

ST MARYS **freight hub**

Biodiversity Development Assessment Report

pacificnational



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Template 2.8.1

Executive Summary

Eco Logical Australia (ELA) were engaged by Pacific National Pty Ltd to prepare a Biodiversity Development Assessment Report (BDAR) in accordance with the *Biodiversity Conservation Act 2016* (BC Act) and the Biodiversity Assessment Method (BAM) at Lot 2 DP 876781 (2 Forrester Rd) St Marys. The proposed development is for the construction of the St Marys Freight Hub which is a State Significant Development (SSD) under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The subject land is located in the City of Penrith Local Government Area (LGA) and is currently zoned IN1 – General Industrial under the Penrith Local Environmental Plan (LEP) 2010.

This BDAR addresses the Secretary's Environmental Assessment Requirements (SEARs) Application Number SSD – 7308 Part 15, which outlines the requirement for a BDAR to be submitted with the Environmental Impact Statement (EIS). This report has been prepared to meet the requirements of the Biodiversity Assessment Method (BAM) established under Section 6.7 of the NSW Biodiversity Conservation Act 2016 (BC Act).

Three Plant Community Types (PCTs) occurring in various conditions are present in the development site. The PCTs have been mapped as *PCT 835 – Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion*, *PCT 1800 – Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley* and *PCT 1071 – Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion*.

PCT 835 and 1800 conform to the endangered ecological community (EEC) 'River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions' listed under the BC Act. This EEC was generally in a degraded condition in the development site.

One threatened flora species, *Grevillea juniperina* subsp. *juniperina* (Juniper-leaved Grevillea), was recorded within the development site. Three threatened microchiropteran bats (microbats) were recorded during the Anabat survey within the development site including *Myotis macropus* (Southern Myotis), *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) and *Mormopterus norfolkensis* (Eastern Freetail-bat). Possible calls of the threatened microbat *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) were also recorded, however, the calls cannot be confidently attributed to this species due to overlapping calls with other species. Impacts on *Grevillea juniperina* subsp. *juniperina* and Southern Myotis habitat require species credit offsets. Impacts to Eastern False Pipistrelle, Eastern Freetail-bat and Eastern Bentwing-bat will be offset as ecosystem credits. Eastern Bentwing-bat is also a species credit species where breeding habitat will be impacted, however, breeding habitat for this species is not present within or in proximity to the development site.

This BDAR outlines the measures taken to avoid, minimise and mitigate impacts on the vegetation and species habitat present within the development footprint and measures to minimise impacts during construction and operation of the development. Following consideration of the above aspects, the residual unavoidable impacts of the project were calculated in accordance with BAM by utilising the Biodiversity Assessment Method Credit Calculator (BAMC).

A total of 15 ecosystem credits are required to offset the residual impacts of the proposed project:

PCT #	PCT Name	Condition	Vegetation Zone	Area (ha) or Number*	Vegetation Integrity Score	Credits
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Degraded	1	0.29	35.6	5
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Regrowth	2	0.28	44.6	6
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Degraded	3	0.06	28.1	1
1071	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Moderate	5	0.19	36.8	3
Total Ecosystem Credits						15

A total of 19 species credits are required to offset the residual impacts of the proposed project:

Scientific Name	Common Name	Direct impact number of individuals / habitat (ha)	Credits required
<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea	0.63	10
<i>Myotis macropus</i>	Southern Myotis	0.94	9
Total Species Credits			19

Serious and Irreversible Impacts (SAIL) values have been considered in this assessment. Eastern Bentwing-bat, which had potential calls identified during the Anabat survey, is a candidate entity for SAIL for impacts to breeding habitat. No breeding habitat for this species will be impacted directly or indirectly by the development. No other candidate entities for SAIL were recorded.

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Abbreviations

Abbreviation	Description
BAM	Biodiversity Assessment Method
BAMC	Biodiversity Assessment Method Credit Calculator
BC Act	NSW Biodiversity Conservation Act 2016
BDAR	Biodiversity Development Assessment Report
BOS	Biodiversity Offsets Scheme
BSSAR	Biodiversity Stewardship Site Assessment Report
CEEC	Critically Endangered Ecological Community

Abbreviation	Description
DNG	Derived Native Grassland
DoEE	Commonwealth Department of Environment and Energy
DPE	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EP&A Act	NSW Environmental Planning and Assessment Act 1979
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
FM Act	NSW Fisheries Management Act 1994
GIS	Geographic Information System
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
LGA	Local Government Area
LLS	Local Land Service
NSW	New South Wales
NOW	NSW Office of Water
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type
SEPP	State Environmental Planning Policy
SSD	State Significant Development
SSI	State Significant Infrastructure
TEC	Threatened Ecological Community
VIS	Vegetation Information System
WM Act	NSW Water Management Act 2000

1. Stage 1: Biodiversity assessment

1.1 Introduction

This Biodiversity Development Assessment Report (BDAR) has been prepared by Kirsten Velthuis and Mike Lawrie who is an Accredited Person (BAAS18162) under the NSW Biodiversity Conservation Act 2016 (BC Act). The contents of this BDAR complies with the minimum requirements outlined in Table 25 of the Biodiversity Assessment Methodology (BAM: OEH, 2017).

1.1.1 General description of the development site

This report includes two base maps, the Site Map (Figure 1) and the Location Map (Figure 2). The subject land (site precinct) includes the following lots:

- Lot 196 DP31912
- Lot 2 & 3 DP876781

The development site has largely been cleared of native vegetation. Some remnant and regrowth vegetation is present, particularly around watercourses and at the fringes of the development site. This vegetation has been degraded by weed incursion. Cleared areas are dominated by exotic grasses and bare ground. Several soil and debris stockpiles are also present in the development site.

Three native Plant Community Types (PCTs) are present in the development site: PCT 835 – *Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion*, PCT 1800 – *Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley* and PCT 1071 – *Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion*. These PCTs are in various condition states and make up a total of five vegetation zones. PCT 835 conform to the endangered ecological community (EEC) River Flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregion (RFEF).

1.1.2 Development site footprint

The development site footprint is shown in Figure 1 which includes both the operational and construction footprint. The development includes:

- Use of existing rail infrastructure for loading and unloading of trains
- Construction of hardstand areas for container storage and laydown, rail and vehicle loading and unloading areas
- Construction of new internal access roads
- Construction of additional service areas, buildings and ancillary features

1.1.3 Sources of information used

The following data sources were reviewed as part of this report:

- Biodiversity Assessment Methodology Calculator
- BioNet Vegetation Classification
- BioNet / Atlas of NSW Wildlife 5 km database search (OEH 2018a)
- EPBC Act Protected Matters Search Tool 5 km database search (DotEE 2019)
- The Native Vegetation of the Sydney Metropolitan Area (OEH 2016)
- Aerial mapping (SIXMaps and Nearmap)

- Additional GIS datasets including soil, topography, geology and drainage
- Additional reports and threatened species information sources

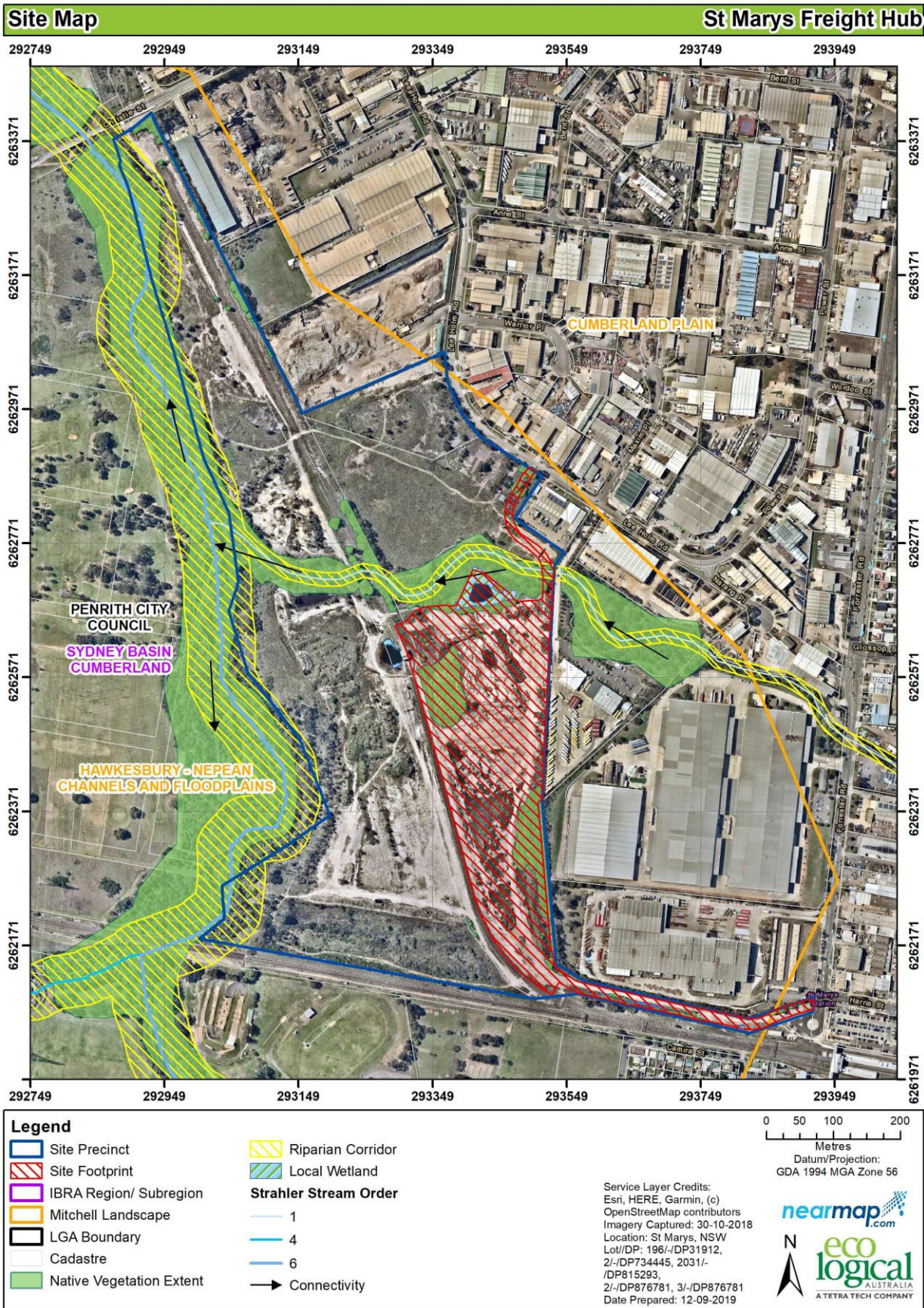


Figure 1: Site Map

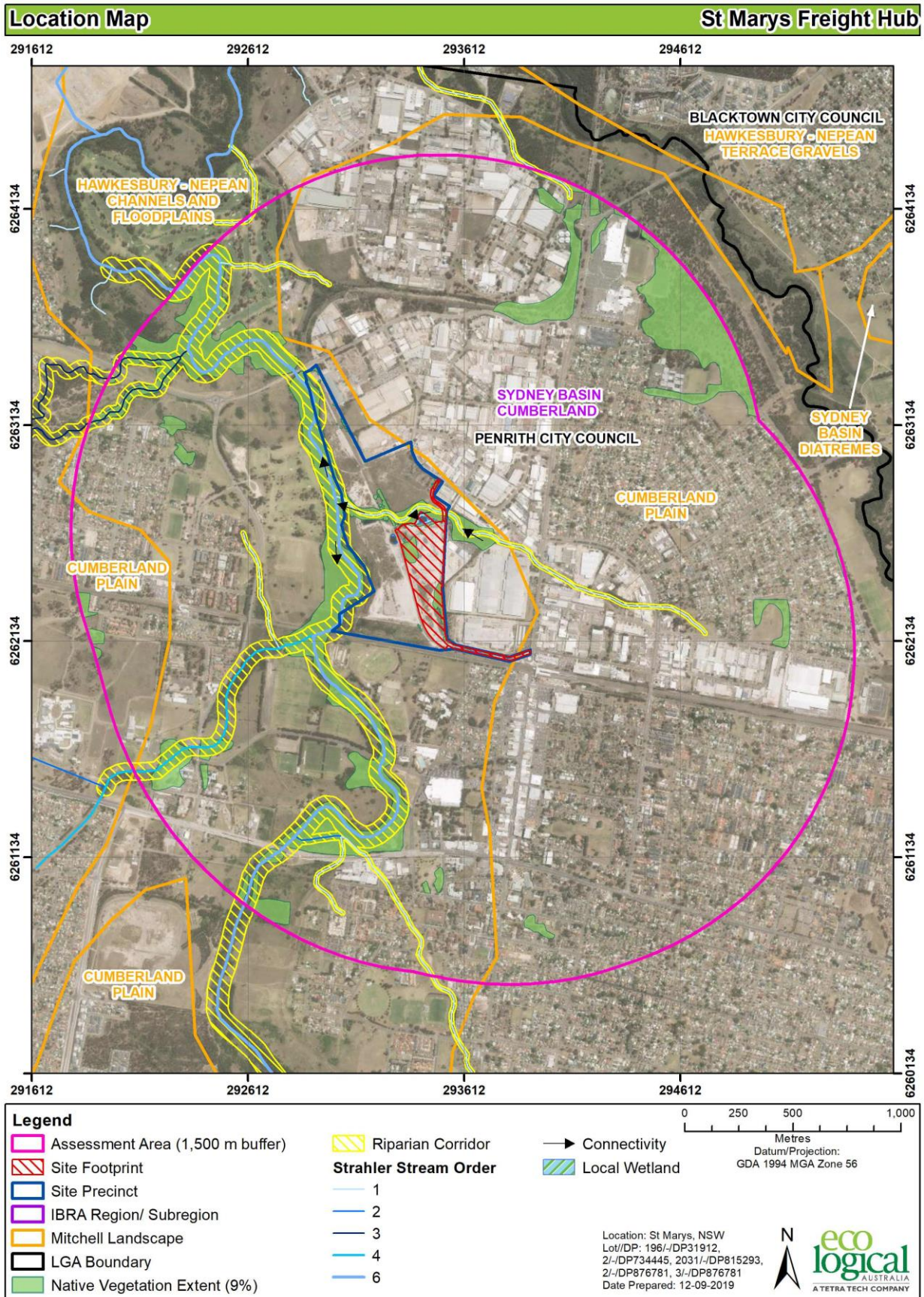


Figure 2: Location Map

1.2 Legislative context

Table 1: Legislative context

Name	Relevance to the project	Report Section
Commonwealth		
Environmental Protection and Biodiversity Conservation Act 1999	Matters of national Environmental Significance have been identified on or near the development site. This report assesses impacts to MNES and concludes that the development is not likely to have a significant impact on MNES.	2.6
State		
Environmental Planning and Assessment Act 1979	The proposed development is State Significant Development and is to be assessed under Part 4.1 of the EP&A Act.	N/A
Biodiversity Conservation Act 2016	The proposed development exceeds the BAM threshold and requires submission of a Biodiversity Development Assessment Report.	BDAR
Local Land Services Amendment Act 2016	The LLS Act does not apply to this development.	N/A
Planning Instruments		
Vegetation SEPP	The Vegetation SEPP applies to development that does not require consent. As this project requires consent under the EP&A Act, the Vegetation SEPP is not relevant.	N/A
SEPP (Coastal Management) 2018	The proposed development is not located on land subject to SEPP (Coastal Management) 2018.	N/A
SEPP 44 – Koala Habitat Protection	The proposed development is not located within a Local Government Area to which SEPP 44 applies.	N/A
Penrith Local Environment Plan 2010	The subject site is zoned IN1 – General Industrial under the Penrith Local Environmental Plan (LEP) 2010. The development site is not mapped on the Natural Resources Sensitivity Land.	N/A

1.3 Landscape features

1.3.1 IBRA regions and subregions

The development site falls within the Sydney Basin IBRA region and Cumberland subregion.

1.3.2 Mitchell Landscapes

The Development Site falls within two Mitchell Landscapes as outlined in Table 2.

Table 2: Mitchell Landscapes

Mitchell landscape	% of Site Footprint	Description
Cumberland Plain	0.38%	Low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast on horizontal Triassic shales and lithic sandstones forming a down-warped block on the coastal side of the Lapstone monocline. Intruded by a small number of volcanic vents and partly covered by Tertiary river gravels and sands (Hawkesbury-Nepean Terrace Gravels ecosystem). Quaternary alluvium along the main streams. General elevation 30 to 120m, local relief 50m. and sometimes affected by salt in tributary valley floors. Pedal uniform red to brown clays on volcanic hills. Red and brown texture-contrast soils on crests grading to yellow harsh texture-contrast soils in valleys Woodlands and open forest of grey box, forest red gum, narrow-leaved ironbark, thin-leaved stringybark, cabbage gum and broad-leaved apple. Grassy to shrubby understorey often dominated by blackthorn, poorly drained valley floors, often salt affected with swamp oak and paperbark.
Hawkesbury-Nepean Channels	99.62%	Meandering channel and moderately wide floodplain of the Hawkesbury and Nepean rivers on Quaternary sand and gravel. Sand is dominant upstream of the Warragamba River junction, general elevation 0 to 20m, local relief <10m. Undifferentiated alluvial sand to poorly structured gradation profiles of sandy loam or clay loam. Forests on the river flats include blue box (<i>Eucalyptus baueriana</i>), broad-leaved apple (<i>Angophora subvelutina</i>), manna gum (<i>Eucalyptus viminalis</i>), river peppermint (<i>Eucalyptus elata</i>) in upstream sectors and dominated by river oak (<i>Casuarina cunninghamiana</i>) possibly originally with rainforest species such as white cedar (<i>Melia azedarach</i>) in the lower sectors. Common reed (<i>Phragmites australis</i>), cumbungi (<i>Typha orientalis</i>) and other aquatic plants are found in the river. Deep organic loams and loamy sands on floodplain with river flat forest of Sydney blue gum (<i>Eucalyptus saligna</i>), round-leaved gum (<i>Eucalyptus deanei</i>), forest red gum (<i>Eucalyptus tereticornis</i>), cabbage gum (<i>Eucalyptus amplifolia</i>), broad-leaved apple, rough-barked apple (<i>Angophora floribunda</i>) and river oak. Water gum (<i>Tristanopsis laurina</i>) in protected channel sections. Large swamps and lagoons on the floodplain and in tributary streams below Richmond dammed by levees on the main stream support tall spike rush (<i>Eleocharis sphacelata</i>), <i>Juncus</i> sp., <i>Melaleuca</i> sp., and <i>Lepidosperma</i> sp. Below Pitt Town the river is tidal and swamp oak (<i>Casuarina glauca</i>), common reed, river mangrove (<i>Aegiceras corniculatum</i>), grey mangrove (<i>Avicennia marina</i>) and limited salt marsh are found on the muddy sands of the inter-tidal zone.

1.3.3 Native vegetation extent

The extent of native vegetation within the development site and buffer is outlined in Table 3.

Table 3: Native vegetation extent

Area within the development site	Area within the 1,500 m buffer area (ha)	Percent cover within 1,500 m buffer area
1.51	92.72	8.69%

There are differences between the mapped vegetation extent and the aerial imagery. Several areas of regrowth native vegetation were identified in the development site which are not visible on the aerial imagery. These regrowth areas have been included in the assessment.

1.3.4 Patch size

All native vegetation within the study formed part of a single patch >100 ha.

1.3.5 Rivers and streams

The development site contains rivers and streams as outlined in Table 4.

Table 4: Rivers and streams

River/stream	Order	Riparian buffer
Unnamed	1	10 m

1.3.6 Wetlands

The development site does not contain any mapped important wetlands. PCT 1071, which has been mapped within and adjacent to the development site is a form of freshwater wetlands, and has been mapped as a local wetland.

1.3.7 Connectivity features

The development site contains areas of connecting habitat as shown in Figure 1 and Figure 2

1.3.8 Areas of geological significance and soil hazard features

The development site does not contain areas of geological significance and soil hazard features.

1.3.9 Method applied

The site based method has been applied to this development.

1.4 Native vegetation

1.4.1 Survey effort

Vegetation survey was undertaken within the development site by Mike Lawrie and Kirsten Velthuis on 6 December 2018 to identify Plant Community Types (PCTs) (Table 5 and Figure 3), collect plot data and note potential threatened species habitat. Four vegetation plots were collected in accordance with the Biodiversity Assessment Method (BAM) to assess the composition, condition and integrity of PCTs.

Additional field work was undertaken by Kirsten Velthuis and Griffin Taylor-Dalton on 29 and 30 January 2019 to collect data from one additional vegetation plot and conduct targeted surveys for threatened flora and *Meridolum corneovirens* (Cumberland Plain Land Snail) as part of the BAM requirements.

Microchiropteran bat (microbat) survey using Anabat detectors was undertaken over four nights between 11 and 15 February 2019. Microbat roost searches in culverts was undertaken by Mike Lawrie on 11 February 2019.

A total of five full-floristic and vegetation integrity plots were surveyed to identify PCTs and TECs on the development site (Table 5).

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

Table 5: Full-floristic and vegetation integrity plots

Veg Zone	PCT ID	PCT Name	Condition	Area (ha)	Plots required	Plots surveyed
1	835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Degraded	0.29	1	1
2	835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Regrowth	0.28	1	1
3	1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Degraded	0.06	1	1
4	1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Poor	0.69	1	1
5	1071	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Moderate	0.19	1	1

1.4.2 Plant Community Types present

A total of three PCTs were identified on the development site (Table 6, Figure 3). All three are listed TECs under the TSC Act (Table 7, Figure 5). The development site does not contain any listed TECs under the EPBC Act. Justification for the selection of PCTs occurring on the development site is based on a quantitative analysis of full-floristic plot data and is provided in Section 1.4.3.

Table 6: Plant Community Types

PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Area	Percent cleared
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland	Coastal Floodplain Wetlands	Forested Wetlands	0.57	93

PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Area	Percent cleared
	Plain, Sydney Basin Bioregion				
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Coastal Floodplain Wetlands	Forested Wetlands	0.75	60
1071	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Freshwater Wetlands	Coastal Freshwater Wetlands	0.19	75

Table 7: Threatened Ecological Communities

PCT ID	BC Act			EPBC Act		
	Listing status	Name	Area (ha)	Listing status	Name	Area (ha)
835	EEC	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.57	Not Listed	N/A	N/A
1800	EEC	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.75	Not Listed	N/A	N/A
1071	EEC	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South	0.19	Not Listed	N/A	N/A

PCT ID	BC Act			EPBC Act		
	Listing status	Name	Area (ha)	Listing status	Name	Area (ha)
		East Corner Bioregions				

1.4.3 PCT selection justification

In determining the PCT for the Development Site, various attributes were considered in combination to assign vegetation to the best fit PCT. Attributes included dominant species in each stratum, community composition, soils and landscape position. Reference was made to the PCT descriptions in the BioNet Vegetation Classification, the final scientific determination and other published documents describing the vegetation community.

ELA considered the native vegetation within the development site comprises three native PCTs:

- PCT 835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- PCT 1800 - Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley
- PCT 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion

1.4.3.1 PCT 835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion

PCT 835 makes up the majority of native vegetation within the development site. This community is generally located along drainage lines and riparian corridors. Previous vegetation mapping (OEH, 2013) mapped this PCT occurring along the drainage line and adjacent to the dam through the centre of the development site. This PCT within the development site was dominated by a canopy of *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus moluccana* (Grey Box) and *Angophora floribunda* (Rough-barked Apple). The midstorey contained *Casuarina glauca* (Swamp Oak), *Acacia parramattensis* (Parramatta Wattle) and *Bursaria spinosa* subsp. *spinosa* (Blackthorn). Parts of this community contained dense stands of the threatened species *Grevillea juniperina* subsp. *juniperina* (Small-flowered Grevillea). The ground layer has been degraded by weed incursion and is dominated by exotic species including *Eragrostis curvula* (African Love Grass) and *Sida rhombifolia* (Paddy's Lucerne). Several native groundcover species are also present including *Microlaena stipoides* (Weeping Meadow Grass), *Themeda triandra* (Kangaroo Grass) and *Dichondra repens* (Kidney Weed).

A quantitative analysis was undertaken for Plot 2 and Plot 4 which have been assigned to this PCT. Plot 2 had 2 diagnostic species matches with PCT 835 using the BioNet Vegetation Classification Community Identification tool. One other PCT was considered to be potentially consistent, PCT 849 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, which had 3 diagnostic species matches. Plot 4 had 3 diagnostic species matches with PCT 835 and 2 diagnostic species matches with PCT 849. It was determined that PCT 835 was the best fit PCT based on the plot data in addition to the location of the PCT within drainage lines and riparian corridors, the presence of *Angophora floribunda* (Rough-barked Apple) and *Casuarina glauca* (Swamp Oak) which typically occur in alluvial woodlands and previous mapping within the study area (OEH, 2013).

1.4.3.2 PCT 1800 - Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley

PCT 1800 has been assigned to patches of vegetation consisting almost entirely of *Casuarina glauca*. These areas are generally located in disturbed drainage ditches and depressions in the landscape. This community does not contain remnant vegetation and is generally composed of disturbed regrowth. This PCT is similar in composition to and has been derived from PCT 835. Within the development site, this PCT has been separated from PCT 835 based on the descriptive attributes of PCT 1800 within BioNet Vegetation Classification which states “*the distinguishing feature is the prominent stands of swamp oak (Casuarina glauca) found along or near streams. Often these are relatively young trees, swarming amongst a mix of old and young eucalypts*”. This differs from PCT 835 in the development site which is dominated by eucalypts with a lower abundance of swamp oak. Other species occurring within this PCT include *Acacia longifolia* subsp. *longifolia*, *Acacia parramattensis*, *Microlaena stipoides* and *Dichondra repens*. Exotic species are also prevalent within this PCT including *Eragrostis curvula*, *Sida rhombifolia*, *Ligustrum lucidum* (Large-leaf Privet) and *Ligustrum sinense* (Small-leaf Privet).

1.4.3.3 PCT 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion

This PCT occurs within dams and man-made waterlogged drainage ditches within the development site. This PCT is dominated by dense stands of *Typha orientalis* (Broad-leaf Cumbungi) and lower abundance of aquatic species including *Juncus acutus* (Sharp Rush) and *Persicaria decipiens* (Slender Knotweed). This PCT has been classified based on the BioNet Vegetation Classification descriptive attributes and landscape position which describes the PCT as occurring in “*man-made water bodies, drainage lines and depressions across a wide variety of environments*”. This PCT is most consistent with vegetation in the development site compared to similar freshwater wetland communities based on the high level of modification of the drainage lines and dams in which it occurs, it does not constitute a remnant or naturally occurring freshwater wetland. Three patches of this PCT are present in the development site, two in man-made detention basins and one in an artificial and ephemeral drainage ditch which is not associated with a natural drainage line.

This PCT was not considered to be consistent with the TEC Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions, further justification is provided in Section 1.4.4.

1.4.3.4 Cleared/Exotic

The majority of the development site consists of cleared areas with no vegetation or vegetation dominated by exotic species. These areas did not constitute native vegetation and are not consistent with any native PCT. . These areas are dominated by exotic grasses including *Eragrostis curvula* (African Love Grass), *Chloris gayana* (Rhodes Grass) and *Cynodon dactylon* (Couch). Other invasive species are common throughout cleared areas including *Verbena bonariensis* (Purple Tops), *Cirsium vulgare* (Spear Thistle), *Gomphocarpus fruticosus* (Narrow-leaved Cotton Bush) and *Senecio pterophorus*.

1.4.4 Threatened Ecological Community Justification

PCT 835 is listed as ‘largely equivalent to’ the TEC RFEF in BioNet Vegetation Classification. It was determined that both zones of PCT 835 are consistent with this TEC based on the BioNet classification in addition to dominant flora species which fits the description of the TEC. These characteristic species are *Eucalyptus tereticornis* and *Angophora floribunda* in the canopy, *Bursaria spinosa*, *Casuarina glauca*

and *Acacia parramattensis* in the mid-storey and groundcovers including *Microlaena stipoides* and *Dichondra repens*.

PCT 1800 is listed as 'largely equivalent to' the TEC 'Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions' (SOFF) and 'wholly subset of' RFEF in BioNet Vegetation Classification. PCT 1800 within the development site has been classified as the TEC 835, given its location between patches of PCT 835 which is consistent with RFEF. These patches of PCT 1800 dominated by *Casuarina glauca* are likely the result of small scale disturbances or increased salinity. It must be noted that Zone 4 (PCT 1800 – Poor) has not been included as the TEC RFEF for this assessment. This zone is located on soil stockpiles and is characterised by scattered regrowth of Swamp Oak Floodplain Forest and some other native shrub and groundcover species, however, is dominated by exotic shrubs and groundcovers. This vegetation zone is the result of dumped soil containing some seedbank and was assigned a 'best fit PCT'.

PCT 1071 is listed as 'partially subset of' the TEC 'Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions'. This means that the PCT and TEC do overlap in some locations but can also occur independently of each other. While there are species consistent in the PCT consistent with the TEC (including *Typha orientalis* and *Persicaria decipiens*), the PCT 1071 in the development site is not considered to be consistent with the TEC Freshwater Wetlands on Coastal Floodplains. Within the development site, PCT 1071 is located in two artificial detention basins in the north of the development site, and in an artificial drainage ditch in the south of the development site. The NSW Scientific Determination for the EEC Freshwater Wetlands on Coastal Floodplains states that "*artificial wetlands created on previously dry land specifically for purposes such as sewerage treatment, stormwater management and farm production, are not regarded as part of this community, although they may provide habitat for threatened species.*" The PCT in the development site would fall into this category of artificial wetland, as the detention basins are expected to have been constructed for stormwater management and sediment capture. The drainage depression in the south of the development site is not associated with any natural drainage lines and is therefore considered to be an artificial wetland. While the larger wetland in the north-east of the development site is adjacent to River Flat Eucalypt Forest and near a natural drainage line, it is higher in the landscape than the drainage line and is not a part of the natural drainage system and is therefore considered artificial. Therefore, PCT 1071 within the development site is not consistent with the EEC Freshwater Wetlands on Coastal Floodplains.

1.4.5 Vegetation integrity assessment

A vegetation integrity assessment using the Credit Calculator (BAMC) was undertaken and the results are outlined in Table 8.

Table 8: Vegetation integrity

Veg Zone	PCT ID	Condition	Area (ha)	Composition Condition Score	Structure Condition Score	Function Condition Score	Current vegetation integrity score
1	835	Degraded	0.29	53.6	18.7	45	35.6
2	835	Regrowth	0.28	45.1	30.8	63.8	44.6

Veg Zone	PCT ID	Condition	Area (ha)	Composition Condition Score	Structure Condition Score	Function Condition Score	Current vegetation integrity score
3	1800	Degraded	0.06	21.6	17.6	58.4	28.1
4	1800	Poor	0.69	35.7	0.4	17.3	6.5
5	1071	Degraded	0.19	32.7	41.4	-	36.8

1.4.6 Vegetation Zone Descriptions

VEGETATION ZONE 1

PCT #	835
PCT Name	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
Condition	Degraded
TEC	River Flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregion (BC Act)
Area	0.29 ha
Plot Number	2
Vegetation Score	Integrity 35.6
Description Justification	/ This PCT is characterised by a native canopy of semi-mature trees with a sparse shrub layer and grassy ground layer. Dominant canopy species are <i>Eucalyptus tereticornis</i> , <i>Eucalyptus moluccana</i> and <i>Angophora floribunda</i> . Mid-storey species include <i>Acacia parramattensis</i> , <i>Casuarina glauca</i> and <i>Bursaria spinosa</i> subsp. <i>spinosa</i> . Ground stratum species included <i>Microlaena stipoides</i> and <i>Dichondra repens</i> .

PCT 835: Plot 2



VEGETATION ZONE 2

PCT # 835

PCT Name River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Condition Regrowth

TEC River Flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregion (BC Act)

Area 0.28 ha

Plot Number 4

Vegetation Integrity Score 44.6

Description / Justification This PCT is characterised by a native canopy of juvenile regrowth eucalypt species including *Eucalyptus tereticornis* and *Angophora floribunda*. The mid-storey is dense with native and exotic shrubs and trees. Native mid-storey species include *Grevillea juniperina* subsp. *juniperina*, *Acacia parramattensis*, *Acacia longifolia*, *Acacia floribunda*, *Casuarina glauca* and *Bursaria spinosa* subsp. *spinosa*. Ground stratum species included *Themeda australis* and *Microlaena stipoides*.

PCT 835: Plot 4



VEGETATION ZONE 3		
PCT #	1800	
PCT Name	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	
Condition	Degraded	
TEC	River Flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregion (BC Act)	
Area	0.06 ha	
Plot Number	1	
Vegetation Score	Integrity	44.6
Description Justification	/ This PCT is characterised by dense stands of <i>Casuarina glauca</i> in the canopy with a sparse mid-storey and ground layer. Native groundcover species included <i>Microlaena stipoides</i> and <i>Dichondra repens</i> .	

PCT 1800: Plot 1



VEGETATION ZONE 4		
PCT #	1800	
PCT Name	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	
Condition	Degraded	
TEC	Not consistent with TEC	
Area	0.69 ha	
Plot Number	5	
Vegetation Score	Integrity	6.5
Description Justification	/ This PCT is located in disturbed areas, generally where soil piles have been dumped. This zone is characterised by weeds and sparse native regrowth including <i>Casuarina glauca</i> , <i>Acacia parramattensis</i> , <i>Acacia longifolia</i> and <i>Lomandra longifolia</i> . The ground cover was dominated by <i>Cynodon dactylon</i> . Whilst this species can be native in some communities, within the development site and particularly this zone, it was evidently an exotic species resulting from dumped soil and disturbance. It has therefore been counted as an exotic species for the purpose of this assessment.	

PCT 1800: Plot 5



VEGETATION ZONE 5		
PCT #	1071	
PCT Name	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	
Condition	Moderate	
TEC	Not consistent with TEC	
Area	0.19	
Plot Number	3	
Vegetation Score	Integrity	36.8
Description Justification	/ This PCT is located around dams and waterlogged drainage lines. It is dominated by <i>Typha orientalis</i> . Other native species present include <i>Juncus acutus</i> , <i>Juncus usitatus</i> and <i>Persicaria decipiens</i>	

PCT 1071



CLEARED/EXOTIC		
PCT #	Cleared/Exotic vegetation – no consistent PCT	
PCT Name	Exotic vegetation – no consistent PCT	
Condition	Poor	
TEC	No	
Area	7.89 ha	
Plot Number	N/A	
Vegetation Score	Integrity	N/A
Description Justification	/ The majority of the development site comprises cleared areas and exotic vegetation. These areas are dominated by exotic grasses including <i>Eragrostis curvula</i> (African Love Grass), <i>Chloris gayana</i> (Rhodes Grass) and <i>Cynodon dactylon</i> (Couch). Other invasive species are common throughout cleared areas including <i>Verbena bonariensis</i> (Purple Tops), <i>Cirsium vulgare</i> (Spear Thistle), <i>Gomphocarpus fruticosus</i> (Narrow-leaved Cotton Bush) and <i>Senecio pterophorus</i> . While regrowth native species may occur very sporadically throughout this vegetation type such as <i>Acacia longifolia</i> (Sydney Golden Wattle) and <i>Acacia parramattensis</i> (Parramatta Wattle), the total native cover is estimated to be less than 5%. Where patches of native vegetation occurred sporadically throughout the north of the cleared area, these patches were attributed to PCT 1800 (degraded) as <i>Casuarina glauca</i> (Swamp Oak) was the dominant species. This Cleared/Exotic does not require further assessment in accordance with Section 10.4.1.1 of the BAM.	

Cleared/Exotic



1.4.7 Use of local data

Use of local data instead of benchmark integrity scores is not proposed.

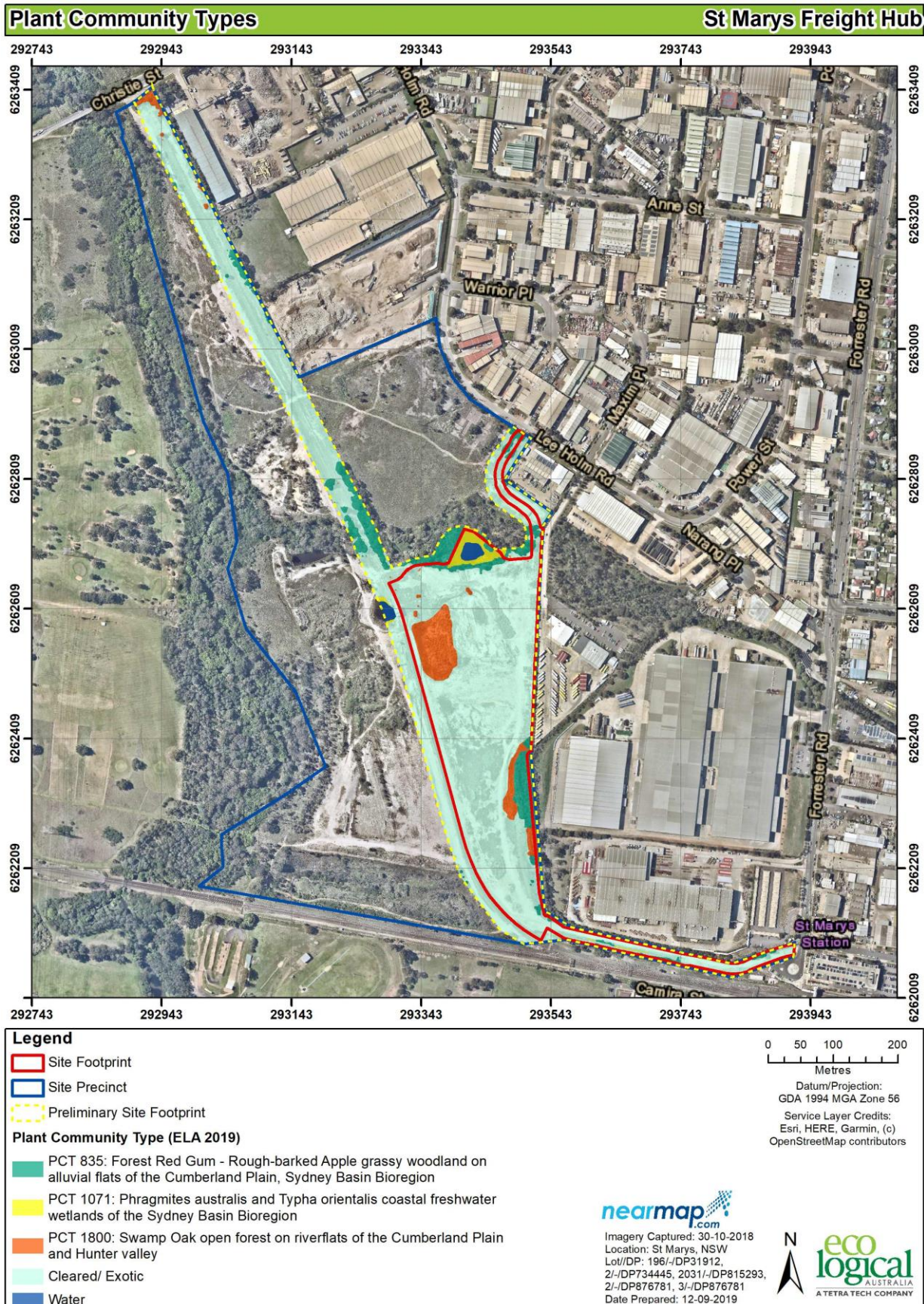


Figure 3: Plant Community Types

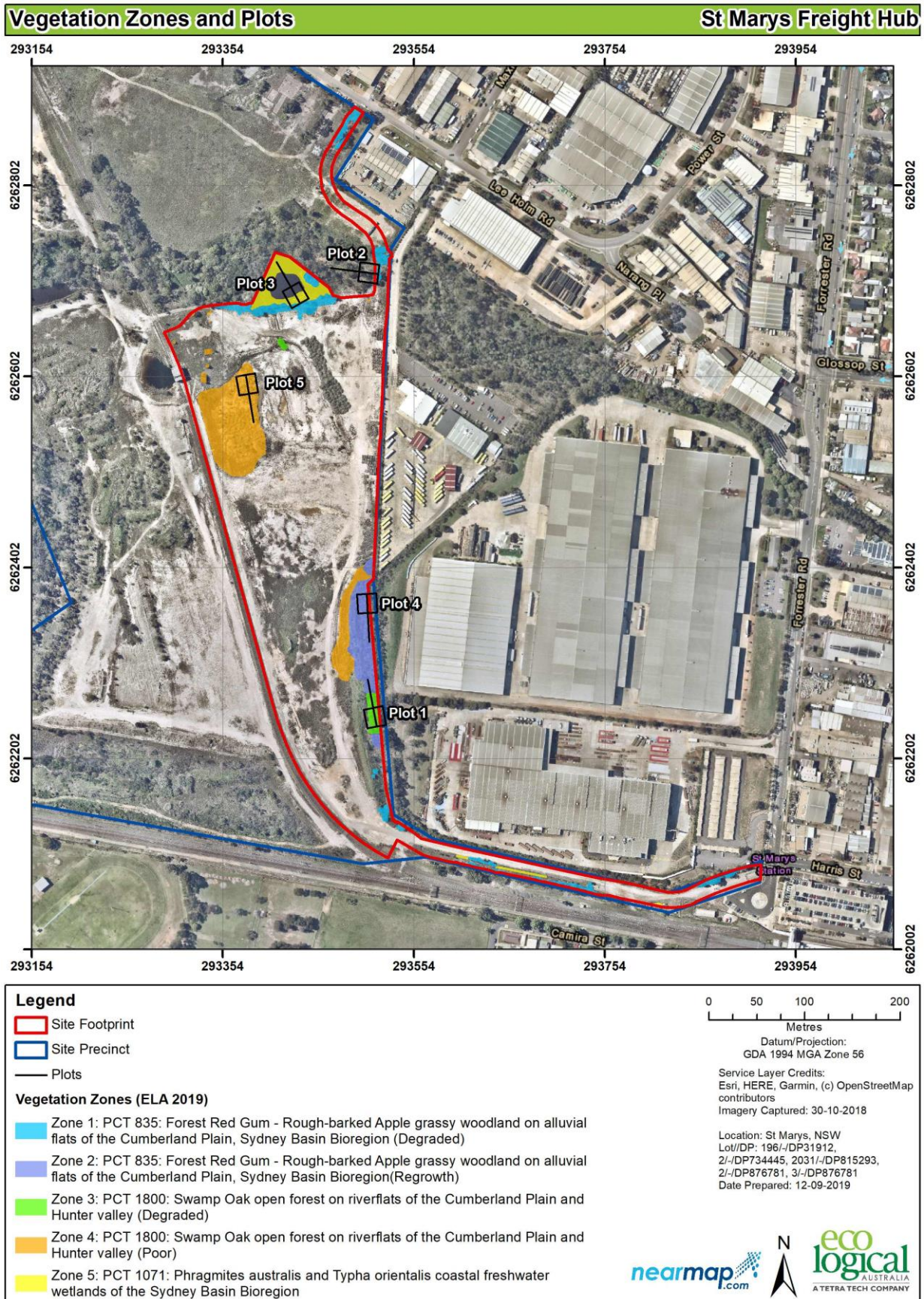


Figure 4: Plot locations

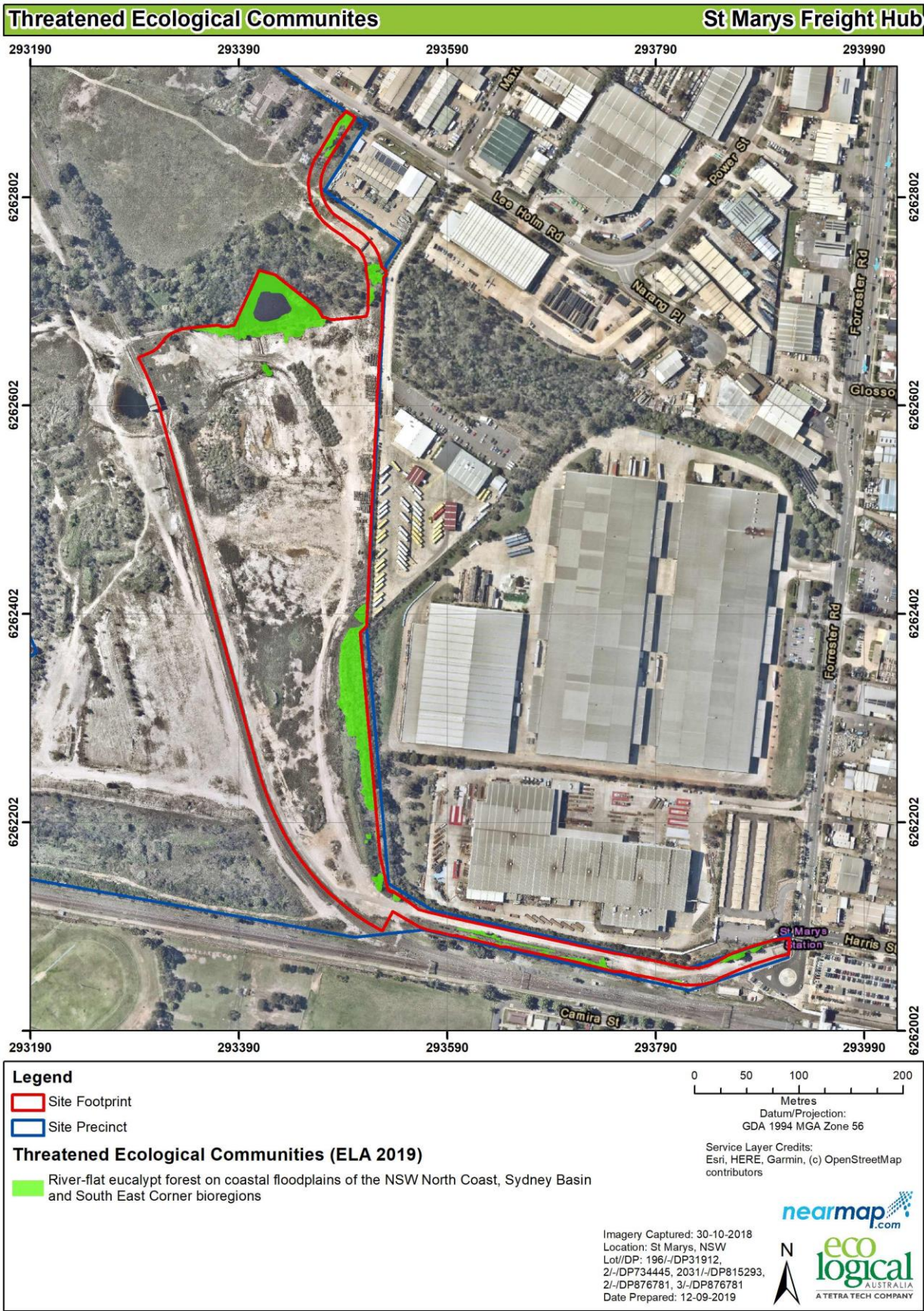


Figure 5: Threatened Ecological Communities

1.5 Ecosystem credit species

Ecosystem credit species predicted to occur at the development site, their associated habitat constraints, geographic limitations and sensitivity to gain class is included in Table 9.

Three ecosystem credit species were recorded during the Anabat survey: *Falsistrellus tasmaniensis* (Eastern False Pipistrelle), *Mormopterus norfolkensis* (Eastern Coastal Free-tailed Bat) and *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) (potential). These species are all microchiropteran bats recorded during the Anabat survey. The calls potentially attributed to *M. schreibersii oceanensis* overlap with several other species and therefore cannot confidently be attributed to the species. Detailed results of the Anabat survey are provided in Appendix C.

Table 9: Predicted ecosystem credit species

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status
<i>Anthochaera phrygia</i>	Regent Honeyeater			High	Critically Endangered	Critically Endangered
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow			Moderate	Vulnerable	Not Listed
<i>Botaurus poiciloptilus</i>	Australasian Bittern	- Waterbodies - Brackish or freshwater wetlands		Moderate	Endangered	Endangered
<i>Calidris ferruginea</i>	Curlew Sandpiper (Foraging)			High	Endangered	Critically Endangered
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo (Foraging)			Moderate	Vulnerable	Not Listed
<i>Chthonicola sagittata</i>	Speckled Warbler			High	Vulnerable	Not Listed
<i>Circus assimilis</i>	Spotted Harrier			Moderate	Vulnerable	Not Listed
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)			High	Vulnerable	Not Listed
<i>Daphoenositta chrysoptera</i>	Varied Sittella			Moderate	Vulnerable	Not Listed
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll			High	Vulnerable	Endangered
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	- Swamps - Shallow, open freshwater of saline wetlands or shallow edges		Moderate	Endangered	Not Listed

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status
		of deeper wetlands within 300m of these Moderate swamps - Shallow lakes, lake margins and estuaries within 300m of these waterbodies				
<i>Epthianura albifrons</i>	White-fronted Chat			Moderate	Vulnerable	Not Listed
<i>Glossopsitta pusilla</i>	Little Lorikeet			High	Vulnerable	Not Listed
<i>Grantiella picta</i>	Painted Honeyeater	- Mistletoes present at a density of greater than five mistletoes per hectare		Moderate	Vulnerable	Vulnerable
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle			High	Vulnerable	Not Listed
<i>Hieraaetus morphnoides</i>	Little Eagle (foraging)			Moderate	Vulnerable	Not Listed
<i>Irediparra gallinacea</i>	Comb-crested Jacana	- Waterbodies - Land within 40m of freshwater and estuarine wetlands, in areas of permanent and dense vegetation		Moderate	Vulnerable	Not Listed
<i>Ixobrychus flavicollis</i>	Black Bittern	- Waterbodies - Land within 40m of freshwater and estuarine wetlands, in areas of permanent water and dense vegetation			Vulnerable	Not Listed
<i>Lathamus discolor</i>	Swift Parrot			Moderate	Endangered	Critically Endangered
<i>Limicola falcinellus</i>	Broad-billed Sandpiper			Moderate	Vulnerable	Not Listed
<i>Limosa limosa</i>	Black-tailed Godwit			High	Vulnerable	Not Listed

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status
<i>Lophoictinia isura</i>	Square-tailed Kite (Foraging)			High	Vulnerable	Not Listed
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)			Moderate	Vulnerable	Not Listed
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)			Moderate	Vulnerable	Not Listed
<i>Miniopterus australis</i>	Little Bentwing-bat (Foraging)			High	Vulnerable	Not Listed
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat (Foraging)			High	Vulnerable	Not Listed
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat			High	Vulnerable	Not Listed
<i>Neophema pulchella</i>	Turquoise Parrot			High	Vulnerable	Not Listed
<i>Ninox connivens</i>	Barking Owl (Foraging)			High	Vulnerable	Not Listed
<i>Ninox strenua</i>	Powerful Owl (Foraging)			High	Vulnerable	Not Listed
<i>Pandion cristatus</i>	Eastern Osprey			Moderate	Vulnerable	Not Listed
<i>Petroica boodang</i>	Scarlet Robin			Moderate	Vulnerable	Not Listed
<i>Petroica phoenicea</i>	Flame Robin			Moderate	Vulnerable	Not Listed
<i>Phascolarctos cinereus</i>	Koala			High	Vulnerable	Vulnerable
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox			High	Vulnerable	Vulnerable
<i>Rostratula australis</i>	Australian Pained Snipe			Moderate	Endangered	Endangered
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat			High	Vulnerable	Not Listed
<i>Stagonopleura guttata</i>	Diamond Firetail			Moderate	Vulnerable	Not Listed
<i>Stictonetta naevosa</i>	Freckled Duck			Moderate	Vulnerable	Not Listed
<i>Tyto novaehollandiae</i>	Masked Owl (Foraging)			High	Vulnerable	Not Listed

1.6 Species credit species

Species credit species predicted to occur at the development site (i.e. candidate species), their associated habitat constraints, geographic limitations and sensitivity to gain class is included in Table 10.

Two species credit species were recorded within the development site. *Grevillea juniperina* subsp. *juniperina* (Juniper-leaved Grevillea) was recorded during the flora survey. *Myotis macropus* (Southern Myotis) was recorded during the Anabat survey. Potential calls of *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) were also recorded during the Anabat survey. *M. schreibersii oceanensis* is an ecosystem credit species and species credit species when impacting on breeding habitat. *M. schreibersii oceanensis* is known only to breed in a small number of locations in maternity caves which are not present in the development site. Therefore, *M. schreibersii oceanensis*, while potentially present, is excluded as a species credit species.

Table 10: Candidate species credit species

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status	Justification for species to be included or excluded
<i>Anthochaera phrygia</i>	Regent Honeyeater	- OEH mapped areas		High	CE	CE	<u>Excluded</u> The development site does not contain mapped important areas.
<i>Burhinus grallarius</i>	Bush Stone-curlew	Fallen/standing dead timber including logs		High	E	Not Listed	<u>Excluded</u> Habitat within the development site is substantially degraded such that the species is unlikely to utilise the subject land in accordance with Section 6.4.1.17 of the BAM.
<i>Calidris ferruginea</i>	Curlew Sandpiper (Breeding)	- OEH mapped areas		High	E	CE	<u>Excluded</u> Species credit species for Curlew Sandpiper are based on OEH mapped important areas. The development site does not contain mapped important areas.
<i>Callistemon linearifolius</i>	Netted Bottlebrush			High	V	Not Listed	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	- Eucalypt tree species with hollows >9 cm diameter		High	V	Not Listed	<u>Excluded</u> No breeding habitat (Eucalypt tree species with hollows >9cm diameter) is present within the development footprint
<i>Cercartetus nanus</i>	Eastern Possum	Pygmy		High	V	Not Listed	<u>Excluded</u> Habitat within the development site is substantially degraded such that the species is unlikely to utilise the subject land in accordance with Section 6.4.1.17 of the BAM. Suitable habitat (well-developed mid-storeys containing

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status	Justification for species to be included or excluded
							nectar-producing shrubs such as Banksia spp.) is not present.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	- Cliffs - Within 2km of rocky areas containing caves, overhangs, escarpments, outcrops or crevices, or within 2km of old mines or tunnels		Very High	V	V	<u>Excluded</u> No suitable cliffs, mines or tunnels are known to be within 2km of the development site.
<i>Commersonia prostrata</i>	Dwarf Kerrawang			High	E	E	<u>Excluded</u> The development site does not contain typical soils (sandy, peaty soil) or vegetation associated with this species. No records within 5km of the development site.
<i>Cynanchum elegans</i>	White-flowered Wax Plant			High	E	E	<u>Excluded</u> Associated habitat in the region (Dry Rainforest) not present within or adjacent to the development site. No records within 5km of the development site.
<i>Deyeuxia appressa</i>	Deyeuxia appressa			N/A	E	E	<u>Included</u> Due to lack of information this species was included in the assessment. No records within 5 km of the development site. No individuals were recorded.
<i>Eucalyptus benthamii</i>	Camden White Gum			High	V	V	<u>Excluded</u> Conspicuous species not recorded during field surveys.

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status	Justification for species to be included or excluded
<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea			High	V	Not Listed	<u>Included</u> This species was included in the targeted survey as it was recorded during vegetation surveys.
<i>Gyrostemon thesioides</i>	Gyrostemon thesioides			High	E	Not Listed	<u>Excluded</u> Suitable habitat (hillsides and riverbanks) not present within development site. No records within 5 km of the development site.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle (Breeding)	- Living or mature dead trees within 1 km of rivers, lakes, large dams or creeks, wetlands and coastlines AND the presence of a large stick nest in the canopy		High	V	Not Listed	<u>Excluded</u> No breeding habitat (large stick nests) present in the development site.
<i>Haloragis exalata</i> subsp. <i>exalata</i>	Square Raspwort	- Edges of coastal lakes after flooding has removed other vegetation, creek banks within flood zone, areas close to these features subject to human disturbance including road verges and powerline easements or within 100m		Moderate	V	V	<u>Excluded</u> There are no known populations of this species in Sydney.
<i>Hibbertia Bankstown</i> sp.				N/A	CE	CE	<u>Excluded</u> Species known from only one population at Bankstown. Associated vegetation type (Castlereagh Ironbark Forest/ Castlereagh

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status	Justification for species to be included or excluded
							Scribbly Gum Woodland) not present within development site. No records within 5 km of the development site.
<i>Hieraetus morphnoides</i>	Little Eagle (Breeding)	- Nest trees – live (occasionally dead) large old trees within vegetation		Moderate	V	Not Listed	<u>Excluded</u> No large nests present within development site.
<i>Lathamus discolor</i>	Swift Parrot (Breeding)	- As per OEH mapped areas		Moderate	E	CE	<u>Excluded</u> Not within OEH mapped area.
<i>Limicola falcinellus</i>	Broad-billed Sandpiper (Breeding)	- As per OEH mapped areas		High	V	Not Listed	<u>Excluded</u> Not within OEH mapped area.
<i>Limosa</i>	Black-tailed Godwit (Breeding)	- As per OEH mapped areas		High	V	Not Listed	<u>Excluded</u> Not within OEH mapped area.
<i>Litoria aurea</i>	Green and Golden Bell Frog	- Within 1km of wet areas - Within 1km of swamp - Within 1km of waterbody		High	E	V	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.
<i>Lophoictinia isura</i>	Square-tailed Kite (Breeding)	- Nest trees		Moderate	V	Not Listed	<u>Excluded</u> No large nests present within development site.
<i>Marsdenia viridiflora</i> subsp. <i>viridiflora</i> – <i>endangered population</i>	<i>Marsdenia viridiflora</i> R. Br. subsp. <i>viridiflora</i> population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith		Those LGAs named in the population's listing	High	E2	Not Listed	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status	Justification for species to be included or excluded
	local government areas						
<i>Maundia triglochinos</i>		- Swamps or shallow fresh water on clay		High	V	Not Listed	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	- Swamps - Swamp margins or creek edges		High	V	V	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.
<i>Meridolum corneovirens</i>	Cumberland Plain Land Snail			High	E	Not Listed	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.
<i>Miniopterus australis</i>	Little Bentwing-bat (Breeding)	Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding		Very High	V	Not Listed	<u>Excluded</u> Species known only to breed in maternity caves. No breeding habitat present in the development site.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat (Breeding)	Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding		Very High	V	Not Listed	<u>Excluded</u> Species known only to breed in maternity caves. No breeding habitat present in the development site.
<i>Myotis macropus</i>	Southern Myotis	- Hollow-bearing trees - Within 200m of a riparian zone - Bridges, caves or artificial structures within 200m of riparian zone		High	V	Not Listed	<u>Included</u> This species was recorded during the targeted survey.

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status	Justification for species to be included or excluded
<i>Ninox connivens</i>	Barking (Breeding)	Owl	Living or dead trees with hollows >20cm diameter and >4m above the ground	High	V	Not Listed	<u>Excluded</u> No breeding habitat (living or dead trees with hollows >20cm diameter and >4m above the ground) present in development site.
<i>Ninox strenua</i>	Powerful (Breeding)	Owl	Living or dead trees with hollows >20cm	High	V	Not Listed	<u>Excluded</u> No breeding habitat (living or dead trees with hollows >20cm diameter) present in development site.
<i>Pandion cristatus</i>	Eastern (Breeding)	Osprey	Living and dead trees (>15m) or artificial structures within 100m of a floodplain	Moderate	V	Not Listed	<u>Excluded</u> No large nests present in development site. No records within 5km of development site.
<i>Persicaria elatior</i>	Tall Knotweed	- Semi-permanent/ephemeral wet areas or within 50m - Swamps or within 50m - Waterbodies including wetlands, or within 50m		Moderate	V	V	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.
<i>Persoonia hirsuta</i>	Hairy Geebung			High	E	E	<u>Excluded</u> No habitat is present in the development site for this species which occurs in woodland or heath on sandstone.
<i>Petaurus norfolcensis</i>	Squirrel Glider			High	V	Not Listed	<u>Excluded</u> Habitat within the development site is substantially degraded such that the species is unlikely to utilise the subject land in accordance with Section 6.4.1.17 of the BAM. No hollow-bearing trees are present within the

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status	Justification for species to be included or excluded
							development site which are an important habitat component of Squirrel Gliders.
<i>Phascolarctos cinereus</i>	Koala (Breeding)	- Areas identified as important habitat via survey		High	V	V	<u>Excluded</u> Habitat within the development site is substantially degraded such that the species is unlikely to utilise the subject land in accordance with Section 6.4.1.17 of the BAM. Potential foraging trees (<i>Eucalyptus tereticornis</i>) occur in low abundance.
<i>Pilularia novae-hollandiae</i>	Austral Pillwort			High	E	Not Listed	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.
<i>Pomaderris brunnea</i>	Brown Pomaderris			High	E	V	<u>Included</u> This species was included in the targeted survey. No individuals were recorded.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox (Breeding)	- Breeding camps		High	V	V	<u>Excluded</u> No camps present in development site.
<i>Tyto novaehollandiae</i>	Masked Owl (Breeding)	Living or dead trees within hollows >20cm diameter		High	V	Not Listed	<u>Excluded</u> No breeding habitat (living or dead trees with hollows >20cm diameter) present in development site.
<i>Wahlenbergia multicaulis endangered population</i>	Tadgell's Bluebell in the local government areas of Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby,	- Land situated in damp, disturbed sites		High	E2	Not Listed	<u>Excluded</u> Development site not within LGA's of endangered population.

Species	Common Name	Habitat Constraints	Geographic limitations	Sensitivity to gain class	NSW listing status	EPBC Listing status	Justification for species to be included or excluded
	Parramatta and Strathfield						
<i>Zannichellia palustris</i>		- Waterbodies - Land containing freshwater bodies		High	E	Not Listed	<u>Excluded</u> This species was not included in the targeted survey. Only two known populations in NSW in the lower Hunter and Sydney Olympic Park. No local records.

1.6.1 Targeted surveys

Targeted surveys for species credit species were undertaken at the development site on the dates outlined in Table 11. The location of targeted surveys are shown in Figure 6, with the results of the surveys shown as individual species polygons on Figure 7. Survey effort undertaken at the development is outlined in Table 12.

Targeted surveys for threatened flora were undertaken in accordance with NSW Guide to Surveying Threatened Plants (OEH 2016).

Targeted surveys for Southern Myotis were undertaken with “Species credit’ threatened bats and their habitats’ (OEH 2018), which requires 16 acoustic detection nights (Anabat nights) over a minimum of 4 nights. This was achieved with 4 detectors set over 4 nights. The species polygon for Southern Myotis was determined in accordance with the bat survey guidelines and BioNet Threatened Biodiversity information, which describes the species polygon as including all PCTs within 200m of foraging habitat. In relation to the development site, a 200m buffer was mapped around riparian areas.

Targeted surveys for Green and Golden Bell Frog was undertaken in accordance with the EPBC guidelines, which requires a minimum of 4 survey nights.

Table 11: Targeted surveys and weather conditions

Date	Surveyors	Target species	Rainfall (mm)	Min temp (°C)	Max temp (°C)
3 December 2018	Danielle Adams-Bennett and Griffin Taylor-Dalton	<i>Litoria aurea</i>	0	14.4	31.4
4 December 2018	Danielle Adams-Bennett and Griffin Taylor-Dalton	<i>Litoria aurea</i>	0	14.7	27.6
5 December 2018	Kirsten Velthuis and Griffin Taylor-Dalton	<i>Litoria aurea</i>	1.0	15.9	20.8
6 December 2018	Kirsten Velthuis, Griffin Taylor-Dalton and Mike Lawrie	<i>Litoria aurea</i> Opportunistic fauna survey	0.2	13.6	30.4
29 January 2019	Kirsten Velthuis and Griffin Taylor-Dalton	Threatened flora	0.2	20.9	34.7
30 January 2019	Kirsten Velthuis and Griffin Taylor-Dalton	<i>Meridolum corneovirens</i>	0	21.4	34.8
11 February 2019	Mike Lawrie / Anabat	<i>Myotis macropus</i>	0	14.7	35.0
12 February 2019	Anabat	<i>Myotis macropus</i>	0	14.4	38.3
13 February 2019	Anabat	<i>Myotis macropus</i>	0	19.5	30.2

Date	Surveyors	Target species	Rainfall (mm)	Min temp (°C)	Max temp (°C)
14 February 2019	Anabat	<i>Myotis macropus</i>	0	17.7	28.9

Table 12: Survey effort

Candidate species	Survey method	Total effort within development site	BAM survey period	Species present
<i>Litoria aurea</i>	Habitat search, call playback	4 nights x 2 ecologists	November - March	No
<i>Meridolum corneovirens</i>	Targeted search	2 days x 2 ecologists	All year	No
<i>Myotis macropus</i>	Acoustic detection Roost search	16 nights (4 nights x 4 Anabats) 1 hour (30 minutes x 2 culverts)	October - March	Yes
<i>Callistemon linearifolius</i>	Parallel transect	2 days x 2 ecologists	September - March	No
<i>Deyeuxia appressa</i>	Parallel transect	2 days x 2 ecologists	Not Listed	No
<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Parallel transect	2 days x 2 ecologists	All year	Yes
<i>Haloragis exalata</i> subsp. <i>exalata</i>	Parallel transect	2 days x 2 ecologists	All year	No
<i>Maundia triglochinosoides</i>	Parallel transect	2 days x 2 ecologists	November - March	No
<i>Persicaria elatior</i>	Parallel transect	2 days x 2 ecologists	December - May	No
<i>Pilularia novae-hollandiae</i>	Parallel transect	2 days x 2 ecologists	October - December	No

Following completion of targeted surveys, the species credit species included in the assessment are outlined in Table 13.

Table 13: Species credit species included in the assessment

Species	Common Name	Species presence	Geographic limitations	Habitat (ha)	Biodiversity Risk Weighting
<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea	Yes (surveyed)	None	0.63 ha	2.00
<i>Myotis macropus</i>	Southern Myotis	Yes (surveyed)	None	0.94 ha	2.00

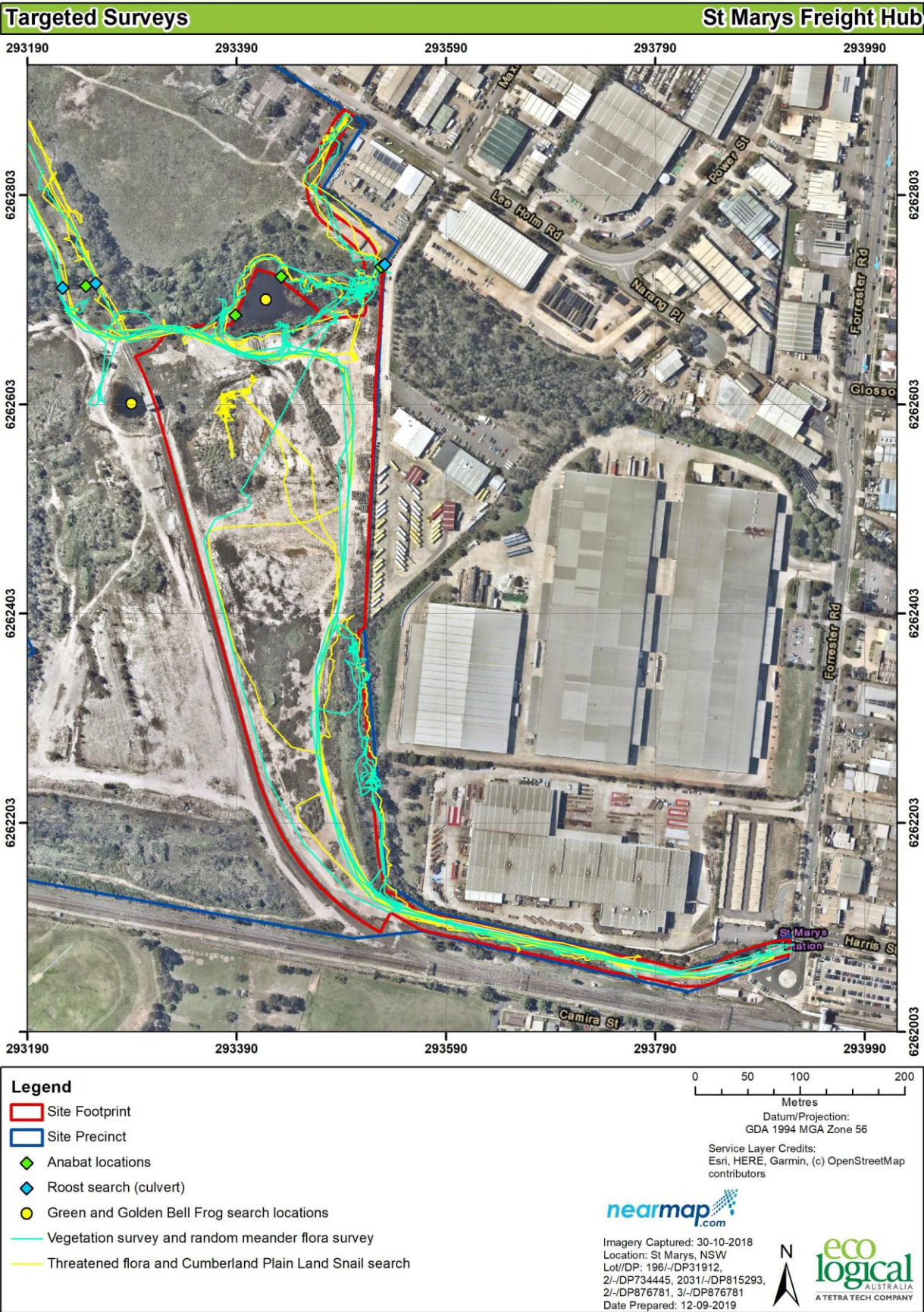


Figure 6: Targeted threatened species surveys

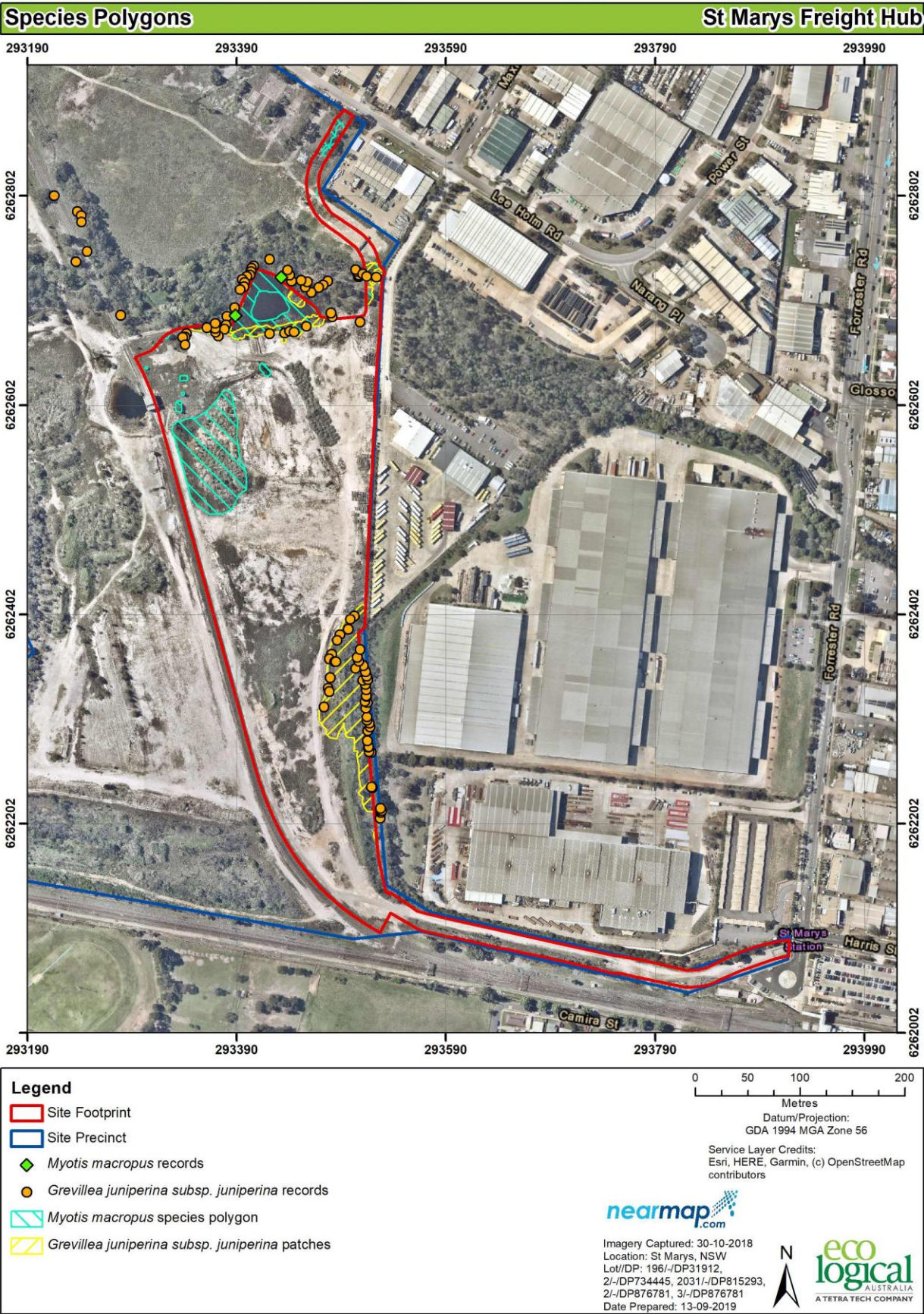


Figure 7: Species credit polygons

1.6.2 Use of local data

Use of local data is not proposed for this assessment.

1.6.3 Expert reports

Expert reports have not been used for this assessment.

2. Stage 2: Impact assessment (biodiversity values)

2.1 Avoiding impacts

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

The development has been located in a way which avoids and minimises impacts as outlined in Table 14.

Table 14: Locating a project to avoid and minimise impacts on vegetation and habitat

Approach	How addressed	Justification
locating the project in areas where there are no biodiversity values	The project has been located predominantly in areas where there are no biodiversity values.	The project has been located predominantly in exotic grasslands and disturbed areas which do not contain biodiversity values. The project area has been reduced in size, resulting in a reduced impact on native vegetation from approximately 2.94 ha to 1.51 ha.
locating the project in areas where the native vegetation or threatened species habitat is in the poorest condition	The project is primarily located in areas where native vegetation is in poor condition.	The project is located predominantly in exotic grassland which does not contain native vegetation. The project has been relocated to minimise impacts to vegetation zones with higher vegetation integrity scores or higher habitat value for threatened species such as <i>Grevillea juniperina</i> .
locating the project in areas that avoid habitat for species and vegetation in high threat categories (e.g. an EEC or CEEC), indicated by the biodiversity risk weighting for a species	The project is predominantly located in exotic grassland and has avoided impacts to vegetation in high threat categories where possible. Impacts to vegetation and species in high threat categories has been reduced.	The project is predominantly located in exotic grassland to avoid impacts to vegetation in high threat categories. Impacts to the EEC River Flat Eucalypt Forest has been reduced through revision of the development footprint size and location. Impacts to Southern Myotis and <i>Grevillea juniperina</i> subsp. <i>juniperina</i> (both species have high biodiversity risk weighting of 2.0) have been reduced where possible through revision of the building footprint. It is noted that the updated footprint following the report exhibition encompasses the detention basin in the north of the development site which has resulted in an increased impact to PCT 1071 and associated foraging habitat for Southern Myotis. This has resulted in a greater offset requirement for Southern Myotis, however the basin will continue to operate as a dam and therefore this

Approach	How addressed	Justification
		area of foraging habitat will not be removed. It is also noted that direct impacts to <i>Grevillea juniperina</i> habitat post exhibition has been reduced from 0.71 ha to 0.63 ha.
locating the project such that connectivity enabling movement of species and genetic material between areas of adjacent or nearby habitat is maintained	Connectivity enabling movement of species and genetic material between areas of nearby habitat will be maintained.	Connectivity between areas of habitat will be maintained. The development site provides a marginal corridor from a small patch of vegetation along the riparian corridor to the east, to the large area of riparian vegetation to the west. This riparian corridor is well connected to several larger patches of habitat to the north. The project will result in the widening of gap between land to the east and the development site. However, these patches are already separated by an existing road and genetic material will still be able to be transferred across the gap and along the stream. This connection is unlikely to be used by fauna except for mobile species which would not be impeded by the existing fencing. The development will not sever the connectivity of these mobile species.

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

The development has been designed in a way which avoids and minimises impacts as outlined in Table 15.

Table 15: Designing a project to avoid and minimise impacts on vegetation and habitat

Approach	How addressed	Justification
reducing the clearing footprint of the project	The clearing footprint has been reduced.	Redesign of the project footprint has resulted in significant reduction in the amount of clearing required. The redesign from the initial development footprint has resulted in the following clearing reductions: • Zone 1 PCT 835 – Degraded: 1.12 ha to 0.29 ha • Zone 2 PCT 835 – Regrowth: 0.71 ha to 0.28 ha • Zone 3 PCT 1800 – Degraded: 0.19 ha to 0.06 ha • Zone 4 PCT 1800 – Poor: No change

Approach	How addressed	Justification
		Zone 5 PCT 1071 – Moderate: 0.23 ha to 0.19 ha
locating ancillary facilities in areas where there are no biodiversity values	Ancillary facilities will be located where there are no biodiversity values.	Ancillary features for the purposes of construction will be located within the operational footprint, avoiding additional impacts to areas containing biodiversity values.
locating ancillary facilities in areas where the native vegetation or threatened species habitat is in the poorest condition (i.e. areas that have a lower vegetation integrity score)	Ancillary facilities will be located within the operational footprint and will not result in removal of additional vegetation or threatened species habitat.	Ancillary features for the purposes of construction will be located within the operational footprint, avoiding additional impacts to areas of native vegetation or threatened species habitat.
locating ancillary facilities in areas that avoid habitat for species and vegetation in high threat status categories (e.g. an EEC or CEEC)	Ancillary facilities will be located within the operational footprint and will not result in removal of threatened species habitat or vegetation in high threat categories.	Ancillary features for the purposes of construction will be located within the operational footprint, avoiding additional impacts threatened species habitat or vegetation in high threat categories.
providing structures to enable species and genetic material to move across barriers or hostile gaps	The development will not include structures to enable species and genetic material to move across barriers or hostile gaps.	It is considered unnecessary to provide structures to allow movement of species and genetic material across gaps. A small gap exists between vegetation in the development site and vegetation to the east of the development site due to an existing road. This gap will be widened, however, genetic material and mobile species such as birds and bats will still be able to cross this gap. The existing culvert also provides a potential crossing point under the road for some species. This culvert will be extended with the construction of an additional road and this connectivity will be maintained.
making provision for the demarcation, ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat on the development site.	Recommendations pertaining to the demarcation and maintenance of retained native vegetation have been provided.	The boundaries of the development footprint are to be clearly demarcated prior to commencement of construction to protect retained native vegetation. It is recommended that a Vegetation Management Plan (VMP) be prepared and implemented within the riparian corridor directly to the north of the development site to enhance retained native vegetation which has been degraded by weed infestation.

Approach	How addressed	Justification
Efforts to avoid and minimise impacts through design must be documented and justified	Efforts to avoid and minimise impacts have been documented and justified.	Efforts to avoid and minimise impacts have been provided below in Figure 9, showing the original development footprint and updated footprint following advice from ELA to modify the development footprint. It is acknowledged that the proposed development will result in a residual impact on native vegetation, threatened ecological communities and threatened species habitat. The residual impacts are considered unavoidable in the scope of the proposed development. The footprint has largely utilised cleared areas and patches of degraded vegetation or regrowth. Where possible, areas of native vegetation and threatened species habitat have been avoided. The following outcomes have been considered in justification of residual biodiversity impacts: • Habitat connectivity will be maintained with the retained with the majority of the vegetated corridor in the north of the site to be retain • Where achievable within the scope of the development, impacts to vegetation and <i>Grevillea juniperina</i> have been avoided • The footprint has been refined to minimise biodiversity impacts. • Designing surface water treatment to minimise downstream impacts • Impacts on native vegetation and threatened species will be offset in accordance with the Biodiversity Offsets Scheme (BOS).

2.1.3 Prescribed biodiversity impacts

The development site has the prescribed biodiversity impacts as outlined in Table 16.

Table 16: Prescribed biodiversity impacts

Prescribed biodiversity impact	Description in relation to the development site	Threatened species or ecological communities effected
impacts of development on the habitat of threatened species or ecological communities associated with human made structures	The development will result in impacts to man-made structures which consists of a culvert at the eastern edge of the development site.	Potential roosting habitat for Southern Myotis, Little Bentwing-bat, Eastern Bentwing-bat and Yellow-bellied Sheathtail-bat.
impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range	The development will increase the distance between to areas of vegetation from 10m to approximately 35 m.	River Flat Eucalypt Forest.
impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities	Construction of culvert over waterbody. Impacts on dams.	Southern Myotis

2.1.3.1 Locating a project to avoid and minimise prescribed biodiversity impacts

The development has been located in a way which avoids and minimises prescribed biodiversity impacts as outlined in Table 17.

Table 17: Locating a project to avoid and minimise prescribed biodiversity impacts

Approach	How addressed	Justification
locating the envelope of surface works to avoid direct impacts on the habitat features	The proposed development has been revised to avoid impacts on man-made habitat features where possible.	The proposed development footprint has been realigned to minimise impacts on man-made habitat features including culverts. The original footprint included works to an existing train line over the top of a culvert in the east of the site which would have indirect impacts on microchiropteran bat species which have potential roosting habitat in the culvert (note that Southern Myotis was not recorded adjacent to any culverts). A new road will be constructed adjacent to the culvert to the east of the development site which could have indirect noise, light and vibration impacts on potentially roosting Southern Myotis. Southern Myotis was not recorded in the eastern culvert despite targeted searches and only limited habitat is available. The culvert will be retained and an additional culvert will be constructed under the new proposed road providing additional roosting habitat.

Approach	How addressed	Justification
locating the project to avoid severing or interfering with corridors connecting different areas of habitat, migratory flight paths to important habitat or preferred local movement pathways	The project has been located to minimise impacting connectivity of habitat.	The proposed development will have only minor impacts to connectivity of habitat. The gap between vegetation in the east of the site and that offsite will be increased from 10 m to approximately 35 m. This is unlikely to prevent the spread of genetic material or impact the movement of mobile species such as birds and bats across the habitat. This area of connectivity is degraded and considering the fenced road currently between the patches, it is likely that only mobile species would currently rely on this connectivity. The existing culvert which may provide a pathway of movement for some species will be retained and extended allowing continued movement under the road.
locating the project to avoid direct impacts on water bodies	The project has been realigned to minimise impacts on waterbodies.	The development footprint has been revised to avoid impacts to one dam in the west which provide foraging habitat for Southern Myotis. It is noted that the updated footprint following the report exhibition encompasses the detention basin in the north of the development site which has resulted in an increased impact to PCT 1071 and foraging habitat for Southern Myotis within the dam. This has resulted in a greater offset requirement for Southern Myotis, however the dam will operate as a bio-retention basin and therefore this area of foraging habitat may still be utilised for foraging habitat. The development will result in the following impacts to foraging habitat for Southern Myotis which is associated with waterbodies: • 25 m section of creekline • 0.08 ha of open water within dams • 0.19 ha of PCT 1071

2.1.3.2 Designing a project to avoid and minimise prescribed biodiversity impacts

The development has been designed in a way which avoids and minimises prescribed biodiversity impacts as outlined in Table 18.

Table 18: Designing a project to avoid and minimise prescribed biodiversity impacts

Approach	How addressed	Justification
design of project elements to minimise interactions with threatened and protected species and ecological communities, e.g. designing turbines to dissuade perching and minimise the diameter of the rotor swept area, designing fencing to prevent animal entry to transport corridors	Design controls should be implemented during construction to prevent impacts on any microbats within the culvert to be impacted.	Controls should be implemented during construction to prevent impacts on any microbats within the culvert to be impacted, if microbats are recorded during pre-clearance surveys.
design of the project to maintain environmental processes critical to the formation and persistence of habitat features not associated with native vegetation	The project will minimise impacts on microbat habitat not associated with native vegetation (i.e. culverts and dams).	The project has been redesigned resulting in avoiding impacting on one additional culvert and minimising impacts on waterbodies. Impacts to microbats associated with direct and indirect impacts to the culvert will be minimised through mitigation measures including pre-clearance surveys and control measures for potentially roosting bats (if found during pre-clearance surveys).
design of the project to avoid and minimise downstream impacts on rivers, wetlands and estuaries by control of the quality of water released from the site.	The proposed development will implement measures to avoid downstream impacts to waterbodies.	Appropriate sediment and stormwater control measures are to be implemented during construction and operation to prevent sedimentation and contamination of downstream waterbodies. The dam in the north of the development site will be utilised as a bio-retention basin. The vegetation and habitat within the basin may be degraded as a result, however, these impacts will be offset using ecosystem credits for PCT 1071 and species credits for Southern Myotis.

2.2 Assessment of Impacts

2.2.1 Direct impacts

The direct impacts of the development on:

- native vegetation are outlined in Table 19
- threatened ecological communities are outlined in Table 20
- threatened species and threatened species habitat is outlined in Table 21
- prescribed biodiversity impacts is outlined in Section 2.2.2

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

Table 19: Direct impacts to native vegetation

PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Direct impact (ha)
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Coastal Floodplain Wetlands	Forested Wetlands	0.57
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Coastal Floodplain Wetlands	Forested Wetlands	0.75
1071	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Freshwater Wetlands	Coastal Freshwater Wetlands	0.19

Table 20: Direct impacts on threatened ecological communities

PCT ID	BC Act			EPBC Act		
	Listing status	Name	Direct impact (ha)	Listing status	Name	Direct impact (ha)
835, 1800 (excluding Zone 4)	EEC	River-Flat Eucalypt Forest of Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.62	Not Listed	N/A	N/A

Table 21: Direct impacts on threatened species and threatened species habitat

Species	Common Name	Direct impact on habitat (ha)	NSW listing status	EPBC Listing status
<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea	0.63	Vulnerable	Not Listed
<i>Myotis macropus</i>	Southern Myotis	0.94	Vulnerable	Not Listed

2.2.2 Change in vegetation integrity

The change in vegetation integrity as a result of the development is outlined in Table 22.

Table 22: Change in vegetation integrity

Veg Zone	PCT ID	Condition	Area (ha)	Current vegetation integrity score	Future vegetation integrity score	Change in vegetation integrity
1	835	Degraded	0.29	35.6	0	-35.6
2	835	Regrowth	0.28	44.6	0	-44.6
3	1800	Degraded	0.06	28.1	0	-28.1
4	1800	Poor	0.69	6.5	0	-6.5
5	1071	Moderate	0.19	36.8	0	-36.8

2.2.3 Indirect impacts

The indirect impacts of the development are outlined in Table 23.

Table 23: Indirect impacts

Indirect impact	Project phase	Nature	Extent	Frequency	Duration	Timing
sedimentation and contaminated and/or nutrient rich run-off	Construction	Runoff during construction and operation	Potential sedimentation and contaminated runoff into adjacent creek and dams	During heavy rainfall or storm events	Throughout construction and operation period	Potentially long-term impacts
noise, dust or light spill	Construction	Noise and dust from machinery. Light spill during operational phase	Adjacent vegetation and culverts	Daily, during construction works and operational phases	Throughout construction and operation period	Potentially long-term impacts
inadvertent impacts on adjacent habitat or vegetation	Construction	Damage to adjacent habitat or vegetation	Adjacent vegetation and culverts	Daily, during construction works and operational phases	Throughout construction and operation period	Potentially long-term impacts
transport of weeds and pathogens from the site to adjacent vegetation	Construction	Spread of weed seed and pathogens from incoming machinery and equipment	Potential spread into nearby habitat	Daily, during construction and operational phases	Throughout construction and operation period	Potentially long-term impacts
vehicle strike	Construction / operation	Potential for native fauna to be struck by working machinery and moving vehicles	Within development site and adjacent	Daily, during construction and operational phases	Throughout construction and operation period	Potentially long-term impacts

Indirect impact	Project phase	Nature	Extent	Frequency	Duration	Timing
trampling of threatened flora species	Construction / operation	Potential impacts to <i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Within and adjacent to development site	Daily, during construction and operational phases	Throughout construction and operation period	Potentially long-term impacts
rubbish dumping	Construction / operation	Illegal dumping by workers	Potential for rubbish to spread into adjacent vegetation and outside development site	Daily, during construction and operational phases	Throughout life of project	Potentially long-term impacts
wood collection	Construction / operation	Removal of wood in vegetation adjacent to development site	Throughout adjacent vegetation	Potential to occur at any time during construction or operational phases	Throughout life of project	Short-term impacts
bush rock removal and disturbance	Construction / operation	Removal of rocks in vegetation adjacent to development site	Potential for disturbance in adjacent vegetation and area surrounding the development site	Potential to occur at any time during construction or operational phases	Throughout life of project	Short-term impacts
increase in predatory species populations	Construction / operation	Potential for an increase in predatory species in the locality through disturbance to vegetation	Throughout adjacent vegetation	Potential to occur gradually after disturbance to habitat and vegetation takes place	During construction phase of project	Potentially long-term impacts
increase in pest animal populations	Construction / operation	Potential to increase if food scraps/rubbish is left on site. Potential to increase +/- decrease due to disturbance to existing vegetation.	Throughout adjacent vegetation	Potential to occur gradually after disturbance to habitat and vegetation takes place	During construction phase of project	Potentially long-term impacts

Indirect impact	Project phase	Nature	Extent	Frequency	Duration	Timing
increased risk of fire	Construction / operation	Potential for fire to spark during construction and operation from any machinery or electrical works	Throughout adjacent vegetation	Potential to occur at any time throughout the operational or construction phases	During operating/ construction hours	During operational /construction hours

disturbance to specialist breeding and foraging habitat, e.g. beach nesting for shorebirds.	Construction / operation	Potential to impact potential breeding habitat of Southern Myotis and roosting habitat of several microchiropteran bats within culverts. Potential to impact Southern Myotis foraging habitat within dams/creeks	Within and adjacent to culverts. Within and adjacent to waterbodies	Potential to occur at any time throughout the operational or construction phases	Throughout life of project	Potentially long-term impacts
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2.2.4 Prescribed biodiversity impacts

The development site has the prescribed biodiversity impacts as outlined in Table 24. An assessment of impacts of the development on prescribed biodiversity impacts is outlined in Table 25 in accordance with Section 9.2.1 of the BAM.

Table 24: Direct impacts on prescribed biodiversity impacts

Prescribed impact	biodiversity	Nature	Extent	Frequency	Duration	Timing
impacts of development on the habitat of threatened species or ecological communities associated with human made structures		Indirect impacts on culvert including noise, vibration and lighting.	Single culvert adjacent to development site.	During construction of new road/culvert.	During construction of new road/culvert.	Short-term impacts
impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range		Increased gap in connectivity between River Flat Eucalypt Forest in the east of the development site.	Increase distance between vegetation from 10m to 35m.	One off event	Permanent	Long-term impact
impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining)		Potential sedimentation and runoff into creek. Reduction in area of water due to construction of road.	25m section of creek, 0.08 ha of dam, 0.19 ha of PCT 1071	Ongoing	Permanent	Long-term impact

Table 25: Assessment of prescribed biodiversity impacts

BAM Criteria	Assessment
9.2.1.3 The assessment of the impacts of the development on the habitat of threatened species or ecological communities associated with human made structures	
a) identify the human made structures with potential to be habitat for threatened species or ecological communities	One culvert is present adjacent to the eastern edge of the development site and provides potential roosting habitat for threatened microchiropteran bat species including Southern Myotis, Eastern Bentwing-bat, Little Bentwing-bat and Eastern Free-tail Bat.
b) identify the species and ecological communities likely to use the habitat	The culvert provides potential roosting habitat for threatened microchiropteran bat species including Southern Myotis, Eastern Bentwing-bat, Little Bentwing-bat and Eastern Free-tail Bat.

BAM Criteria	Assessment
c) describe the nature, extent and duration of short and long-term impacts	A proposed road and culvert will be built directly adjacent to the existing culvert. This will result in impacts to the potential roosting habitat including vibration, noise, lighting and temporary obstruction of the culvert. This could disrupt potential breeding for Southern Myotis and winter roosting for species such as Eastern Bentwing-bat and Little Bentwing-bat. Following completion of the road the culvert will remain in place with an additional adjacent culvert.
d) describe, with reference to relevant literature the importance within the bioregion of the habitat of these species or ecological communities	Eastern Bentwing-bat and Little Bentwing-bat are known to utilise culverts and similar man-made structures temporarily during winter months. These species breed in maternity caves during summer and are not known to roost in small culverts such as that present in the development site. Southern Myotis is known to utilise culverts for breeding in the Sydney region and was recorded foraging in the riparian corridor within which the culvert is located. While none of the above species were observed within the impacted culvert during the survey, potential roosting habitat is available within narrow seams and the Fairy Martin mud nests in the culvert. It is considered unlikely that the culvert is currently used as a breeding site for the above species, however, may be temporarily utilised as a roost throughout the year for different microbat species. Two similar culverts are also present adjacent to the development site which provide higher quality roosting habitat due to deeper seams in the culvert.
e) predict the consequences of the impacts for the local and bioregional persistence of the suite of threatened species and communities likely to use these areas as habitat, with reference to relevant literature and other published sources of information.	The proposed development, which involves the construction of a road and culvert directly adjacent to the existing culvert would result in temporary impacts including vibration, noise, lighting and blockage of the culvert during construction. This could have impacts on microchiropteran bats (if present) during construction including disruption to seasonal roosting for those microchiropteran bat species and potential injury to bats. Given the presence of higher quality roosting culverts in the vicinity and unlikely disruption to breeding, it is unlikely that impacts on the culvert would have significant impacts for the local and bioregional persistence of the above listed microchiropteran bats. Mitigation measures are proposed in Section 2.2.5 to minimise potential impacts on roosting microbats during construction.

9.2.1.5 The assessment of the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range must:

(a) identify the area/s of connectivity joining different areas of habitat that intersect with the subject land and the areas of habitat that are connected according to Paragraph 4.2.1.3	The vegetation in the north of the development site forms part of a connective corridor from vegetation to the east of the development site to the riparian corridor to the west which connects to large patches of native vegetation and habitat to the north and south.
(b) identify the species and ecological communities likely to benefit from the connectivity	The species most likely to utilise the connectivity would be mobile species such as <i>Falsistrellus tasmaniensis</i> (Eastern False Pipistrelle) Southern Myotis, Eastern Bentwing-bat, Little Bentwing-bat, Eastern Free-tail Bat and <i>Pteropus poliocephalus</i> (Grey-headed Flying-fox). The corridor also creates a connective patch of the EEC River Flat Eucalypt Forest.

BAM Criteria	Assessment
(c) describe the nature, extent and duration of short and long-term impacts	At the eastern edge of the site there is a current gap of approximately 10m in the corridor of vegetation across an internal road in the adjacent land. The construction of a new road within the development site will widen this gap between vegetation patches to approximately 35 m.
(d) describe, with reference to relevant literature and other reliable published sources of information, the importance of the area of connectivity within the bioregion	The development site connects vegetation to the east with the vegetation riparian corridor to the west, which connects to large patches of native vegetation to the north and south. Vegetation within the development site which forms part of the corridor is highly degraded, as is the vegetation directly to the east. Only a small fragment of the entire corridor is located to the east of the development site (approximately 3 ha), located primarily along a narrow riparian corridor between industrial developments which is likely degraded and modified from its original vegetation. While this corridor would provide a passage for movement for mobile species and dispersal of genetic material for River Flat Eucalypt Forest, it is not considered important on a bioregional scale.
(e) predict the consequences of the impacts for the bioregional persistence of the suite of threatened species and communities currently benefitting from the connectivity with reference to relevant literature and other published sources of information and taking into consideration mobility, abundance, range and other relevant life history factors.	A variety of mobile threatened species are likely to utilise the connective habitat within and adjacent to the development site, particularly microchiropteran bats and Grey-headed Flying-fox. The development will result in a widened gap in the vegetated corridor from 10 m to 35 m. However, given the high mobility of these species and the relatively small decrease in connectivity, this impact would be insignificant on a local and bioregional scale. The widened gap will also result in a minor increase in fragmentation of the EEC River Flat Eucalypt Forest. This EEC is highly degraded and the section to be impacted is dominated by weeds in the understorey and relatively young canopy trees. The increased gap to 35 m will not prevent the movement of genetic material by birds and Grey-headed Flying-fox between the patches. The impacts are not significant for this community on a local or bioregional scale.
9.2.1.7 The assessment of the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened species and threatened ecological communities must:	
(a) identify water bodies with potential to be habitat for threatened species or threatened ecological communities likely to use the habitat	The proposed development will impact on the dam in the north of the development site and a small section of creek line in the east of the development site.
(b) identify the threatened species and threatened ecological communities likely to use the habitat.	The waterbodies are utilised by Southern Myotis for foraging.
(c) identify the hydrological processes that sustain threatened species or ecological communities and the species and communities that area dependent on them	Southern Myotis rely on waterbodies for foraging habitat.
(d) describe, with reference to relevant literature and other reliable published sources of information, the importance within the bioregion of the	Southern Myotis is known to utilise the water bodies within the site for foraging, including the dam to be impacted. The habitat to be impacted makes up only a very small portion of similar habitat available in the wider study area and bioregion. Given the small area

BAM Criteria	Assessment
waterbody or hydrological process to these species or ecological communities.	to be impacted (0.01 ha) it is not considered important on a local or bioregional scale.
(e) describe the nature, extent and duration of short-term impact and long-term impacts on water quality.	Proposed development controls should be implemented during construction and operation to prevent runoff and sedimentation which could affect downstream water quality in the short term or long term. The dam in the north of the development site is to be used as a detention basin and therefore PCT 1071 within the dam may become degraded. PCT 1071 within the dam has been included within offsets.
(g) predict the consequences of the impacts for the bioregional persistence of the suite of threatened species and communities likely to use these areas as habitat, with reference to relevant literature and other published sources of information.	It is noted that the updated footprint following the report exhibition encompasses the detention basin in the north of the development site which has resulted in an increased impact to PCT 1071 and foraging habitat for Southern Myotis within the dam. This has resulted in a greater offset requirement for Southern Myotis, however the dam will operate as a bio-retention basin and therefore this area of foraging habitat may still be utilised for foraging habitat. The habitat, however, may become degraded over time due to decreased water quality. Given the small area to be potentially impacted, relative to the larger areas to be retained within the subject land and larger areas in the locality and bioregion, the proposed development would be unlikely to impact the persistence of Southern Myotis in the locality or bioregion.
(h) predict the nature, extent and duration of short and long-term impacts on the habitat and life cycle of species using the natural features of any water dependent plant community	The dam in the north of the development site is to be utilised as a bio-retention and sediment detention basin. This may have impacts and result in degradation to PCT 1071. While this PCT may persist within the dam, a worst-case scenario has been assumed and the PCT is to be offset.
(i) justify predictions of impact on any water dependent plant communities, with appropriate modelling and with reference to relevant literature and other published sources of information	The dam in the north of the development has been previously used for sediment detention and currently contains an area PCT 1071 (a form of freshwater wetland). While this PCT may persist within the dam, a worst-case scenario has been assumed and the PCT is to be offset.
(j) predict the cumulative impacts of the project together with existing mining operations mining underneath the same water dependent plant communities	Not applicable.
(k) based on predictions of impacts on water dependant plant communities and the species they support, calculate the maximum predicted offset liability in accordance with the Upland Swamp Policy	Not applicable.
(l) justify any prediction of 'nil' or 'negligible' environmental consequences for any impact on water dependent plant communities and the species they support.	Not applicable.

2.2.5 Mitigating and managing impacts

Measures proposed to mitigate and manage impacts at the development site before, during and after construction are outlined in Table 26.

Table 26: Measures proposed to mitigate and manage impacts

Measure	Risk before mitigation	Risk after mitigation	Action	Outcome	Timing	Responsibility
Displacement of resident fauna and microbat controls	High	Low	- Pre-clearance surveys for microbats in culverts should be undertaken several weeks prior to construction commencing. If microbats are present within the culvert, a Microbat Management Plan should be prepared to minimise impacts to bats during construction. Measures may include exclusion of bats from culverts for duration of works. - Additional pre-clearance survey should be undertaken immediately before construction. - Monitor response of bats to works/noise at nearby culverts	Prevent injury to any resident microbats within culverts	Prior to and during construction	Project Manager, Project Ecologist
timing works to avoid critical life cycle events such as breeding or nursing	Medium	Low	- Avoid impacts on culverts during breeding season of Southern Myotis (November-March) if Myotis are recorded roosting within culverts during the breeding season	Avoid impacts to breeding Southern Myotis	During construction	Project Manager
instigating clearing protocols including pre-clearing surveys, daily surveys and staged clearing, the	Medium	Low	- Pre-clearance survey for microbats in culverts and any bird/other nests present. - Monitor response of bats to works/noise.	Prevent injury to any microbats within culverts or nesting birds	During construction	Project Manager, Project Ecologist

Measure	Risk before mitigation	Risk after mitigation	Action	Outcome	Timing	Responsibility
presence of a trained ecological or licensed wildlife handler during clearing events						
clearing protocols that identify vegetation to be retained, prevent inadvertent damage and reduce soil disturbance; for example, removal of native vegetation by chain-saw, rather than heavy machinery, is preferable in situations where partial clearing is proposed	High	Low	- Boundaries of the impact area to be clearly delineated with fencing, retained areas marked with "No Go" signage, in particular for TECs and areas containing <i>Grevillea juniperina</i> subsp. <i>juniperina</i> - Where possible, removal of vegetation with chainsaw to prevent inadvertent damage to vegetation outside of the development footprint	Protection of vegetation outside development footprint	During construction	Project Manager
sediment barriers or sedimentation ponds to control the quality of water released from the site into the receiving environment	Medium	Low	- Install sediment barriers and erosion control during and post construction to prevent runoff into adjacent creeklines. Maintain controls throughout construction and undertake weekly inspections.	Control of erosion, sedimentation and runoff of contaminated substances into adjacent waterways	Throughout life of project	Project Manager
noise barriers or daily/seasonal timing of construction and operational activities to reduce	Low	Very Low	Microbat Management Plan as discussed above (if required) to outline mitigation measures relating to noise.	Minimise potential noise related impacts on microbats.	For the duration of construction works	Project Manager

Measure	Risk before mitigation	Risk after mitigation	Action	Outcome	Timing	Responsibility
impacts of noise						
staff training and site briefing to communicate environmental features to be protected and measures to be implemented	Low	Very Low	All staff working on the development will undertake an environmental induction as part of their site familiarisation. Site briefings should be updated based on phase of the work. This induction will include items such as: 1. Site environmental procedures (vegetation management, sediment and erosion control, exclusion fencing and noxious weeds) 2. What to do in case of environmental emergency (chemical spills, fire, injured fauna) 3. Key contacts in case of environmental emergency	All staff entering the site are fully aware of all environmental aspects relating to the development and know what to do in case of any environmental emergencies	To occur for all staff entering / working at the site and when environmental issues become apparent	Project Manager, all staff
making provision for the ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat on or adjacent to the development site	Medium	Low	- Preparation and implementation of a VMP is recommended to protect and enhance retained vegetation	Protection of flora and fauna outside of the development footprint	Prior to the commencement of construction	Client

2.2.6 Serious and Irreversible Impacts (SAIL)

Serious and Irreversible Impacts (SAIL) values have been considered in this assessment. Eastern Bentwing-bat, which had potential calls identified during the Anabat survey, is a candidate entity for SAIL for impacts to breeding habitat. No breeding habitat for this species will be impacted directly or indirectly by the development. No other candidate entities for SAIL were recorded.

2.3 Risk assessment

A risk assessment has been undertaken for any residual impacts likely to remain after the mitigation measures have been applied. Likelihood criteria, consequence criteria and the risk matrix are provided in Table 27, Table 28 and Table 29 respectively.

Table 27: Likelihood criteria

Likelihood criteria	Description
Almost certain (Common)	Will occur, or is of a continuous nature, or the likelihood is unknown. There is likely to be an event at least once a year or greater (up to ten times per year). It often occurs in similar environments. The event is expected to occur in most circumstances.
Likely (Has occurred in recent history)	There is likely to be an event on average every one to five years. Likely to have been a similar incident occurring in similar environments. The event will probably occur in most circumstances.
Possible (Could happen, has occurred in the past, but not common)	The event could occur. There is likely to be an event on average every five to twenty years.
Unlikely (Not likely or uncommon)	The event could occur but is not expected. A rare occurrence (once per one hundred years).
Remote (Rare or practically impossible)	The event may occur only in exceptional circumstances. Very rare occurrence (once per one thousand years). Unlikely that it has occurred elsewhere; and, if it has occurred, it is regarded as unique.

Table 28: Consequence criteria

Consequence category	Description
Critical (Severe, widespread long-term effect)	Destruction of sensitive environmental features. Severe impact on ecosystem. Impacts are irreversible and/or widespread. Regulatory and high-level government intervention/action. Community outrage expected. Prosecution likely.
Major (Wider spread, moderate to long term effect)	Long-term impact of regional significance on sensitive environmental features (e.g. wetlands). Likely to result in regulatory intervention/action. Environmental harm either temporary or permanent, requiring immediate attention. Community outrage possible. Prosecution possible.
Moderate (Localised, short-term to moderate effect)	Short term impact on sensitive environmental features. Triggers regulatory investigation. Significant changes that may be rehabilitated with difficulty. Repeated public concern.

Consequence category	Description
Minor (Localised short-term effect)	Impact on fauna, flora and/or habitat but no negative effects on ecosystem. Easily rehabilitated. Requires immediate regulator notification.
Negligible (Minimal impact or no lasting effect)	Negligible impact on fauna/flora, habitat, aquatic ecosystem or water resources. Impacts are local, temporary and reversible. Incident reporting according to routine protocols.

Table 29: Risk matrix

Consequence	Likelihood				
	Almost certain	Likely	Possible	Unlikely	Remote
Critical	Very High	Very High	High	High	Medium
Major	Very High	High	High	Medium	Medium
Moderate	High	Medium	Medium	Medium	Low
Minor	Medium	Medium	Low	Low	Very Low
Negligible	Medium	Low	Low	Very Low	Very Low

Table 30: Risk assessment

Potential impact	Project phase	Risk (pre-mitigation)	Risk (post mitigation)
Vegetation clearing	Construction / operation	Medium	Low
sedimentation and contaminated and/or nutrient rich run-off	Construction	Medium	Low
noise, dust or light spill	Construction	Medium	Low
inadvertent impacts on adjacent habitat or vegetation	Construction	High	Low
trampling of threatened flora species	Construction / operation	High	Low
rubbish dumping	Construction / operation	Low	Very Low
wood collection	Construction / operation	Low	Very Low
disturbance to specialist breeding and foraging habitat (culverts)	Construction / operation	High	Low

2.4 Adaptive management strategy

Adaptive Management Strategy is required for those impacts that are infrequent, cumulative or difficult to predict. Impacts associated with the proposed development have been considered and addressed in Section 2 and no further impacts are required to be addressed.

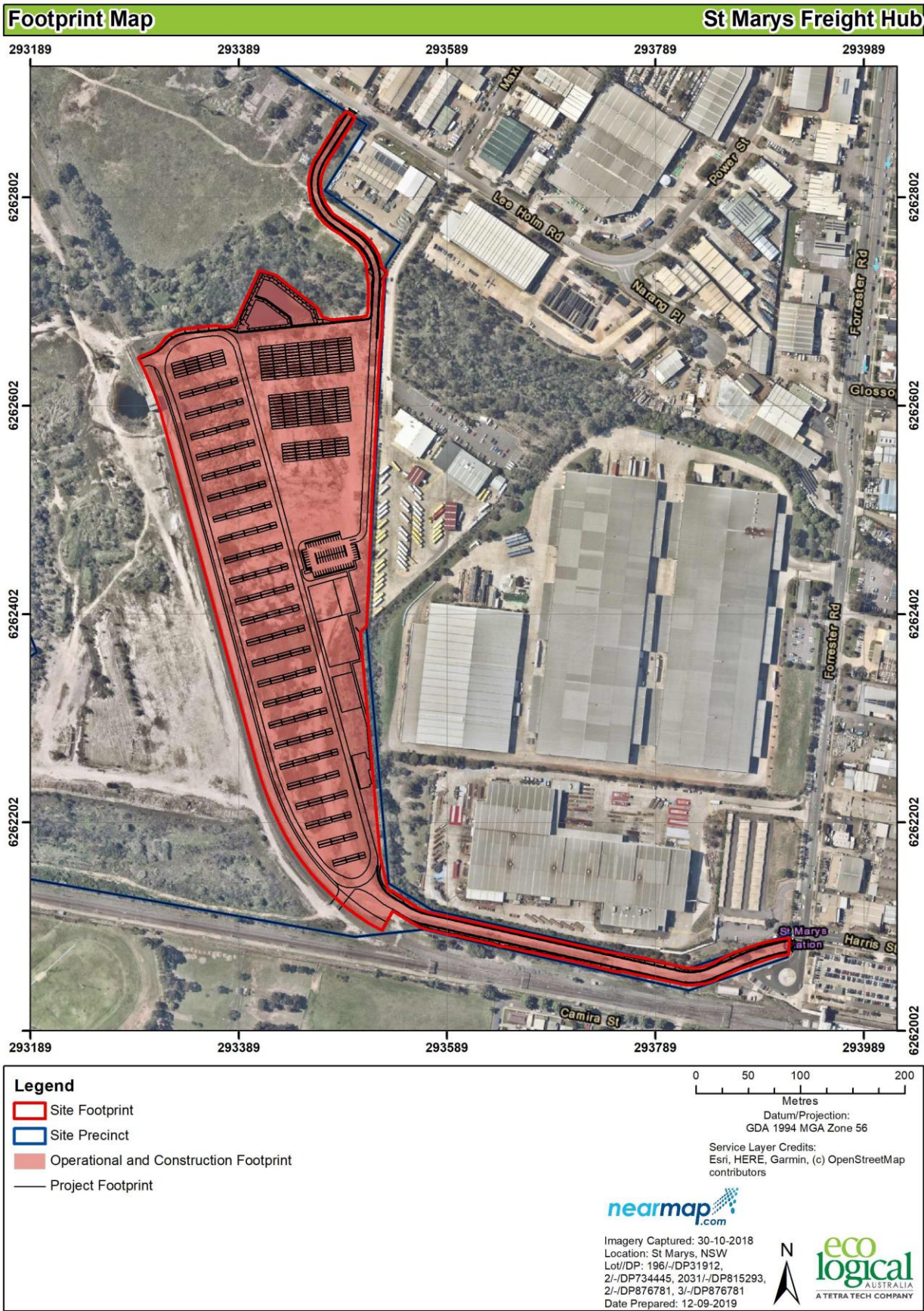


Figure 8: Final project footprint including construction and operation

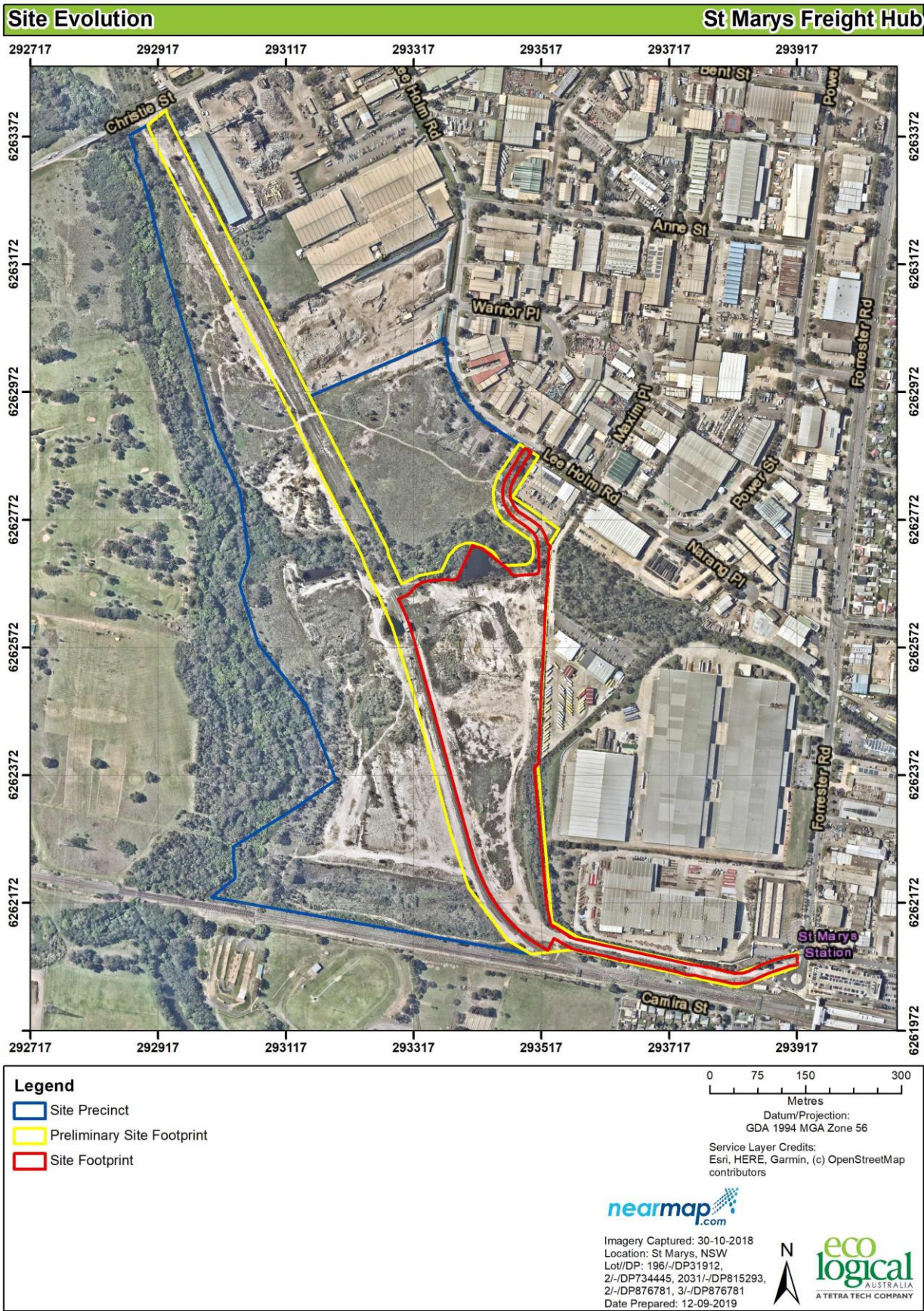


Figure 9: Preliminary and final development footprint

2.5 Impact summary

Following implementation of the BAM and the BAMC, the following impacts have been determined.

2.5.1 Serious and Irreversible Impacts (SAIL)

The development does not have any Serious and Irreversible Impacts (SAIL).

2.5.2 Impacts requiring offsets

The impacts of the development requiring offset for native vegetation are outlined in Table 31 and shown on Figure 10. The impacts of the development requiring offset for threatened species and threatened species habitat are outlined in Table 32 and on Figure 10.

Table 31: Impacts to native vegetation that require offsets

Zone	PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Direct impact (ha)
1	835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Coastal Floodplain Wetlands	Forested Wetlands	0.29
2	835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Coastal Floodplain Wetlands	Forested Wetlands	0.28
3	1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Coastal Floodplain Wetlands	Forested Wetlands	0.06
5	1071	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Freshwater Wetlands	Coastal Freshwater Wetlands	0.19

Table 32: Impacts on threatened species and threatened species habitat that require offsets

Species	Common Name	Direct impact number of individuals / habitat (ha)	NSW listing status	EPBC Listing status
<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea	0.63	Vulnerable	Not Listed
<i>Myotis macropus</i>	Southern Myotis	0.94	Vulnerable	Not Listed

2.5.3 Impacts not requiring offsets

The impacts of the development not requiring offset for native vegetation are outlined in Table 33 and shown on Figure 11.

Table 33: Impacts to native vegetation that do not require offsets

Zone	PCT ID	PCT Name	Vegetation Class	Vegetation Formation	Direct impact (ha)	Rationale
4	1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Coastal Floodplain Wetlands	Forested Wetlands	0.69	Vegetation integrity score (6.5) lower than threshold

2.5.4 Areas not requiring assessment

Areas not requiring assessment are shown on Figure 12. These areas have been cleared of native vegetation and do not contain habitat for threatened species. These areas are dominated by exotic species such as *Eragrostis curvula* (African Love Grass), *Chloris gayana* (Rhodes Grass) and *Sida rhombifolia* (Paddy's Lucerne).

2.5.5 Credit summary

The number of ecosystem credits required for the development are outlined in Table 34. The number of species credits required for the development are outlined in Table 35. A biodiversity credit report is included in Appendix D.

Table 34: Ecosystem credits required

Zone	PCT ID	PCT Name	Condition	Vegetation Formation	Direct impact (ha)	Credits required
1	835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland	Degraded	Forested Wetlands	0.29 ha	5

Zone	PCT ID	PCT Name	Condition	Vegetation Formation	Direct impact (ha)	Credits required
		Plain, Sydney Basin Bioregion				
2	835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Regrowth	Forested Wetlands	0.28 ha	6
3	1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Degraded	Forested Wetlands	0.06 ha	1
5	1071	Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Moderate	Coastal Freshwater Wetlands	0.19 ha	3
Total					0.82 ha	15

Table 35: Species credit summary

Species	Common Name	Direct impact number of individuals / habitat (ha)	Credits required
<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea	0.63 ha	10
<i>Myotis macropus</i>	Southern Myotis	0.94 ha	9
Total			19

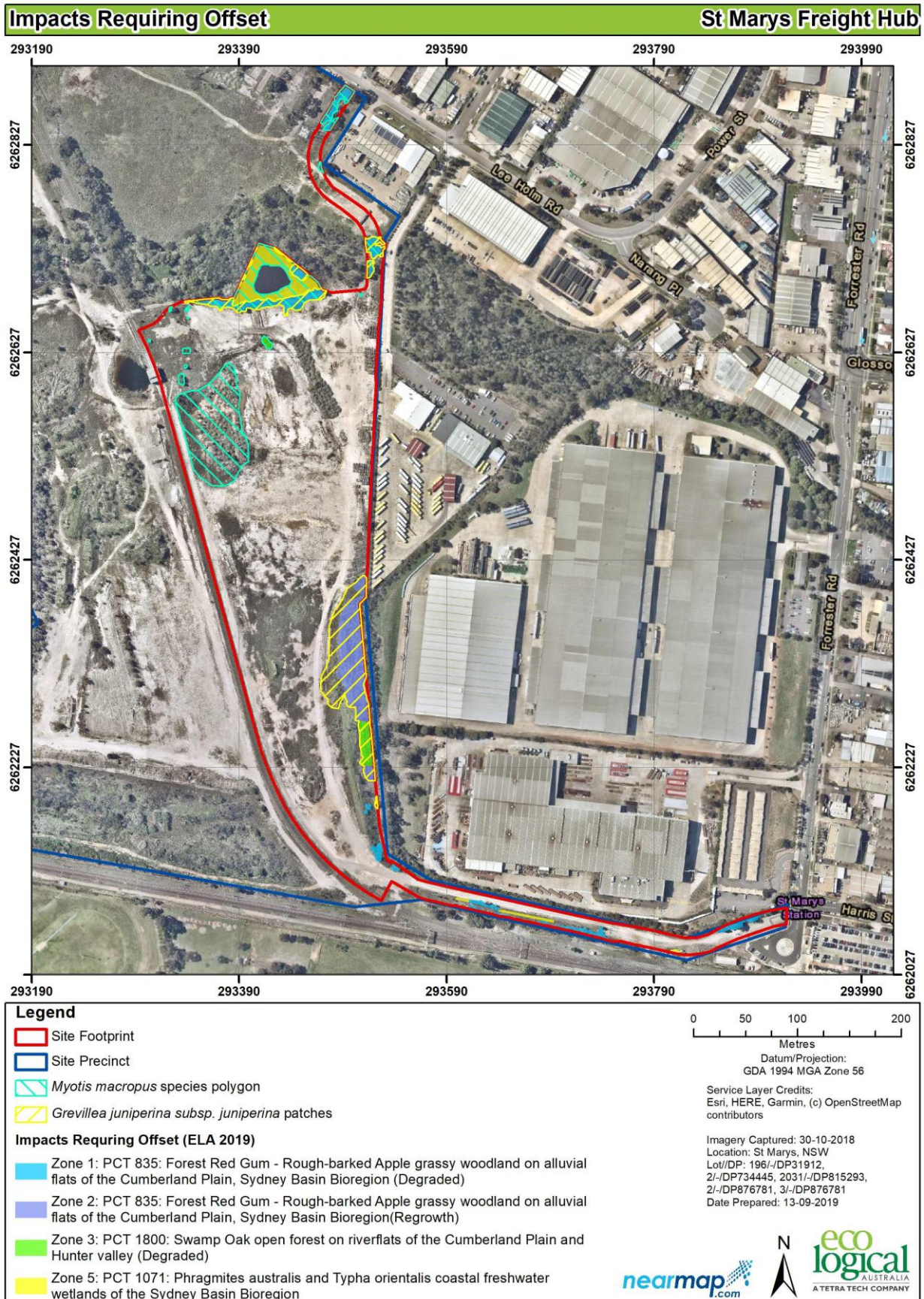


Figure 10: Impacts requiring offset

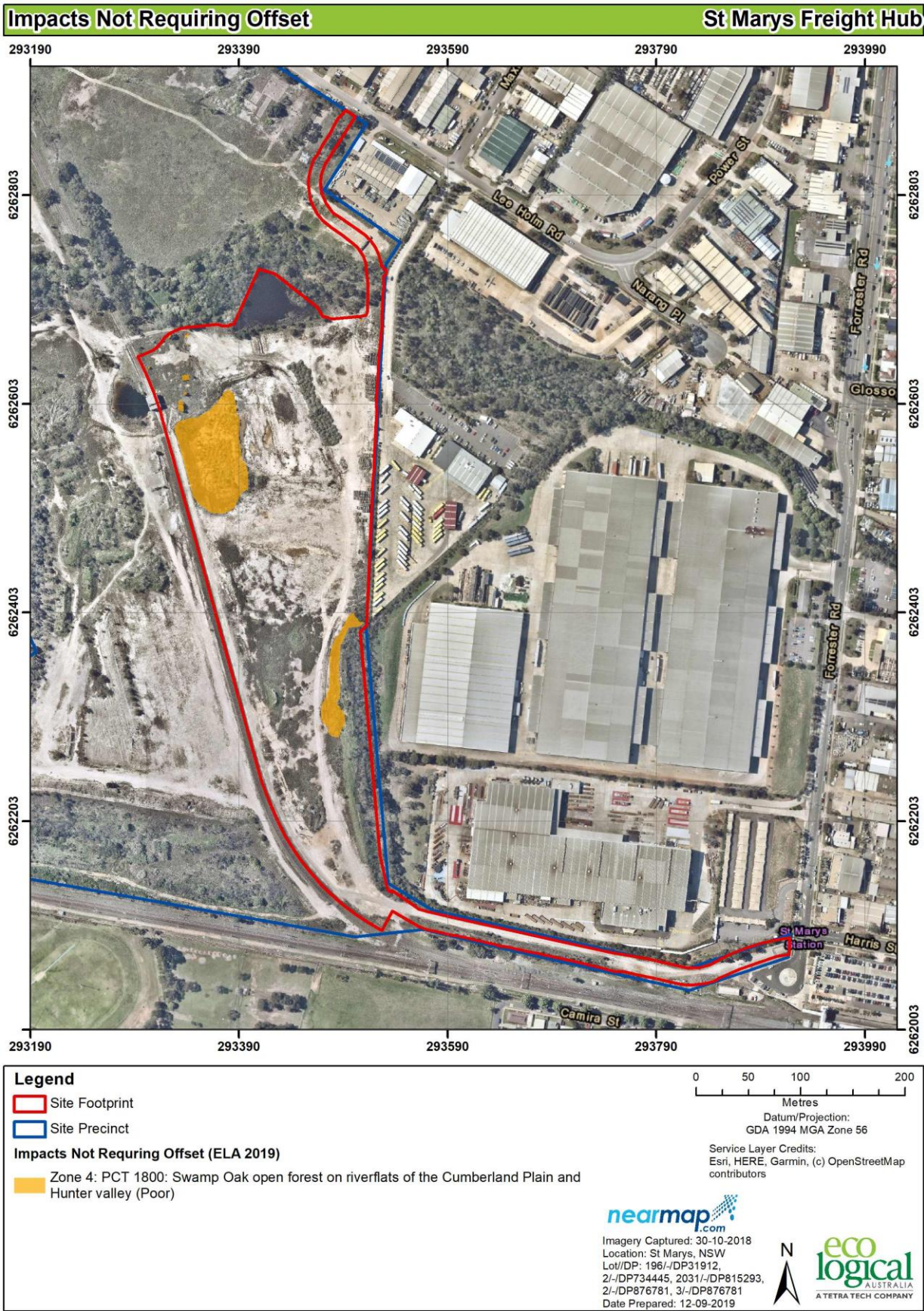


Figure 11: Impacts not requiring offset

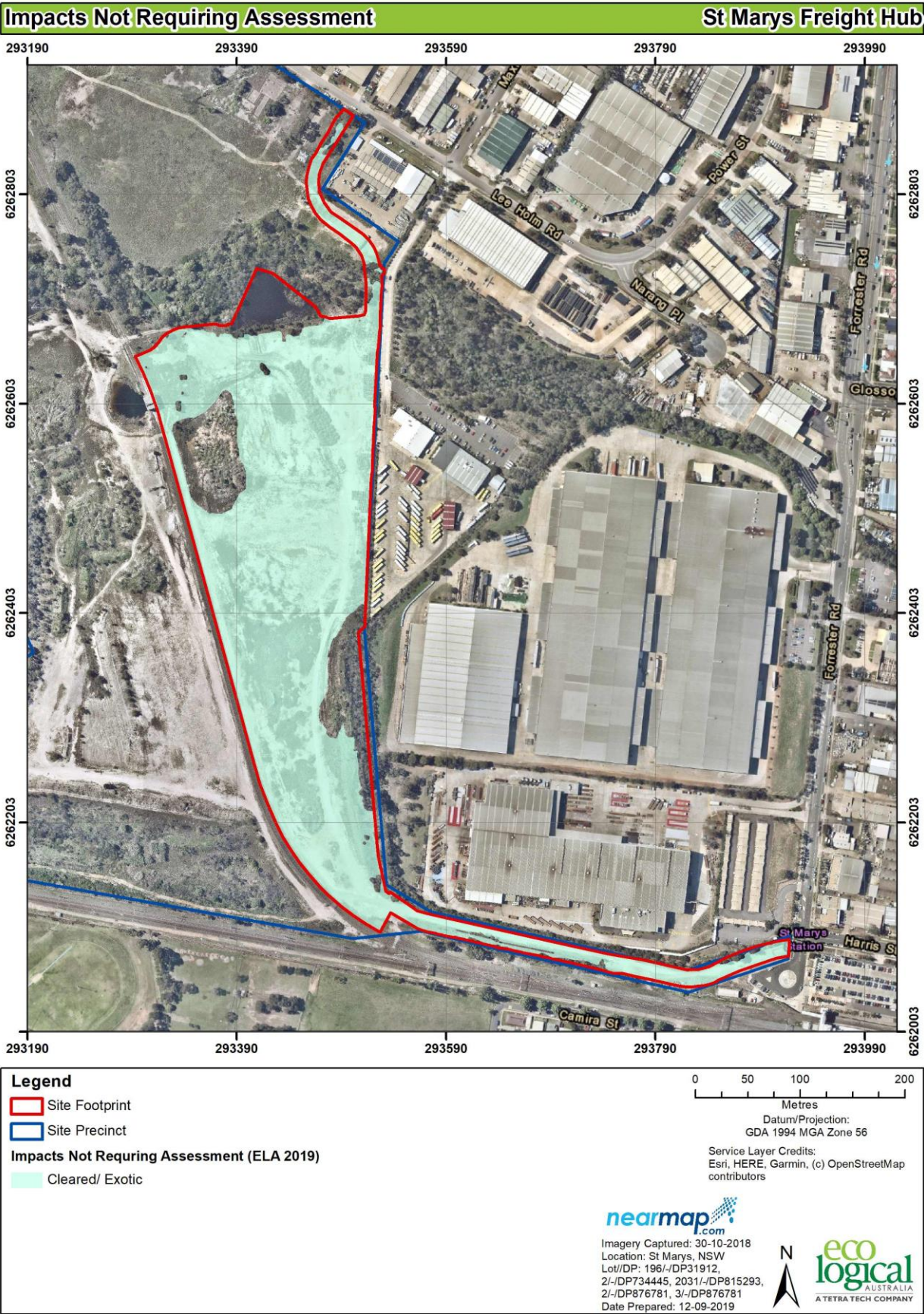


Figure 12: Areas not requiring assessment

2.6 Consistency with legislation and policy

Additional matters relating to impacts on flora and fauna which are not covered by the BC Act must also be addressed for the proposed development. Potential impacts on Matters of National Environmental Significance (MNES) in accordance with the EPBC Act have been addressed below.

2.6.1 Environment Protection and Biodiversity Conservation Act (EPBC Act) 1999.

The EPBC Act establishes a process for assessing the environmental impact of activities and developments where MNES may be affected. Under the Act, any action which 'has, will have, or is likely to have a significant impact on a matter of MNES' is defined as a 'controlled action', and requires approval from the Commonwealth Department of the Environment and Energy (DotE), which is responsible for administering the EPBC Act (DotE 2013).

The process includes an assessment for listed threatened species and ecological communities that will be affected as a result of the proposed action. The Commonwealth has developed Significant impact guidelines (DotEE 2013) and species-specific referral guidelines that outline a number of criteria to provide assistance in assessing impacts on MNES and help decide whether or not a referral to the Commonwealth is required.

Two MNES were originally considered as having the potential to occur based on a desktop review, including NSW BioNet Records, Atlas of Living Australia records, aerial imagery and the BAMC. These MNES include:

- *Litoria aurea* (Green and Golden Bell Frog)
- *Pteropus poliocephalus* (Grey-headed Flying-fox)

2.6.1.1 *Litoria aurea* (Green and Golden Bell Frog)

Green and Golden Bell Frog is listed as a vulnerable species under the EPBC Act. It inhabits marshes, dams and stream-sides, particularly those containing *Typha* spp. (bullrushes) or *Eleocharis* spp. (spikerushes). Some populations occur in highly disturbed areas. Potential habitat is present within the development footprint within drainage ditches dominated by *Typha orientalis* (Broadleaf Cumbungi) and the creekline. Suitable habitat is also present within the two dams which are now outside of the development site after revision of the development footprint. Green and Golden Bell Frog has been previously recorded approximately 1.3 km to the north west of the development site in 1998 and more recently in 2005 approximately 3.5 km from the development site. There are a total of 11 records within 5 km of the development site.

Four nights of targeted survey were undertaken for the Green and Golden Bell Frog in accordance with EPBC Act policy statement 3.19 (DEWHA, 2009). The survey included nocturnal call-playback survey and targeted habitat searches. No individuals were recorded during the survey and therefore this species is assumed not present. Furthermore, an impact assessment for this species as outlined in the Significant impact guidelines (DotE 2013) and/or a referral is not required.

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

Grey-headed Flying-fox is listed as a vulnerable species under the EPBC Act. This species utilises a wide variety of habitats (including disturbed areas) for foraging, and has been recorded travelling long distances on feeding forays. Fruits and flowering plants of a wide variety of species are the main food source. The species roosts in large 'camps' of up to 200 000 individuals. Camps are usually formed close

to water and along gullies, however, the species has been known to form camps in urban areas. Grey-headed Flying-foxes may travel up to 50 km from camps to forage.

There are 23 Grey-headed Flying-fox records within 5 km of the development site. The vegetation within the site provides potential foraging habitat in the form of seasonally flowering myrtaceous tree species including *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus moluccana* (Grey Box) and *Angophora floribunda* (Rough-barked Apple). It is considered likely that this species would use the site and adjacent areas on occasion for foraging purposes. No roosting camps are located within the site.

The closest Grey-headed Flying-fox camp is located at Ropes Creek approximately 3.5 km to the south-east. Another camp is located at Emu Plains approximately 8km to the west. The Ropes Creek population was last estimated to contain 500 – 2,499 individuals in February 2017. The Emu Plains population was last estimated to contain 1 – 499 individuals in May 2018, however, has been previously estimated at 16,000 – 49,000 in February 2015.

Considering that Grey-headed Flying-fox is likely to forage within the development site on an occasional basis, a significance assessment has been undertaken in accordance with Significant impact guidelines 1.1 under the EPBC Act (Table 36)

Table 36: EPBC Act Significance Assessment for *Pteropus poliocephalus* (Grey-headed Flying-fox)

Criterion	Assessment
Criterion a: lead to a long-term decrease in the size of an important population of a species	The closest camp is located at Ropes Creek approximately 3.5 km to the south-east of the development site. Another occurs 8 km to the west at Emu Plains. Foraging for this species occurs within 50 km radius around the camps. Available foraging resources include: street trees, urban bushland and conservation reserves. Only a relatively small area of potential foraging habitat would be removed under the proposed action. The amount of habitat to be affected is small given the extensive amount of similar or better quality habitat available in the local area. No individuals or camps of <i>P. poliocephalus</i> were recorded on the site. The proposed action will not impact on any part of any known camps for this species. Given that other foraging habitat exists in the surrounding landscape, and that this species is wide-ranging (traveling up to 50 km in one night), the proposal is unlikely to affect any important populations of this species that would lead to a long-term decrease in the size of an important population of the Grey-headed Flying-fox.
Criterion b: reduce the area of occupancy of an important population	The Australian population of Grey-headed Flying-fox is an important population. The area of occupancy for this population is dynamic, and individuals move between bat camps throughout the Australian east coast. This species is highly mobile and camp sizes may change during seasonal fluctuations. The proposal is unlikely to reduce the area of occupancy for this population given the availability of foraging and roosting habitat present in adjacent areas and the highly mobile nature of this species.
Criterion c: fragment an existing important population into two or more populations	The Grey-headed Flying-fox population across Sydney is highly dynamic and individuals move between permanent camps to utilise foraging resources. They will return to permanent camps to rear offspring. Individuals are highly mobile and populations are not static. No known camp or important population will be fragmented under the proposed action. The proposed action will result in up to 1.32 ha of potential foraging habitat for the Grey-headed Flying-fox (remnant and planted vegetation). Large amounts

Criterion	Assessment
	of similar habitat are available in the wider locality. Therefore, the proposed action is unlikely to fragment the existing important population into two or more populations.
Criterion d: adversely affect habitat critical to the survival of a species	As the proposal would not involve the removal of any camp, it would be unlikely to create a barrier to movement or remove breeding habitat. The proposal would remove 1.32 ha of potential foraging habitat. Abundant foraging habitat of higher quality would remain in the wider locality. Larger areas of foraging habitat are present nearby the development site along Wianamatta Creek and significant areas of intact bushland are also available approximately 12 km to the west alongside the Nepean River and into the Blue Mountains. Therefore, it is unlikely that habitat critical to the survival of this species would be adversely affected by the development. While it is likely that this species utilises foraging resources in the site on an occasional basis, it is unlikely to rely on such resources for survival.
Criterion e: disrupt the breeding cycle of an important population	As no roosting habitat would be removed or disturbed, it is unlikely the proposed work would disrupt the breeding cycle of an important population.
Criterion f: Adversely affect habitat critical to the survival of a species; modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	As no campsites would be removed or disturbed, and large areas foraging habitat exist outside of the subject site, the proposal would be unlikely to modify, destroy, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Criterion g: Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The proposal would not result in the establishment or increase of invasive species, such as weeds, that would be harmful to Grey-headed Flying-fox.
Criterion h: Introduce disease that may cause the species to decline	Grey-headed Flying-fox are reservoirs for the Australian bat lyssavirus (ABL) and can cause clinical disease and mortality in GHFF (DECCW, 2009). The proposal is unlikely to present significant ecological stress on known individuals or camps utilizing the subject site and is therefore unlikely to affect this species. The proposal would be unlikely to introduce a disease that may cause this species to decline.
Criterion i: Interfere substantially with the recovery of the species	A Draft National Recovery Plan for the Grey-headed Flying-fox was developed in 2009. As no maternity camps would be removed the proposal would only remove some potential resting habitat consisting of exotic trees it is unlikely that the proposal works interfere with the recovery of this species.
Conclusion	In consideration of the above, the proposed works considered unlikely to have a significant impact on the Grey-headed Flying-fox, and therefore, an EPBC Act referral is not required.

3. References

BAM Calculator. <https://www.lmbc.nsw.gov.au/bamcalc/home/AssessmentCal>

Bannerman, S.M. and Hazelton, P. A. 1990. 'Soil Landscapes of the Penrith 1:100 000 Sheet'. Soil Conservation Service of NSW, Sydney.

BioNet Threatened Biodiversity profiles.

<https://www.environment.nsw.gov.au/NSWVCA20PRapp/default.aspx>

BioNet Vegetation Classification.

<https://www.environment.nsw.gov.au/NSWVCA20PRapp/default.aspx>

Cropper, S.C. 1993. Management of Endangered Plants. CSIRO Australia, Melbourne.

Department of Environment and Climate Change. 2002, 'Descriptions for NSW (Mitchell) Landscapes Version 2'. Sourced 7 November 2017 from:

<http://www.environment.nsw.gov.au/resources/conservation/landscapesdescriptions.pdf>

Department of Environment and Conservation, 2004, Threatened Species Survey and Assessment: Guidelines for developments and activities (working draft), New South Wales Department of Environment and Conservation, Hurstville, NSW.

Department of the Environment (DotE) 2019. National Flying-fox monitoring viewer. Australian Government. Accessed 27/02/19.

Department of the Environment and Energy (DotEE) 2018a. Protected Matters Search Tool [online]. Available: <http://www.environment.gov.au/epbc/protect/index.html> (Accessed: January 2019).

Department of the Environment and Energy (DotEE) 2019b. Species Profile and Threats Database. Available <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>.

Department of the Environment, Water, Heritage and the Arts (DEWHA), 2009. 'Significant impact guidelines of the vulnerable green and golden bell frog (*Litoria aurea*)'. Commonwealth of Australia 2009.

Land and Property Information. 2015, 'SIX maps aerial imagery'.

NSW Flora Online 2017. Available: www.plantnet.rbgsyd.nsw.gov.au.

OEH 2011. 'River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing— Final Determination'. Accessed 27/02/19.

<https://www.environment.nsw.gov.au/determinations/RiverflatEucalyptForestEndSpListing.htm>

Office of Environment and Heritage (OEH) 2013. Remnant Vegetation of the western Cumberland subregion, 2013 Update'.

OEH 2017. 'Guidance to assist a decision-maker to determine a serious and irreversible impact.

OEH 2018a. Threatened Species Database (5 km radius search). OEH Sydney, NSW. (Accessed December 2018).

OEH 2018b. Threatened Species Profiles. Available:
<http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?>

OEH 2018. "Species credit' threatened bats and their habitats – NSW survey guide for the Biodiversity Assessment Method'.

Appendix A Definitions

Terminology	Definition
Biodiversity credit report	The report produced by the Credit Calculator that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site, or on land to be biodiversity certified, or that sets out the number and class of biodiversity credits that are created at a biodiversity stewardship site.
BioNet Atlas	The BioNet Atlas (formerly known as the NSW Wildlife Atlas) is the OEH database of flora and fauna records. The Atlas contains records of plants, mammals, birds, reptiles, amphibians, some fungi, some invertebrates (such as insects and snails) and some fish
Broad condition state:	Areas of the same PCT that are in relatively homogenous condition. Broad condition is used for stratifying areas of the same PCT into a vegetation zone for the purpose of determining the vegetation integrity score.
Connectivity	The measure of the degree to which an area(s) of native vegetation is linked with other areas of vegetation.
Credit Calculator	The computer program that provides decision support to assessors and proponents by applying the BAM, and which calculates the number and class of biodiversity credits required to offset the impacts of a development or created at a biodiversity stewardship site.
Development	Has the same meaning as development at section 4 of the EP&A Act, or an activity in Part 5 of the EP&A Act. It also includes development as defined in section 115T of the EP&A Act.
Development footprint	The area of land that is directly impacted on by a proposed development, including access roads, and areas used to store construction materials.
Development site	An area of land that is subject to a proposed development that is under the EP&A Act.
Ecosystem credits	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at a biodiversity stewardship site.
High threat exotic plant cover	Plant cover composed of vascular plants not native to Australia that if not controlled will invade and outcompete native plant species.
Hollow bearing tree	A living or dead tree that has at least one hollow. A tree is considered to contain a hollow if: (a) the entrance can be seen; (b) the minimum entrance width is at least 5 cm; (c) the hollow appears to have depth (i.e. you cannot see solid wood beyond the entrance); (d) the hollow is at least 1 m above the ground. Trees must be examined from all angles.
Important wetland	A wetland that is listed in the Directory of Important Wetlands of Australia (DIWA) and SEPP 14 Coastal Wetlands
Linear shaped development	Development that is generally narrow in width and extends across the landscape for a distance greater than 3.5 kilometres in length
Local population	The population that occurs in the development site. In cases where multiple populations occur in the development site or a population occupies part of the development site, impacts on each subpopulation must be assessed separately.
Local wetland	Any wetland that is not identified as an important wetland (refer to definition of Important wetland).
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000.

Terminology	Definition
Multiple fragmentation impact development	Developments such as wind farms and coal seam gas extraction that require multiple extraction points (wells) or turbines and a network of associated development including roads, tracks, gathering systems/flow lines, transmission lines
Operational Manual	The Operational Manual published from time to time by OEH, which is a guide to assist assessors when using the BAM
Patch size	An area of intact native vegetation that: a) occurs on the development site or biodiversity stewardship site, and b) includes native vegetation that has a gap of less than 100 m from the next area of native vegetation (or ≤ 30 m for non-woody ecosystems). Patch size may extend onto adjoining land that is not part of the development site or stewardship site.
Proponent	A person who intends to apply for consent to carry out development or for approval for an activity.
Reference sites	The relatively unmodified sites that are assessed to obtain local benchmark information when benchmarks in the Vegetation Benchmarks Database are too broad or otherwise incorrect for the PCT and/or local situation. Benchmarks can also be obtained from published sources.
Regeneration	The proportion of over-storey species characteristic of the PCT that are naturally regenerating and have a diameter at breast height < 5 cm within a vegetation zone.
Remaining impact	An impact on biodiversity values after all reasonable measures have been taken to avoid and minimise the impacts of development. Under the BAM, an offset requirement is calculated for the remaining impacts on biodiversity values.
Retirement of credits	The purchase and retirement of biodiversity credits from an already-established biobank site or a biodiversity stewardship site secured by a biodiversity stewardship agreement.
Riparian buffer	Riparian buffers applied to water bodies in accordance with the BAM
Sensitive biodiversity values land map	Development within an area identified on the map requires assessment using the BAM.
Site attributes	The matters assessed to determine vegetation integrity. They include native plant species richness, native over-storey cover, native mid-storey cover, native ground cover (grasses), native ground cover (shrubs), native ground cover (other), exotic plant cover (as a percentage of total ground and mid-storey cover), number of trees with hollows, proportion of over-storey species occurring as regeneration, and total length of fallen logs.
Site-based development	a development other than a linear shaped development, or a multiple fragmentation impact development
Species credits	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Biodiversity Data Collection.
Subject land	Is land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land. It includes land that may be a development site, clearing site, proposed for biodiversity certification or land that is proposed for a biodiversity stewardship agreement.
Threatened Biodiversity Data Collection	Part of the BioNet database, published by OEH and accessible from the BioNet website.
Threatened species	Critically Endangered, Endangered or Vulnerable threatened species as defined by Schedule 1 of the BC Act, or any additional threatened species listed under Part 13 of the EPBC Act as Critically Endangered, Endangered or Vulnerable.

Terminology	Definition
Vegetation Benchmarks Database	A database of benchmarks for vegetation classes and some PCTs. The Vegetation Benchmarks Database is published by OEH and is part of the BioNet Vegetation Classification.
Vegetation zone	A relatively homogenous area of native vegetation on a development site, land to be biodiversity certified or a biodiversity stewardship site that is the same PCT and broad condition state.
Wetland	An area of land that is wet by surface water or ground water, or both, for long enough periods that the plants and animals in it are adapted to, and depend on, moist conditions for at least part of their life cycle. Wetlands may exhibit wet and dry phases and may be wet permanently, cyclically or intermittently with fresh, brackish or saline water
Woody native vegetation	Native vegetation that contains an over-storey and/or mid-storey that predominantly consists of trees and/or shrubs

Appendix B Vegetation plot data

Table 37: Species matrix (species recorded by plot)

Form	Species name	Common name	Exotic (*)	High Threat Weed	Cover (%) Plot 1	Cover (%) Plot 2	Cover (%) Plot 3	Cover (%) Plot 4	Cover (%) Plot 5
SG	<i>Acacia falcata</i>	Hickory Wattle							1
SG	<i>Acacia longifolia</i> subsp. <i>longifolia</i>	Sydney Golden Wattle						0.1	1
TG)	<i>Acacia parramattensis</i>	Parramatta Wattle			0.5	2		25	
	<i>Ageratina adenophora</i>	Crofton Weed	*	*			0.1		
TG	<i>Allocasuarina littoralis</i>	Black She-oak						5	
OG	<i>Amyema spp.</i>	Mistletoe				0.5			
	<i>Anagallis arvensis</i>	Scarlet Pimpernel	*			0.1			
TG	<i>Angophora floribunda</i>	Rough-barked Apple						1	
GG	<i>Anisopogon avenaceus</i>	Oat Speargrass			0.1				
	<i>Araujia sericifera</i>	Moth Vine	*	*	0.1	0.1		0.5	
OG	<i>Archontophoenix cunninghamiana</i>	Bangalow Palm				0.2			
	<i>Asparagus asparagoides</i>	Bridal Creeper	*	*		0.1		0.1	
	<i>Bidens pilosa</i>	Cobblers Pegs	*	*		0.2			
	<i>Brassica rapa</i>	Field Mustard	*		0.2	0.1		2	0.1
	<i>Briza subaristata</i>		*	*				0.2	
SG	<i>Bursaria spinosa</i>	Blackthorn						2	

Form	Species name	Common name	Exotic (*)	High Threat Weed	Cover (%) Plot 1	Cover (%) Plot 2	Cover (%) Plot 3	Cover (%) Plot 4	Cover (%) Plot 5
TG	<i>Casuarina glauca</i>	Swamp Oak			50	1	1		0.1
FG	<i>Centella asiatica</i>	Indian Pennywort				0.3		0.1	
	<i>Centaurea spp.</i>		*			0.1			
	<i>Cestrum parqui</i>	Green Cestrum	*	*	0.1	0.1		0.5	
EG	<i>Cheilanthes sieberi</i>	Mulga Fern			0.1				
	<i>Chloris gayana</i>	Rhodes Grass	*	*	1				0.3
	<i>Cirsium vulgare</i>	Spear Thistle	*			1			5
	<i>Conyza bonariensis</i>	Flax-leaf Fleabane	*					0.2	
GG	<i>Cymbopogon refractus</i>	Barbed-wire Grass							0.1
	<i>Cynodon dactylon</i>	Couch	*			2			10
	<i>Daucus carota</i>	Wild Carrot	*						0.1
SG	<i>Daviesia ulicifolia</i>	Gorse Bitter Pea						0.5	
OG	<i>Desmodium varians</i>				0.1				
FG	<i>Dianella caerulea</i>	Blue Flax Lily				0.1		0.1	
GG	<i>Dichelachne spp.</i>								0.1
FG	<i>Dichondra repens</i>	Kidney Weed			0.3	0.1		0.1	0.2
FG	<i>Einadia nutans</i>	Climbing Saltbush							0.1
	<i>Eragrostis curvula</i>	African Lovegrass	*	*	10	30	0.5	60	10
TG	<i>Eucalyptus moluccana</i>	Grey Box				20			
TG	<i>Eucalyptus spp.</i>								0.2
TG	<i>Eucalyptus tereticornis</i>	Forest Red Gum					1		
	<i>Euphorbia spp.</i>		*						0.5
	<i>Foeniculum vulgare</i>	Fennel	*			0.1			
	<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush	*			0.1	0.1		0.1
SG	<i>Grevillea juniperina</i> subsp. <i>juniperina</i>	Juniper-leaved Grevillea						10	
OG	<i>Hardenbergia violacea</i>	False Sarsaparilla					0.1		
	<i>Juncus acutus</i>	Sharp Rush	*	*			0.5		
GG)	<i>Juncus usitatus</i>					0.1	0.1		
	<i>Lactuca serriola</i>	Prickly Lettuce	*						0.2
	<i>Lantana camara</i>	Lantana	*	*				0.2	
	<i>Ligustrum lucidum</i>	Broad-leaf Privet	*	*		0.5			10
	<i>Ligustrum sinense</i>	Small-leaf Privet	*	*	0.2	1	0.1	0.2	8
	<i>Linum trigynum</i>	French Flax	*					0.2	
	<i>Lolium perenne</i>	Perennial Ryegrass	*						2

Form	Species name	Common name	Exotic (*)	High Threat Weed	Cover (%) Plot 1	Cover (%) Plot 2	Cover (%) Plot 3	Cover (%) Plot 4	Cover (%) Plot 5
GG	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush							0.2
	<i>Melinis repens</i>	Red Natal Grass	*						0.12
GG	<i>Microlaena stipoides</i>	Weeping Meadow Grass			0.1	0.5			
	<i>Modiola caroliniana</i>	Red-flowered Mallow	*			0.2			
	<i>Najas browniana</i>	Water nymph							
	<i>Ochna serrulata</i>	Mickey Mouse Plant	*	*	0.1				
	<i>Olea europaea</i> subsp. <i>cuspidata</i>	African Olive	*	*		0.1			
FG)	<i>Oxalis</i> spp.				0.1	0.2		0.1	0.2
	<i>Paspalum dilatatum</i>		*	*		0.1			0.2
	<i>Paspalum urvillei</i>	Vasey Grass	*				2	0.1	
	<i>Pavonia hastata</i>		*		0.2	0.5		0.2	
FG	<i>Persicaria decipiens</i>	Slender Knotweed					0.1		
FG	<i>Phyllanthus virgatus</i>					0.1			
	<i>Plantago lanceolata</i>	Plantain	*			0.1			
	<i>Robinia pseudoacacia</i>	Black Locust	*	*					10
	<i>Rubus fruticosus</i> sp. <i>agg.</i>	Blackberry	*	*				15	0.1
	<i>Senecio madagascariensis</i>	Fireweed	*	*		0.1		0.1	0.1
	<i>Senecio pterophorus</i>		*						4
GG	<i>Setaria</i> spp.		*			0.1			2
	<i>Sida rhombifolia</i>	Paddy's Lucerne	*		0.1	2		0.2	
OG	<i>Smilax glyciphylla</i>	Sweet Sarsaparilla						0.1	
	<i>Solanum linnaeanum</i>	Apple of Sodom	*		0.1			0.1	2
	<i>Solanum nigrum</i>	Blackberry Nightshade	*					0.1	
	<i>Sonchus oleraceus</i>	Common Sowthistle	*			0.1			
	<i>Stellaria</i> spp.		*		0.2				
	<i>Stenotaphrum secundatum</i>	Buffalo Grass	*	*					10
	<i>Taraxacum officinale</i>	Dandelion	*			0.1			
GG	<i>Themeda triandra</i>	Kangaroo Grass						0.2	

Form	Species name	Common name	Exotic (*)	High Threat Weed	Cover (%) Plot 1	Cover (%) Plot 2	Cover (%) Plot 3	Cover (%) Plot 4	Cover (%) Plot 5
GG	<i>Trifolium repens</i>	White Clover	*		0.1	0.1			
	<i>Typha orientalis</i>	Broadleaf Cumbungi					50		
	<i>Verbena bonariensis</i>	Purple Tops	*		0.1	0.2		0.1	2
	<i>Verbena rigida</i>	Veined Verbena	*					0.1	1

Tree (TG), Shrub (SG), Grass & Grasslike (GG), Forb (FG), Fern (EG), Other (OG)

Table 38: Vegetation integrity data (Composition, Structure and function)

Plot location data						
Plot no.	PCT	Vegetation Zone	Condition	Eastings	Northings	Bearing
1	1800	3	Degraded	293525	6262237	340
2	835	1	Degraded	293518	6262709	270
3	1071	5	Degraded	293435	6262678	345
4	835	2	Regrowth	293505	6262374	155
5	1800	4	Low			178

Composition (number of species)						
Plot no.	Tree	Shrub	Grass	Forb	Fern	Other
1	2	0	2	2	1	1
2	3	0	3	5	0	2
3	2	0	2	1	0	1
4	3	4	1	4	0	1
5	2	2	4	3	0	0

Structure (Total cover)						
	Tree	Shrub	Grass	Forb	Fern	Other
1	50.5	0	0.2	0.4	0.1	0.1
2	23.0	0	0.7	0.8	0	0.7
3	2.0	0	50.1	0.1	0	0.1
4	31.0	12.6	0.2	0.4	0	0.1
5	0.3	2	2.4	0.5	0	0

Function											
Plot no.	Large Trees	Hollow trees	Litter Cover	Length Fallen Logs	Tree Stem 5- 9 cm	Tree Stem 10-19 cm	Tree Stem 20-29 cm	Tree Stem 30-49 cm	Tree Stem 50-79 cm	Tree Regen	High Threat Weed Cover
1	0	0	85	7	1	1	1	0	0	1	11.5
2	0	0	50	0	1	1	1	1	0	1	32.3
3	0	0	0	0	0	0	0	0	0	0	1.2
4	0	0	56	17	1	1	1	0	0	1	62.0
5	0	0	2.4	0	1	0	0	0	0	1	49.0

Appendix C Ultrasonic Analysis Report

Methods

16 Anabat survey nights

Two Anabat recorders and two Anabat Swifts were placed in four locations within the St Marys Intermodal Facility. One Anabat and one Anabat Swift were placed on either side of the large dam and the other two devices were placed within small creek lines near two culverts for four nights between 11 and 16 February 2019.

Data Analysis

Bat calls were analysed by Danielle Adams-Bennett using the program AnalookW (Version 4.2n 16 March 2017, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al 2004); and south-east Queensland and north-east New South Wales (Reinhold et al 2001) and the accompanying reference library of over 200 calls from Sydney Basin, NSW (which is available at <http://www.forest.nsw.gov.au/research/bats/default.asp>). Danielle has over four years of experience in the identification of ultrasonic call recordings. This report and a sample of the calls was reviewed by Alicia Scanlon from Eco Logical Australia, who has over eleven years of experience in the identification of ultrasonic call recordings.

Bat calls were analysed using species-specific call profile parameters including call shape, characteristic frequency, initial slope and time between pulses (Reinhold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et al 2006) were followed:

Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al 2002). Cruise phase or feeding calls were labelled as being unidentifiable.

Recorded calls containing less than three pulses were not analysed and these sequences were labelled as unidentifiable, being too short to confidently determine the identity of the species making the call (Law et al 1999).

For those calls that were useful to identify the species making the call, two categories of confidence were used (Mills et al 1996):

Definitely present – the quality and structure of the call profile is such that the identity of the bat species making the calls is not in doubt

Potentially present – the quality and structure of the call profile is such that there is some / low probability of confusion with species that produce similar calls profiles

Calls made by bats which cannot be used for identification purposes such as social calls, short and low-quality calls, cruise and approach phase calls were labelled as unidentifiable.

Sequences labelled as unidentifiable were of inferior quality and therefore not able to be identified to any microbat species, they can however be used as an indicator of microbat activity at the site.

Nyctophilus spp. (Long-eared bats) are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al 2004). There are two potential *Nyctophilus* species that could occur in the study area. Both species; *N. geoffroyi* (Lesser Long-eared Bat) and *N. gouldii* (Gould's Long-eared Bat) are relatively common and widely distributed across NSW.

The Free-tailed Bats (previously referred to as the genus *Mormopterus*) have recently undergone taxonomic revision (Reardon et al 2014) and published reference calls for this group of species (Pennay et al 2004) are believed to contain errors (Greg Ford pers comm.). This report uses nomenclature for Free-tailed bat species as referred to in Jackson and Groves (2015). The correlation between nomenclature used in this report and that used in NSW State legislation is presented in Table 39 below.

Sequences not attributed to microbat echolocation calls (e.g. insect buzzes, wind, train and vehicle movement) were dismissed from the analysis.

Table 39: Correlations between current and previous nomenclature for the Free-tailed bats of NSW

Jackson and Groves 2015	Previously known as	Common Name	BC Act
<i>Austronomus australis</i>	<i>Tadarida australis</i>	White-striped Free-tailed Bat	
<i>Micronomus norfolkensis</i>	<i>Mormopterus norfolkensis</i>	Eastern Coastal Free-tailed Bat	Vulnerable
<i>Ozimops petersi</i>	<i>Mormopterus species 3</i> (small penis)	Inland Free-tailed Bat	
<i>Ozimops planiceps</i>	<i>Mormopterus species 4</i> (long penis eastern form)	Southern Free-tailed Bat	
<i>Ozimops ridei</i>	<i>Mormopterus species 2</i>	Ride's Free-tailed Bat	
<i>Setirostris eleryi</i>	<i>Mormopterus species 6</i>	Bristle-faced Free-tailed Bat	Endangered

Results

There were 307 sequences recorded from two Anabat detectors and two Anabat Swifts placed at four separate locations (Sites 1, 2, 3 and 4) for a total of sixteen (16) detector-nights within the study area at St Marys between 11 and 16 February 2019. Approximately 53% of sequences (163) submitted were able to be identified to genus or species with the remainder being too short or of low quality preventing positive identification.

High insect activity was recorded across all the devices which could have contributed to the low number of microbat calls recorded on the detectors.

There were at least nine and up to 14 species recorded in this survey (Table 40). Up to four species listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act) were recorded (Table 40 and Figure 15 to Figure 26). Three threatened species were confidently identified;

- ***Falsistrellus tasmaniensis* (Eastern False Pipistrelle)**
- ***Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat)**
- ***Myotis macropus* (Southern Myotis)**

One other threatened species were recorded as being potentially present, because this species has calls that overlap with other more common species. There were no defining call characteristics present in the recorded sequences that could be confidently attributed to the following species;

- ***Miniopterus schreibersii oceanensis* (Eastern Bent-winged Bat)**

Eastern False Pipistrelles are primarily a tree roosting species that prefers wet sclerophyll and coastal mallee forests (Churchill, 2008). This species is known from the Sydney Basin, forages over the St Mary's Internodal site and may roost in hollow bearing trees on site.

Eastern Coastal Free-tailed Bats are primarily a tree roosting species that has also been known to roost in buildings (Churchill, 2008). This species prefers dry sclerophyll forest and woodland and forages over open spaces. It is known from the Sydney Basin, particularly from the open woodlands and forests of the Cumberland Plain. This species forages over the St Mary's Intermodal site and may roost within hollow bearing trees or buildings on the site.

Southern Myotis is known from the Sydney Basin, particularly on the Cumberland Plain in western Sydney. Southern Myotis will roost in hollow bearing trees (generally within 200 m of permanent water) as well as subterranean structures such as old railway tunnels, military bunkers, culverts, bridges, stormwater drains and mines (Churchill, 2008; Campbell, 2014). This species is resident year round in the Sydney Basin with a breeding season that runs from October to March. It has a unique feeding strategy amongst Australian bats in that it forages exclusively over water, trawling the surface for small insects and aquatic species such as fish and crustaceans. Suitable waterbodies generally contain at least 3m of open water and include farm dams. Southern Myotis forages across waterbodies on site and may roost within hollow bearing trees or culverts on site.

Eastern Bent-winged Bats are known to occur in the Sydney Basin. This species is a subterranean roosting species that is only known to breed in a small number of caves in NSW (Churchill, 2008). These caves provide the perfect microclimatic conditions for rearing of young. Breeding occurs over the summer months and bats disperse to other non-breeding winter and hibernation roosts between March and August each year (Churchill, 2008). There are several Eastern Bent-winged Bat winter roosts within the Sydney basin. These roosts are found in a range of man-made structures such as old railway tunnels, military bunkers, culverts, bridges, stormwater drains, mines and sea caves. It is likely that Eastern Bent-winged Bats will forage over the St Mary's Intermodal site and possible that it could roost in culverts or other man-made structures on site.

The most commonly recorded species were *Chalinolobus gouldii* (Gould's Wattled Bat) and *Ozimops ridei* (Ride's Free-tailed Bat) either individually or as a species combination, accounting for 35% of all recorded calls (including unidentifiable sequences), and 65% of identifiable call sequences (Figure 13). Calls from the four threatened species accounted for less than 12% of recorded calls (including unidentifiable sequences) and less than 25% of identifiable sequences recorded (Figure 14).

There was very little microbat activity recorded at the culverts at dusk and dawn (Table 43 and Table 44). A couple of Gould's Wattled Bat calls were recorded at the western culvert and one Gould's Wattled Bat / Ride's Free-tailed Bat recorded at the eastern culvert at dawn. Gould's Wattled Bats have been recorded roosting in culverts but commonly prefer tree hollows. Ride's Free-tailed Bats commonly roost in tree hollows and have also been recorded in buildings but not in culverts. It is not possible to

determine whether the recorded calls were made by bats flying overhead close to the culvert or by bats entering or leaving the culvert.

See the Survey Limitations section provided below for further information.

Table 40: Summary of microbat species recorded at St Marys during surveys on 11-16 February 2019.

Scientific Name	Common Name	Definitely present	Potentially present
<i>Austronomus australis</i>	White-striped Free-tailed Bat	x	
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	x	
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	x	
<i>Falsistrellus tasmaniensis</i> *	Eastern False Pipistrelle	x	
<i>Micronomus norfolkensis</i> *	Eastern Coastal Free-tailed Bat	x	
<i>Miniopterus schreibersii</i> <i>oceanensis</i> *	Eastern Bent-winged Bat		x
<i>Myotis macropus</i> *	Southern Myotis	x	
<i>Ozimops ridei</i>	Ride's Free-tailed Bat	x	
<i>Nyctophilus sp.</i>	Long-eared Bats		x
<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	x	x
<i>Vespadelus darlingtoni</i>	Large Forest Bat		x
<i>Vespadelus regulus</i>	Southern Forest Bat		x
<i>Vespadelus vulturnus</i>	Little Forest Bat	x	

* Threatened species listed under BC Act

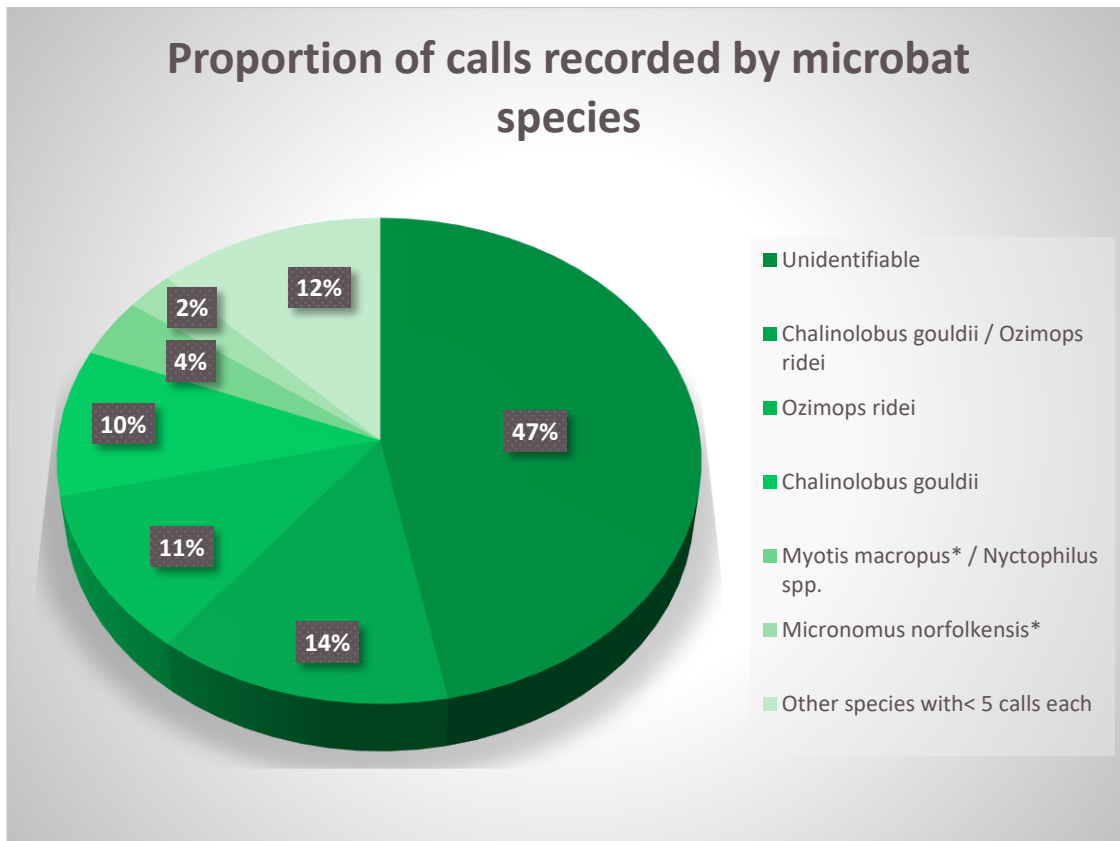


Figure 13: Proportion of microbat calls recorded by species at St Mary's Intermodal Facility 11 – 16 February 2019.

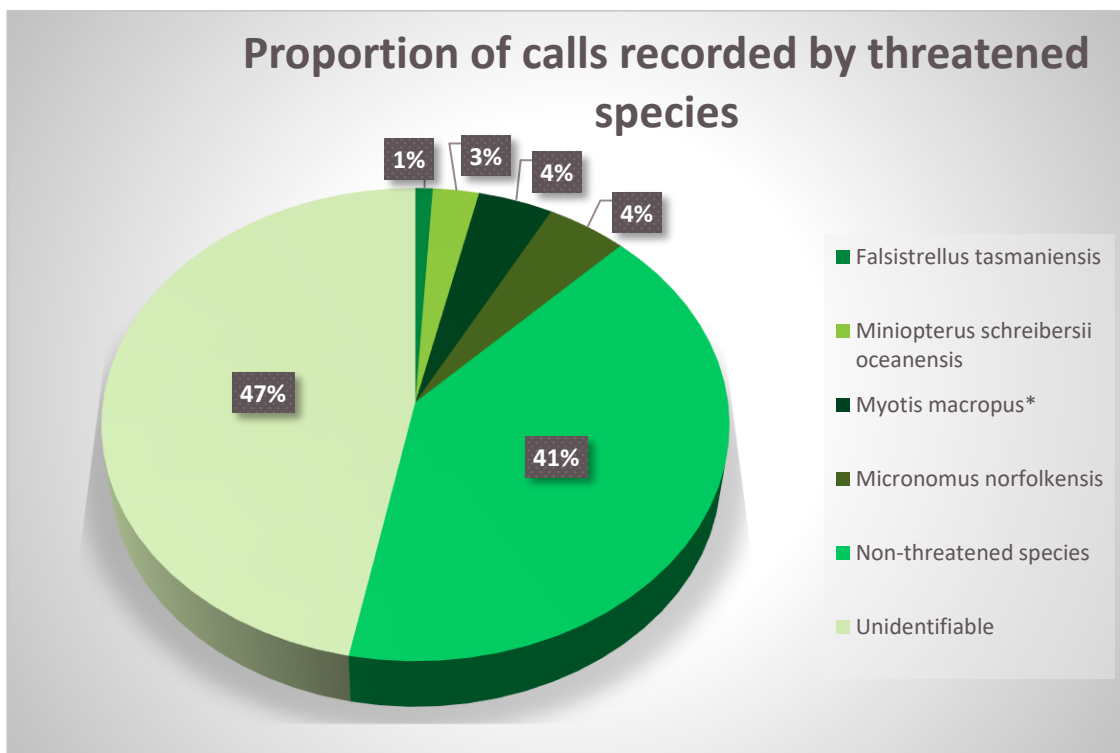


Figure 14: Proportion of calls recorded by threatened species at St Mary's Intermodal Facility 11- 16 February 2019.

Survey Limitations

Calls can only be positively identified when the defining characteristics are present and there is no chance of confusion between species with overlapping and/or similar calls. In this survey, there were some call sequences that could not be positively identified to species level because they were too unclear or too short.

The calls of *Chalinolobus gouldii* (Gould's Wattled Bat) and *Ozimops ridei* (Ride's Free-tailed Bat) can be difficult to separate. Calls were identified as Ride's Free-tailed Bat when the call shape was flat (slope S1 of less than 100 OPS generally) and the frequency was between 24 – 36 kHz. Gould's Wattled Bat was distinguished by a frequency of 27.5 – 32.5 kHz and alternation in call frequency between pulses. When no distinguishing characteristics were present calls were assigned to multi-species groups.

The calls of **Eastern False Pipistrelle**, *Scoteanax rueppellii* (**Greater Broad-nosed Bat**), and *Scotorepens orion* (Eastern Broad-nosed Bat) can be difficult to separate as their call frequencies and some other call characteristics overlap.

Greater Broad-nosed Bats can be distinguished by a frequency of 32.5 – 36 kHz, lack of a tail or short down-sweeping tail, frequency of the knee greater than 37 kHz, and drop of more than 3 kHz from the knee to the characteristic section.

Eastern False Pipistrelle bat calls have a characteristic frequency between 35.5 and 40.5 kHz, display curved, often steep pulses without up-sweeping tails and sometimes with down-sweeping tails. The pre-characteristic section is often long. This species can only be separated from Eastern Broad-nosed Bat when calls are above 37 kHz.

Eastern Broad-nosed Bat calls fall between 34.5 and 37 kHz with the frequency of the knee > 38 kHz. They can only be separated from Eastern False Pipistrelle when calls are between 34 and 35 kHz, and the frequency of the knee is above 38 kHz. Distinguished from Greater Broad-nosed Bat when there is less than a 3 kHz drop between the knee and characteristic section.

Eastern Bent-winged Bats have call profiles that overlap with other species in the Sydney Basin, including *Vespadelus darlingtoni* (Large Forest Bat) and *Vespadelus regulus* (Southern Forest Bat). Eastern Bent-winged Bat calls can be identified by a characteristic frequency of 43.5 – 47.5 kHz, a down-sweeping tail, uneven time between call pulses and pulse shape within a sequence and a drop of more than 2 kHz between the knee and characteristic section of the call. Large Forest Bat calls have a characteristic frequency of 40 - 44 kHz, have no tail or up-sweeping tails and often have a long characteristic section. Southern Forest Bats call between 43.5 and 46 kHz, and generally have up-sweeping tails with even consecutive pulses. Some of the calls recorded during this survey displayed a drop of more than 2 kHz, downward sweeping tails and variability between the pulses leading to an identification of Eastern Bent-winged Bat.

The calls of Southern Myotis are very similar to all *Nyctophilus* (Long-eared Bat) species and it is often difficult to separate these species on call characteristics alone. Calls can be identified as *Nyctophilus spp.* when the time between calls (TBC) is higher than 95ms and the initial slope S1 is lower than 300 octaves per second (OPS). Calls can be identified as Southern Myotis when the time between calls (TBC) is lower than 75ms and the initial slope S1 is greater than 400 (OPS). Where the TBC is between 75 and

95ms and the OPS is between 300 and 400 calls are assigned a mixed species label of Southern Myotis / Long-eared Bats.

Table 41: Combined Anabat results for four nights 11-16 February 2019, Site 1 (western side of dam), St Marys.

Scientific name	Common name	Definitely present	Potentially potential	Total
<i>Austronomus australis</i>	White-striped Free-tailed Bat	4		4
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	11		11
<i>Chalinolobus gouldii</i> / <i>Ozimops ridei</i>	Gould's Wattled Bat / Ride's Free-tailed Bat			19
<i>Falsistrellus tasmaniensis</i> *	Eastern False Pipistrelle	1		1
<i>Falsistrellus tasmaniensis</i> * / <i>Scotorepens orion</i>	Eastern False Pipistrelle / Eastern Broad-nosed Bat			1
<i>Micronomus norfolkensis</i> *	Eastern Coastal Free-tailed Bat	4		4
<i>Micronomus norfolkensis</i> * / <i>Ozimops ridei</i>	Eastern Coastal Free-tailed Bat / Ride's Free-tailed Bat			3
<i>Miniopterus schreibersii oceanensis</i> * / <i>Vespadelus darlingtoni</i> / <i>Vespadelus regulus</i>	Eastern Bent-winged Bat / Large Forest Bat / Southern Forest Bat			5
<i>Myotis macropus</i> * / <i>Nyctophilus spp.</i>	Southern Myotis / Long-eared Bats			5
<i>Ozimops ridei</i>	Ride's Free-tailed Bat	25		25
<i>Vespadelus darlingtoni</i> / <i>Vespadelus regulus</i>	Large Forest Bat / Southern Forest Bat			1
Unidentifiable				66
Total identified calls				79
Total calls				145
Percentage identifiable				54.5%

*Threatened species listed under BC Act

Table 42: Combined Anabat results for four nights 11-16 February 2019, Site 2 (north eastern side of dam), St Marys.

Scientific name	Common name	Definitely present	Potentially present	Total
<i>Austronomus australis</i>	White-striped Free-tailed Bat	3		3
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	14		14
<i>Chalinolobus gouldii</i> / <i>Ozimops ridei</i>	Gould's Wattled Bat / Ride's Free-tailed Bat			7
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	2		2
<i>Micronomus norfolkensis</i> *	Eastern Coastal Free-tailed Bat	4		4
<i>Micronomus norfolkensis</i> * / <i>Ozimops ridei</i>	Eastern Coastal Free-tailed Bat / Ride's Free-tailed Bat			2
<i>Miniopterus schreibersii oceanensis</i> * * / <i>Vespadelus darlingtoni</i> / <i>Vespadelus regulus</i>	Eastern Bent-winged Bat / Large Forest Bat / Southern Forest Bat			1
<i>Miniopterus schreibersii oceanensis</i> * / <i>Vespadelus regulus</i>	Eastern Bent-winged Bat / Southern Forest Bat			2
<i>Myotis macropus</i> *	Southern Myotis	1		1
<i>Myotis macropus</i> * / <i>Nyctophilus spp.</i>	Southern Myotis / Long-eared Bats			5
<i>Ozimops ridei</i>	Ride's Free-tailed Bat	5		5
<i>Vespadelus darlingtoni</i> / <i>Vespadelus regulus</i>	Large Forest Bat / Southern Forest Bat			1
<i>Vespadelus vulturnus</i>	Little Forest Bat	2		2
Unidentifiable				44
Total identified calls				49
Total calls				93
Percentage identifiable				52.7%

*Threatened species listed under BC Act

Table 43: Combined Anabat results for four nights 11-16 February 2019, Site 3 (eastern culvert), St Marys.

Scientific name	Common name	Definitely present	Potentially present	Total
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	2		2
<i>Chalinolobus gouldii</i> / <i>Ozimops ridei</i>	Gould's Wattled Bat / Ride's Free-tailed Bat			11
<i>Micronomus norfolkensis</i> * / <i>Ozimops ridei</i>	Eastern Coastal Free-tailed Bat / Ride's Free-tailed Bat			1
<i>Ozimops ridei</i>	Ride's Free-tailed Bat	1		1
Unidentifiable				29
Total identified calls				15
Total calls				44
Percentage identifiable				34.1%

*Threatened species listed under BC Act

Table 44: Combined Anabat results for four nights 11-16 February 2019, Site 4 (western culvert), St Marys.

Scientific name	Common name	Definitely present	Potentially present	Total
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	3		3
<i>Chalinolobus gouldii</i> / <i>Ozimops ridei</i>	Gould's Wattled Bat / Ride's Free-tailed Bat			5
<i>Chalinolobus morio</i> / <i>Vespadelus vulturnus</i>	Chocolate Wattled Bat / Little Forest Bat			2
<i>Falsistrellus tasmaniensis</i> *	Eastern False Pipistrelle	1		1
<i>Myotis macropus</i> * / <i>Nyctophilus spp.</i>	Southern Myotis / Long-eared Bats			2
<i>Ozimops ridei</i>	Ride's Free-tailed Bat	2		2
<i>Vespadelus darlingtoni</i> / <i>Vespadelus regulus</i>	Large Forest Bat / Southern Forest Bat			4
<i>Vespadelus vulturnus</i>	Little Forest Bat	1		1
Unidentifiable				5
Total identified calls				20
Total calls				25
Percentage identifiable				80%

*Threatened species listed under BC Act

Call Profiles

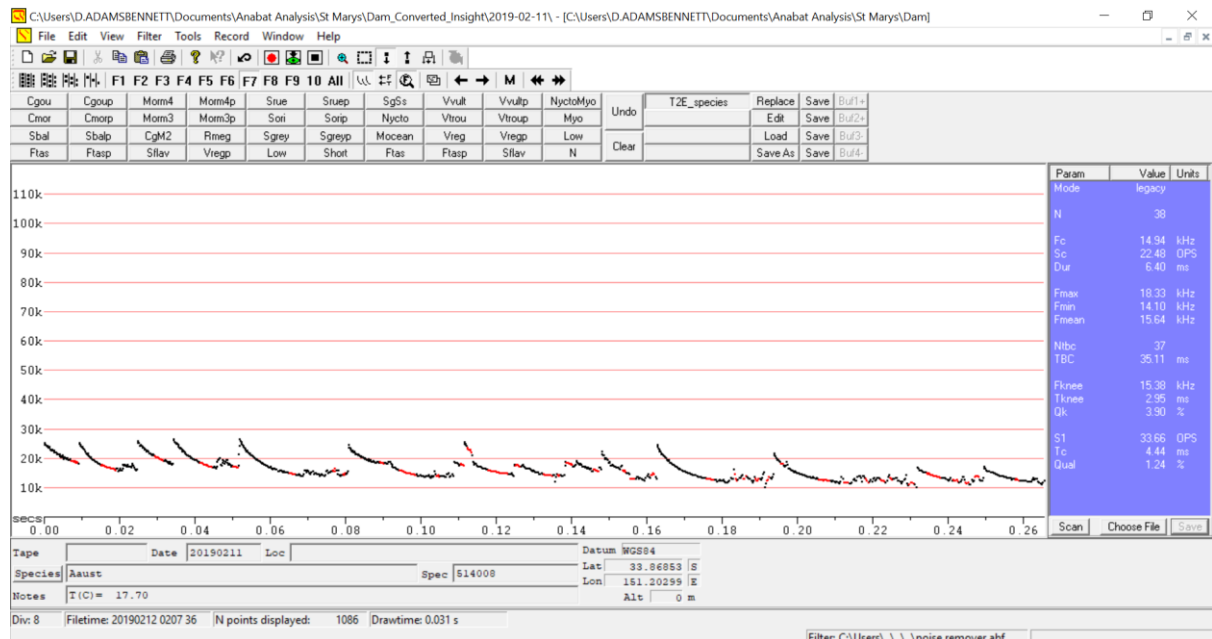


Figure 15: Call profile for *Austronomus australis* (White-striped Free-tailed Bat) recorded at Site 1, St Marys at 02:07 (2:07am) on 12 February 2019.

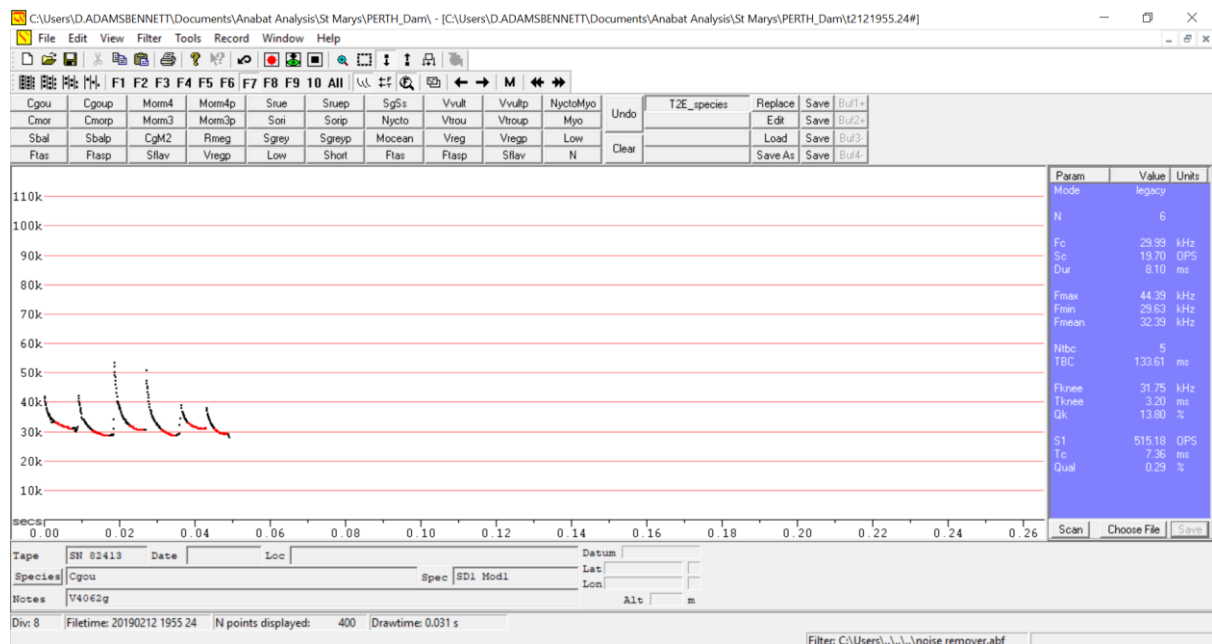


Figure 16: Call profile for *Chalinolobus gouldii* (Gould's Wattled Bat) recorded at Site 2, St Marys at 19:55 (7:55pm) on 12 February 2019.

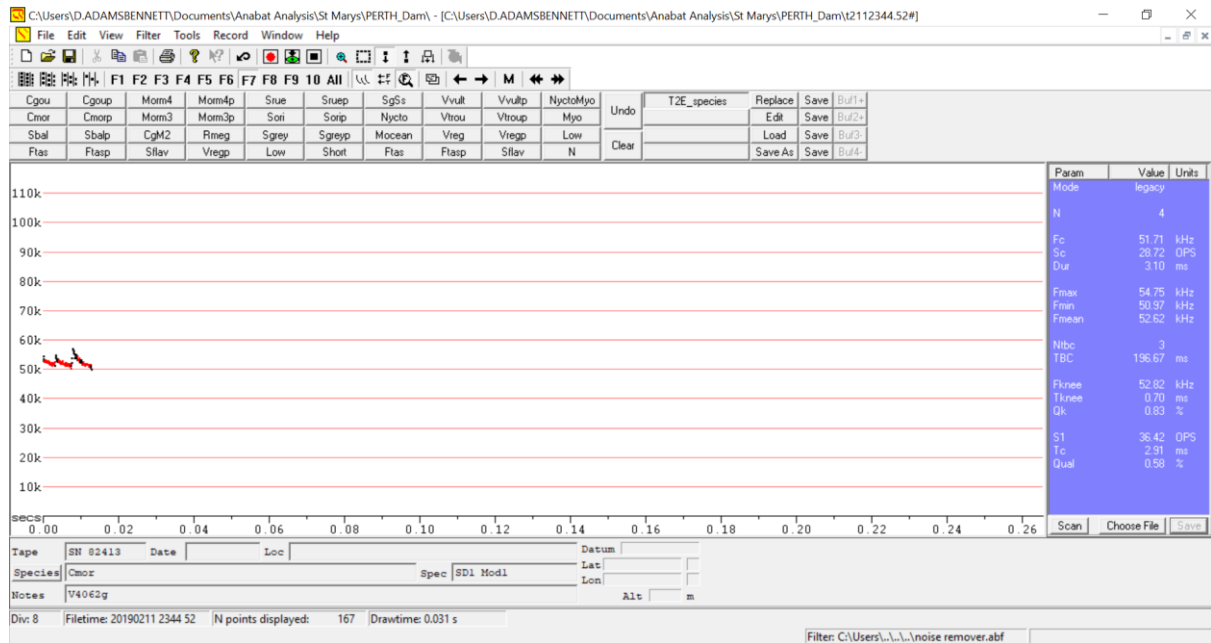


Figure 17: Call profile for *Chalinolobus morio* (Chocolate Wattled Bat) recorded at Site 2, St Marys at 23:44 (11:44pm) on 11 February 2019.

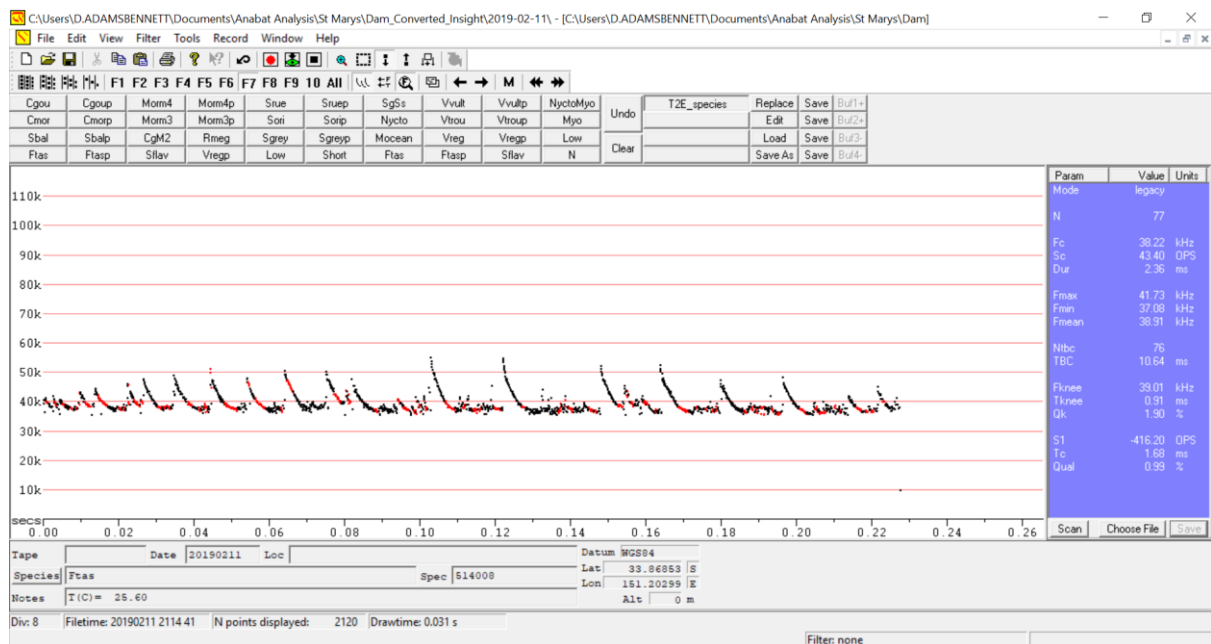


Figure 18: Call profile for *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) recorded at Site 1, St Marys at 21:14 (9:14pm) on 11 February 2019.

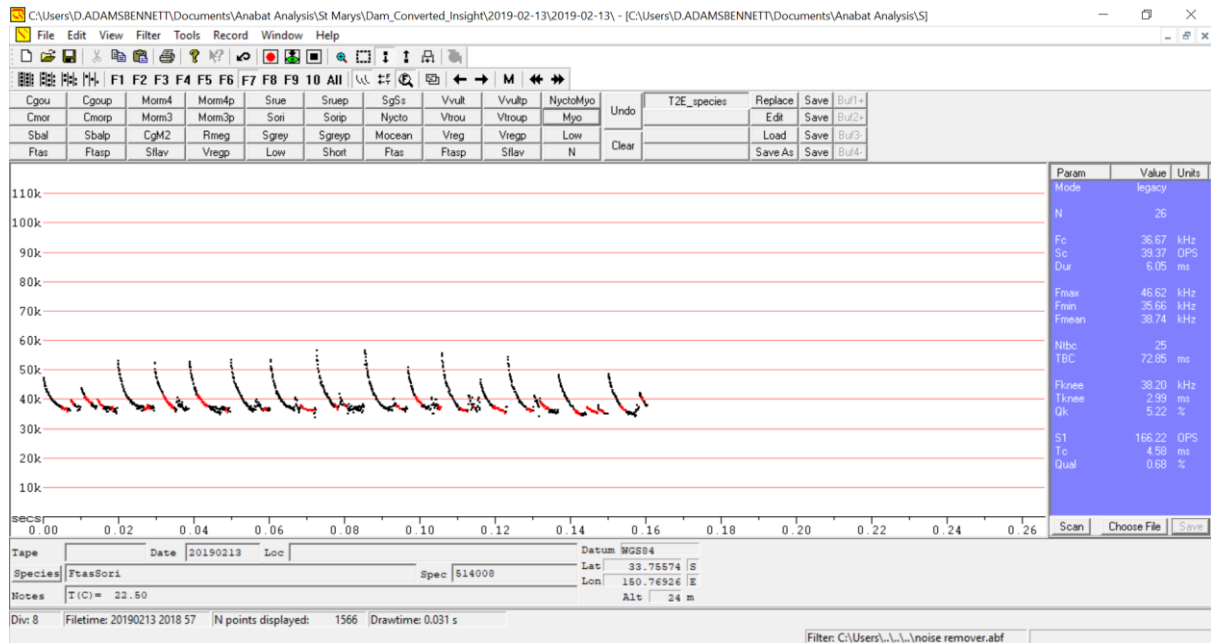


Figure 19: Call profile for *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) / *Scotorepens orion* (Eastern Broad-nosed Bat) recorded at Site 1, St Marys at 20:18 (8:18pm) on 13 February 2019.

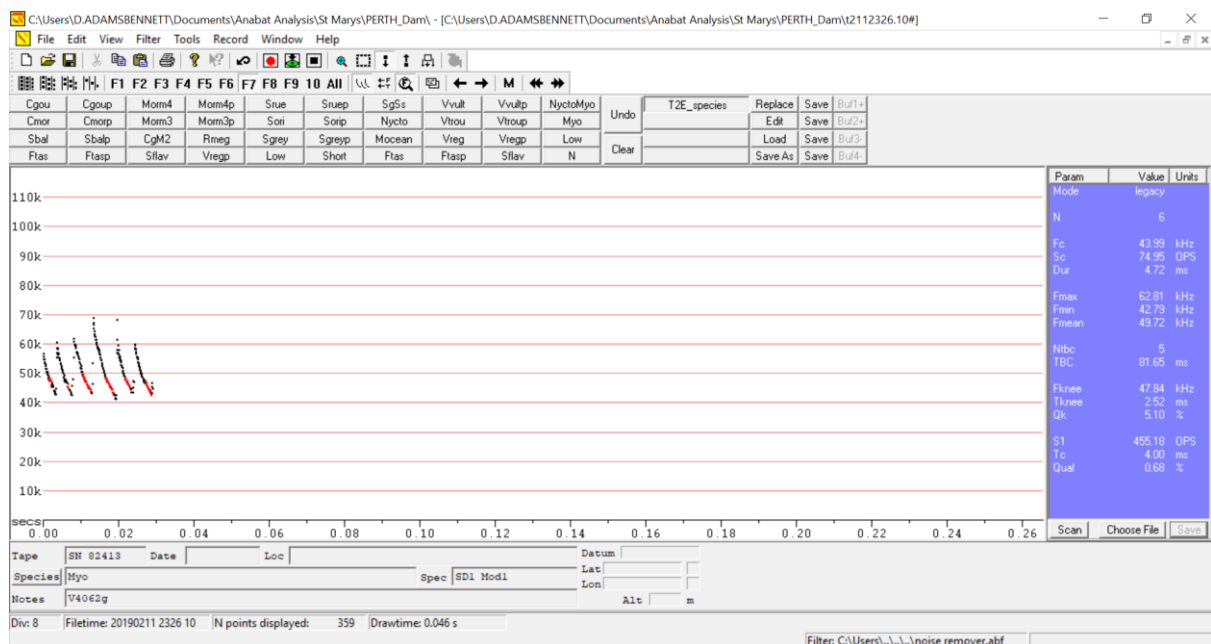


Figure 20: Call profile for *Myotis macropus* (Southern Myotis) recorded at Site 2, St Marys at 23:26 (11:26pm) on 11 February 2019.

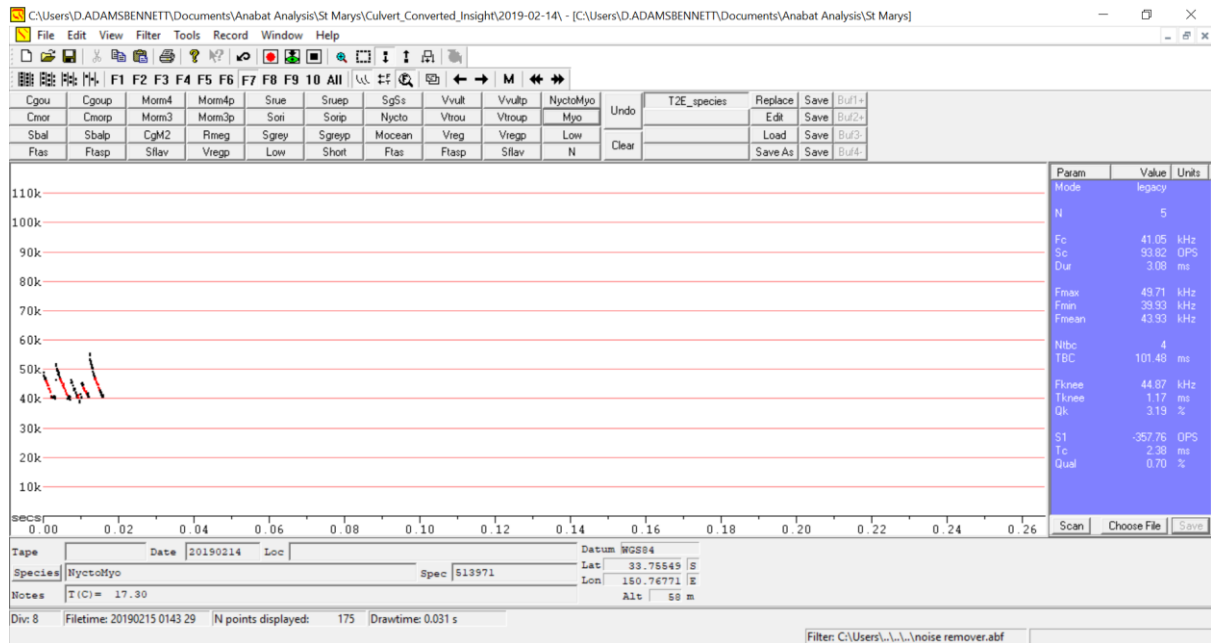


Figure 21: Call profile for *Myotis macropus* (Southern Myotis) / *Nyctophilus* sp. (Long-eared Bat) recorded at Site 4, St Marys at 01:43 (1:43am) on 15 February 2019.

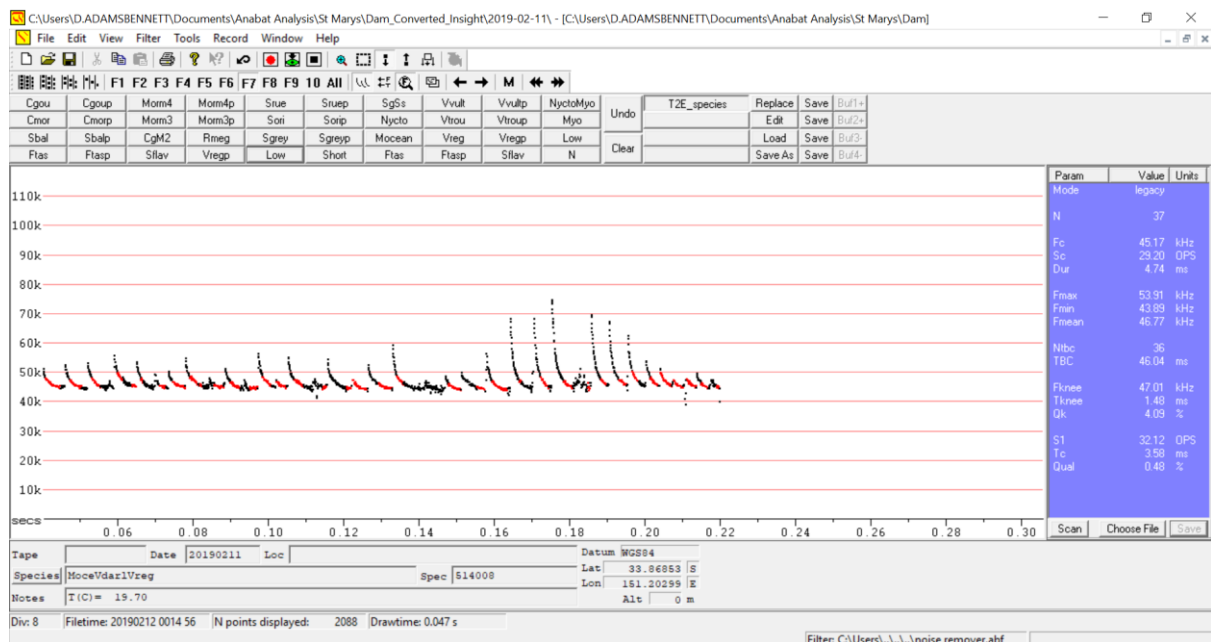


Figure 22: Call sequence for *Miniopterus schreibersii oceanensis* (Eastern Bent-winged Bat) / *Vespadelus darlingtoni* (Large Forest Bat) / *Vespadelus regulus* (Southern Forest Bat) recorded at Site 1, St Marys at 00:14 (12:14am) on 12 February 2019.

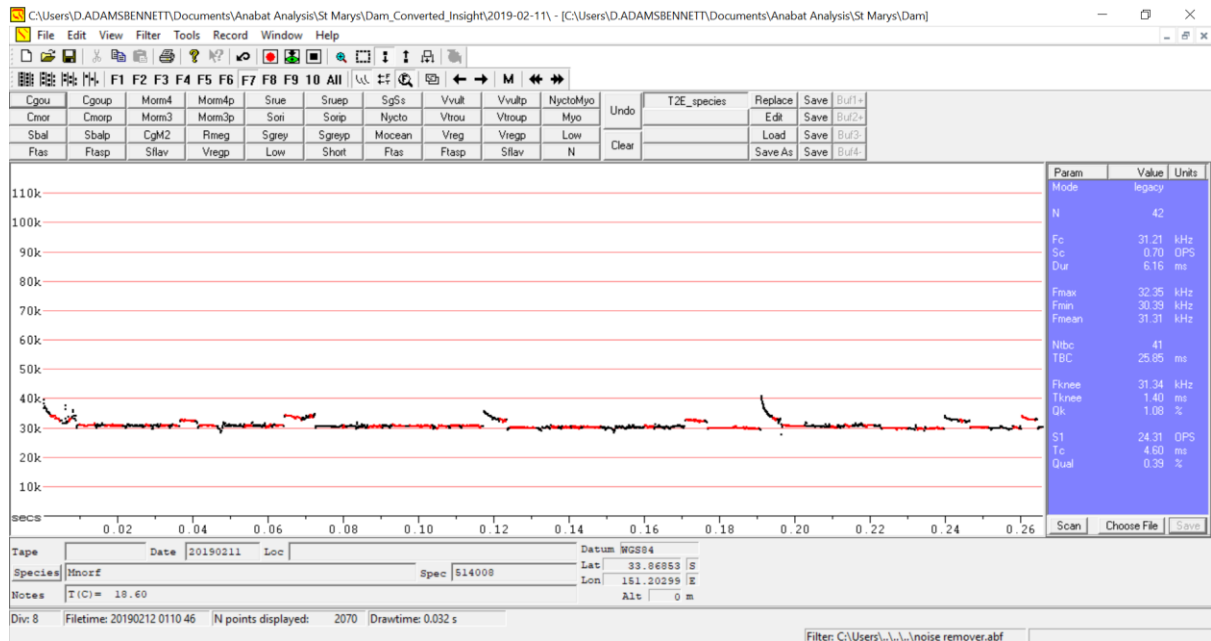


Figure 23: Call profile for *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) recorded at 0110 (1:10am) at Site 1 St Marys on 12 February 2019.

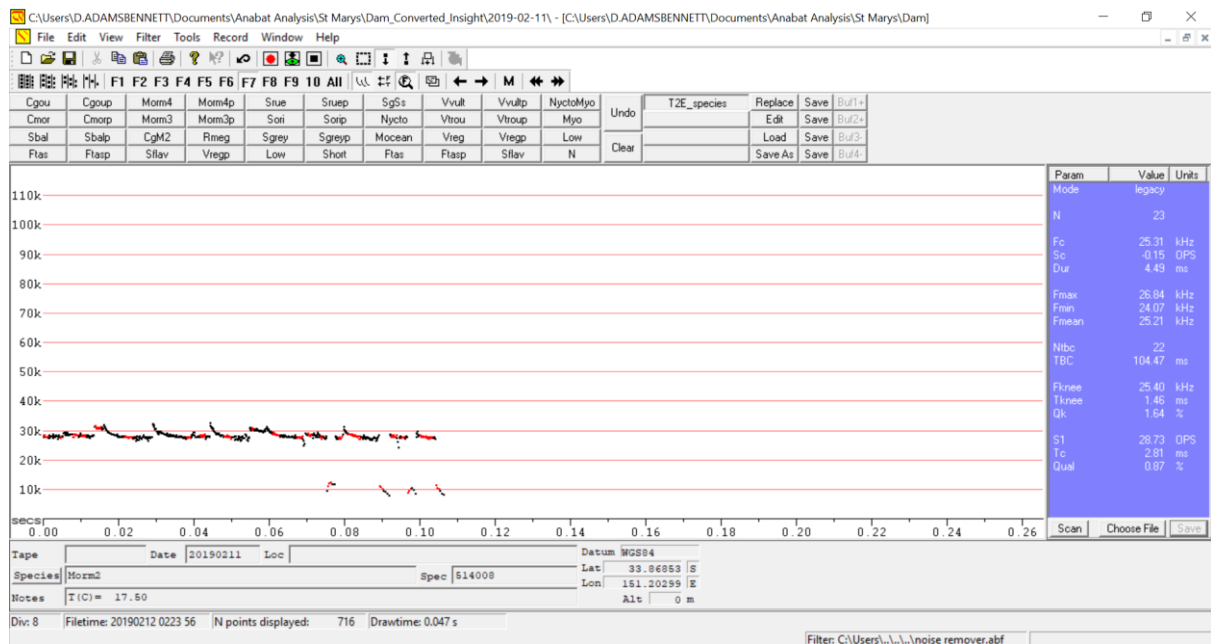


Figure 24: Call profile for *Ozimops ridei* (Ride's Free-tailed Bat) recorded at Site 1, St Marys at 02:23 (2:23am) on 12 February 2019.

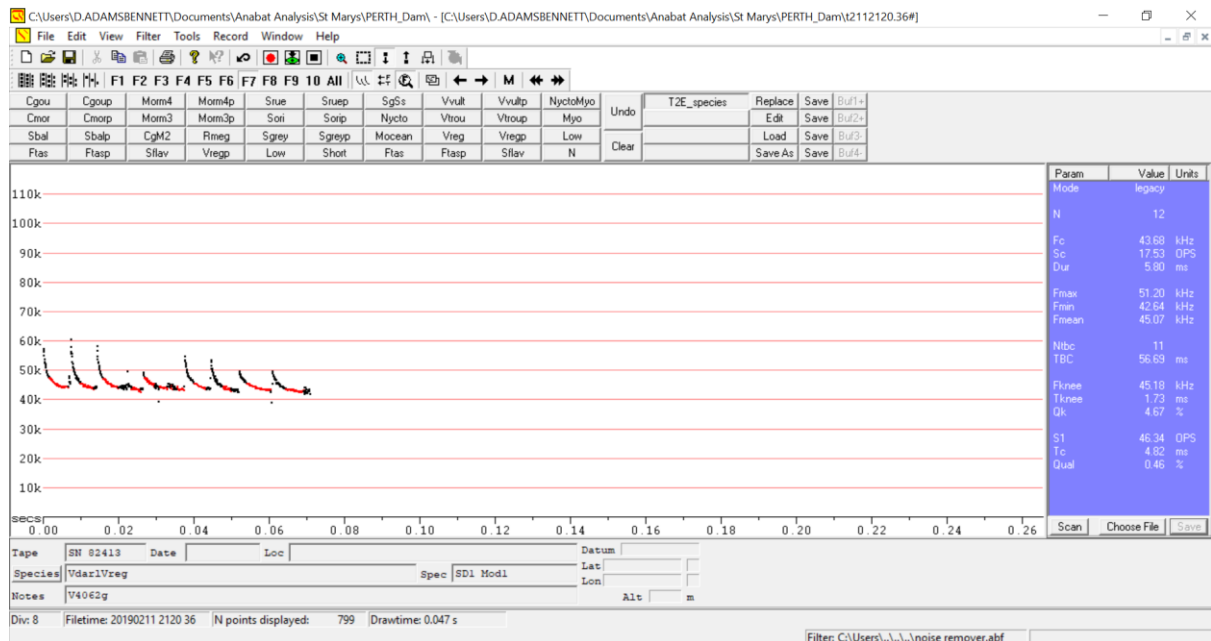


Figure 25: Call profile for *Vespadelus darlingtoni* (Large Forest Bat) / *Vespadelus regulus* (Southern Forest Bat) recorded at Site 2, 21:20 (9:20pm) on 11 February 2019.

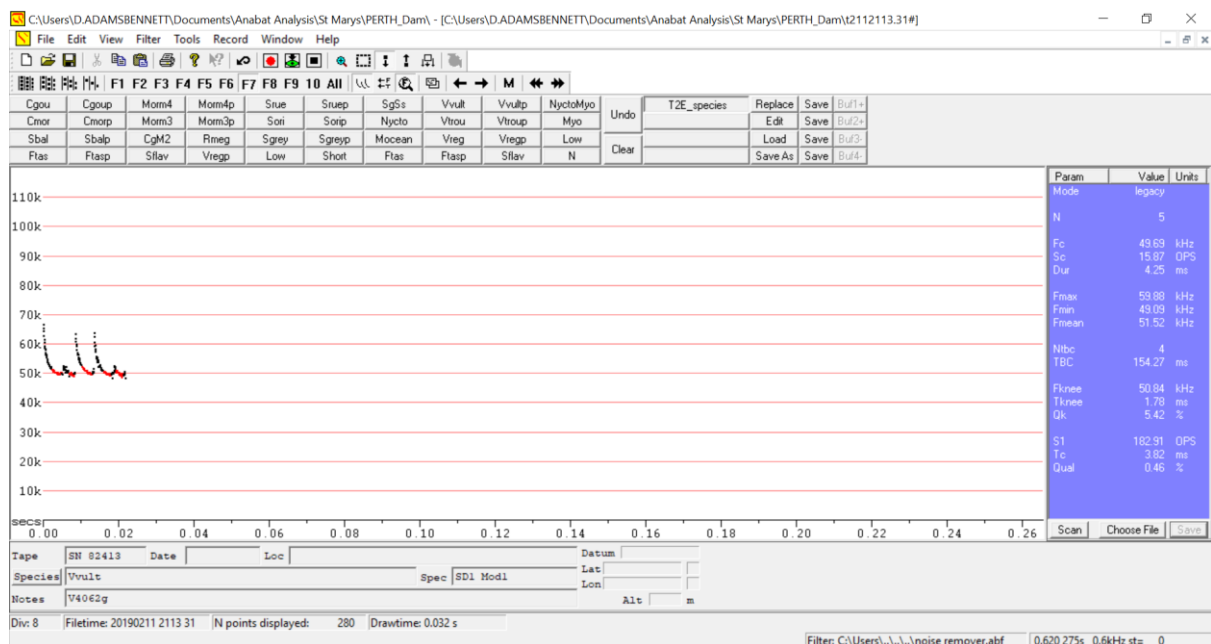


Figure 26: Call profile for *Vespadelus vulturnus* (Little Forest Bat) recorded at Site 2, St Marys at 21:13 (9:13pm) on 11 February 2019.

References

- Campbell, S. (2009) So long as it's near water: variable roosting behaviour of the large-footed myotis (*Myotis macropus*). *Australian Journal of Zoology* 57: 89-98.
- Churchill, S. (2008). *Australian Bats*. Second Edition. Allen and Unwin. NSW.
- Jackson, C. and Groves, S. (2015) *Taxonomy of Australian Mammals*. CSIRO Publishing.
- Law, B. S., Anderson, J., and Chidel, M. (1999). Bat communities in a fragmented forest landscape on the south-west slopes of New South Wales, Australia. *Biological Conservation* 88, 333-345.
- Lloyd, A.M., Law, B.S., and Goldingay, R. (2006) Bat activity on riparian zones and upper slopes in Australian timber production forests and the effectiveness of riparian buffers. *Biological Conservation* 129, 207-220.
- McKenzie, N. L., Start, A. N., and Bullen, R. D. (2002). *Foraging ecology and organisation of a desert bat fauna*. *Australian Journal of Zoology* 50, 529-548.
- Mills, D. J., Norton, T. W., Parnaby, H. E., Cunningham, R. B., and Nix, H. A. (1996). *Designing surveys for microchiropteran bats in complex forest landscapes - a pilot study from south-east Australia*. Special issue: Conservation of biological diversity in temperate and boreal forest ecosystems 85, 149-161.
- Pennay, M., Law, B., and Reinhold, L. (2004). *Bat calls of New South Wales: Region based guide to echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville.
- Reardon, T.B., McKenzie, N.L., Cooper, S.J.B., Appleton, B., Carthew, S. and Adams, M. 2014. A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats *Mormopterus* (Chiroptera: Molossidae). *Australian Journal of Zoology* 62: 109 – 136.
- Reinhold, L., Law, B., Ford, G., and Pennay, M. (2001). Key to the bat calls of south-east Queensland and north-east New South Wales. 2001. Queensland, DNR.

Appendix D Biodiversity credit report

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00013531/BAAS18162/19/00013532	St Marys Intermodal Facility	30/08/2019
Assessor Name	Report Created	BAM Data version *
Mike Lawrie	13/09/2019	13
Assessor Number	BAM Case Status	Date Finalised
BAAS18162	Open	To be finalised
Assessment Revision	Assessment Type	
2	Major Projects	

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAIL	Ecosystem credits
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion								
1	835_Degraded	35.6	0.3	0.25	High Sensitivity to Potential Gain	2.00		5
2	835_Regrowth	44.6	0.3	0.25	High Sensitivity to Potential Gain	2.00		6
							Subtotal	11

BAM Credit Summary Report

Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion								
4	1071_Moderate	36.8	0.2	0.25	High Sensitivity to Potential Gain	2.00		3
							Subtotal	3
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley								
3	1800_Degraded	28.1	0.1	0.25	High Sensitivity to Potential Gain	2.00		1
5	1800_Poor	6.5	0.7	0.25	High Sensitivity to Potential Gain	2.00		0
							Subtotal	1
							Total	15

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAIL	Species credits
<i>Grevillea juniperina subsp. juniperina</i> / Juniper-leaved Grevillea (Flora)						
835_Degraded	35.6	0.16	0.25	2	False	3
835_Regrowth	44.6	0.27	0.25	2	False	6
1800_Degraded	28.1	0.05	0.25	2	False	1
1800_Poor	6.5	0.14	0.25	2	False	0
					Subtotal	10
<i>Myotis macropus</i> / Southern Myotis (Fauna)						
835_Degraded	35.6	0.2	0.25	2	False	4
1800_Degraded	28.1	0.01	0.25	2	False	0
1071_Moderate	36.8	0.18	0.25	2	False	3



BAM Credit Summary Report

1800_Poor	6.5	0.55	0.25	2	False	2
					Subtotal	9



BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00013531/BAAS18162/19/00013532	St Marys Intermodal Facility	30/08/2019
Assessor Name	Assessor Number	BAM Data version *
Mike Lawrie	BAAS18162	13
Proponent Name(s)	Report Created	BAM Case Status
	13/09/2019	Open
Assessment Revision	Assessment Type	Date Finalised
2	Major Projects	To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Nil

Nil

Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

BAM Biodiversity Credit Report (Variations)

Predicted Threatened Species Not On Site

No Changes

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	Number of credits to be retired
835-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 of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.6	11.00
1800-Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.8	1.00
1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.2	3.00

835-Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Like-for-like credit retirement options			
	Name of offset trading group	Trading group	HBT	IBRA region

BAM Biodiversity Credit Report (Variations)

	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 686, 828, 835, 839, 941, 971, 1064, 1108, 1109, 1212, 1228, 1232, 1293, 1318, 1326, 1386, 1522, 1556, 1594, 1618, 1646, 1648, 1720, 1794, 1800	-	No	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region
	Forested Wetlands	Tier 2 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Like-for-like credit retirement options			
	Name of offset trading group	Trading group	HBT	IBRA region
	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 780, 781, 782, 828, 1071, 1735, 1736, 1737, 1738, 1739, 1740, 1741, 1742, 1911	-	No	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion	Variation options			
	Formation	Trading group	HBT	IBRA region
	Freshwater Wetlands	Tier 3 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1800-Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Like-for-like credit retirement options			
	Name of offset trading group	Trading group	HBT	IBRA region
	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 686, 828, 835, 839, 941, 971, 1064, 1108, 1109, 1212, 1228, 1232, 1293, 1318, 1326, 1386, 1522, 1556, 1594, 1618, 1646, 1648, 1720, 1794, 1800	-	No	Cumberland,Burraborang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options			
	Formation	Trading group	HBT	IBRA region

BAM Biodiversity Credit Report (Variations)

	Forested Wetlands	Tier 3 or higher	No	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
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Species Credit Summary

Species	Area	Credits
Grevillea juniperina subsp. juniperina / Juniper-leaved Grevillea	0.6	10.00
Myotis macropus / Southern Myotis	0.9	9.00

Grevillea juniperina subsp. juniperina /Juniper-leaved Grevillea	1800_Degraded	Like-for-like options		
		Spp		IBRA region
		Grevillea juniperina subsp. juniperina /Juniper-leaved Grevillea		Any in NSW
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

BAM Biodiversity Credit Report (Variations)

		Flora	Vulnerable	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1800_Poor	Like-for-like options			
	Spp		IBRA region	
	Grevillea juniperina subsp. juniperina/Juniper-leaved Grevillea		Any in NSW	
	Variation options			
	Kingdom		Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Flora		Vulnerable	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
835_Degraded	Like-for-like options			
	Spp		IBRA region	

BAM Biodiversity Credit Report (Variations)

		Grevillea juniperina subsp. juniperina /Juniper-leaved Grevillea		Any in NSW
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Flora	Vulnerable	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
835_Regrowth		Like-for-like options		
		Spp	IBRA region	
		Grevillea juniperina subsp. juniperina /Juniper-leaved Grevillea		Any in NSW
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

BAM Biodiversity Credit Report (Variations)

		Flora	Vulnerable	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Myotis macropus/ Southern Myotis	1071_Moderate	Like-for-like options		
		Spp		IBRA region
		Myotis macropus/Southern Myotis		Any in NSW
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
		Fauna	Vulnerable	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	1800_Degraded	Like-for-like options		
		Spp		IBRA region
Myotis macropus/Southern Myotis		Any in NSW		

BAM Biodiversity Credit Report (Variations)

Myotis macropus/ Southern Myotis	1800_Degraded	Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	1800_Poor	Fauna	Vulnerable	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
		Like-for-like options		
		Spp		IBRA region
		Myotis macropus/Southern Myotis		Any in NSW
		Variation options		
		Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

BAM Biodiversity Credit Report (Variations)

		Fauna	Vulnerable	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
835_Degraded	Like-for-like options			
	Spp		IBRA region	
	Myotis macropus/Southern Myotis		Any in NSW	
	Variation options			
	Kingdom		Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	

