Bushland Management Strategy

Vineyard Creek, Western Sydney University Parramatta Campus

Report prepared by Narla Environmental Pty Ltd

for

Western Sydney University

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Report Certification

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As Principal of Narla Environmental Pty Ltd I, Kurtis Lindsay, certify that:

- This report has been prepared in accordance with the brief provided by the client.
- The information presented in this report is a true and accurate record of the study findings in the opinion of the authors.

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Glossary

Acronym or Term	Definition
EEC	Endangered Ecological Community
BMS	Bushland Management Strategy
PCT	Plant Community Type
VRZ	Vegetated Riparian Zone
RC	Riparian Corridor
BC Act	New South Wales Biodiversity Conservation Act 2016
EPBC Act	The Environment Protection and Biodiversity Conservation Act 1999
ha	Hectare
km	Kilometres
LGA	Local Government Area
m	Metre

1. Introduction

Narla Environmental Pty Ltd (Narla) was engaged by Western Sydney University to research and prepare a Bushland Management Strategy (BMS) for the bushland vegetation within the Vegetated Riparian Zone of Vineyard Creek, Rydalmere, New South Wales.

This BMS specifically addresses the management of the patch of bushland that lies at the western extent of the Western Sydney University's Parramatta campus boundary (**Figure 1**). This area is hereafter referred to as the 'subject site'.

The subject site comprises the land along the eastern extent of the Vineyard Creek with the land on the western extent being held under the ownership of Parramatta Council (zoned 'W1 Natural Waterways').

This report will provide the basis for ongoing management of the natural assets found within the riparian zone.

In producing this BMS, Narla has drawn information from the following key documents:

- Western Sydney University Environmental Management Plan (2015)
- City of Parramatta Council Local Environmental Plan (2011)
- City of Parramatta Council Development Control Plan (2011)
- The Native Vegetation of the Sydney Metropolitan Area (2013)

1.1 Objectives for Management

The subject site is currently under the management of the Western Sydney University and requires a thorough BMS in order to guide future management and highlight priority management issues occurring with tin the area.

Narla Environmental's provided the first comprehensive flora and fauna survey of the subject site, this involved the following:

- Comprehensive list of flora species occurring within the subject site;
- Representative list of fauna species occurring within the subject site
- Detailed mapping of fauna habitat features within the subject site
- Targeted microbat survey conducted over four days
- Comprehensive identification and mapping of all vegetation communities occurring within the subject site
- A comprehensive weed mapping exercise identifying priority management areas

This BMS will identify all potential biodiversity management issues apparent within the bushland patch and prioritise them according to a management timeline.

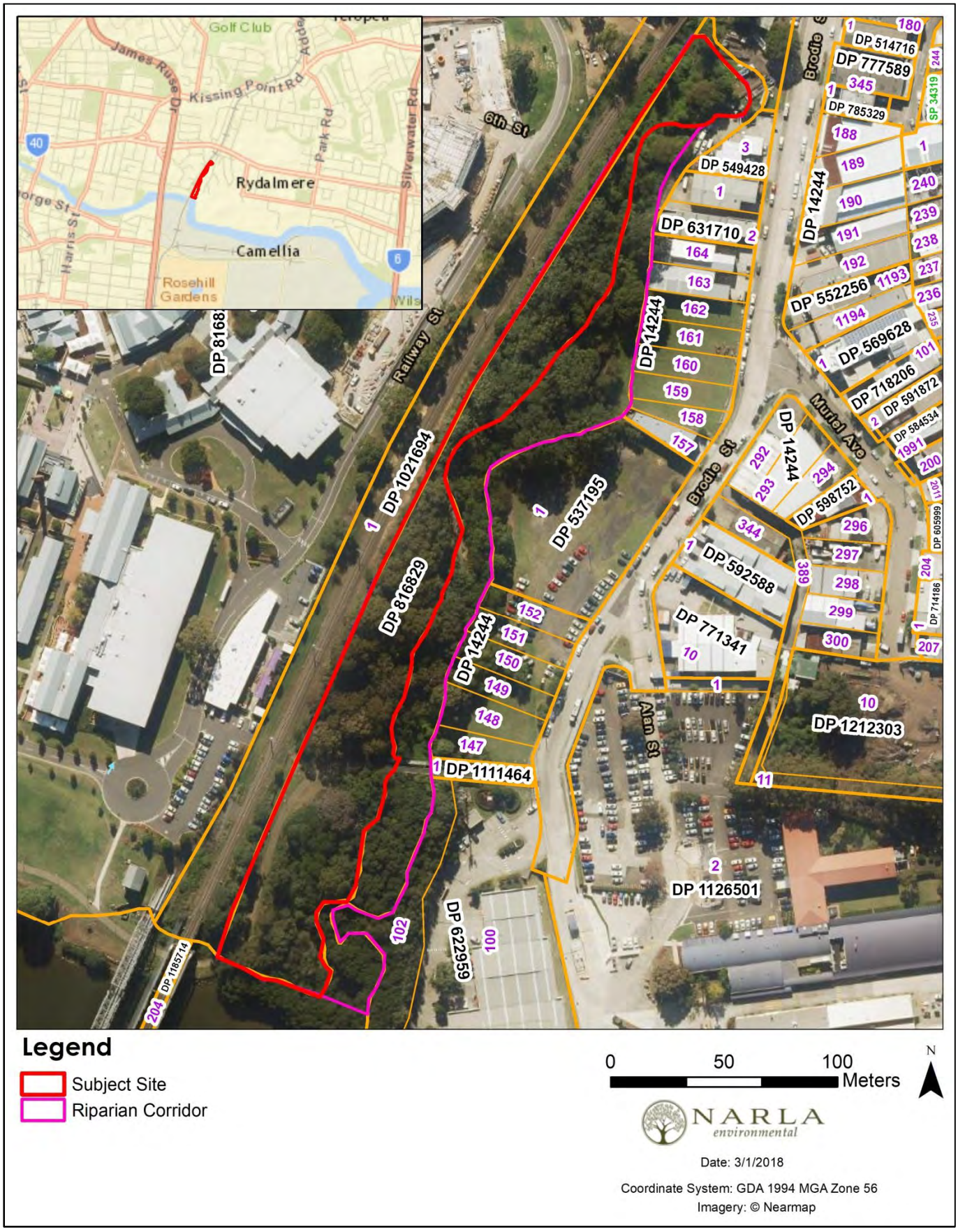

Figure 1. The Subject site bushland area adjoining Vineyard Creek, Rydalmere. The subject property is mapped in red. The adjoining vegetated riparian corridor is mapped in pink.

2.Site Description

2.1 Site Description

The subject site is comprised of native vegetation that extends from Parramatta River, north toward Victoria Road. It lies entirely within Lot 100 /DP 816829 east of Carlingford railway line, north of Parramatta River and west of the Rydalmere Industrial precinct (Brodie Street). The vegetation area is intersected by a public footpath/ cycleway that follows the Parramatta River and crosses Vineyard Creek.

The entire vegetated riparian corridor area covers approximately 2.11 ha. This area includes the subject site which comprises land held by Western Sydney University and covers approximately 1.26ha.

2.2 Current land uses

The subject site is currently unused by Western Sydney University and is separated from the main campus by the Carlingford train line, as presented (**Figure 1**). The vegetation within the subject site forms a unique cross section of geological influences on floristic assemblage and may be used as a case study example for teachings by the University.

A popular walking/ cycle path intersects the site towards the southern extent of the vegetation and provides a thoroughfare for a moderate number of pedestrians.

Activities already taking place in the subject site include volunteer bush regeneration activities (e.g. Bushcare) and passive recreation.

2.3 Historic land uses

The subject site comprises the easternmost extent of the Western Sydney University's Parramatta Campus. Historically, the area had been partially cleared, leaving only two small areas of remnant vegetation assumed to still be standing within the subject site as was the case in 1943 (**Figure 2**).

A comparison of the landscape along Parramatta River and the mouth of Vineyard Creek is presented c. 1837 (**Figure 3**) the present day (**Figure 4**).

It is interesting to note the intensive cleared land on either bank and floodplain of the Parramatta River in 1837, as well as the scattered remnant, tall trees which appear to be *Eucalyptus elata* (River Peppermint) growing in a landscape position on the bank of the Parramatta River that is now dominated by *Avicennia marina* (Grey Mangrove). Colonisation by mangroves appears to have begun in this part of the river in the latter part of the 19th century (Mcloughlin

Figure 2. Historical aerial imagery (C.1943) displaying the partially cleared subject site

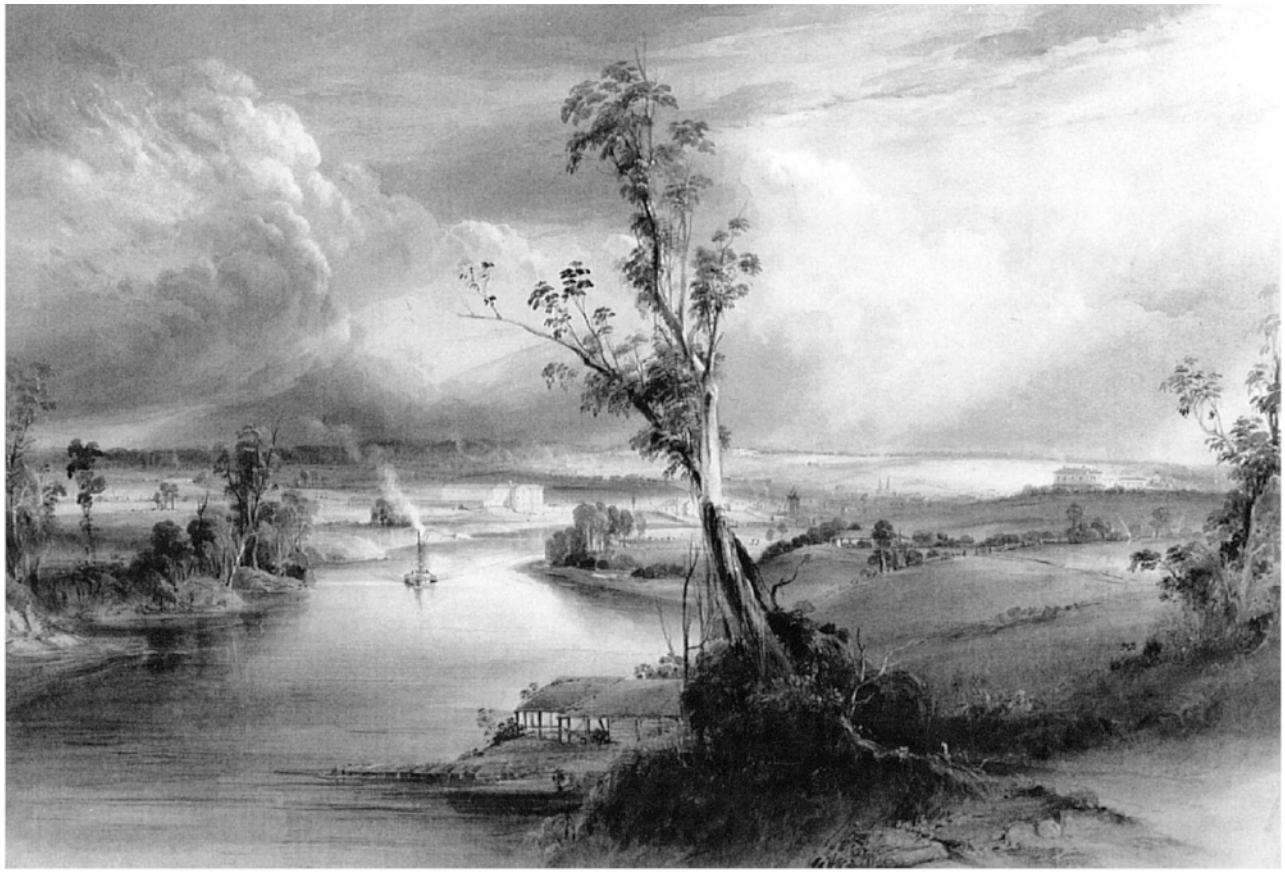

Figure 3. A painting by Conrad Martens c. 1837 (The Clyde Bank Collection, Sydney) showing a view from the mouth of Vineyard Creek (the subject site) looking up the Parramatta River toward Parramatta. Note the absence of a mangrove fringe and abundant cleared paddocks instead of industry.

Figure 4. A Google Earth terrain view image showing a view from the mouth of Vineyard Creek (the subject site) looking up the Parramatta River toward Parramatta. Note the dense vegetation (mangrove) fringe in either side of the river, along with the notable increased hard surfaces and industry.

2.4 Local Environmental Plan

2.4.1 Zoning

The Western Sydney University Parramatta campus is currently zoned under the Parramatta Local Environmental Plan (PLEP 2011) as 'SP1 – Special Purpose Zones'. The objectives of this zone are:

- To provide for special land uses that are not provided for in other zones.
- To provide for sites with special natural characteristics that are not provided for in other zones.
- To facilitate development that is in keeping with the special characteristics of the site or its existing or intended special use, and that minimises any adverse impacts on surrounding land.

The site satisfies the requirements to be considered *Bushland in Urban Areas*, and applicable under State Environmental Planning Policy No. 19. The general aim of this Policy is to protect and preserve bushland within the urban areas referred to in Schedule 1 due to:

(a) Its value to the community as part of the natural heritage,
(b) Its aesthetic value, and
(c) Its value as a recreational, educational and scientific resource.

The specific aims of this policy are to:

(a) Protect the remnants of plant communities which were once characteristic of land now within an urban area,
(b) Retain bushland in parcels of a size and configuration which will enable the existing plant and animal communities to survive in the long term,
(c) Protect rare and endangered flora and fauna species,
(d) Protect habitats for native flora and fauna,
(e) Protect wildlife corridors and vegetation links with other nearby bushland,
(f) Protect bushland as a natural stabiliser of the soil surface,
(g) Protect bushland for its scenic values, and to retain the unique visual identity of the landscape,
(h) Protect significant geological features,
(i) Protect existing landforms, such as natural drainage lines, watercourses and foreshores,
(j) Protect archaeological relics,
(k) Protect the recreational potential of bushland,
(l) Protect the educational potential of bushland,
(m) Maintain bushland in locations which are readily accessible to the community, and
(n) Promote the management of bushland in a manner which protects and enhances the quality of the bushland and facilitates public enjoyment of the bushland compatible with its conservation.

2.4.2 Biodiversity and Riparian Lands Mapping

The subject site is not currently included in the City of Parramatta Council's biodiversity or riparian lands and waterways mapping. It is not sure why this land is not mapped.

2.5 Hydrology and Catchment

Vineyard Creek runs the length of the subject site in a southerly direction where it eventually joins the Parramatta River. It is a second order stream as classified under the Strahler System (WM Act 2000).

The catchment of Vineyard Creek comprises a combination of residential and light industrial land along with a number of Council managed parks and reserves. A portion of the southern extent of Vineyard creek is subject to the tidal influence of the Parramatta estuary.

Vineyard Creek itself is understood to be public owned land.

2.6 Riparian Corridor

Riparian corridors are essential transition zones between the terrestrial environment and the aquatic environment. Riparian corridors provide a number of essential benefits to both the environment and community by:

- providing bed and bank stability and reducing bank and channel erosion;
- protecting water quality by trapping sediment, nutrients and other contaminants;
- providing diversity of habitat for terrestrial, riparian and aquatic flora and fauna;
- providing connectivity between wildlife habitats;
- conveying flood flows and controlling the direction of flood flows;
- providing an interface or buffer between developments and waterways; and
- providing passive recreational uses. (DPI 2012)

As per the requirements of a second order stream under the NSW Department of Primary Industries '*Guidelines for riparian corridors on waterfront land*' (DPI 2012), a riparian corridor or Vegetated Riparian Zone (VRZ) of 20m either side of the watercourse must be maintained. Therefore, the total required VRZ width for Vineyard Creek is 40m + the width of the channel (~50m wide).

3. Methodology

3.1 Desktop Assessment and Literature Review

A thorough literature review of local information relevant to the City of Parramatta Council Local Government Area (LGA) and Western Sydney University's Parramatta Campus was undertaken. Searches utilising NSW Wildlife Atlas (Bionet) and the Commonwealth Protected Matters Search Tool were conducted to identify all current threatened and migratory flora and fauna records within a 10 km² search area centred on the subject site. This data was used to assist in establishing the presence or likelihood of any such ecological values as occurring on or adjacent the subject site and helped inform our Ecologists during their site assessment.

Soil landscape and geological mapping was examined to gain an understanding of the environment on the subject site and assist in determining whether any threatened flora or ecological communities may occur there (Chapman and Murphy 1989).

3.2 Ecological Site Assessment

An initial site visit and bird survey was undertaken by Narla Ecologist Kurtis Lindsay on 6th November 2017. This was followed by a comprehensive ecological assessment of the subject site undertaken by Narla Ecologists Alexander Graham and Guy Smith on Monday the 15th of January 2018. The entire subject site was assessed in detail over a full working day.

During the site assessment, the following activities were undertaken:

- Identifying and recording all vegetation communities present on the Subject Site, with focus on identifying any Endangered Ecological Communities (EEC);
- Recording a detailed list of flora species encountered on the Subject Site, with a focus on threatened species, species diagnostic of threatened ecological communities and priority weeds;
- Recording opportunistic sightings of any fauna species seen or heard on or within the immediate surrounds of the Subject Site;
- Identifying and recording the locations of any notable fauna habitat such as important nesting, roosting or foraging microhabitats;
- Targeting the habitat of any threatened and regionally significant fauna including:
    - Tree hollows (habitat for threatened large forest owls, parrots, cockatoos and arboreal mammals);
    - Caves and crevices (habitat for threatened reptiles, small mammals and microbats);
    - Termite mounds (habitat for threatened reptiles and the echidna);
    - Soaks (habitat for threatened frogs and dragonflies);
    - Wetlands (habitat for threatened fish, frogs and water birds);
    - Drainage lines (habitat for threatened fish and frogs);
    - Fruiting trees (food for threatened frugivorous birds and mammals);
    - Flowering trees (food for threatened nectarivorous mammals and birds);
    - Trees and shrubs supporting nest structures (habitat for threatened birds and arboreal mammals); and
    - Any other habitat features that may support fauna (particularly threatened) species.
- Assessing the connectivity and quality of the vegetation within the subject site and surrounding areas.
- Targeted surveys for threatened flora identified as part of literature review and desktop assessment

3.2.1 Fauna and Fauna Habitat

During the site assessment, both Narla Ecologists recorded:

- Opportunistic sightings of any fauna species seen or heard on or within the immediate surrounds of the subject site
- The locations of notable fauna habitat such as important nesting, roosting or foraging microhabitats
- Any habitat trees such as hollow-bearing trees that may be potential habitat for any threatened and regionally significant fauna such as threatened large forest owls, parrots, cockatoos and arboreal mammals.
- The locations or evidence of any pest fauna

The Ecologists also assessed the habitat for its suitability to implement fauna and habitat augmentation measures such as nest box installation or tree-hollow excavation, habitat planting or fauna reintroduction.

3.2.2 Microbat Survey

The subject site was observed to contain a number of both natural and artificial habitat features that could potentially act as microbat roost sites.

As part of the comprehensive ecological assessment of the subject site, Narla undertook a passive acoustic bat survey using an automated bat detector (Wildlife Acoustics Songmeter SM4BAT ZC, Serial # 00368). The automated bat detector was set up on the afternoon of Thursday the 11th of January and remained in the field until the day of the site assessment (15th January 2018). The device recorded all potential sonic microbat traces and was set to begin recording an hour prior to sunset and ceasing an hour prior to sunrise each evening.

4. Results and Discussion

4.1 Vegetation Communities

4.1.1 Historically Mapped Vegetation communities

Native Vegetation Mapping of the Sydney Metropolitan Area (OEH 2016) indicated that the subject site contained a combination of four different vegetation communities including two Endangered Ecological Communities (EEC) (**Figure 5**), they were:

- S_Fow02: Coastal Flats Swamp Mahogany Forest (EEC);
- S_Fow08: Estuarine Swamp Oak forest (EEC);
- S_SW01: Estuarine Mangrove Forest; and
- Weeds and Exotics.

Vegetation mapping undertaken for the Native Vegetation of the Sydney Metropolitan Area (OEH 2016) was the product of aerial imagery interpretation with little field-based ground-truthing and is therefore not reliable as an accurate representation of the vegetation of the subject site. This is especially relevant to areas with unique geomorphological, tidal and historical influences such as the subject site.

One of the objectives of this report was to prepare more accurate, ground-truthed analysis of the vegetation present within the subject site. This is provided in **section 4** of this report.

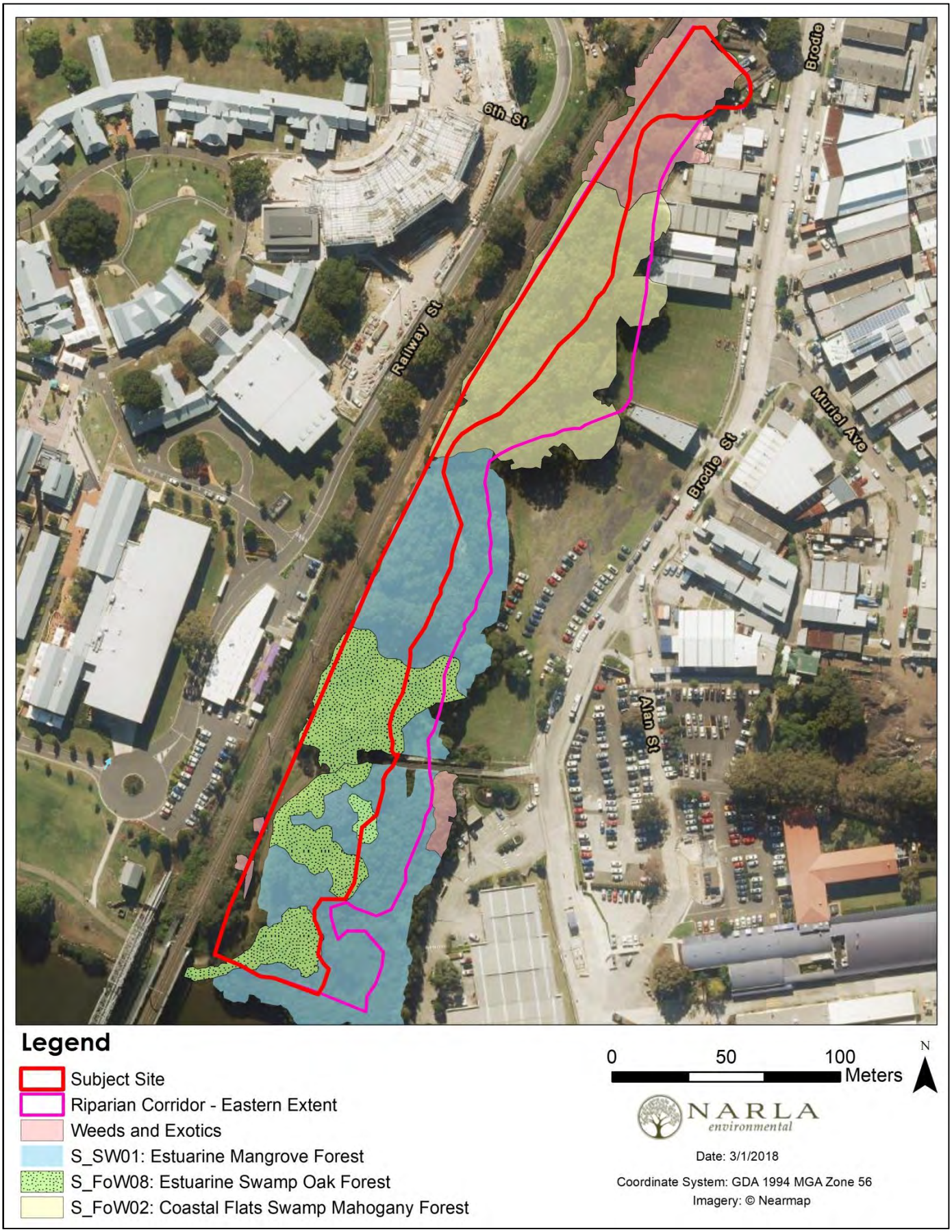

Figure 5. Historically mapped vegetation occurring within the subject site (OEH 2016)

4.1.2 Confirmed Vegetation Communities

Narla Environmental identified a diverse suite of vegetation communities across the subject site. This included four EEC. Vegetation Communities identified within the subject site are detailed in **Table 1** and **Figure 6**.

The vegetation represented a cross sectional strip of land containing diverse examples of unique vegetation communities (including EEC) caused by the convergence between the Wianamatta Shales of the Cumberland Plain, the Quaternary sediments of the Parramatta River valley and the Hawkesbury Sandstones of the Hornsby Plateau (McLoughlin 2000). These vegetation communities once occurred more extensively along the banks and tributaries of the Parramatta River.

Figure 6. Confirmed vegetation communities observed within the subject site

Table 1. Nomenclature of the vegetation communities present within the subject site

Narla Map Unit	Photo	Sydney Metropolitan Vegetation Mapping (OEH 2013)	Plant Community Type (PCT)	Biodiversity Conservation Act 2016 Status	Environment Protection and Biodiversity Conservation Act 1999 Status
Swamp Sclerophyll Forest		Coastal Flats Swamp Mahogany forest (S_FoW02)	1795: Coastal Flats Swamp Mahogany Forest	Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions – Endangered Ecological Community	Not Listed
					

Narla Map Unit	Photo	Sydney Metropolitan Vegetation Mapping (OEH 2013)	Plant Community Type (PCT)	Biodiversity Conservation Act 2016 Status	Environment Protection and Biodiversity Conservation Act 1999 Status
River-flat Eucalyptus Forest		Cumberland Riverflat Forest (S_F0W06)	835: Forest Red Gum-Rough-barked Apple Grassy Woodland on Alluvial Flats of the Cumberland Plain, Sydney Basin	River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - Endangered Ecological Community	Not Listed

Narla Map Unit	Photo	Sydney Metropolitan Vegetation Mapping (OEH 2013)	Plant Community Type (PCT)	Biodiversity Conservation Act 2016 Status	Environment Protection and Biodiversity Conservation Act 1999 Status
Estuarine Mangrove Forest		Estuarine Mangrove Forest (S_SW01)	920: Mangrove Forest in Estuaries of the Sydney Basin and South East Corner	Not Listed	Not Listed

Narla Map Unit	Photo	Sydney Metropolitan Vegetation Mapping (OEH 2013)	Plant Community Type (PCT)	Biodiversity Conservation Act 2016 Status	Environment Protection and Biodiversity Conservation Act 1999 Status
Shale Gravel Transition Forest		Castlereagh Shale-Gravel Transition forest (S_DSF02)	724: Broad-leaved Ironbark-Grey Box-Melaleuca decora Grassy Open Forest on Clay/Gravel Soils of the Cumberland Plain, Sydney Basin	Shale Gravel Transition Forest in the Sydney Basin Bioregion – Endangered Ecological Community	Cumberland Plain Woodlands and Shale-Gravel Transition Forest – Critically Endangered Ecological Community

Narla Map Unit	Photo	Sydney Metropolitan Vegetation Mapping (OEH 2013)	Plant Community Type (PCT)	Biodiversity Conservation Act 2016 Status	Environment Protection and Biodiversity Conservation Act 1999 Status
Swamp Oak Floodplain Forest		Estuarine Swamp Oak Forest (S_FoW08)	1234: Swamp Oak Swamp Forest Fringing Estuaries, Sydney Basin and South East Corner	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions – Endangered Ecological Community	Not Listed

Narla Map Unit	Photo	Sydney Metropolitan Vegetation Mapping (OEH 2013)	Plant Community Type (PCT)	Biodiversity Conservation Act 2016 Status	Environment Protection and Biodiversity Conservation Act 1999 Status
Noxious and Invasive Weeds		Noxious and Invasive Weeds	N/A	N/A	N/A

4.2 Geology, Topography and Soils

The subject site occurs on a unique geological transition zone. Historical geological mapping undertaken at a scale of 1:100000 (Herbert 1983) shows that the vegetation across the site is influenced by these diverse geologies, specifically:

- The eastern portion of the site is heavily influenced by Hawkesbury Sandstone, while the western portion is a transitional zone between Quaternary Alluvium (*silty to peaty quartz sand, silt, and clay, Ferruginous and humic cementation in places*)
- the western portion of the site is influenced by Wianamatta Shales Parramatta River Estuary on the floristic assemblage of the southern extent of the site.
- The southern portion of the site is influenced by estuarine sediments associated with Parramatta River

The subject site topography rises consistently from the southern extent adjoining the Parramatta River (approximately 5m asl) and gently rises to 9m asl at the centre of the subject site where it maintains a consistent elevation in a northward direction. Local topography at all points within the subject site slopes in a westerly direction into Vineyard Creek.

Soils present within the subject site will vary depending on the different geological and hydrological influences present however will generally consist of Red and Brown Podzolic Soils/ Yellow Earth and Earthy Sands on crests and upper slopes, Yellow Podzolic soils on outer edges and lower slopes as well as Siliceous Sands, Leached Sands and silts along drainage lines (Chapman and Murphy 1989).

4.3 Flora

During the site survey, Narla Environmental recorded 40 native flora species, and 51 exotic flora species across the subject site (**Appendix 1**).

Native plant species within the site were predominantly restricted to the mid-storey and canopy strata in most areas due to the extensive presence and persistence of weeds in the lower strata. The site contains a number of large *Eucalyptus Robusta* as well as *Eucalyptus elata* that appear, based on an assessment of historical imagery to have been present within the subject site prior to 1943.

The unique geomorphological location of the site resulted in notably clear distinctions between vegetation assemblages throughout the subject site. Overall, the site contained four Endangered Ecological Communities across its extent (**Figure 6**). This high diversity over a small area contributes to the conservation and educational value of this patch and its representation of endangered flora assemblages from across the Sydney Basin Bioregion.

4.3.1 Weeds

Exotic plant species were highly prevalent across the ground and understorey strata of the subject site, particularly along the banks of Vineyard Creek. A total of 51 exotic flora species were recorded by Narla Environmental. Large infestations of environmental weeds such as *Lantana camara* (Lantana) dominated the majority of the subject site. Invasive vines and climbers such as *Cardiospermum grandiflorum* (Balloon Vine), *Anredera cordifolia* (Madeira Vine) and *Dolichandra unguis-cati* (Cats-Claw Creeper) were present in high abundance within the VRZ of Vineyard Creek. Weeds represent an on-going threat to the biodiversity of the Reserve.

The high concentrations and intensity of noxious and exotic weeds present within the site poses a severe risk to the long-term viability to a number of areas of EECs as well as the overall biodiversity of the subject site (**Plate 2**).

Throughout the subject site a total of 9 exotic plants identified as Priority Weeds within the Greater Sydney region that includes the City of Parramatta Council LGA. Several of these species are also listed under the EPBC Act as 'Weeds of National Environmental Significance' (WoNS) they are listed as follows:

- Prohibition on Dealings
  - *Lantana Camara* (Lantana) [WoNS]
  - *Salix spp. (Willow Species)* [WoNS]
  - *Anredera cordifolia* (Madeira Vine) [WoNS]
  - *Asparagus aethiopicus* (Groung Asparagus) [WoNS]
  - *Asparagus asparagoides* (Bridal Creeper) [WoNS]
  - *Opuntia spp.* (Prickly Pear Species) [WoNS]

- Regional Recommended Measure
  - *Cestrum parqui* (Green Cestrum)
  - *Olea europaeasubsp. Cuspidata* (African Olive)
  - *Alternanthera philoxeroides* (Alligator Weed) [WoNS]
  - *Dolichandra unguis-cati* (Cat's Claw Creeper) [WoNS]

Of the priority weeds listed above, seven are also listed as Weeds of National Significance (WoNS). WoNS have been recognised by the Commonwealth Government as a result of their invasiveness, potential for spread and environmental, social and economic impacts. It is the responsibility of landowners and land managers at all levels to manage WoNS.
The approximate weed concentration percentages occurring within the subject site, are categorised in **Table 2** and mapped in **Figure 7.**

Table 2. Weed mapping concentration thresholds

Classification	Weed Percentage Thresholds
Low Weed Concentration	Contains <15% weed coverage
Moderate Weed Concentration	Contains between 15% and 49% weed coverage
High Weed Concentration	Contains between 50% and 84% weed coverage
Extreme Weed Concentration	Contains > 85% weed coverage

4.3.1 Threatened Flora

Despite thorough searches of the entire subject site, no threatened flora was identified during the site survey.

The geology and vegetation communities of the subject site have potential to support some threatened flora species, including *Acacia pubescens* (Downy Wattle).

While it is not a threatened species, a stand of the tall, native tree, the River Peppermint (*Eucalyptus elata*) was recorded in the subject site (**Plate 1**) within the area mapped by Narla as 'Riverflat Forest' (**Figure 6**). This attractive, tall tree species is indigenous to the Parramatta River area as evident from historical paintings of mature individuals growing along the banks of the Parramatta River near the subject site (**Figure 3**). This tree is not known to currently occur within the Sydney Metropolitan Area (OEH 2016). The small population on the subject site may be the only natural population in metropolitan Sydney and therefore should be considered regionally significant.

Plate 1. A River Peppermint (*Eucalyptus elata*) that forms part of a stand present in the Subject Site. This species is indigenous to the area and may form part of a significant local population.

Plate 2. Invasive vines and climbers threatening the viability of the native canopy in the subject site

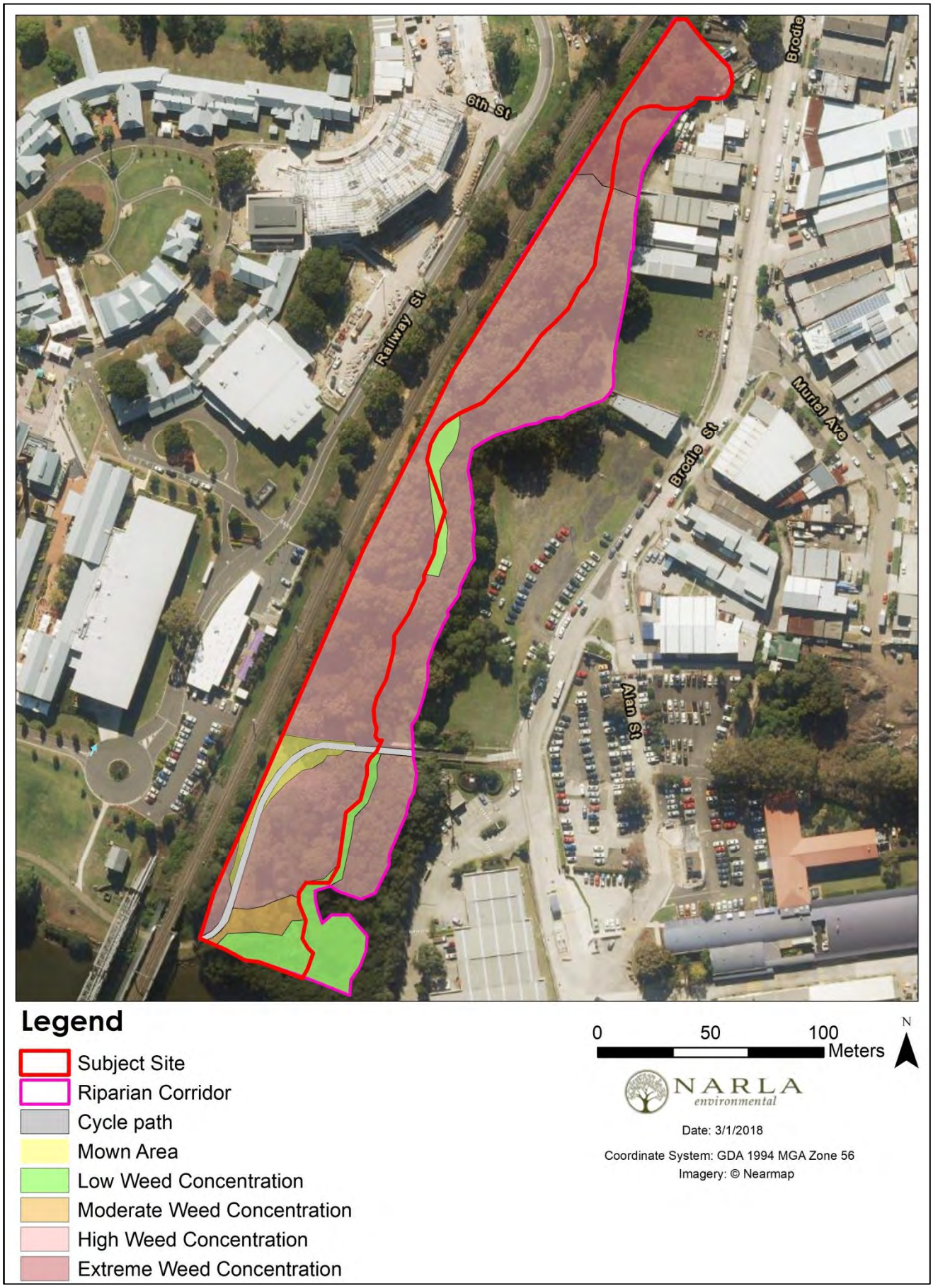

Figure 7. Weed concentrations across the subject site

4.4 Fauna

A total of 50 fauna species were encountered during field survey. All but four of these species encountered were native and therefore listed as 'protected' under the NSW Biodiversity Conservation Act 2016. Only one species encountered was listed threatened, this being *Miniopterus australis* (Little Bentwing Bat).

The majority of fauna encountered were typical of urban vegetation, however, of note were the presence of several disturbance sensitive small bird species including *Acanthorhynchus tenuirostris* (Eastern Spinebill), *Acanthiza nana* (Yellow Thornbill), *Sericornis frontalis* (White-browed Scrubwren), *Pardalotus punctatus* (Spotted Pardalote) and *Rhipidura rufifrons* (Rufous Fantail). The Rufous Fantail is is a listed 'Migratory' species under the Commonwealth EPBC Act.

Two uncommon, estuarine-mangrove specialist bird species were recorded in the subject site during the site assessment, *Lichmera indistincta* (Brown Honeyeater) and *Butorides striata* (Striated Heron). These two sensitive birds are most likely to inhabit only the southern, estuarine portions of the subject site. Their presence reflects the habitat complexity of the subject site.

Five reptile species, *Physignathus lesueurii* (Eastern Water Dragon), *Eulamprus quoyii* (Eastern Water Skink), *Chelodina longicollis* (Eastern Long-neck Turtle), *Cryptoblepharus pulcher* (Elegant Snake-eyed Skink) and *Pseudechis porphyriacus* (Red-bellied Black Snake) were observed within the vegetation of the subject site.

No frog species were recorded during the site assessment however suitable habitat is present in the form of sandstone pools and creek line with accompanying fringing semi-aquatic vegetation, common species that may occur include *Crinia signifera* (Common Brown Froglet) and *Limnodynastes peronii* (Striped Marsh Frog).

Anguilla australis (Short-finned Eel) was observed within Vineyard Creek and were the only completely aquatic species observed during the site assessment.

One native, terrestrial mollusc, *Austrorhytida capillacea* (Southern Carnivorous Snail) was identified in the northern extent of the subject site. The presence of this snail reflects the suitable microhabitat present (leaf litter, logs and bark).

The list of fauna species recorded during the site visit was produced opportunistically and thus only represents a subset of the species that may potentially occur on the Subject Site at any one time. The full list of fauna recorded on site is presented in **Appendix 2**.

Four exotic species were identified within the subject site, *Pycnonotus jocosus* (Red-whiskered Bulbul), *Spilopelia chinensis* (Spotted Dove), *Columba livia* (Rock Dove) and *Acridotheres tristis* (Common Myna). Warrens made by *Oryctolagus cuniculus* (European Rabbit) were observed within the subject site. Given the disturbed, urban nature of the subject site, it is likely that the site is used for foraging by exotic predators such as *Vulpes vulpes* (Red Fox) and *Felis catus* (Domestic/ Feral cat). It is expected that the occurrence of these species within and surrounding the subject site will cause localised reduction in the presence and diversity of native species within the site.

4.4.1 Targeted Microbat Survey

A total of 424 trace files were recorded over the period, with analysis showing that 282 of these were attributable to bat echolocation calls (Pearson 2018).

The calls collected were analysed by industry expert Tim Pearson, who identified a potential total of seven species of microbat occurring within the subject site including most notably, *Miniopterus australis* (Little Bentwing Bat) which is listed as 'Vulnerable under the New South Wales Biodiversity conservation Act 2016 (Pearson 2018).

The species occurring within the subject site, identified as a result of the targeted survey include:

- *Chalinolobus gouldi* (Gould's Wattled Bat)
- *Vespadalus darlingtoni* (Large Forest Bat)
- *Vespadalus vulturnus* (Little Forest Bat)
- *Scotorepens orion* (Eastern Broad-nosed Bat) or *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Mormopterus ridei* (Eastern Freetail Bat)
- *Nyctophilus gouldi* (Gould's Long-eared Bat) or *Nyctophilus geoffroyi* (Lesser Long-eared Bat)
- *Miniopterus australis* (Little Bentwing Bat)

Two roosting micro bats were observed within a disused railway bridge occurring within the north eastern extent of the subject site during the field survey.

4.4.2 Habitat Features

A thorough assessment of fauna habitat availability within the subject site was conducted as part of the comprehensive site assessment. The habitat assessment provided an understanding of the fauna species that may potentially occur on the Subject Site during part of their lifecycle (**Figure 8**).

An assessment of the subject site identified the following fauna habitat features:

- Sandstone shelfing and ridgeline that may provide shelter for a number of native reptiles and mammals;
- Deep leaf-litter and grassy groundcovers, that may provide foraging habitat for the invertebrates and small reptiles and frogs;
- Fallen woody debris and large hollow-bearing logs provide suitable shelter for small mammals, reptiles, frogs and invertebrates;
- Areas of dense mid-storey vegetation that provides suitable foraging and nesting shelter for small woodland birds;
- Freshwater pools transitioning into a brackish estuarine creek line that provides habitat for semi-aquatic birdlife as well as native amphibians and aquatic life;
- Native canopy containing flower and seed resources for foraging parrots, cockatoos and nectarivorous mammals;
- A number of large terrestrial termite bounds that provide a food source and potential nesting site for native reptiles; and
- Twenty-one (21) hollow bearing trees were identified containing 39 tree hollows comprising:
    - Twenty-two (22) small hollows (2.5-5cm)
    - Fourteen (14) medium sized hollows (5-10cm)
    - Three (3) large hollows (>10cm);and
    - Two (2) fissures suitable for roosting microbats

Dense weed growth provides similar habitat values to dense native shrubbery. When weeds are removed and not replaced with sufficient, dense native shrubbery small birds are less likely to occupy the habitat as they become increasingly susceptible to predation and harassment from overabundant aggressive bird such as *Manorina melanocephala* (Noisy Miner). For this reason, it is essential to undertake weed removal progressively and promote regeneration of dense, native, locally indigenous shrubbery species such as B*reynia oblongifolia, Bursaria spinosa, Acacia spp., Ozothamnus spp.,* and *Dillwynia spp.* in order to replace weedy shrubs removed.

A burrow likely to have been created and used by European Rabbit and potentially used by *Vulpes vulpes* (Red Fox) was identified just outside the western extent of the centre of the subject site in the western bank of Vineyard Creek. Although the burrow is located outside the subject site, the animals within will likely enter the subject site on a regular basis to forage and may subsequently impact the biodiversity within.

Two bird nests were identified within the survey area of the subject site. One medium sized mud nest, likely to belong to *Grallina cyanoleuca* (Magpie-lark) as well as a medium sized stick nest likely to belong to a member of the *Corvidae* family.

Plate 3. Important fauna habitat features on the subject site (sandstone crevices left) and coarse woody debris (right)

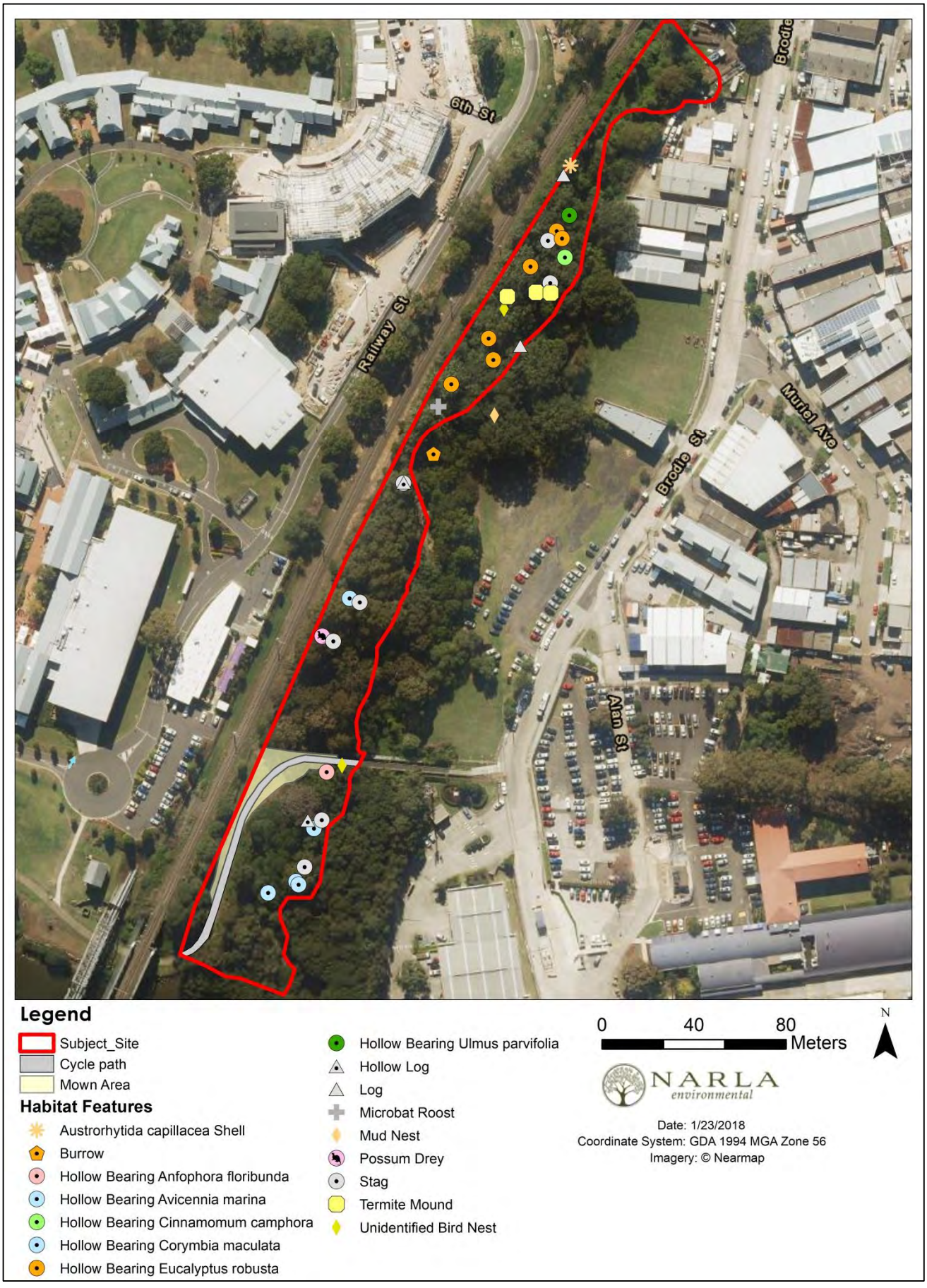

Figure 8. Significant fauna habitat features recorded in the subject site

5. Management Issues

5.1 Feral Pests

Vegetated riparian corridors within areas of considerable urban development provide refuge and corridors for native species as well as pest species such as *Vulpes vulpes* (Red Fox) and *Felis catus* (Feral Cat). While no direct evidence of the presence of either of these species was identified within the subject site, it is considered highly likely that one or both of these species would use this area for both foraging as well as an area of thoroughfare. Predation by both of these exotic predators is listed as a Key Threatening Process (KTP) under the New South Wales BC Act. They are a particular threat to small, native mammals, reptiles and birds.

A burrow potentially belonging to the exotic Oryctolagus cunniculus (European Rabbit) was identified just outside the western extent of the subject site. If present within close proximity to the subject site, it is likely that this species will occasionally graze on understorey vegetation present within the site. Constant grazing pressure from European rabbits can affect the resilience of the native vegetation within the subject site and may have contributed to the distinct lack of ground-cover species present.

5.2 Illegal Dumping and Illegitimate Occupancy

The illegal dumping of waste material and illegitimate occupancy of the site was identified as a management issue. A dumped car engine block as well as an abandoned camp (**Plate 4**) were identified within the subject site. Disturbed areas where dumping occurs are likely to support weed plumes and infestations. Such areas may also be susceptible to increased risk of fire or erosion. Waste products could enter the riparian environment and cause environmental degradation.

Plate 4. Evidence of illegal camp within the subject site.

Illegal dumping can impede bushland management actions as it may act as a continual source of weed propagules and has the ability to crush native regeneration and introduce contaminants which put the environment and public at risk. While large pieces of anthropogenic waste such as old tyres or sheet metal may provide some shelter habitat for native fauna, such as reptiles, amphibians and invertebrates, natural coarse woody debris provides superior habitat values and is recommended to replace removed waste.

A number of noticeable tracks and trails cut through understorey vegetation were observed during the site visit. The destination and origin of these tracks is unclear however their presence poses a risk to the integrity of the subject site and can further exacerbate to a number of preventable management issues.

5.3 Riparian Management Issues

5.3.1 Erosion and Sedimentation

Small areas of localised erosion were evident within the subject site. Past erosion control measures were evident along areas within the southern extent of Vineyard Creek in the form of erosion fencing. This fencing was intact in areas and had been compromised in other areas (**Plate 5**). Increased sedimentation of vineyard Creek is likely to reduce the habitability of the watercourse for native aquatic and semi-aquatic fauna.

Plate 5. Compromised sediment retention fencing along Vineyard Creek

Sedimentation was evident along the majority of Vineyard Creek. This is a common issue in urban drainage lines and is caused by hard surface runoff and release of loose sediments from exposed soil surfaces such as in construction sites located further up in the creek catchment. Areas of sediment accumulation can alter the hydrology of creeks and impact on their habitat values.

5.3.2 Pollution

The water within Vineyard Creek was observed to contain both micro and macro pollutants, including a dense surface slick (**Plate 6**). A considerable amount of plastic waste had entered the subject site, presumably via the northern extent of vineyard creek.

Although comprehensive water and sediment tests were not undertaken as part of this assessment, it is possible that the level of pollution evident within and surrounding the watercourse is a contributing factor to the lack of sensitive bio-indicators such as native frog species or a diverse aquatic macroinvertebrate assemblage.

Vineyard Creek acts as a source of pollutants of both chemicals and litter into the subject site as well as the wider Parramatta River Estuary.

Plate 6. Pollution within Vineyard Creek

5.3.3 Flow Alteration and Impediment

The culverts that form a part of the structure of an abandoned rail bridge located along a section of the eastern border of the subject site through which Vineyard Creek flows appear to be partially blocked by various large pieces of debris (**Plate 7**). These large pieces of debris were lodged perpendicular to the flow of the creek and appeared to be damming Vineyard Creek.

Plate 7. Debris blocking the rail bridge culvert within Vineyard Creek on the eastern extent of the subject site

5.4 Exotic Weedy Vegetation

A suite of noxious and priority weeds were identified within the subject site. Notable weed species identified include:

- *Lantana Camara* (Lantana) [WoNS]
- Salix spp. (Willow Species) [WoNS]
- Anredera cordifolia (Madeira Vine) [WoNS]
- Asparagus aethiopicus (Groung Asparagus) [WoNS]
- Asparagus asparagoides (Bridal Creeper) [WoNS]
- Opuntia spp. (Prickly Pear Species) [WoNS]
- *Cestrum parqui* (Green Cestrum)
- Olea europaea subsp. Cuspidata (African Olive)
- *Dolichandra unguis-cati* (Cat's Claw Creeper) [WoNS]

While significant infestations of all the above listed weeds were identified within the site, *Lantana camara* occurred consistently throughout the subject site except for the extreme southern extent. The constant pressure of *Lantata* in combination with a number of other environmental weeds appeared to be suppressing the regeneration efforts of native flora species.

Woody weed species such as *Olea europaea subsp. Cuspidata* and *Cinnamomum camphora* (Camphor Laurel) were present throughout the subject site and included a number of large, mature individual trees. Ongoing management and removal of these large woody weed species will be integral to the survival and rehabilitation of the native vegetation within the subject site.

Overall, the severe weed infestation occurring across the majority of the subject site presents a clear threat to the long-term viability of the multiple EECs present within

The presence of large, mature *Cinnamomum camphora* (Camphor Laurel) and *Ulmus parvifolia* (Chinese Elm) trees within the centre-northern extent of the subject site has resulted in a significant increase in the depth and character of the leaf litter within this area. The high concentration of dry leaf litter poses a has altered the litter and soil composition which may be preventing natural regeneration of native canopy, shrub and ground flora.

5.5 Absence of Natural Fire Regimes

The subject site contained areas of dense weed growth, leaf litter accumulation and senescent native vegetation. This dense, accumulation of organic material has caused increased competition for resource with native flora, particularly ground covers, shrubs and canopy germinant. If managed with a well-timed ecological burn the subject site could be relieved of some of these pressures allowing improved response of natural regeneration.

5.6 Absence of Natural Flood Regimes

Alterations to upstream hydrology and natural flood regimes is considered to have impacts upon the native vegetation communities of the subject site. At least two vegetation communities mapped, Swamp Oak Floodplain Forest, and Swamp Sclerophyll Forest, have evolved on floodplains and are likely to require natural floodplain processes to survive and regenerate in the long-term.

The historical and continued lack of natural flood regimes is likely to have deprived these communities of natural nutrient fluxes and cycling, canopy tree germination events, and other natural process usually associated with natural flood regimes.

It is likely that the Vineyard Creek catchment is nowadays only exposed to short, high-powered flow and flood events caused by increased hard surface runoff upstream. The effects of this on the vegetation the subject site are not known, but not likely to be favourable.

6. Management Recommendations

6.1 Weed Management

Weed infestation is considered to be the most significant management issue affecting the subject site. Narla recommend that the professional management of weeds is implemented as soon as is practicable and that priority be given to remove and control WoNS and weed species listed as 'priority' within the Greater Sydney area. Effort should be made to progressively expand the quality of native vegetation communities through the gradual replacement of weeds with ecologically-equivalent native plants. This can be achieved through the action of professional Bushland Restoration professionals with the aid of on-going efforts driven by volunteers (e.g. local environment groups, university bushland / environmental clubs or BushCare Groups).

6.1.1 Herbicide Usage

As the majority of the subject site occurs within the vegetated riparian zone of Vineyard Creek, the use of herbicide should be minimised, however the use of Glyphosate-based herbicides such as Roundup Biactive can be utilised effectively on problem weeds by trained and experienced personnel such as professional bush regenerators.

6.1.2 Progressive Weed Replacement

Effective bushland restoration involves the restoration and enhancement of native flora diversity, vegetation structure and habitat for fauna. While weeds impact on native floristic diversity and vegetation structure, they often provide shelter and foraging resources for native fauna, particularly small woodland bird species. For this reason, it is important to ensure that all weeds removed are replaced (through regeneration or revegetation) gradually and with ecologically-equivalent native flora.

Woody weeds like *Lantana camara* (which is prolific throughout the subject site) often provide sheltering and nesting habitat for small, native bird species. The immediate removal of this structural strata from the subject site would have a detrimental effect on the presence and longevity of these species within the immediate area. Structural habitat-forming weeds such as Lantana, Ligustum spp, Camphor Laurel and vines, should be removed at rate that allows congruent infill planting of ecologically equivalent, native flora species such as *Bursaria spinosa and Hakea spp* (depending on the recommended flora assemblage identified within each of the communities occurring within the subject site). Importantly, all revegetation efforts must be managed and permitted to mature before to provide replacement habitat before managing the subject site of weeds in its entirety. Managing of weeds using a staged or 'mosaic' approach is most suited to this site.

6.1.3 Bushcare and Equivalent Volunteer Programs

The subject site contains a unique combination of EECs and fauna habitats and may attract the attention of council/ local volunteer groups to assist in restoration. Western Sydney University partners with a number of local landcare, bushcare and environmental groups who could be invited to assist in the management of the site.

The University and local environmental groups could work together to obtain grants for on-going management of the site. It is recommended that all groups are made aware of the subject site and the sensitive vegetation contained within as well as the immediate threats posed by the extent of weeds throughout the site. It is also imperative that potential bush care volunteers are made aware of any potential safety risks posed by working within the subject site (e.g. working close to ledges, working close to water, the presence of snakes). To ameliorate this risk, the subject site could be stratified into different 'management zones' with the safety risks present within each zone clearly identified and articulated. Pre-work 'toolbox talks' could address safety risks prior to volunteer work commencing.

6.1.4 Professional Bush Regeneration

It is recommended that a professional Bush Regeneration company with skills and expertise in supporting the natural regeneration of native vegetation, particularly the three recorded EECs is employed to provide on-going support in vegetation management and restoration within the subject site. This presence is especially important when the use of powered machinery (e.g. brush cutters, augers, chainsaws) is required. Such Bush Restoration Professionals will work to support the efforts made by volunteers (e.g. bushcare) and assist in monitoring and improving the biodiversity, and quality of the bushland and habitat present within this unique location.

Professional Bush Regenerators can also assist in training and educating local community and volunteers in effective bushland restoration techniques.

6.1.5 Replacement of Sediment Fencing

It is recommended that the damaged sediment fencing along the western bank of Vineyard Creek, in the southern extent of the subject site be at least removed and ideally, replaced. As the damaged fencing material continues to deteriorate, it poses a risk to the health of the native fauna within the creek as well as not preventing the mobilisation of sediments and other material into the water course as it is intended to do.

6.1.6 Flooding

Narla Environmental recommends that all pieces of debris found to be affecting or restricting the flow of Vineyard Creek are removed in order to restore the natural water flow to the creek line as well as annul the significant risk of flooding posed by the debris during heavy rainfall events. The management of this issue, present on the western side of the disused railway bridge may be the responsibility of either the City of Parramatta Council or the adjoining land holders located on the eastern side of the subject site.

6.1.7 Gross Pollution Control

As a result of the visible macro and micro pollution observed within Vineyard Creek, Narla Environmental recommends the implementation of a floating pollution collection/ exclusion boom to reduce the impact of water borne pollution within the subject site. Such a device should be implemented at the northern extent of the subject site where it could prevent the mobilisation of macro-pollutants throughout the subject site and would not inhibit the dispersal of mangrove propagules within the brackish, southern extent of the subject site.

Sediment and litter traps could be installed where tributaries and drains meet Vineyard Creek to reduce the downstream accumulation of wastes.

6.1.8 Water Quality Monitoring

It is recommended that regular water quality monitoring is undertaking within Vineyard Creek. This could be undertaken monthly or biannually, and focus on assessing nutrient levels, pollutants (e.g. hydrocarbons, pesticides and heavy metals), algal blooms and biodiversity indicators (e.g. macroinvertebrate assemblages).

Water quality monitoring parameters should be assessed against suitable local benchmarks and managed in a database. Findings should influence future management actions and efforts undertaken in the management of the subject site and campus.

6.2 Revegetation

Many areas within the subject site present opportunities to significantly enhance the area through revegetation. The focus of revegetation efforts would be within the groundcover and mid-level strata in areas where dense weed cover currently dominates. The removal of weeds and subsequent replacement with locally indigenous, native flora should be a gradual process as to prevent the ability of native fauna to seek refuge in this mid to low level vegetation.

Flora species selected for planting and revegetation efforts should conform to the corresponding vegetation community mapped for that specific area, with particular attention being paid to areas containing EECs (**Figure 6**).

The strategic positioning of native, thorny shrub species such as *Bursaria spinosa*, *Daviesia ulicifolia, Ozothamnus diosmifolius* or dense rows of *Lomandra longifolia* on the edges of bushland can be undertaken to dissuade people and domestic animals from penetrating into bushland patches (off tracks). This in turn may reduce illegal dumping and trampling within the subject site and support an increase in native fauna habitat.

The canopy of all native vegetation communities across the subject site appeared to be intact and was well represented. Regenerative planting of native canopy species is recommended within the northern, extremely weed infested extent of the site once weed control actions have been undertaken.

All native flora used for revegetation should be, where possible, sourced from a local provenance nursery to ensure the genetic integrity of the vegetation communities occurring within the subject site.

6.3 Threatened Fauna Species Management

Although no threatened fauns were identified within the subject site, a number of species were identified as having the potential to occur in the site based on site conditions, location and historical records. Threatened fauna species identified by the attending ecologists as having a potential to occur within the subject site are listed below in Table 3.

Table 3. Threatened flora species with potential to occur within the subject site

Species	NSW BC Act Status	Federal EPBC Act Status	Likely area of occupancy within the Subject Site
Acacia pubescens (Downy Wattle)	Vulnerable	Not listed	Has potential to occur within the areas containing dry sclerophyllous vegetation within the subject site.
Wahlenbergia multicaulis (Tadgell's Bluebell)	Endangered population	Not listed	Has potential to occur within the areas containing dry sclerophyllous vegetation within the subject site.
Wilsonia backhousei (Narrow-leaved Wilsonia)	Vulnerable	Not listed	Has potential to occur within the mangrove and swamp oak floodplain forest occurring within the southern extent of the subject site
Hibbertia superans	Endangered	Not listed	Has potential to occur within the areas containing dry sclerophyllous vegetation within the subject site
Grammitis stenophylla (Narrow-leaved Finger-fern)	Endangered	Not listed	Has potential to grow on rocks along the bed and banks of Vineyard Creek
Triplarina imbricata (Creek Triplarina)	Endangered	Endangered	The species was previously recorded in Parramatta, near Sydney, however, the species is no longer thought to occur in this area. Has potential to occur along Vineyard Creek.
Pomaderris prunifolia (Plum-leaf Pomaderris)	Endangered population	Not listed	Has potential to occur within the areas containing dry sclerophyllous vegetation within the subject site.
Zannichellia palustris (Horned Pond Weed)	Endangered	Not listed	Has potential to occur within the waters of Vineyard Creek

6.4 Native Fauna Habitat

Increasing the availability and range of fauna habitat found within the subject site will help to enhance local biodiversity. Currently, hollow-dwelling native fauna, such as gliders, possums and owls are expected to be rare within the area due to the low-density of suitably sized tree hollows present. A low representation of these fauna species within the subject site is also possibly due to the lack of potential foraging habitat available as well as limited connectivity to other areas of suitable habitat.

6.4.1 Threatened Fauna Habitat

The vulnerable *Miniopterus australis* (Little Bentwing-bat) was confirmed to be using the site to forage and is considered likely to be roosting within the site (Pearson 2018). Stormwater drains, culverts and bridges are noted roost sites for this species and while these features occur within the subject site, they were in a state of disrepair and were of no use to any additional, potentially roosting threatened microbats (OEH 2017). Two unidentified microbats were observed roosting in a drainage pipe within a culvert of an abandoned railway bridge on the eastern extent of the subject site. Narla recommends removing the mass of spider webs and other debris are removed from within the sealed drainage pipes of the abandoned rail bridge and this microhabitat feature is maintained as bat roosting habitat .

It is possible that the threatened *Meridolum corneovirens* (Cumberland Land Snail) and *Pommerhelix duralensis* (Dural Woodland Snail) occur within the subject site. Well-timed, targeted surveys by experienced and qualified Ecologists could be undertaken to establish the presence, extent and if possible, population density of the species within the site. Optimal survey timing is early daylight (two hours either end of sunrise), after rain, during spring and summer. If these species are not currently present within the reserve or population density is low, reintroduction of either of these threatened land snails could be explored. However, owing to the Endangered status of this species, any proposed translocation would only be possible if preceded by a translocation plan that is development with the assistance and approval of the relevant Conservation Officers and licensing personnel of the NSW Office of Environment and Heritage.

6.4.2 Nest Boxes and Hollow Augmentation

Owing to the low number of natural tree-hollows larger than 10cm diameter within the subject site, it is recommended that an appropriate number of artificial hollows, suitable for larger hollow dwelling native animals be installed to improve the available habitat resources within the site.

Tree hollow augmentation through installation of artificial nestboxes has been proven to provide effective shelter habitat for arboreal mammals in small remnant patches of Cumberland Plain Woodland and Riverflat Forest in Western Sydney (Narla Environmental 2017). A study undertaken by Narla Environmental (2017) revealed one resident arboreal mammal (Sugar Glider, Ring-tailed Possum or Brush-tailed Possum) recorded per 7.5 nest boxes installed (Narla Environmental 2017).

An alternative to installation of artificial nest boxes is the cutting of artificial hollows into standing dead or living trees. This type of activity requires specialised skills and qualifications in tree climbing and chainsaw use. Only skilled and qualified arborists are able to provide such services. This technique can provide successful results and should be explored as a habitat augmentation option within the subject site.

Hollow augmentation could be preceded by a 'Nest box Management Plan' produced by an experienced and qualified Ecologist or equivalent experienced and qualified person. The management plan should identify a suite of target fauna species, and the appropriate nest box/hollow design, positioning and density required to maximise suitability for those target fauna species. The plan should also detail a nest box monitoring and maintenance regime, along with a procedure for removing unwanted pests including feral European Honey Bees, Black Rats, Common Starlings and the Common Myna.

6.5 Education and Signage

The subject site contains a narrow, yet diverse cross section of local vegetation communities. It supports one of the few unbroken examples of the original vegetation community 'catena' that extended from the Parramatta River to the sandstone and shale plateaux of inner-western Sydney.

Despite its small size and extent, the subject site supports several distinct vegetation communities, including significant local stands of EEC, as well as four distinct geological units. The subject site presents a rare and valuable example of a geological / geomorphological transition area that supports a diverse assemblage of vegetation communities, including EEC. This unusual geological and vegetation diversity is rare in inner-western Sydney and is valuable from both perspectives of education and biodiversity conservation.

Narla recommends that educational signage is erected to inform visitors to the site of the environmental values of the site. Signs would be ideally placed to identify each vegetation type and important habitat features (e.g. mature hollow trees). Vegetation descriptions could include the vegetation community name, a short species list and a transverse diagram of Vineyard Creek and the location of each vegetation community in relation to it.

6.6 Fencing

It is recommended that the University installs permanent fencing located along the edge of vegetated areas to prevent unauthorised access and maximise protection of the EEC and habitat values. A suitable place for fence installation would be between the cycle way and native vegetation. The installation of a chain-link fence with a gate, or even a simple post and wire style fence would provide the added benefit of a deterrent to would be vandals or trespassers.

6.7 Community Engagement

Rehabilitating and revegetating a site can indicate to the community and other involved stakeholders that the area is valued, monitored and used. Tree planting days and guided walks and talks could be undertaken to promote further community involvement and entice volunteers. Increasing the number of people involved or increasing the visibility of such projects can build community pride and can lead to changed perceptions and increased community surveillance, which may contribute to reducing antisocial activity (such as dumping, trespassing and squatting). Educational signs, if erected, will also act to inform the local community on the unique flora and fauna within.

6.8 Cultural Heritage Values

6.8.1 European Heritage

First explored by European Settlers including Govenor Phillip in April of 1788, the banks of the Parramatta River in close proximity to that of the subject site were noted as having "*trees immensely large and a considerable distance from each other*" with the land below "*well covered in a rich and succulent grass layer*" (Benson & Howell 1990). This description illustrated the condition of the vegetation surrounding the subject site prior to European settlement and landscape modification.

6.8.2 Aboriginal Heritage

Due to the geographic location and the natural features identified within the subject site, it is possible that the site had been utilised by indigenous Australians as a source of food and potentially shelter. Vineyard Creek contains a number of sandstone pools and flowing channels that may have provided suitable areas to hunt Eastern Long-Neck Turtles (*Chelodina longicollis*) and Freshwater Eel (Angulla spp.) also known as '*Burramatta*' by local Aboriginal peoples, the 'Burramatagal Clan' of the Darug Nation who occupied the area of present day Parramatta '*where the eels lie down*' (McClymont 2009).

The subject site also contains or is likely to have contained an array of native wild food plants that may have been harvested by indigenous Australians. Narla have compiled a table that discusses the range of native wild food and resource plants (from Low 1991) that are currently present within the subject site and that may be able to be protected or enhanced (**Table 4**). Other species not currently present may be reintroduced as part of future bush regeneration efforts.

Table 4. Native food and resource plants currently present within the subject site and proposed to be reintroduced to the subject site (Low 1991).

Scientific Name	Common Name	Potential Use	Present within subject site?
Tetragonia tetragonoides	New Zealand Spinach	Foliage can be safely eaten	Yes, in the southern extent on the shores of the Parramatta River
Acacia longifolia *Acacia parramattensis*	Sydney Golden Wattle And Parramatta Wattle	Seed pods can be steamed and eaten	Yes
Avicennia marina	Grey Mangrove	Seed propagules and be cooked and eaten	Yes, naturally occurring within the tidal zone of the Parramatta River
Billardiera scandens	Apple Berry	Berries can be eaten raw when ripe.	No, but this species is known to naturally occur in all of the terrestrial vegetation communities mapped in this study and can be reintroduced through revegetation efforts.
Eustrephus latifolius	Wombat Berry	New shoots and fruit can be eaten raw.ep	No, but this species is known to naturally occur in all of the terrestrial vegetation communities mapped in this study and can be reintroduced through revegetation efforts.
Lomandra longifolia	Mat Rush	Stem bases can be eaten raw or boiled.	Yes.
Persoonia linearis	Narrow-leaved Geebung	Berries can be eaten when ripe (only when fallen off the tree) skin and seed must be discarded.	Present. The population is likely to be locally important as there are few records of this species so close to the Parramatta River.
Plantago deblis	Native Plantain	Seeds and seed heads can be 'bruised to create an edible 'porridge'	No, can be integrated within suitable vegetation communities as part of bush regeneration efforts
Geranium solanderi	Native Geranium	Tap root can be cooked and eaten	No, can be integrated within suitable vegetation communities as part of bush regeneration efforts
Imperata cylindrical	Blady Grass	Tough grass leaves were used to thatch hut roofs and weave dillies	No, can be integrated within suitable vegetation communities as part of bush regeneration efforts

6.9 Feral Fauna Management

In order to gain an understanding of the extent of the presence of feral fauna within the subject site and the adjoining vegetation patches, it is recommended that a "Pest Monitoring Program" is implemented. This may involve the use of carefully positioned trail cameras to monitor site usage by pest fauna. This type of monitoring will also double as an effective way to identify and monitor native fauna utilising the site.

Successful fox management requires ongoing action, with greatest success found when a regional approach is undertaken (DPI 2015). No single control method will be successful on its own, and when foxes are removed from an area, reinvasion or immigration from existing untreated areas generally occurs within 2 to 6 weeks (DPI 2015). Suitable management techniques which could be applied within Sartor Crescent may include den destruction in combination with baiting and trapping. In the case that these management techniques are adopted they must include appropriate measures to inform the local consent authority and residents who may need to take steps to protect pets, as required in accordance with the Local Land Services Act 2013 (LLS Act). Management of Feral Cats could be undertaken using similar means.

All rat or feral bird nests present in tree hollows or nest boxes should be removed by appropriately trained tree climbers, pest control experts or ecologists quickly and efficiently to ensure these scarce habitat resources remain available for use by native fauna.

6.10 Maintaining Public Safety

It is important to note the presence of the shared cycle- and walk-way which runs through the southern extent of the subject site. This cycleway is very popular with local residents and commuters alike and as such, all works proposed to be undertaken within the subject site should be done so under the best available safety and traffic management practices. Key elements to address prior to the onset of any works may include:

- Development of a Traffic Management Plan (TMP) to demonstrate how access to the site and walkways will be managed. The TMP will specifically address how plant, labour and materials will cross walkways and be stored on site – without risk to the public. The TMP will also demonstrate how the works will be accessed from the road, and cover traffic and pedestrian activities in this area.
- Ensuring any feral fauna control is undertaken in accordance to Department of Primary Industries Control Orders with measures taken to reduce the potential risk to the public and pets.
- Ensuring Bush Regeneration Contractors, Educational Personnel, Ecologists or Research Institutions are trained, inducted and insured to deliver the tasks required.

6.11 Ongoing Monitoring

An annual ecological monitoring program could be implemented to gauge the success of on-going management of the biodiversity within the subject site. Ongoing monitoring could contain some/all of the following components:

- Targeted microbat surveys to assess the population trends present for the threatened Little Bentwing-bat amongst other species;
- Targeted survey for rare and threatened flora recording all individual occurrences and abundance in a GPS enabled device;
- Fauna survey including diurnal bird, land snail and nocturnal spotlighting/call playback or trail camera components; and
- Riparian corridor vegetation health and quality monitoring.

7. Summary

The vegetation within the subject site of Western Sydney University's Parramatta campus provides a unique example of the original vegetation communities that once existed across the extensively cleared and urbanised mid-Parramatta River catchment. The unique assemblage of vegetation communities present is directly related to the underlying geological and geomorphological diversity of the Vineyard Creek catchment. The fact that this vegetation extent has remained in its current state is surprising considering the extensive history of clearing and urban development in the area. It is one of the last, patches of remnant riparian forest in this part of Sydney. For this reason alone, the vegetation of this part of Vineyard Creek should be managed and protected into the future.

Survey of the subject site was undertaken by Narla Environmental ecologists and involved observational surveys along with the installation of an acoustic bat recorder in an area likely to contain feeding microbats over a period of four days as well as a full floristic and opportunistic fauna survey throughout the entire subject site. Results from the bat survey were analysed and revealed that a suite of at least seven bat species were using the subject site as a corridor or for feeding, including the threatened Little Bentwing-bat (Pearson 2018).

The assessment of vegetation present within the subject site identified a total of four Endangered Ecological communities (EECs) occurring within the site. The EECs identified within the site included:

- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions;
- Shale Gravel Transition Forest in the Sydney Basin Bioregion; and
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Field survey and observation indicated that the native vegetation within the subject site is at significant risk from the extensive weed infestations apparent throughout the majority of the site. Ongoing weed management and bush regeneration is recommended to ameliorate this issue and restore the native biodiversity values the subject site once contained. Regular monitoring of management actions should be undertaken to ensure the effectiveness of the proposed works and the rehabilitation of the EECs present.

The initial biodiversity surveys undertaken in preparation of this Management Strategy provide a baseline data set and are by no means intended to contain a complete biodiversity inventory of the subject site. Over time regular and strategic monitoring will build a more complete understanding of the processes, threats and opportunities present within the subject site.

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Appendices

Appendix 1 - Flora Species List

Appendix 2 - Fauna Species List

Appendix 3 - Summary report of bat echolocation survey

Appendix 1. Flora species identified within the subject site.

Scientific Name	Native	Exotic	Canopy	Mid-strata	Groundcover/Vine
Acacia decurrens	x			x	
Acacia parramattensis	x				
Angophora floribunda	x		x		
Avicennia marina	x		x		
Bursaria spinosa	x			x	
Callistemon salignus	x			x	
Casuarina glauca	x		x		
Commelina cyanea	x				x
Croymbia maculata	x		x		
Cupaniopsis anacardioides	x			x	
Cynodon dactylon	x				x
Cyperus gracilis	x				x
Dichondra repens	x				x
Einadia hastata	x				x
Einadia nutans	x				x
Entolasia marginata	x				x
Eucalyptus crebra	x		x		
Eucalyptus elata	x		x		
Eucalyptus fibrosa	x		x		
Eucalyptus robusta	x		x		
Exocarpus cupressiformis	x			x	
Ficus rubiginosa	x			x	
Glochidion ferdinandi	x			x	
Glycine tabacina	x				x
Grevillea robusta	x		x		
Juncus krausii	x				x
Lomandra longifolia	x				x
Microlena stipoides	x				x
Microsorum scandens	x				x
Oplismenus aemulus	x				x
Ozothamnus diosmifolius	x			x	
Pandorea jasminoides	x				x
Persicaria decipiens	x				
Persoonia linearis	x			x	
Pittosporum revolutum	x			x	
Pittosporum undulatum	x			x	
Samolus repens	x				x
Sporobolus virginicus	x				x
Syncarpia glomulifera	x		x		
Tetragonia tetragonioides	x				x

Scientific Name	Native	Exotic	Canopy	Mid-strata	Groundcover/Vine
Acetosa sagittata		x			x
Ageratina adenophora		x			x
Alternanthera philoxeroides		x			
Anredera cordifolia		x			x
Araujia sericifera		x			x
Asparagus aethiopicus		x			x
Asparagus asparagoides		x			x
Bidens pilosa		x			x
Bromus wildenowie		x			x
Canna x generalis		x			x
Cardiospermum grandiflorum		x			x
Cestrum parqui		x		x	
Chloris gayana		x			x
Chlorophytum comosum		x			x
Cinnamomum camphora		x	x		
Conyza bonariensis		x			x
Cyperus eragrostis		x			x
Cyperus rotundus		x			x
Delairea odorata		x			x
Dolichandra unguis-cati		x			x
Ehrharta erecta		x			x
Eragrostis curvula		x			x
Erythrina crista galli		x		x	
Foeniculum vulgare		x			x
Jacaranda mimosifolia		x	x		
Lantana camara		x		x	
Lagunaria patersonii		x		x	
Ligustrum lucidum		x		x	
Ligustrum sinense		x		x	
Malus sp.		x		x	
Modiola caroliniana		x			x
Morus nigra		x		x	
Ochna serrulata		x		x	
Olea europaeasubsp. cuspidata		x		x	
Opuntia sp.		x			x
Parietaria judaica		x			
Paspalum dilatatum		x			x
Pennisetum clandestinum		x			x
Phoenix canariensis		x		x	
Rumex brownii		x			x
Salix sp.		x		x	
Senna pendula var. glabrata		x		x	

Scientific Name	Native	Exotic	Canopy	Mid-strata	Groundcover/Vine
Sida rhombifolia		x			x
Solanum cinereum		x			x
Solanum mauritianum		x		x	
Solanum nigrum		x			x
Tradescantia fluminensis		x			x
Ulmus parvifolia		x	x		
Verbena bonariensis		x			x
Wisteria sp.		x			x
Zantedeschia aethiopica		x			x

Appendix 2. Fauna species observed during field survey

Class	Scientific Name	Common Name
Aves	*Pycnonotus jocosus**	Red-whiskered Bulbul*
	Acanthorhynchus tenuirostris	Eastern Spinebill
	*Acridotheres tristis**	Common Myna*
	Anas superciliosa	Pacific Black Duck
	Acanthiza nana	Yellow Thornbill
	Anthochaera carunculata	Red Wattlebird
	Butorides striata	Striated Heron
	Cacatua galerita	Sulphur-crested Cockatoo
	*Columba livia**	Rock Dove*
	Coracina novaehollandiae	Black-faced Cuckoo-Shrike
	Corvus coronoides	Australian Raven
	Cracticus torquatus	Grey Butcherbird
	Chroicocephalus novaehollandiae	Silver Gull
	Dacelo novaeguineae	Laughing Kookaburra
	Eolophus roseicapilla	Galah
	Grallina cyanoleuca	Magpie Lark
	Gymnorhina tibicen	Australian Magpie
	Hirundo neoxena	Welcome Swallow
	Lichmera indistincta	Brown Honeyeater
	Malurus cyaneus	Superb Fairywren
	Manorina melanocephala	Noisy Miner
	Ocyphaps lophotes	Crested Pigeon
	Pardalotus punctatus	Spotted Pardalote
	Psephotus haematonotus	Red-rumped Parrot
	Phylidonyris novaehollandiae	New Holland Honyeater
	Rhipidura leucophrys	Willie Wagtail
	Rhipidura rufifrons	Rufous Fantail
	Sericornis frontalis	White-browed Scrubwren
	Strepera graculina	Pied Currawong
	*Spilopelia chinensis**	Spotted Dove*
	Threskiornis molucca	Australian White Ibis
	Trichoglossus moluccanus	Rainbow Lorikeet
	Vanellus novaehollandiae	Black-shouldered Lapwing
	Zosterops lateralis	Silvereye
Reptilia	*Physignathus lesueurii*	Eastern Water Dragon
	Eulamprus quoyii	Eastern Water Skink
	Chelodina longicollis	Eastern Long-neck Turtle
	Cryptoblepharus pulcher	Elegant Snake-eyed Skink
	Lampropholis delicata	Delicate Garden Sunskink
	Lampropholis guichenoti	Pale-flecked Garden Sunskink
	Pseudechis porphyriacus	Red-bellied Black Snake
Actinopterygii	*Anguilla australis*	Short-finned Eel

Class	Scientific Name	Common Name
Mammalia	*Chalinolobus gouldi*	Gould's Wattled Bat
	Vespadalus darlingtoni	Large Forest Bat
	Vespadalus vulturnus	Little Forest Bat
	Scotorepens orion/ Scoteanax rueppellii	Eastern Broad-nosed Bat/ Greater Broad-nosed Bat
	Mormopterus ridei	Eastern Freetail Bat
	Nyctophilus gouldi/ Nyctophilus geoffroyi	Gould's Long-eared Bat/ Lesser Long-eared Bat
	Miniopterus australis	Little Bentwing Bat
Mollusca	*Austrorhytida capillacea*	Southern Carnivorous Snail

***Indicates exotic fauna species**

Appendix 3. Summary report for bat echolocation survey undertaken

Report for Narla Environmental

Results of bat echolocation survey, Parramatta New South Wales, January 11 - 15, 2018.

Tim Pearson BSc(Hons)

Wildlife Ecologist

An ultrasonic bat detector (Wildlife Acoustics Songmeter SM4BAT ZC, Serial # 00368) was deployed at Western Sydney Universities Parramatta campus, NSW, over 4 nights from the 11th - 15th January, 2018. The unit was set to record from sunset to sunrise.

A total of 424 trace files were recorded over the period, with analysis showing that 282 of these were attributable to bat echolocation calls.

Traces were analysed using Analook for Windows Version 4.2n (Chris Corben), and then identified to species level where possible using the standard key to bat calls of New South Wales (Pennay et al. 2004) and Australian Bats (Churchill 2009).

Only 87 of the bat echolocation traces were able to be positively identified to species level, with 197 traces too fragmented or incomplete to positively identify.

By far the most common bat detected, with 72 positive traces, was Gould's wattled bat Chalinolobus gouldi, possibly the most common and widespread microbat species in eastern Australia. A number of the fragmented traces were also probably from this species. The wide temporal spread of the traces, combined with very few traces containing feeding buzz suggests a reasonable population of these bats in the area, but using the immediate area more for transiting than feeding.

Small numbers of traces were identified as coming from two different species of forest bat - the Large forest bat Vespadalus darlingtoni, and the Little forest bat Vespadalus vulturnus.

Two traces were from one of the broad-nosed bats - either the Eastern broad-nosed bat Scotorepens orion, or the Greater broad-nose bat Scoteanax rueppellii. Calls from these two species are similar; good quality traces can be separated, however the traces recorded in this survey were only distinct enough to identify to one of these two species.

Distant but distinct traces were identified from a species which flies fast and high above the canopy - the Eastern freetail bat Mormopterus ridei.

Three traces were from one of the long-eared bats, either Gould's long-eared bat Nyctophilus gouldi or the Lesser long-eared bat Nyctophilus geoffroyi. These two species cannot be distinguished by echolocation calls.

Four traces were identified as being from the Little bentwing bat Miniopterus australis. This is a small cave-dwelling bat, and is listed as "Vulnerable" under the New South Wales Biodiversity Conservation Act 2016. It is not listed under the Federal Environment Protection and Biodiversity Conservation Act 1999.

All of these species have been previously detected in the broad area (Threlfall et al. 2011).

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