one being on coastal flats, the other being on an undulating landscape.

Both PCT 849 (on site) and PCT 850 incorporate the TSC CEEC Cumberland Plain Woodland, and as such, the ecological values are very similar, and fauna habitats are much the same.

If deemed appropriate by DP&E, offsetting the loss of PCT 849 with PCT 850 would likely be sought.

Table 8.1 – Ecosystem credits available for ME019 and ME018

Search results for ecosystem credits



IBRA sub-region - Cumberland
Credit status - Issued/Pending

Credit owner(s)	Email	Agreement ID	Plant Community Code	IBRA sub-region	Vegetation Formation	Credit Status	Credits
Roads and Maritime Services	melissa.huntsman@rms.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	117
Roads and Maritime Services	melissa.huntsman@rms.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	47
Roads and Maritime Services	melissa.huntsman@rms.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	36
Transport for NSW	Biobanking@environment.nsw.gov.au	70	ME019	Cumberland - Sydney Metro	GRW	Issued	33
Roads and Maritime Services	melissa.huntsman@rms.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	28
Western Sydney Parklands Trust	enquiries@wspt.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	23
Western Sydney Parklands Trust	enquiries@wspt.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	17
Baulkham Hills Shire Council	LDOOREY@thehills.nsw.gov.au	148	ME018	Cumberland - Sydney Metro	GRW	Issued	8
Western Sydney Parklands Trust	enquiries@wspt.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	7
Transport for NSW	Biobanking@environment.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	5
Baulkham Hills Shire Council	LDOOREY@thehills.nsw.gov.au	148	ME018	Cumberland - Sydney Metro	GRW	Issued	3
Sydney Water	Biobanking@environment.nsw.gov.au	119	ME019	Cumberland - Sydney Metro	GRW	Issued	2

With respect to sourcing of species credits for Cumberland Plain Land Snail, there are no credits on the BioBanking Public Register.

8.7.2 Sourcing of required credits to offset the loss of biodiversity value

The required ecosystem and species credits can be obtained & retired via the following mechanisms:

- Biobank site expressions of interest (EOI) register – sourcing the required credits from landowners who are interested in establishing biobank sites, but have not entered into a BioBanking agreement.
- Credits wanted register – register the required credits on the credit wanted register to allow other assessors to link with proponents who are seeking biodiversity credits. Varying the rules to match PCT 849 (ME020) on the project lands to PCT 850 (ME019) in the same IBRA sub-region given it has similar values, forms part of the same TSC CEEC and has the same amount cleared. PCT 849 is not available on the BioBanking Public Register as at 02/11/16, however there are several available PCT

850 sites that would satisfy the 74 ecosystem credits required. The equivalent vegetation types in adjoining IBRA sub-region is PCT 849 (HN528). The same may go for ME018 as there are only 11 credits available on the register and 121 are required. If these credits are acceptable then Western Sydney Parklands Trust currently have a number available.

- Sourcing and establishing a biobank site of equivalent or greater credit value.

This report concludes that using the variations and supplementary measures, the required offsets can be sourced from the open biobank market by:

1. Varying the rules to allow to match PCT 849 and 835 on the project lands to PCT 850 in the same IBRA sub-region. Ecosystem credits for PCT 850 are available from the BioBanking Public Register therefore all ecosystem credits can be sourced and retired, or alternatively offsetting with HN528 in the adjoining IBRA subregion.
2. Register interest for purchasing of Cumberland Plain Land Snail as a species credit.
3. Sourcing and establishing a biobank site with the required combined credits.

It is anticipated that a trust fund will be set up to establish the offset sites and provide the required ongoing management funding.

References

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Appendix A

Plot and Transect Data

Table A1 – Plot transect data from the development site

Zone	Quadrat	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
1	1	17	15.5	15	15	1	4	70	0	1	7	296284	6227620	56
1	3	22	28.5	18	16	22	8	16	2	1	17	296262	6227750	56
1	4	13	28.5	16	8	6	4	25	0	1	4	296308	6227788	56
1	5	15	21.5	17	22	8	8	22	0	1	7	296322	6227723	56
1	9	14	1	17.5	12	2	14	64	0	1	2	296538	6227766	56
1	10	14	9.5	9.5	16	4	2	72	1	1	0	296758	6227753	56
1	11	4	42	0	6	0	4	70	0	1	0	296928	6227788	56
1	15	14	22	15.5	50	2	2	24	1	1	3	296678	6227713	56
2	14	10	0	46	44	0	4	22	0	0	0	296571	6227689	56
3	6	12	7	26.5	66	0	2	30	0	1	8	296418	6227739	56
3	7	9	24.5	14	42	6	2	20	0	1	8	296380	6227812	56
3	12	22	21	10.5	38	1	8	5	0	1	5	296349	6227629	56
3	13	19	22	14	40	2	8	6	0	1	11	296447	6227654	56
4	2	7	0	38.5	15	4	2	60	0	0	0	296199	6227679	56
5	8	7	0	0	72	1	1	26	0	0	0	296464	6227774	56

NPS – native plant species

NOS – native overstorey projected foliage cover

NMS – native mid-storey projected foliage cover

NGCG – native groundcover, projected foliage cover - grasses

NGCS – native groundcover, projected foliage cover – shrubs under 1m

NGCO – native groundcover, projected foliage cover – other

EPC – exotic plant cover

NTH – number of trees with hollows

OR – overstorey regeneration proportion out of 1

FL – fallen logs

Only highlighted columns were used in the biobanking calculator. All other columns related to transect plots (quadrats) which occur in areas of vegetation to be retained.

Appendix B

Flora Species List

Table B1 – Flora species list for the development site

Family	Scientific name	Common name
Trees		
Mimosaceae	<i>Acacia decurrens</i>	Black Wattle
Mimosaceae	<i>Acacia parramattensis</i>	Parramatta Wattle
Casuarinaceae	<i>Allocasuarina littoralis</i>	Black She-oak
Myrtaceae	<i>Angophora floribunda</i>	Rough-barked Apple
Myrtaceae	<i>Angophora subvelutina</i>	-
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak
Ulmaceae	<i>Celtis sinensis</i> *	Chinese Hackberry
Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum
Myrtaceae	<i>Eucalyptus amplifolia</i>	Cabbage Gum
Myrtaceae	<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark
Myrtaceae	<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
Myrtaceae	<i>Eucalyptus microcorys</i>	Tallowwood
Myrtaceae	<i>Eucalyptus moluccana</i>	Grey Box
Myrtaceae	<i>Eucalyptus sp.</i>	-
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum
Bignoniaceae	<i>Jacaranda mimosifolia</i> *	Jacaranda
Meliaceae	<i>Melia azedarach</i>	White Cedar
Arecaceae	<i>Phoenix canariensis</i> *	Canary Island Date Palm
Anacardiaceae	<i>Schinus areira</i> *	Pepper Tree
Shrubs		
Mimosaceae	<i>Acacia falcata</i>	Sickle Wattle
Mimosaceae	<i>Acacia floribunda</i>	Sally Wattle
Mimosaceae	<i>Acacia implexa</i>	Hickory
Agavaceae	<i>Agave americana</i> *	Century Plant
Euphorbiaceae	<i>Breynia oblongifolia</i>	Coffee Bush
Pittosporaceae	<i>Bursaria spinosa</i>	Native Blackthorn
Fabaceae	<i>Daviesia ulicifolia</i>	Gorse Bitter Pea
Sapindaceae	<i>Dodonaea viscosa</i>	Sticky Hop-bush
Apocynaceae	<i>Gomphocarpus fruticosus</i> *	Narrow Leaf Cotton Bush
Fabaceae	<i>Indigofera australis</i>	Native Indigo
Oleaceae	<i>Ligustrum lucidum</i> *	Large-leaved Privet
Oleaceae	<i>Ligustrum sinense</i> *	Small-leaved Privet
Solanaceae	<i>Lycium ferocissimum</i> *	African Boxthorn
Oleaceae	<i>Olea europaea</i> subsp. <i>cuspidata</i> *	African Olive
Asteraceae	<i>Ozothamnus diosmifolius</i>	White Dogwood
Phytolaccaceae	<i>Phytolacca octandra</i> *	Inkweed
Polygalaceae	<i>Polygala virgata</i> *	-
Rosaceae	<i>Rubus fruticosus</i> sp. agg.*	Blackberry Complex
Asteraceae	<i>Senecio pterophorus</i> *	African Daisy
Groundcovers		
Polygonaceae	<i>Acetosa saggitata</i> *	Turkey Rhubarb
Polygonaceae	<i>Acetosella vulgaris</i> *	Sheep Sorrel
Asteraceae	<i>Ageratina adenophora</i> *	Crofton Weed
Amaranthaceae	<i>Alternanthera pungens</i>	-
Amaranthaceae	<i>Amaranthus viridis</i> *	Green Amaranth
Myrsinaceae	<i>Anagallis arvensis</i> *	Scarlet Pimpernel
Poaceae	<i>Andropogon virginicus</i> *	Whisky Grass
Poaceae	<i>Aristida ramosa</i>	Wire Grass

Family	Scientific name	Common name
Poaceae	<i>Aristida vagans</i>	Three-awn Speargrass
Asparagaceae	<i>Asparagus aethiopicus</i> *	Asparagus Fern
Rubiaceae	<i>Asperula conferta</i>	Common Woodruff
Poaceae	<i>Austrostipa pubescens</i>	Tall Speargrass
Poaceae	<i>Austrostipa ramosissima</i>	Stout Bamboo Grass
Asteraceae	<i>Bidens pilosa</i> *	Cobbler's Pegs
Brassicaceae	<i>Brassica fruticulosa</i> *	Twiggy Turnip
Brassicaceae	<i>Brassica rapa</i> *	Wild Turnip
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet
Acanthaceae	<i>Brunoniella pumilio</i>	Dwarf Blue Trumpet
Crassulaceae	<i>Bryophyllum pinnatum</i> *	-
Cyperaceae	<i>Carex appressa</i>	Tall Sedge
Apiaceae	<i>Centella asiatica</i>	Indian Pennywort
Sinopteridaceae	<i>Cheilanthes sieberi</i>	Rock Fern
Poaceae	<i>Chloris gayana</i> *	Rhodes Grass
Poaceae	<i>Chloris truncata</i>	Windmill Grass
Asteraceae	<i>Cirsium vulgare</i> *	Spear Thistle
Asteraceae	<i>Conyza bonariensis</i> *	Flaxleaf Fleabane
Asteraceae	<i>Conyza sumatrensis</i> *	Fleabane
Poaceae	<i>Cymbopogon refractus</i>	Barbwire Grass
Poaceae	<i>Cynodon dactylon</i>	Common Couch
Cyperaceae	<i>Cyperus eragrostis</i> *	Umbrella Sedge
Cyperaceae	<i>Cyperus gracilis</i>	-
Phormiaceae	<i>Dianella revoluta</i>	Blueberry Lily
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed
Poaceae	<i>Ehrharta erecta</i> *	Panic Veldtgrass
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush
Chenopodiaceae	<i>Einadia nutans</i> subsp. <i>linifolia</i>	Climbing Saltbush
Chenopodiaceae	<i>Einadia polygonoides</i>	-
Poaceae	<i>Entolasia marginata</i>	Bordered Panic
Poaceae	<i>Entolasia stricta</i>	Wiry Panic
Poaceae	<i>Eragrostis brownii</i>	Brown's Lovegrass
Poaceae	<i>Eragrostis curvula</i> *	African Lovegrass
Asteraceae	<i>Euchiton sphaericus</i>	Cudweed
Euphorbiaceae	<i>Euphorbia peplus</i> *	Spurge
Asteraceae	<i>Euryops</i> sp.*	-
Apiaceae	<i>Foeniculum vulgare</i> *	Fennel
Geraniaceae	<i>Geranium homeanum</i>	Northern Cranesbill
Geraniaceae	<i>Geranium solanderi</i>	Cutleaf Cranesbill
Clusiaceae	<i>Hypericum gramineum</i>	Small St Johns Wort
Clusiaceae	<i>Hypericum perforatum</i> *	St Johns Wort
Asteraceae	<i>Hypochaeris radicata</i> *	Flatweed
Poaceae	<i>Imperata cylindrica</i> var. <i>major</i>	Blady Grass
Juncaceae	<i>Juncus usitatus</i>	Common Rush
Asteraceae	<i>Lactuca serriola</i> *	Prickly Lettuce
Lomandraceae	<i>Lomandra filiformis</i>	Wattle Mat-rush
Lomandraceae	<i>Lomandra longifolia</i>	Spiky-headed Mat-rush
Lomandraceae	<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	Many-flowered Mat-rush
Fabaceae	<i>Lotus suaveolans</i> *	Hairy Bird's Foot Trefoil
Fabaceae	<i>Medicago polymorpha</i> *	Burr Medic

Family	Scientific name	Common name
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass
Malvaceae	<i>Modiola caroliniana</i> *	Red-flowered Mallow
Brassicaceae	<i>Nasturtium officinale</i>	Watercress
Poaceae	<i>Oplismenus aemulus</i>	Basket Grass
Poaceae	<i>Oplismenus imbecillis</i>	-
Cactaceae	<i>Opuntia stricta</i> *	Prickly Pear
Oxalidaceae	<i>Oxalis corniculata</i> *	Yellow Wood Sorrel
Oxalidaceae	<i>Oxalis latifolia</i> *	Pink Fishtail
Oxalidaceae	<i>Oxalis perennans</i>	-
Poaceae	<i>Panicum simile</i>	Two Colour Panic
Poaceae	<i>Paspalum dilatatum</i> *	Paspalum
Poaceae	<i>Paspalum quadrifarium</i> *	Tussock Paspalum
Poaceae	<i>Paspalum urvillei</i> *	Vasey Grass
Sinopteridaceae	<i>Pellaea falcata</i>	Sickle Fern
Poaceae	<i>Pennisetum clandestinum</i> *	Kikuyu
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed
Poaceae	<i>Phalaris aquatica</i> *	Phalaris
Poaceae	<i>Phragmites australis</i>	Common Reed
Plantaginaceae	<i>Plantago lanceolata</i> *	Ribwort
Lamiaceae	<i>Plectranthus parviflorus</i>	Cockspur Flower
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot
Iridaceae	<i>Romulea rosea</i> *	Onion Grass
Polygonaceae	<i>Rumex crispus</i> *	Curled Dock
Poaceae	<i>Rytidosperma caespitosum</i>	Ringed Wallaby Grass
Poaceae	<i>Rytidosperma racemosum</i>	-
Asteraceae	<i>Senecio madagascariensis</i> *	Fireweed
Poaceae	<i>Setaria parviflora</i> *	-
Poaceae	<i>Setaria pumila</i> *	Pale Pigeon Grass
Malvaceae	<i>Sida rhombifolia</i> *	Paddy's Lucerne
Solanaceae	<i>Solanum nigrum</i> *	Black Nightshade
Solanaceae	<i>Solanum prinophyllum</i>	Forest Nightshade
Asteraceae	<i>Sonchus oleraceus</i> *	Common Sow-thistle
Poaceae	<i>Sporobolus africanus</i> *	Parramatta Grass
Asteraceae	<i>Taraxacum officinale</i> *	Dandelion
Poaceae	<i>Themeda triandra</i>	Kangaroo Grass
Fabaceae	<i>Trifolium repens</i> *	White Clover
Typhaceae	<i>Typha orientalis</i>	Cumbungi
Verbenaceae	<i>Verbena bonariensis</i> *	Purpletop
Verbenaceae	<i>Verbena litoralis</i> *	-
Verbenaceae	<i>Verbena rigida</i> *	Veined Verbena
Plantaginaceae	<i>Veronica plebeia</i>	Creeping Speedwell
Violaceae	<i>Viola hederacea</i>	Ivy-leaved Violet
Vines		
Basellaceae	<i>Anredera cordifolia</i> *	Madeira Vine
Apocnyaceae	<i>Araujia sericifera</i> *	Mothvine
Asparagaceae	<i>Asparagus asparagoides</i> *	Bridal Creeper
Vitaceae	<i>Cayratia clematidea</i>	Native Grape
Ranunculaceae	<i>Clematis glycinoides</i>	Headache Vine
Fabaceae	<i>Desmodium rhytidophyllum</i>	-
Fabaceae	<i>Desmodium varians</i>	-
Luzuriagaceae	<i>Geitonoplesium cymosum</i>	Scrambling Lily

Family	Scientific name	Common name
Fabaceae	<i>Glycine clandestina</i>	Twining Glycine
Fabaceae	<i>Glycine tabacina</i>	Variable Glycine
Fabaceae	<i>Hardenbergia violacea</i>	False Sarsparilla
Apocynaceae	<i>Parsonsia straminea</i>	Common Silkpod
Fabaceae	<i>Vicia sativa</i> subsp. <i>sativa</i> *	Common Vetch
Epiphytes		
Loranthaceae	<i>Amyema gaudichaudii</i>	Mistletoe
* denotes exotic species		

Appendix C

Fauna Species List

Table C1 – Fauna species list from the development site

Common name	Scientific name	Method observed
Birds		July 16
Australian King Parrot	<i>Alisterus scapularis</i>	O W
Australian Magpie	<i>Cracticus tibicen</i>	O W
Australian Raven	<i>Corvus coronoides</i>	O W
Australian White Ibis	<i>Threskiornis molucca</i>	O
Australian Wood Duck	<i>Chenonetta jubata</i>	O
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	O W
Clamorous Reed-Warbler	<i>Acrocephalus stentoreus</i>	W
Common Myna *	<i>Sturnus tristis</i>	O W
Common Starling *	<i>Sturnus vulgaris</i>	O W
Crested Pigeon	<i>Ocyphaps lophotes</i>	O
Eastern Rosella	<i>Platycercus eximius</i>	O W
Eastern Whipbird	<i>Psophodes olivaceus</i>	O W
Galah	<i>Eolophus roseicapillus</i>	O W
Grey Butcherbird	<i>Cracticus torquatus</i>	O W
Grey Fantail	<i>Rhipidura albiscapa</i>	O W
Little Corella	<i>Cacatua sanguinea</i>	O W
Little Lorikeet ^{TS}	<i>Glossopsitta pusilla</i>	O W
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>	O
Little Wattlebird	<i>Anthochaera chrysoptera</i>	O W
Magpie-lark	<i>Grallina cyanoleuca</i>	O W
Masked Lapwing	<i>Vanellus miles</i>	W
Musk Lorikeet	<i>Glossopsitta concinna</i>	O W
Nankeen Kestrel	<i>Falco cenchroides</i>	O
Noisy Friarbird	<i>Philemon corniculatus</i>	O W
Noisy Miner	<i>Manorina melanocephala</i>	O W
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	O W
Red-rumped Parrot	<i>Psephotus haematotus</i>	O W
Red Wattlebird	<i>Anthochaera carunculata</i>	O W
Red-whiskered Bulbul *	<i>Pycnonotus jocosus</i>	W
Rock Dove *	<i>Columba livia</i>	O
Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	O W
Silvereye	<i>Zosterops lateralis</i>	O W
Spotted Turtle-Dove *	<i>Streptopelia chinensis</i>	O W
Striated Pardalote	<i>Pardalotus striatus</i>	W
Sulphur Crested Cockatoo	<i>Cacatua galerita</i>	O W
Superb Fairy-wren	<i>Malurus cyaneus</i>	O W
Variigated Fairy-wren	<i>Malurus lamberti</i>	O W
Welcome Swallow	<i>Hirundo neoxena</i>	O
White-browed Scrubwren	<i>Sericornis frontalis</i>	O W
White-faced Heron	<i>Egretta novaehollandiae</i>	O
White-winged Chough	<i>Corcorax melanorhamphos</i>	O
Willie Wagtail	<i>Rhipidura leucophrys</i>	O W
Yellow Thornbill	<i>Acanthiza nana</i>	O W
Mammals		
Chocolate Wattled Bat	<i>Chalinolobus morio</i>	U ^{PO}
Domesticated Dog *	<i>Canis lupus familiaris</i>	W
Eastern Bentwing-bat ^{TS}	<i>Miniopterus orianae oceanensis</i>	U
European Red Fox *	<i>Vulpes vulpes</i>	O

Common name	Scientific name	Method observed
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	U
Little Forest Bat	<i>Vespadelus vulturnus</i>	U
Rabbit *	<i>Oryctolagus cuniculus</i>	O
Swamp Wallaby	<i>Wallabia bicolor</i>	O
Reptiles		
Delicate Skink	<i>Lampropholis delicata</i>	O
Eastern Bearded Dragon	<i>Pogona barbata</i>	O
Eastern Water Skink	<i>Eulamprus quoyii</i>	O
Grass Skink	<i>Lampropholis guichenoti</i>	O
Amphibians		
Common Eastern Froglet	<i>Crinia signifera</i>	W
Whistling Tree Frog	<i>Litoria verreauxii</i>	W
Mollusc		
Cumberland Plain Land Snail ^{TS}	<i>Meridolum corneovirens</i>	O
<p>Note: * indicates introduced species ^{TS} indicates threatened species</p> <p>All species listed are identified to a high level of certainty unless otherwise noted as:</p> <p>^{PR} indicates species identified to a 'probable' level of certainty – more likely than not ^{PO} indicates species identified to a 'possible' level of certainty – low-moderate level of confidence</p> <p>E - Nest/roost H - Hair/feathers/skin P - Scat W - Heard call F - Tracks/scratchings K - Dead Q - Camera X - In scat FB - Burrow O - Observed T - Trapped/netted Y - Bone/teeth/shell G - Crushed cones OW - Obs & heard call U - Anabat/ultrasound Z - In raptor/owl pellet</p>		

Appendix D

BioBanking Credit Report

BioBanking credit report



This report identifies the number and type of credits required at a DEVELOPMENT SITE.

Date of report: 22/12/2016

Time: 11:50:42AM

Calculator version: v4.0

Development details

Proposal ID: 199/2016/3955D
Proposal name: Macarthur Gardens North
Proposal address: Goldsmith Avenue, Campbelltown NSW 2560

Proponent name: Urban Growth NSW
Proponent address: PO Box 237 Parramatta NSW 2124
Proponent phone: 98418670

Assessor name: Lindsay Holmes
Assessor address: PO BOX 7138, Kariong NSW 2250
Assessor phone: 0414 365 723
Assessor accreditation: 199

Improving or maintaining biodiversity

An application for a red flag determination is required for the following red flag areas

Red flag	Reason
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Vegetation type being > 70% cleared; or it contains an endangered ecological community;
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Vegetation type being > 70% cleared; or it contains an endangered ecological community;

The application for a red flag determination should address the criteria set out in the BioBanking Assessment Methodology. Please note that a biobanking statement cannot be issued unless the determination is approved.

Additional information required for approval:

- Change to percent cleared for a vegetation type/s
- Use of local benchmark
- Change negligible loss
- Expert report...
- Request for additional gain in site value
- Predicted threatened species not on site
 - Swift Parrot Lathamus discolor*
- Change threatened species response to gain (Tg value)

Ecosystem credits summary

Plant Community type	Area (ha)	Credits required	Red flag
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	1.32	29.66	No
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	2.28	91.02	Yes
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.80	13.60	No
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	1.43	60.43	Yes
Total	5.83	195	

Credit profiles

1. Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (ME020)

Number of ecosystem credits created	74
IBRA sub-region	Cumberland - Sydney Metro

Offset options - vegetation types	Offset options - CMA sub-regions
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (ME020)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (ME018)

Number of ecosystem credits created	121
IBRA sub-region	Cumberland - Sydney Metro

Offset options - vegetation types	Offset options - CMA sub-regions
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (ME018)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Species credits summary

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Cumberland Plain Land Snail	<i>Meridolum corneovirens</i>	5.83	76

Appendix E

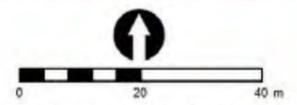
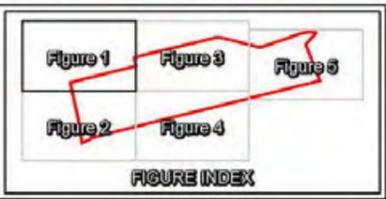
Site and Locality Maps at Required Scales



Legend

- ▭ Site boundary - 18.32ha (source: LPI)
- ▭ Contours - 1m (source: LiDAR)
- ▭ Verified native vegetation - 7.81ha (Travers Bushfire & Ecology, 2016)
- ▬ Rivers, Streams & Waterbodies
- ▬ Creek line
- ▬ Drainage
- ▭ Dams/Aquatic macrophytes

Aerial source: Naomap (29/04/2016)



Disclaimer: The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

PROJECT & MKD REFERENCE
 Macarthur Gardens North
 A16113_FBA001_

DATE & ISSUE NUMBER
 2/02/2017
 Issue 1

SCALE & COORDINATE SYSTEM
 1:1,000 @A3
 GDA 1994 MGA Zone 56

TITLE
 Site Map (Figure 1)

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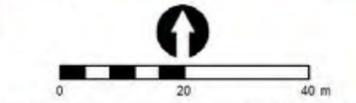
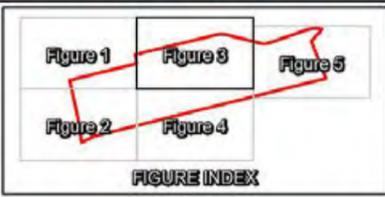




<p>Legend</p> <ul style="list-style-type: none"> Site boundary - 18.32ha (source: LPI) Contours - 1m (source: LIDAR) Verified native vegetation - 7.81ha (Travers Bushfire & Ecology, 2016) 	<p>Rivers, Streams & Waterbodies</p> <ul style="list-style-type: none"> Creek line Drainage Dams/Aquatic macrophytes 	<p>FIGURE INDEX</p>	<p>Scale: 0 20 40 m</p> <p>Disclaimer: The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.</p>	<p>PROJECT & MXD REFERENCE</p> <p>Macarthur Gardens North A16113_FBA001_</p>	<p>DATE & ISSUE NUMBER</p> <p>2/02/2017 Issue 1</p>	<p>SCALE & COORDINATE SYSTEM</p> <p>1:1,000 @A3 GDA 1994 MGA Zone 56</p>	
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- Legend**
- Site boundary - 18.32ha (source: LPI)
 - Contours - 1m (source: LIDAR)
 - Verified native vegetation - 7.81ha (Travers Bushfire & Ecology, 2016)
- Rivers, Streams & Waterbodies**
- Creek line
 - Drainage
 - Dams/Aquatic macrophytes



Disclaimer: The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

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TITLE
 Site Map (Figure 3)



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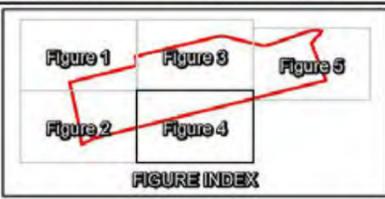
Legend

- Site boundary - 18.32ha (source: LPI)
- Contours - 1m (source: LIDAR)
- Verified native vegetation - 7.81ha (Travers Bushfire & Ecology, 2016)

Rivers, Streams & Waterbodies

- Creek line
- Drainage
- Dams/Aquatic macrophytes

Aerial source: Nearmap (29.04.2016)



↑

0 20 40 m

Disclaimer: The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

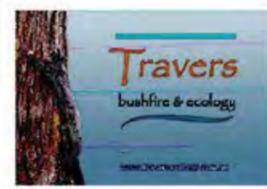
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TITLE
Site Map (Figure 4)

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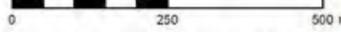
<p>Legend</p> <ul style="list-style-type: none"> Site boundary - 18.32ha (source: LPI) Contours - 1m (source: LIDAR) Verified native vegetation - 7.81ha (Travers Bushfire & Ecology, 2016) 	<p>Rivers, Streams & Waterbodies</p> <ul style="list-style-type: none"> Creek line Drainage Dams/Aquatic macrophytes 	<p>FIGURE INDEX</p>	<p>Scale: 0 20 40 m</p> <p>Disclaimer: The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.</p>	<p>PROJECT & MXD REFERENCE</p> <p>Macarthur Gardens North A16113_FBA001_</p>	<p>DATE & ISSUE NUMBER</p> <p>2/02/2017 Issue 1</p>	<p>SCALE & COORDINATE SYSTEM</p> <p>1:1,000 @A3 GDA 1994 MGA Zone 56</p>	
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Legend

- Suburb boundary
- Site boundary - 18.32ha (source: LPI)

Aerial Imagery: GeoMap (27/03/2015)

Disclaimer: The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

PROJECT & MAP REFERENCE

**Macarthur Gardens North
A16113_FBA002_**

TITLE

Site Location

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DATE & ISSUE NUMBER

**2/02/2017
Issue 1**

SCALE & COORDINATE SYSTEM

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