Transport
for NSW

NSW
GOVERNMENT

Updated Biodiversity Development Assessment Report

Parramatta Light Rail Stage 2

October 2023

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Transport for NSW

July 2023

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Certification under Section 6.15 of the *Biodiversity Conservation Act 2016*

We, Dr Kirsten Crosby (BAAS17011) and Kath Chesnut (BAAS17031), certify that this Updated Biodiversity Development Assessment Report and the accompanying finalised credit report dated 22 September 2023 have been prepared in accordance with the requirements of (and information provided under) the Biodiversity Assessment Method.

Dr Kirsten Crosby – BAAS17011
22 September 2023

Kath Chesnut – BAAS17031
22 September 2023

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Glossary and abbreviations

Acronym/term	Definition
Alignment	The project alignment refers to the physical horizontal and vertical location, position and direction of the light rail tracks.
Amended project	The project incorporating the amendments described in the Amendment Report
AOBV	Areas of Outstanding Biodiversity Value
BAM	Biodiversity Assessment Methodology 2020
BAM-C	Biodiversity Assessment Method Calculator
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BC Regulation	Biodiversity Conservation Regulation 2017 (NSW)
BCF	Biodiversity Conservation Fund
BCS	Biodiversity, Conservation and Science Directorate of the Department of Planning and Environment
BCT	Biodiversity Conservation Trust
BDAR	Biodiversity Development Assessment Report
Biodiversity offsets	Biodiversity offsets are measures that benefit biodiversity by compensating for the residual adverse impacts elsewhere of an action, such as clearing for development. Biodiversity offsets work by protecting and managing biodiversity values in one area to compensate for impacts on biodiversity values in another.
Biodiversity credit	A unit of biodiversity value to measure specific development impacts or conservation gains in accordance with the BAM. Includes ecosystem credits and species credits.
Biodiversity credit report	Specifies the number and type of biodiversity credits required to offset the impacts of a development to obtain a Biodiversity Certification Agreement; or that would be generated through conservation and management of a Stewardship site under a Biodiversity Stewardship site agreement.
Biodiversity offsets	Specific measures that are put in place to compensate for impacts on biodiversity values.
Biodiversity values	The composition, structure and function of ecosystems, including threatened species, populations and ecological communities, and their habitats.
BOM	Bureau of Meteorology
BOS	Biodiversity Offsets Scheme
CAMBA	China-Australia Migratory Bird Agreement
CEEC	Critically endangered ecological community
CEMP	Construction environmental management plan
CMA	Catchment Management Authority
DAWE	Department of Agriculture, Water and the Environment (Commonwealth) (former)
DBH	Diameter at breast height
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
DEC	Department of Environment and Conservation (NSW) (former)
DECC	Department of Environment and Climate Change (NSW) (former)
DECCW	Department of Environment, Climate Change and Water (NSW) (former)
DEE	Department of Environment and Energy (Commonwealth) (former)
DEWHA	Department of Environment, Water, Heritage and the Arts (Commonwealth) (former)
DIWA	Directory of Important Wetlands of Australia

Acronym/term	Definition
DLWC	Department of Land and Water Conservation (NSW) (former)
DotE	Department of the Environment (Commonwealth) (former)
DPE	Department of Planning and Environment (NSW) (formerly DPIE)
DPI	Department of Primary Industries (NSW)
DPIE	Department of Planning, Industry and Environment (NSW) (former)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (former)
Ecosystem credit	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at a biodiversity stewardship site.
EEC	Endangered ecological community
EES	NSW Environment, Energy and Science Division of the Department of Planning and Environment (formerly known as OEH)
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
Exhibited project	The project described in the EIS
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater dependent ecosystems
GIS	Geographic information system
GPS	Global positioning system
ha	Hectare
HTE	High threat exotic (weed)
IBRA	Interim Biogeographic Regionalisation for Australia
JAMBA	Japan-Australia Migratory Bird Agreement
km	Kilometre
KTP	Key threatening process
LGA	local government area
Locality	The area within a 10 kilometre radius of the project site
m	Metre
MCA	Multi-criteria analysis
Migratory species	Species listed under listed under international agreements (i.e. Ramsar, JAMBA, CAMBA and ROKAMBA conventions) to which Australia is a party.
ML	Mega litres
MNES	Matters of National Environmental Significance
NPWS	National Parks and Wildlife Services
OEH	Office of Environment and Heritage (NSW) (former)
PCT	Plant community type
PMST	Protected Matters Search Tool
PRCG	Parramatta River Catchment Group
project	Parramatta Light Rail Stage 2
project site	Defined as the area that would be directly affected by construction of the project (also known as the construction footprint). It includes the location of project infrastructure, the area that would be directly disturbed by the movement of construction plant and machinery, and the location of the compounds and laydown areas that would be used during construction.

Acronym/term	Definition
Proponent (designated)	Individual or organization who is proposed to be designated as the proponent if the Minister decides that the action is a controlled action and further assessment, and approval is required. The proponent is responsible for meeting the requirements of the EPBC Act during the assessment process. The proponent may or may not be the person proposing to take the action. Transport for NSW is the proponent for this assessment.
Ramsar wetland	Wetlands of International Significance especially as Waterfowl Habitat, identified by the Ramsar Convention.
RBGT	Royal Botanic Gardens and Domain Trust
RDPs	Rapid Data Points
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SAII	Serious and irreversible impact
SAII entity	Species and ecological communities that are likely to be the subject of serious and irreversible impacts (SAIIs)
SEARs	Secretary's Environmental Assessment Requirements
SEED	Sharing and Enabling Environmental Data
SOPA	Sydney Olympic Park Authority
Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the threatened species profile database.
SPRAT	Species Profile and Threats Database
State significant infrastructure (SSI)	Major transport and services infrastructure which has been declared to be State significant infrastructure for the purposes of Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979*.
Study area	The area that was subject to a site survey and assessed for direct or indirect impacts arising from construction and operation of the project. The study area incorporated a number of alternate alignment options. Comprises the 'subject land' as referenced in the BAM. A buffer of 500 metres has been used in desktop assessments in accordance with the BAM for linear developments.
TBDC	Threatened Biodiversity Data Collection
TEC	Threatened ecological community
Threatened biota	Threatened species, populations or ecological communities listed under the BC Act, FM Act and/or the EPBC Act
Transport for NSW	Transport for NSW is the lead agency of the NSW Transport cluster.
TSSC	Threatened Species Scientific Committee
VI	Vegetation integrity
VIS	Vegetation information system
WONS	Weeds of National Significance

Executive summary

Introduction

Transport for NSW proposes to construct and operate Stage 2 of Parramatta Light Rail ('the project'). Stage 2 would connect the Parramatta CBD and Stage 1 to Camellia, Rydalmere, Ermington, Melrose Park, Wentworth Point and Sydney Olympic Park.

An environmental impact statement (EIS) was prepared to assess the potential impacts of the project, and to identify the management measures to address those impacts. The EIS was exhibited by the NSW Department of Planning and Environment from 9 November 2022 to 16 December 2022.

The EIS was supported by a range of technical papers, which provided detailed assessments of the potential impacts of the project as they relate to the key environmental issues defined by the Secretary's environmental assessment requirements (SEARs). This included Technical Paper 9 (Biodiversity Development Assessment Report).

Additional assessment of the potential biodiversity impacts of constructing and operating the project has been undertaken since exhibition of the EIS. The assessment has been undertaken to assist with considering and responding to issues raised in submissions and during consultation with stakeholders, assessing the impacts of the proposed amendments and to further progress commitments made in the EIS. The Biodiversity Development Assessment Report (BDAR), originally prepared to support the EIS, has been updated based on the additional assessment undertaken. It has been prepared in accordance with the NSW Biodiversity Offsets Scheme (BOS) and the Secretary's environmental assessment requirements (SEARs) for biodiversity.

A desktop assessment, the identification of relevant landscape features, and detailed flora and fauna field surveys of the construction footprint (referred to as the project site) was carried out between 2019 and 2022, in accordance with the Biodiversity Assessment Method (BAM) (Department of Planning, Industry and Environment (DPIE) 2020a).

The Biodiversity Assessment Method Calculator (BAM calculator) was used following field surveys and desktop assessment to calculate the total number and types of ecosystem and species credits that need to be purchased and retired to offset residual impacts in the project site. This report also provides an assessment of the significance of impacts on matters of national environmental significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a result of construction and operation of the project. The project was determined to be a controlled action under the EPBC Act, and requires approval from the Australian Minister for the Environment.

Impacts on marine vegetation and key fish habitat protected under the NSW *Fisheries Management Act 1994* (FM Act) have been assessed, as well as potential impacts on protected and sensitive lands, including nature reserves and coastal wetlands.

The project site is located within the localities of Parramatta, Camellia, Rydalmere, Ermington, Melrose Park, Wentworth Point and Sydney Olympic Park. Much of the vegetation within Sydney Olympic Park has been planted, with the exception of some small patches of remnant and regenerating native forest. The banks of the Parramatta River support intact stands of mangroves, as well as small patches of saltmarsh vegetation. Outside of Wentworth Point and Sydney Olympic Park, the environment is extensively developed, with vegetation restricted to planted landscapes within council reserves and along streets and gardens in residential properties.

Impacts of construction and operation

The project would clear 2.43 hectares of native vegetation and 5.51 hectares of planted vegetation. The project would directly impact five native Plant Community Types (PCTs) in the project site, including the following threatened ecological communities and protected marine vegetation types:

– Estuarine mangroves, which is protected marine vegetation under the FM Act
– Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions listed as an endangered ecological community (EEC) under the NSW *Biodiversity Conservation Act 2016* (BC Act). This is also commensurate with Subtropical and Temperate Coastal Saltmarsh vulnerable ecological community listed under the EPBC Act and is protected marine vegetation under the FM Act
– Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC listed under the BC Act
– Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC listed under the BC Act
– Planted condition Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion critically endangered ecological community (CEEC) listed under the BC Act.

There would be no direct impact on remnant Sydney Turpentine Ironbark Forest in the Newington Nature Reserve. The project would remove 1.05 hectares of planted vegetation that has been assigned to Sydney Turpentine Ironbark Forest. An assessment of serious and irreversible impacts has been provided for this CEEC. This vegetation was specifically planted to provide habitat for small woodland birds. Mitigation measures are proposed to minimise impacts on this vegetation through the design development process and limiting vegetation clearing where practicable.

Clearing of native vegetation would result in direct and indirect impacts on a range of threatened and migratory species, including:

– *Wilsonia backhousei* – population present in Newington Nature Reserve
– Green and Golden Bell Frog – key populations present at Sydney Olympic Park and Camellia areas
– Grey-headed Flying-fox – known population that would forage in the study area
– Large Bentwing Bat – known to roost and forage in the area
– Southern Myotis – breeding colony present at Sydney Olympic Park
– Powerful Owl – known to forage in the area
– Bar-tailed Godwit and Curlew Sandpiper – mapped important habitat present along the Parramatta River and Haslams Creek.

Various other threatened species and migratory waders are known to occur in the locality and may also be impacted by the project.

The project would result in the clearing of vegetation within key fish habitat and coastal wetlands.

The bridges between Camellia and Rydalmere and between Melrose Park and Wentworth Point would require the construction of abutments on the banks of the Parramatta River and piers in the river. The bridge piers between Melrose Park and Wentworth Point would result in higher flood levels on the upstream side of the bridge structures. The increase in flood levels is limited to 50 millimetres in the one per cent Annual Exceedance Probability flood event and extends into the Newington Nature Reserve Wetland. This has the potential to impact the extent and composition of wetland vegetation and associated threatened species habitat.

Construction of the two bridges over the Parramatta River would result in shading impacts to 0.91 hectares of native vegetation around the bridge structures. A conservative approach has been taken and any native vegetation likely to experience additional shade impacts has been considered likely to die off for the purposes of impact and biodiversity offset calculations.

Offsets

The majority of the project site contains non-native vegetation or other site features that do not comprise habitat for threatened biota and do not require biodiversity offsets under the BAM. Offsets are required for residual impacts on native vegetation and threatened species habitat that cannot be avoided or mitigated. Credit requirements for the direct impacts resulting from the project were calculated using the BAM calculator and comprise:

– 13 Estuarine mangrove forest (PCT 920) credits
– 1 Estuarine saltmarsh (PCT 1126) credits
– 10 Estuarine swamp oak forest (PCT 1234) credits
– 1 *Phragmites australis* and *Typha orientalis* coastal freshwater wetland (PCT 1071) credit
– 11 Sydney Turpentine-Ironbark Forest (PCT 1281) credits
– 1 *Wilsonia backhousei* species credit
– 20 Green and Golden Bell Frog species credits
– 28 Southern Myotis species credits
– 6 Bar-tailed Godwit species credits
– 9 Curlew Sandpiper species credits.

Additional credits are recommended for indirect shade impacts to vegetation and known or potential habitat surrounding each bridge structure, as follows:

– 13 Estuarine mangrove forest (PCT 920) credits
– 1 Estuarine saltmarsh (PCT 1126) credits
– 2 Estuarine swamp oak forest (PCT 1234) credits
– 1 *Wilsonia backhousei* species credits
– 4 Green and Golden Bell Frog species credits
– 16 Southern Myotis species credits
– 10 Bar-tailed Godwit species credits
– 15 Curlew Sandpiper species credits.

The preferred approach to offset the residual impacts of the project is to secure and retire appropriate credits from stewardship site/s that fit within the trading rules of the BOS in accordance with the 'like for like' report generated by the credit calculator.

A payment to the Biodiversity Conservation Fund could be considered if a suitable number and type of biodiversity credits could not be secured from third parties. Funding a biodiversity action may be available as a last resort, subject to consultation with approval authorities, if all other options are determined to be unsuitable.

Impacts to key fish habitat are to be offset to ensure no net loss in accordance with the Policy and guidelines for fish habitat conservation and management. A calculation of offsets for pier construction would be undertaken once the design is confirmed, and should include the area of impact of the piles and associated scour protection. Offsets may also be required for shading impacts. Transport for NSW would liaise with DPI Fisheries regarding the potential for compensatory works and total quantum of offsets required.

The Australian Government formally endorsed the NSW Biodiversity Offsets Scheme (BOS) in March 2020. Offset requirements for threatened biota listed under the EPBC Act likely to be significantly impacted have been calculated in accordance with BAM and will be delivered in accordance with the BOS and BC Act, pursuant to the assessment bilateral agreement.

Mitigation

Mitigation measures are proposed for the construction and operation of the project. Key measures would include:

- minimising clearing of vegetation to be investigated during the next stages of design, particularly in the Millennium Parklands
- minimising of overhead wiring adjacent to Newington Nature Reserve and Narawang Wetland, along Holker Busway and the bridges over Parramatta River to limit impacts on the Grey-headed Flying-fox, White-bellied Sea-eagle and migratory waders
- bridge design to minimise impacts to fish habitat and mangroves
- appropriate design of lighting in compliance with the *National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds* (Department of the Environment and Energy 2020) and to prevent light spill in the Sydney Olympic Park area, including the prioritisation of lighting fixtures with reduced or filtered blue, violet and ultra-violet wavelengths
- preparation of a Biodiversity Management Plan including relevant subplans such as threatened species management plans for the Green and Golden Bell Frog and microbats
- design and implementation of mitigation measures for the protection of sensitive areas outside the project site during construction, particularly with regards to management of contaminated and acid sulfate soils, and stormwater runoff
- protocols developed in conjunction with Sydney Olympic Park Authority ecologists for landscaping, hygiene and biosecurity during minor works and construction phases within Sydney Olympic Park
- weed and pest management measures, including maintenance periods
- procedures for the management and assessment of unexpected finds
- pre-clearing surveys during minor works and construction phases in the vicinity of areas of known threatened species habitat, including surveys to identify and manage removal of hollow-bearing trees
- management of fauna and habitat features during clearing, with particular attention regarding protection of Green and Golden Bell Frog and migratory wader habitat outside the project site, developed in consultation with ecologists from Sydney Olympic Park Authority
- timing of construction works to minimise impacts on threatened microbats roosting at Holker Street or other culverts, and installation of nest boxes or inclusion of microbat-friendly roosts in the design of bridge structures to mitigate the loss of hollows as a result of mangrove clearing
- consideration of maintenance of connectivity for Green and Golden Bell Frog habitat, and quality of habitat with frog-proof fencing and other measures, to be designed based on advice from Sydney Olympic Park Authority ecologists
- monitoring of construction and operation impacts on *Wilsonia backhousei* and threatened fauna species including the Green and Golden Bell Frog, White-bellied Sea-eagle and Southern Myotis
- rehabilitation of disturbed areas not affected by permanent works following construction
- mitigation of edge effects with native landscaping in sensitive areas such as adjacent to Newington Nature Reserve, along Holker Busway and Hill Road with regard to the *National Light Pollution Guidelines for Wildlife* (Department of the Environment and Energy, 2020)
- planting of feed trees for the Grey-headed Flying-fox would be considered, with a particular focus on locally indigenous winter flowering species, such as Forest Red Gum (*Eucalyptus tereticornis*), Spotted Gum (*Corymbia maculata*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*).

1. Introduction

1.1 Parramatta Light Rail

The NSW Government's Greater Sydney Region Plan *A Metropolis of Three Cities* (Greater Sydney Commission 2018) outlines a vision for a three-city metropolis. The Central River City covers the four local government areas of the City of Parramatta, Blacktown City, Cumberland City and The Hills Shire. *A Metropolis of Three Cities* highlights Greater Parramatta as the focal point for the Central River City, with employment growth and public transport being of key importance.

The Greater Parramatta and the Olympic Peninsula area (GPOP), which extends from Westmead and Parramatta in the west to Sydney Olympic Park to the east, is fast emerging as the heart of Sydney's Central River City and is set to grow and change significantly over the next 20 years. Forecasts predict that GPOP will accommodate almost 170,000 new residents by 2041. Employment opportunities will also grow, with an additional 100,000 jobs predicted by 2041 (SGS 2017).

Parramatta Light Rail will deliver an integrated light rail service that supports the population and employment growth expected throughout GPOP. It will integrate with existing and future modes of transport, including buses, trains, ferries and active transport (pedestrian and cycle networks), as well as Sydney Metro West services and the existing road network.

Parramatta Light Rail will be delivered in stages to keep pace with development:

- Stage 1 will connect Westmead to Carlingford via the Parramatta central business district (CBD) and Camellia. The construction and operation of Parramatta Light Rail Stage 1 was approved by the NSW Minister for Planning in May 2018. Major construction is underway, with the track installation complete and light rail stop construction in progress. Stage 1 is expected to start operating in 2024. Further information on Stage 1 is available at **Parramatta Light Rail**
- Transport for NSW is now proposing to construct and operate Stage 2 of Parramatta Light Rail ('the project'). Stage 2 would connect the Parramatta CBD and Stage 1 to Camellia, Rydalmere, Ermington, Melrose Park, Wentworth Point and Sydney Olympic Park.

Figure 1.1 provides an overview of Parramatta Light Rail network showing both stages.

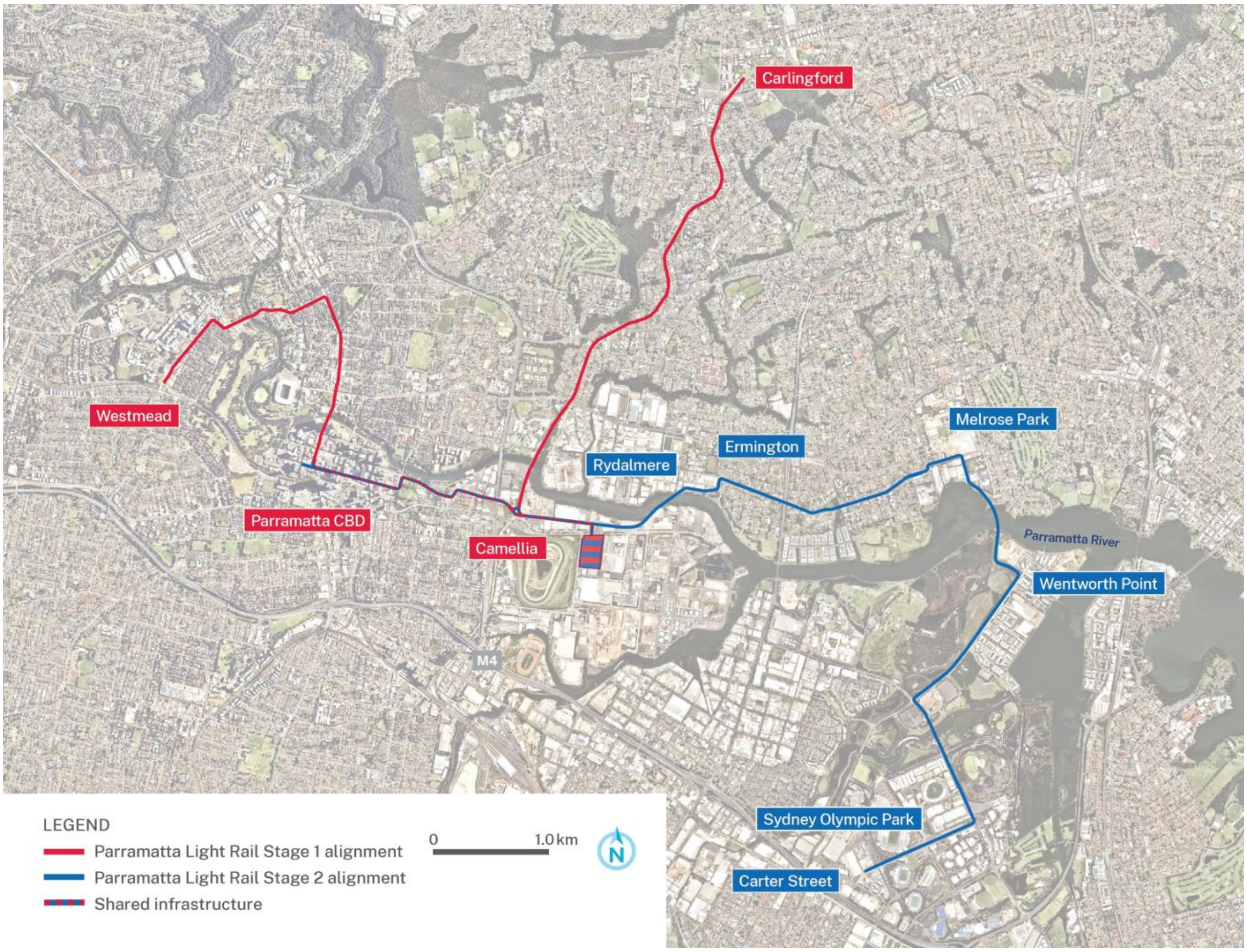


Figure 1.1 Parramatta Light Rail network

1.2 Approval and assessment requirements

1.2.1 Approval requirements

The project is critical State significant infrastructure and is subject to approval by the NSW Minister for Planning under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act).

The project is also determined to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) and requires approval from the Australian Minister for the Environment and Water.

An environmental impact statement (EIS) was prepared to assess the potential impacts of the project, and to identify the management measures to address those impacts. The EIS was exhibited by the NSW Department of Planning and Environment from 9 November 2022 to 16 December 2022. The EIS was also prepared to support Transport for NSW's application for approval of the project under the EPBC Act.

The EIS was supported by a range of technical papers, which provided detailed assessments of the potential impacts of the project as they relate to the key environmental issues defined by the Secretary's environmental assessment requirements (SEARs). This included Technical Paper 9 (Biodiversity Development Assessment Report).

1.2.2 Responding to submissions and proposed amendments

During the exhibition period, stakeholders and members of the community were able to review the EIS, participate in consultation and engagement activities, and make a written submission to the Department of Planning and Environment for consideration in its assessment of the project.

Transport for NSW has prepared a submissions report to address the Planning Secretary's request to submit a response to the issues raised in submissions to the EIS during public exhibition and DPE's State Significant Infrastructure and State Significant Project Guidelines.

During and following public exhibition of the EIS, Transport for NSW has undertaken further investigations and is proposing a number of design amendments to the project. The aim of these amendments is to address issues raised during consultation and in submissions, and to minimise the potential impacts of the project. A summary of the proposed amendments is provided in Table 1.1. Further information is provided in the Amendment Report.

Table 1.1 Summary of amendments

Proposed amendment	Overview
Camellia foreshore to Rydalmere alignment and bridge	As described in section 5.4.2 and Appendix D of the EIS, investigation of an alternative alignment between Camellia and Rydalmere (the 'Camellia foreshore to Rydalmere option') was ongoing in parallel with development of the EIS. It is now proposed to amend the project to incorporate this alternative alignment of the light rail track, active transport link and bridge over the Parramatta River. The new alignment extends along the Sandown Line corridor in Camellia; however, instead of crossing south over to Grand Avenue, it continues along the Parramatta River foreshore in Camellia before extending across a new bridge structure and along the boundary of Eric Primrose Reserve in Rydalmere. The bridge design has been amended and includes different pier arrangements in the river. It is also proposed to locate the light rail stop at John Street closer to Rydalmere Wharf.
Bridge between Melrose Park and Wentworth Point	The project as described in the EIS included a bridge located between the southern end of Wharf Road in Melrose Park and the northern end of Wentworth Point. It is proposed to amend the alignment and locate the bridge further to the west to avoid direct impacts to residential properties. The works would also include removing the existing high voltage transmission tower at Melrose Park and relocating the wires to three new poles located to the west of the original tower.
Bridge at Hill Road	The project as described in the EIS included retaining the Hill Road bridge in Sydney Olympic Park and providing a new bridge for light rail vehicles on the western side of the existing bridge. It is now proposed to remove the existing bridge at Hill Road and construct a new bridge, which would accommodate road traffic and light rail vehicles in an on-road (segregated) running corridor to reduce impacts on Narawang Wetland.

In addition, refinements are proposed to the location of the traction power substation near Atkins Road, and the cut and fill volumes generated during earthworks.

1.3 Project overview

The project comprises two main elements:

– construction of about 10 kilometres of light rail infrastructure between Camellia and the Carter Street precinct adjacent to Sydney Olympic Park
– operation of about 13 kilometres of light rail alignment between the Parramatta CBD and the Carter Street precinct, including a section of infrastructure constructed by Parramatta Light Rail Stage 1 between Camellia and the Parramatta CBD.

Further information on the location of the project, and a description of the project site for the purposes of this document, is provided in the Amendment Report.

1.3.1 Key features

The key features of the project (as amended), which are shown on Figure 1.2, include:

Light rail track and bridges

- a new 10 kilometre long dual light rail track, with 14 stops, between the Parramatta Light Rail Stage 1 line in Camellia and the Carter Street precinct adjacent to Sydney Olympic Park
- two bridges over the Parramatta River between Camellia and Rydalmere, and between Melrose Park and Wentworth Point
- a bridge over Silverwater Road between Rydalmere and Ermington
- other bridge works in Ken Newman Park and Sydney Olympic Park.

Active and public transport integration

The project would also deliver:

- about 9.5 kilometres of new active transport links between Camellia and the Carter Street precinct, which would connect with the existing cycling and pedestrian network
- interchanges with other forms of public transport, including trains, ferries, buses and Sydney Metro West, with the main interchanges located in the Parramatta CBD, Rydalmere and Sydney Olympic Park
- a light rail and pedestrian zone (no through vehicle access) within Sydney Olympic Park along Dawn Fraser Avenue between Australia Avenue and Olympic Boulevard
- bus access over the proposed bridge between Melrose Park and Wentworth Point.

Other works

Works proposed to support the project's operation:

- turnback facilities, including along part of Macquarie Street in the Parramatta CBD
- adjustments to the Parramatta Light Rail stabling and maintenance facility at Camellia
- five new traction power substations to convert electricity to a form suitable for use by light rail vehicles
- new and improved open spaces and recreation facilities at Eric Primrose Reserve, Ken Newman Park and the Atkins Road stop.

Further information on the project's features is provided in the updated project description chapters in Appendix A of the Amendment Report.

Figure 1.2 *Key features of the project*

1.3.2 Operation

The project would operate between the Parramatta CBD and the Carter Street precinct, using a section of the Parramatta Light Rail Stage 1 alignment and the alignment constructed as part of the project.

Between the Parramatta CBD and Camellia, the project would operate along about three kilometres of the Parramatta Light Rail Stage 1 alignment. Parramatta Light Rail Stage 2 services would terminate at the Stage 1 Parramatta Square stop to allow customers direct and convenient access to Parramatta's CBD, and interchange with Stage 1 light rail services, trains, buses and Sydney Metro West.

From Camellia, the project would operate along the light rail infrastructure proposed as part of Stage 2, terminating at the proposed Carter Street stop.

The project would operate as a turn-up-and-go light rail service from 5am to 1am, seven days a week, in line with Parramatta Light Rail Stage 1. The project would have travel times of around 29 minutes from the Carter Street stop in Lidcombe to the proposed Sandown Boulevard stop in Camellia, and a further seven minutes to the Parramatta Square stop in the Parramatta CBD.

Further information on the project's operation is provided in the Amendment Report.

1.3.3 Timing

It is anticipated that construction would start in 2025, subject to obtaining all necessary approvals, and the first passenger services are proposed to start from 2030/2031.

An indicative construction methodology is provided in the Amendment Report.

1.4 Purpose and scope of this report

Additional assessment of the potential biodiversity impacts of constructing and operating the project has been undertaken since exhibition of the EIS. The assessment has been undertaken to assist with responding to issues raised in submissions and during consultation, to assess the impacts of the proposed amendments, and to further progress commitments made in the EIS.

The Biodiversity Development Assessment Report, originally prepared to support the EIS, has been updated based on the additional assessment undertaken.

This report has been prepared to assess the potential biodiversity impacts from constructing and operating the project. The report:

- addresses the relevant SEARs listed in Table 1.2
- describes the existing environment of the project site, including the results of the desktop assessment and site surveys
- assesses the value and conservation significance of native vegetation and habitats at the project site (as amended) and the potential for threatened biota and matters of national environmental significance (MNES) to occur at the project site or be affected by the project
- provides a description of the project (as amended), including potential impacts on biodiversity values and measures to avoid or mitigate impacts
- assesses the significance of impacts on threated biota and MNES
- presents the data used to perform the Biodiversity Assessment Method (BAM) credit calculations for the project
- calculates the number and type of biodiversity credits that would be required to offset impacts of the project in accordance with the BAM
- provides additional information as required to respond to issues raised in submissions and during consultation
- recommends measures to mitigate and manage the impacts identified.

The methodology for the assessment is described in section 3.

Table 1.2 Secretary's environmental assessment requirements relevant to biodiversity

Item	Section	Where addressed in this report
General 1. Environmental Impact Assessment Process	The proposal will impact matters of national environmental significance (MNES) protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and will be assessed in accordance with the bilateral assessment agreement between the Australian and NSW governments (Amending Agreement No.1 2020). The Proponent must assess impacts to MNES protected under the EPBC Act. The assessment must be in accordance with the requirements listed in Attachment A.	The project has been referred to the Minister for the Environment for assessment and is a controlled action.
	For each of the EPBC Act listed species predicted to occur within and surrounding the proposed action area, likely to be significantly impacted, the EIS must provide: 1. Survey results, including details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Commonwealth guidelines and policy statements and/or the relevant NSW offsetting method. 2. A description and quantification of habitat in the study area (including suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advices, conservation advices, recovery plans, and threat abatement plans. 3. Maps displaying the above information (specific to each EPBC protected matter) overlaid with the proposed action. It is acceptable, where possible, to use the mapping and assessment of Plant Community Types (PCTs) and the species surveys prescribed by the BAM as the basis for identifying EPBC Act-listed species and communities. The EIS must clearly identify which PCTs are considered to align with habitat for the relevant EPBC Act listed species or community and provide individual maps for each species or community. 4. Description of the nature, geographic extent, magnitude, timing and duration of any likely direct, indirect and consequential impacts on any relevant EPBC Act listed species and communities. It must clearly identify the location and quantify the extent of all impact areas to each relevant EPBC Act listed species or community. 5. For each of the EPBC Act listed species and communities likely to be impacted by the development, the EIS/assessment must provide information on proposed avoidance and mitigation measures to deal with the impacts of the action, and a description of the predicted effectiveness and outcomes that the avoidance and mitigation measures will achieve. 6. Quantification of the offset liability for each species and community significantly impacted, and information on the proposed offset strategy, including discussion of the conservation benefit for each species and community, how offsets will be secured, and the timing of protection. All suitable habitat for MNES significantly impacted must be offset. It is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like-for-like'.	Survey methods are detailed in section 3 Plant community types and fauna habitats are identified in section 5, Threatened species in section 6, and Protected Matters are identified in section 7 Potential impacts on Protected Matters are discussed in section 9.10 and Appendix G Mitigation measures are provided in section 10 The requirements for offsets are provided section 11

Item	Section	Where addressed in this report
Key issue 3. Biodiversity	The EIS must address the following specific issues:	
	1. Assess biodiversity impacts in accordance with s7.9 of the *Biodiversity Conservation Act 2016* (BC Act), the Biodiversity Assessment Method (BAM), and be documented in a Biodiversity Development Assessment Report (BDAR).	This report is the BDAR prepared in accordance with the BAM
	2. The BDAR must document the application of the avoid, minimise and offset framework in accordance with the BAM.	Measures to avoid and minimise impacts are outlined in section 9.1 Mitigation measures are provided in section 10 The requirements for offsets are provided section 11
	3. The BDAR must include information in the form detailed in s6.12 of the BC Act, cl6.8 of the Biodiversity Conservation Regulation 2017 and the BAM, with specific reference to, but not limited to: (a) green and golden bell frog; (b) white-bellied sea-eagle; (c) various threatened microbat species; and (d) powerful owl.	This report is the BDAR prepared in accordance with the BAM Threatened species listed under the BC Act are discussed in section 6 The requirements for offsets are provided section 11
	4. The BDAR must be submitted with all digital spatial data associated with the survey and assessment as per Appendix K of the BAM.	Spatial data will be provided to the Department of Planning and Environment
	5. The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2020 under s6.10 of the BC Act.	Staff qualifications and accreditations are provided in section 3.8
	6. The BDAR must include details of the measures proposed to address offset obligation as follows: (a) the total number and classes of biodiversity credits required to be retired for the developments/proposal; (b) the number of classes of like-for-like biodiversity credits proposed to be retired; (c) the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; (d) any proposal to fund a biodiversity conservation action; and (e) any proposal to make a payment to the Biodiversity Conservation Fund; and (f) any staged retirement of credits based on when the development is carried out that would impact on biodiversity values. *Note: If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.*	Ecosystem and species credit requirements are provided in section 11
	7. Impacts on biodiversity values not covered by the BAM must be assessed. This includes a threatened aquatic species assessment (Part 7A *Fisheries Management Act 1994*) to address whether there are likely to be any significant impact on listed threatened species, populations or ecological communities listed under the *Fisheries Management Act 1994* (FM Act).	Aquatic habitats are identified in section 5.7 Impacts on aquatic habitats are discussed in section 9 The requirements for offsets are provided section 11
	8. Identify whether the proposal, or any component of the proposal, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the BC Act, FM Act and the EPBC Act.	Key threatening processes are discussed in section 9.8
	9. Undertake an assessment of the potential impact on the Narawang Wetland habitats, and Newington Nature Reserve and Millennium Parklands.	Wetland habitats and parklands have been identified in section 5.8 and impacts summarised in section 9

Item	Section	Where addressed in this report
12. Protected and Sensitive Lands	1. Impacts of the proposal on environmentally sensitive land and processes (and the impact of processes on the proposal) including, as relevant, but not limited to: (a) land identified as "Coastal wetlands and littoral rainforests area" under the State Environmental Planning Policy (Coastal Management) 2018;	Protected and sensitive lands are identified in section 5.8 and impacts summarised in section 9.9
	(b) high biodiversity value land identified on the Biodiversity Values Map under the BC Act;	
	(c) coastal hazards identified in studies completed by local councils or state agencies (including risk mitigation strategies that reduce coastal hazards exposure and funding of such strategies); (d) coastal processes (including disruptions to wave direction, dune stability, sediment movement etc.) associated with adopted risk mitigation actions; (e) safe public access to coastal areas, beaches, headlands and foreshores;	Not covered in this report, refer to Chapter 17 (Water) of the EIS
	(f) protected areas (including land and water) managed by the Department under the *National Parks and Wildlife Act 1974* and the *Marine Estate Management Act 2014;* (g) Key Fish Habitat as mapped and defined in accordance with the *Fisheries Management Act 1994* (FM Act); (h) waterfront land as defined in the *Water Management Act 2000;* (i) land or waters identified as Critical Habitat under the FM Act or EPBC Act or areas of outstanding biodiversity value under the BC Act; and (j) biodiversity stewardship sites, private conservation lands and other lands identified as offsets.	Protected and sensitive lands are identified in section 5.8 and impacts summarised in section 9.9

The project has been declared a controlled action under the EPBC Act due to likely significant impacts on MNES. The relevant MNES and the corresponding EPBC Act controlling provisions for the proposed action are:

– listed threatened species and communities (sections 18 and 18A).

The Australian Department of Climate Change, Energy, the Environment and Water (DCCEEW) delegate for the Commonwealth Minister for the Environment and Water considers that the proposed action is likely to significantly impact the following MNES, including but not limited to:

– Green and Golden Bell Frog (*Litoria aurea*).

This BDAR has assessed potential impacts on threatened species and communities listed under the EPBC Act (section 7 and 9.10). Offsets for impacts on the Green and Golden Bell Frog have been calculated in accordance with the BAM (section 11).

1.5 Disclaimer

This report has been prepared by GHD for Transport for NSW and may only be used and relied on by Transport for NSW for the purpose agreed between GHD and the Transport for NSW.

GHD otherwise disclaims responsibility to any person other than Transport for NSW arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

2. Legislative context

2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Environmental Planning and Assessment Regulation 2021 (EP&A Regulation) provide the statutory basis for planning and environmental assessment in NSW. The EP&A Act provides the framework for environmental planning and development approvals. The EP&A Act includes provisions to ensure that the potential environmental impacts of a development are assessed and considered in the decision-making process.

The EP&A Act contains two parts that impose requirements for planning approval. These are generally as follows:

– Part 4 provides for the control and assessment of ‘development’ that requires development consent. This includes local, regional and State significant development (SSD)
– Part 5 provides for the control and assessment of ‘activities’ that do not require development consent (Division 5.1) and declared State significant infrastructure (Division 5.2).

The project is State significant infrastructure and is therefore subject to assessment and approval by the Minister for Planning under Part 5, Division 5.2 of the NSW EP&A Act.

The need or otherwise for development control and the relevant approval authority is set out in environmental planning instruments – consisting of local environmental plans (LEPs) and State environmental planning policies (SEPPs). Section 5.22(2)(a) of the EP&A Act provides that SEPPs do not apply to or in respect of State significant infrastructure, except where they apply to the declaration of State significant infrastructure. Clause 2.4 of the Resilience and Hazards SEPP provides that a consent authority must not grant consent for development in mapped coastal wetland and environment area unless it is satisfied that the listed matters are addressed, including that sufficient measures have been, or will be, taken to protect, and where possible enhance, the biophysical, hydrological and ecological integrity of the coastal wetland. The potential for impacts of the project on coastal wetlands is assessed in this report.

2.2 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) provides legal protection for biota of conservation significance in NSW. The BC Act aims to, amongst other things, ‘maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development’. It provides for the listing of threatened species and communities, establishes a framework to avoid, minimise and offset the impacts of proposed development (the Biodiversity Offsets Scheme (BOS)), and establishes a scientific method for assessing the likely impacts on biodiversity values and calculating measures to offset those impacts (the Biodiversity Assessment Method (BAM)). These are discussed further below.

2.2.1 Biodiversity Offset Scheme and Biodiversity Assessment Methodology

The BC Act, together with the Biodiversity Conservation Regulation 2017, provides a mechanism to address impacts on biodiversity from land clearing associated with development. Under this legislation, there are provisions for a Biodiversity Offsets Scheme (BOS), which includes a framework to avoid, minimise and offset impacts of development on biodiversity.

The aim of the BOS is to provide a transparent, consistent and scientifically based approach to biodiversity assessment and offsetting. It also allows for the establishment of biodiversity stewardship agreements, which are in-perpetuity agreements entered into by landholders, to secure offset sites and generate biodiversity credits, which can be used to offset impacts of development. The aim of the BOS is to ensure that the impacts of development, clearing or biodiversity certification will result in no net loss of biodiversity.

The Biodiversity Assessment Method (BAM) was established by the former Office of Environment and Heritage (OEH, now part of DPE) as a standard method to implement the aims of the BOS and to address the loss of biodiversity and threatened species. The scheme creates a market framework for the conservation of biodiversity values and the offsetting of development impacts. It also provides the mechanisms to offset impacts of development, clearing or biodiversity certification such that there is no loss of biodiversity values.

The BAM sets out how biodiversity values will be assessed, prescribes requirements to avoid and minimise impacts, establishes rules for calculating the number and class of credits required for unavoidable impacts, and determines the trading rules that will apply. The methodology includes a software package known as the Biodiversity Assessment Method Calculator (the BAM calculator) which processes site survey and assessment data. The BAM calculator specifies the type and extent of surveys required for a biodiversity assessment and then processes survey data to calculate the number and type of biodiversity credits that are either required at a development site or will be generated at a stewardship site. The BAM must be applied by a person accredited under the BC Act.

The sale of biodiversity credits to offset the impacts of development provides funds for landowners to carry out management actions at biodiversity stewardship sites and provides a financial incentive to landowners to conserve biodiversity values. The BOS ensures accountability and compliance through legislation, regular reporting requirements and financial measures. Under certain circumstances a developer may make a payment directly into the Biodiversity Conservation Fund (BCF) to offset the impacts of a proposed development in lieu of purchasing and retiring biodiversity credits. The Biodiversity Conservation Trust (BCT) must then use funds in the BCF to purchase and retire appropriate biodiversity credits.

The BOS and BAM have been addressed in accordance with the project SEARs through the preparation of this BDAR by accredited assessors.

2.3 Fisheries Management Act 1994

The objects of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. It provides for the listing of threatened species, populations and ecological communities, listing of 'Key Threatening Processes' (KTPs), and the requirements or otherwise for the preparation of a Species Impact Statement (SIS).

One of the objectives of the FM Act is to 'conserve key fish habitats ' which includes aquatic habitats that are important to the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. To assist in the protection of key fish habitats, the Department of Primary Industries (DPI) Fisheries has produced the *Policy and guidelines for fish habitat conservation and management* (DPI 2013). This policy applies to the following developments, works or activities, each of which can impact on key fish habitat:

- dredging or reclamation
- impeding fish passage
- damaging marine vegetation
- de-snagging.

The FM Act has been considered in this assessment through:

- desktop review to determine the threatened biota that are predicted to occur within the locality of the project and hence could occur, subject to the habitats present
- aquatic habitat assessment
- assessment of potential impacts on threatened biota and key fish habitat
- identification of suitable impact mitigation and environmental management measures for aquatic habitats, where required.

In accordance with Section 5.23(1) of the EP&A Act, the following permits (which may have been required were the project not declared SSI) would not be required:

- Section 201 – permit to carry out works of dredging and reclamation
- Section 205 – permit to harm marine vegetation
- Section 219 – permit to obstruct the free passage of fish.

2.4 Biosecurity Act 2015

The *Biosecurity Act 2015* provides for risk-based management of biosecurity in NSW. It provides a statutory framework to protect the NSW economy, environment and community from the negative impact of pests, diseases and weeds.

The primary object of the Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers.

In NSW, all plants are regulated, with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

Priority weeds for the Greater Sydney region were recorded in the study area. Legal requirements to minimise the potential for the introduction and/or spread of weeds as a result of the project are discussed in section 5.4.1.

2.5 Environment Protection and Biodiversity Conservation Act 1999

The purpose of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to ensure that actions likely to cause a significant impact on ‘matters of national environmental significance’ undergo an assessment and approval process. Under the EPBC Act, an action includes a project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things. An action that ‘has, will have or is likely to have a significant impact on a matter of national environmental significance (MNES)’ is deemed to be a ‘controlled action’ and may not be undertaken without prior approval from the Australian Minister for the Environment. MNES relevant to this report include threatened species and ecological communities and migratory species.

The NSW Government and Australian Government finalised amendments to the Assessment Bilateral Agreement after changes to NSW legislation, and the Amending Agreement no. 1 was signed on 24 March 2020. The Australian Government formally endorsed the NSW BOS through the *EPBC Act Condition-setting Policy* (Department of Agriculture, Water and the Environment (DAWE) 2020).

Under the bilateral agreement, only one decision including conditions on approval is made by NSW, accounting for impacts to MNES occurring in NSW. Specific consideration of the assessment, approval and offsetting requirements for MNES under the bilateral agreement is only required for controlled actions. The EPBC Act condition setting policy (DAWE 2020) notes that where a project demonstrates compliance with an endorsed state or territory policy, the proponent will not be required to simultaneously comply with the corresponding Australian Government policy. As such, a proponent is not required to calculate offsets separately using the EPBC Act offsets policy (Department of Sustainability, Environment, Water, Population and Communities (former), DSEWPaC 2012) and associated calculator, unless offsets are required for a species not listed under the BC Act.

Transport for NSW referred the project to the Australian Minister for the Environment. The project was determined a controlled action regarding sections 18 and 18A of the EPBC Act (listed threatened species and communities, and in particular the Green and Golden Bell Frog) on 30 September 2022 (EPBC 2022/09300).

The EPBC Act has been considered in this assessment through:

– desktop review to determine the listed biodiversity matters that are predicted to occur within the locality of the project and hence could occur, subject to the habitats present
– targeted field surveys for listed threatened biota and migratory species
– assessment of potential impacts on threatened and migratory biota, including assessments of significance in accordance with the EPBC Act *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (Department of the Environment (former), DotE 2013)
– identification of suitable impact mitigation and environmental management measures for threatened and migratory biota, where required
– calculation of offsets in accordance with the BAM for the Green and Golden Bell Frog.

2.6 Assessment guidelines

This report has been prepared in accordance with the BAM (Department of Planning, Industry and Environment (DPIE) 2020a) and with reference to the following guidelines:

- *Surveying threatened plants and their habitats – NSW survey guide for the Biodiversity Assessment Metho*d (DPIE 2020b)
- *NSW survey guide for threatened frogs – A guide to the survey of threatened frogs and their habitats for the Biodiversity Assessment Method* (DPIE 2020c)
- *Survey guidelines for Australia's threatened bats – Guidelines for detecting bats listed as threatened under the Environmental Protection and Biodiversity Conservation Act 1999* (Department of the Environment, Water, Heritage and the Arts (former) DEWHA 2010)
- *'Species credit' threatened bats and their habitats – NSW survey guide for the Biodiversity Assessment Method* (OEH 2018)
- *Policy and Guidelines for Fish Habitat Conservation and Management* – Update 2013 (DPI 2013)
- *National Light Pollution Guidelines for Wildlife including Marine Turtles. Seabirds and Migratory Shorebirds*" (Department of the Environment and Energy 2020)
- *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013).

3. Methods

3.1 Desktop assessment

3.1.1 Data review

A desktop database review was carried out to identify threatened flora and fauna species, populations and ecological communities (threatened biota) listed under the BC Act and EPBC Act, that could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present. These were also used to obtain the necessary site data to perform BAM calculations.

Information sources used in the preparation of this report include:

- NSW BioNet Atlas for records of threatened biota previously recorded in a 10 kilometre radius around the project site (DPIE 2021a) and Threatened Biodiversity Data Collection (TBDC) profiles of threatened species listed under the BC Act (DPIE 2021b)
- NSW BioNet Vegetation Classification (DPIE 2021c) to identify matching plant community types (PCTs) in the study area
- NSW Threatened biodiversity profile search online database for threatened ecological communities and species listed under the BC Act (DPIE 2021d)
- DAWE (2021a) EPBC Act Protected Matters Search Tool – for a 10 kilometre radius around the project site (searched July 2021)
- DAWE (2021b) Species profile and threats database, online profiles (SPRAT)
- The list of candidate species credit-type species and predicted species identified by the BAM calculator (DPIE 2022a).

The threatened biota and migratory species identified in the desktop assessment are presented in Appendix B. Following collation of database records and threatened species and community profiles, a list of threatened species requiring assessment was compiled according to the ‘steps for identifying habitat suitability for threatened species’ presented in Section 6.4 of the BAM. This was further refined following field surveys and identification and assessment of habitat present within the project site. A likelihood of occurrence ranking was attributed to biota based on this information and used to compile lists of ‘predicted threatened species’ (that is, ecosystem credit species) and ‘candidate threatened species’ (that is, species credit entities requiring targeted survey) according to Step 2 ‘assessment of habitat constraints’ of Section 6.4 of the BAM.

3.1.2 Background research

Background research was conducted to identify:

- landscape-scale features of the study area in accordance with sub-section 3.1.3 of the BAM (DPIE 2020a)
- site context of the study area that includes assessing vegetation cover and patch size as required under Section 3.2 and sub-sections 4.3.2 of the BAM (DPIE 2020a)
- the likely distribution of native vegetation and threatened ecological communities, based on previous mapping and aerial photograph interpretation, for targeted field verification as required under Section 4 of the BAM (DPIE 2020a)
- a list of predicted and candidate threatened species and populations of flora and fauna to assess the habitat suitability and threatened biodiversity data collection as required under Section 5 of the BAM (DPIE 2020a)
- availability of baseline information to determine whether additional surveys, mapping and reporting is required to support project approval.

The background research included analysis of the following information sources:

– NSW (Mitchell) Landscapes mapping Version 3.1 (DPIE 2016) and Descriptions for NSW (Mitchell) Landscapes Version 2 (DECC 2002)
– Interim Biogeographic Regionalisation of Australia (IBRA version 7.0) mapping
– initial BAM calculations
– The Native Vegetation of the Sydney Metropolitan Area – Version 3.1 (OEH 2016)
– Atlas of Groundwater Dependent Ecosystems (GDE) (BOM 2021a)
– Australian Wetlands Database (DAWE 2021e)
– aerial photographs and satellite imagery of the study area
– Parramatta Light Rail (Stage 1) Biodiversity Assessment Report – Technical Paper 4, prepared by WSP (Transport for NSW 2017)
– Stage 2 – Ecological constraint assessment and targeted surveys memo (WSP 2018)
– ecological monitoring data and previous reports relating to biodiversity values of Sydney Olympic Park, provided by Sydney Olympic Park Authority (SOPA), including:
  - Green and Golden Bell Frog Monitoring: Sydney Olympic Park, 2020-21 (Tactecol Consulting 2021)
  - Habitat Management Plan: MP06 Narawang Wetland 2021 (SOPA 2021a)
  - Latham’s Snipe Population Monitoring 2020-21 (SOPA 2021b)
  - Mapping and Analysis of the Extent, Distribution and Condition of Coastal Saltmarsh at Sydney Olympic Park 2019 (Pacific Wetlands 2019)
  - An Olympic legacy: Green and golden bell frog conservation at Sydney Olympic Park 1993-2006 (Darcovich and O’Meara 2008)
  - Anabat survey Sydney Olympic Park (Turton 2014)
  - Biodiversity Management Plan (SOPA 2019a).

3.2 Site survey

3.2.1 Survey overview

Staged surveys of the project site were conducted in accordance with the BAM and with reference to appropriate threatened species survey guidelines for targeted species. Site surveys included:

– initial site stratification and vegetation mapping
– sampling of vegetation integrity plots
– habitat assessments, including hollow-bearing tree assessments
– targeted surveys for threatened flora
– targeted surveys for threatened fauna.

Survey effort was formally stratified across the project site in accordance with the BAM. Survey effort that has directly contributed to this BDAR is summarised in Table 3.1, mapped on Figure 3.1 and is described in detail below.

Table 3.1 Survey techniques and timing

Stage	Date	Survey technique
Long-lead in surveys	25 & 28 February 2019 12 March 2019	Fauna habitat assessment Mapping of frog fencing Diurnal searches for basking frogs Spotlighting and call playback Diurnal bridge inspections Ultrasonic call recording
Initial site stratification and vegetation mapping / BAM assessment survey	29 May 2019	Vegetation mapping Vegetation integrity survey plots Targeted flora surveys Fauna habitat assessment Diurnal bird surveys
Initial site stratification and vegetation mapping / BAM assessment survey	26 July 2019	Vegetation mapping Vegetation integrity survey plots
BAM assessment survey	15 & 16 September 2021 12 & 13 October 2021 10 & 11 November 2021	Vegetation integrity survey plots Targeted flora surveys Vegetation mapping Fauna habitat assessment Diurnal bird surveys Anabat
Green and Golden Bell Frog targeted survey	25 & 28 February 2019 12 March 2019 12 October 2021 22 & 23 November 2021 7 December 2021 20 January 2022	Spotlighting Call playback

3.2.2 Vegetation and flora surveys

Vegetation mapping

Vegetation was assessed with reference to the BAM (DPIE 2020a). Regional vegetation mapping (OEH 2016) and previous mapping of the study area (WSP 2018) was ground-truthed in the field to verify community type and boundaries, floristic and structural homogeneity within patches and to update mapping as required. The proposed alignment was inspected via walked transects across accessible patches of the study area. Where access was not available, vegetation type mapping was extrapolated based on aerial photograph interpretation, existing regional vegetation mapping (OEH 2016), results of previous surveys of the study area (WSP 2018) and visual inspection of vegetation through binoculars from accessible portions of the study area.

Native vegetation communities in the study area were assigned to the closest equivalent Plant Community Type (PCT) held in the BioNet Vegetation Classification database (DPIE 2021c). The closest equivalent PCT for each vegetation community was determined through a comparison of the floristic descriptions of PCTs in the database with the vegetation integrity plot data collected from the site. In addition to floristic and structural similarity, the landscape position, soil type and other diagnostic features of the vegetation communities on the sites were also compared to the descriptions in the database to determine the most suitable PCT. Threatened ecological communities (TECs) as defined in NSW and Commonwealth legislation were also identified.

The native vegetation in the project site was then stratified into vegetation zones in accordance with Section 4.3 of the BAM (DPIE 2020a). A vegetation zone is defined in the BAM as a relatively homogenous area that is the same PCT and has the same broad condition state. Each vegetation zone was assigned a patch size in accordance with sub-section 4.3.2 of the BAM (DPIE 2020a).

Planted native vegetation assessment

The study area includes large areas of highly modified land, such as the Parramatta CBD, residential suburbs to the north of the Parramatta River, and Wentworth Point and Sydney Olympic Park to the south of the river. Many of these areas have been subject to substantial historical disturbance (including use as landfill and industrial areas). These areas have been rehabilitated and, in some cases, plant species native to NSW have been used in revegetation or landscaping works.

Previous reports relating to the landscaping and revegetation work completed at Sydney Olympic Park were reviewed to ascertain if the intent of these works were to replicate the native vegetation types that would have once occurred in the area. This information was relied upon when mapping the vegetation types across the study area, to assist in determining which areas may need to be mapped as a vegetation type that was not a native PCT. To confirm whether the vegetation should be mapped as native or non-native, plot surveys were completed to identify the species that had been planted to allow comparison with locally occurring PCTs. Where the species present had been planted and the species did not align with any local PCT types, the vegetation was mapped as non-native or planted vegetation, and assessed in accordance with Appendix D of the BAM (Streamlined assessment module – planted native vegetation).

The decision-making key in Appendix D.1 of the BAM was applied and planted native vegetation within the study area was considered to have been planted for functional and aesthetic purposes as part of landscaping works for the Millennium Parklands as well as for aesthetic purposes in council reserves and parks and street tree planting in residential areas (see section 5.2). As such, vegetation that meets these criteria does not need to be assessed in line with Chapter 4 or 5 of the BAM, but Appendix D.2 must be applied, and the vegetation must be assessed for threatened species habitat (see section 6.2).

Vegetation integrity survey plots (assessing site condition)

Following the stratification of the project site into vegetation zones, plot surveys were conducted in accordance with the BAM (DPIE 2020a) to obtain vegetation integrity data for the calculation of biodiversity credits. The field data sheets are provided in Appendix E.

Plots were sampled at random locations within each of the vegetation zones by walking a random distance into the vegetation zone and then locating the plot on a randomly generated compass bearing; this was then repeated for subsequent plots within the vegetation zone. Where possible, plots were not located near ecotones, tracks and their edges or other locally disturbed areas, however given the generally modified and fragmented nature of vegetation within the study area, this was not always possible. Plots were located where possible to comply with the minimum number of plots required by Table 3 in the BAM (DPIE 2020a). In some instances, plots were located just outside of the study area, to enable use of a full 50 metre transect, as there was insufficient room within the study area to complete a full survey plot. Given the highly modified and linear nature of the project site, often more plots than required were sampled.

The site value was determined by assessing ten attributes used to assess function, composition and structure of vegetation within a 50 metre by 20 metre plot centred on a 50 metre transect. These attributes were then assessed against benchmark values. Benchmarks are quantitative measures of the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement (DECC, 2009). Attributes assessed within each plot are listed in Table 3.2.

All flora species within a 20 metre by 20 metre quadrat nestled within the 50 metre by 20 metre plot were identified according to the nomenclature of the Royal Botanic Gardens and Domain Trust (RBGT 2021). Where vegetation zones were narrow or linear and did not allow for the placement of a 20 metre by 20 metre quadrat, a 10 metre by 40 metre quadrat was used instead.

Each species identified was allocated a growth form group and designated as either native, exotic or high threat weed (HTW) as per the lists provided to accredited assessors by the Biodiversity, Conservation and Science Directorate (BCS) of DPE. The overall condition of vegetation was assessed through general observation and comparison against the PCT condition benchmark data as well as using parameters such as species diversity, history of disturbance, weed invasion and canopy health.

The location of survey plots is shown on Figure 3.1 and the minimum plot survey requirements are summarised in Table 3.3.

Table 3.2 Site data collected within each plot

Attribute	Area assessed
Plant species identity*	20 x 20 metre plot
Percentage foliage cover for each species*	20 x 20 metre plot
Estimated number of individuals for each species	20 x 20 metre plot
Number of large trees	50 x 20 metre plot
Tree regeneration (presence/absence)	50 x 20 metre plot
Tree stem size class	50 x 20 metre plot
Total length of fallen logs	50 x 20 metre plot
Litter cover	5 times 1 x 1 metre plot
Hollow-bearing trees	50 x 20 metre plot

Note: * processed and compiled into species richness and cover of native plant growth form groups, HTW cover and exotic plant cover using spreadsheet analysis and comparison with lists provided to accredited assessors by the BCD.

Table 3.3 Vegetation survey effort

Vegetation	PCT	Condition	Area in project site (ha)	Minimum number of plots required	Plot numbers
Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	920	Good	0.72	1	4, 9, 10, 11
Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	1126	Moderate	0.03	1	7, 8, 12
Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	1234	Poor	0.33	1	5
Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	1234	Moderate	0.01	1	13a
Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	1234	Planted	0.28	1	16, 20
Phragmites australis and *Typha orientalis* coastal freshwater wetland	1071	Moderate	0.01	1	14, 25
Sydney Turpentine - Ironbark forest	1281	Planted	1.05	1	18, 19
Planted vegetation	N/A	Non-native	5.51	N/A	6, 13, 15, 17, 21, 22, 23, 24

Threatened plant surveys

Potential candidate species credit entities for the project site were identified and assessed in accordance with Section 5.2 and Section 5.3 of the BAM (DPIE 2020a). All threatened plants are classified under the BAM as species credit entities as their occurrence cannot be reliably predicted based on vegetation type. The suite of threatened plants with potential to occur in the project site was identified based on the desktop assessment results and the species credit entities identified by preliminary BAM-C calculations (see Appendix B and Appendix F).

A likelihood of occurrence ranking was attributed to potential candidate species based on this information and used to compile lists of 'confirmed candidate threatened species' (that is, threatened flora requiring targeted survey) according to Step 2 'assess the habitat constraints and vagrant species on the subject land' of Section 5.2.2 of the BAM (see Table 3.4).

Habitat for these species was identified and assessed based on existing literature relating to the study area (WSP 2018; Pacific Wetlands 2019; SOPA 2019a) threatened species profiles, knowledge of local land managers (SOPA Ecologists), and the experience and judgement of GHD ecologists. A large area of the project site is highly modified and is dominated by hardstand surfaces and can be readily discounted as supporting populations of threatened plant species. However, areas of native vegetation adjacent to the Parramatta River were considered to have the potential to provide habitat for certain threatened flora species, as well as areas of known and potential threatened species habitat within Newington Nature Reserve and Sydney Olympic Park.

Many of the threatened flora species predicted by the BAM calculator are linked to PCT 1281: Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion (Sydney Turpentine Ironbark Forest) and are only potential candidate species-credit species due to the presence of this PCT. When considering the species that had the potential to occur within the project site, these species were all discounted given the only occurrence of PCT 1281 within the footprint is a planted form, on an artificial soil profile, with no natural parent material or soil seed bank. Pursuant to section 5.2.3 of the BAM “A candidate species credit species is considered unlikely to occur on the subject land (or specific vegetation zones) if…ii. the assessor determines that the habitat constraints or microhabitats are degraded to the point that the species is unlikely to use the subject land (or specific vegetation zones)” (DPIE 2020a, p22). The ‘habitat degraded’ button was selected in the BAM calculator for all flora species associated only with PCT 1281 to reflect this conclusion.

Searches were carried out with reference to threatened flora survey guidelines (DPIE 2020b), by conducting meandering traverses within all areas of potential habitat within the project site outside of Newington Nature Reserve. Within Newington Nature Reserve, GHD ecologists were accompanied by a Sydney Olympic Park Authority ecologist, who showed GHD ecologists the location of the known population of *Wilsonia backhousei*. Rather than map the location of each individual plant, it was considered appropriate to map the edges of the area of occurrence of this species, so as to minimise disturbance to the fragile saltmarsh environment that it occurs in. GHD ecologists mapped a polygon around the extent of this population of the species. This aligns with the unit of measure for this species, as it is an area species.

Table 3.4 Candidate flora species for which targeted surveys were conducted

Scientific name	Common name	Appropriate survey period	Months surveys conducted
Haloragis exalata subsp. *exalata*	Square Raspwort	All year	September, October, November 2021
Maundia triglochinoides	*Maundia triglochinoides*	Nov-Mar	November 2021
Melaleuca biconvexa	Biconvex Paperbark	All year	September, October, November 2021
Persicaria elatior	Tall Knotweed	Dec-May	May 2019
Wilsonia backhousei	Narrow-leafed Wilsonia	All year	September, October 2021
Zannichellia palustris	*Zannichellia palustris*	Oct-Jan	October 2021

3.2.3 Terrestrial fauna surveys

Given the location of the study area in inner Sydney, and with much of it located within Sydney Olympic Park area, substantial information on fauna already exists for the area. Detailed surveys and annual monitoring have been conducted by or for the Sydney Olympic Park Authority (Green and Golden Bell Frog surveys, migratory bird surveys, microbat surveys), and by BirdLife Australia (e.g. monitoring of nesting White-bellied Sea-eagles at Newington Nature Reserve, and shorebird monitoring in the area). This BDAR relies on this information, and supplementary surveys (described below) have been conducted throughout the study area as necessary to identify candidate species and MNES.

Fauna habitat assessment

Fauna habitat assessments were carried out throughout much of the project site during all survey periods, including observation of potential shelter, basking, roosting, nesting and/or foraging sites. Specific habitat features and resources such as water bodies, food trees, the density of understorey vegetation, the composition of ground cover, the soil type, presence of hollow-bearing trees, leaf litter and ground debris were noted.

Indicative habitat criteria for targeted threatened species (i.e. those determined as having the potential to occur within the project site following the desktop review) were identified prior to fieldwork. Habitat criteria were based on information provided in DPE and DCCEEW threatened species profiles, field guides, and the knowledge and experience of GHD field ecologists.

Habitat assessments included searches for resources of potential value to threatened fauna including:

- waterbodies with emergent vegetation
- trees with bird nests or other potential fauna roosts such as hollows
- distinctive scats or latrine sites, owl white-wash and regurgitated pellets under roost sites
- tracks or animal remains
- evidence of activity such as feeding scars, scratches and diggings
- specific food trees and evidence of foraging (e.g. chewed *Allocasuarina* cones).

The locations and quantitative descriptions of significant habitat features were captured with a handheld GPS unit and photographed where appropriate. The field survey effort included dusk observations of hollows for evidence of occupancy.

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. This included a conscious focus on suitable areas of habitat during flora surveys, for instance fallen timber was scanned and/or turned for reptiles and mature trees and stags were scanned for roosting birds, or evidence of roosting microbats.

No surveys were conducted in the Parramatta CBD and other portions of the project site with no particular habitat values.

Targeted surveys

Targeted, seasonal surveys are required for candidate species credit entities, that is species credit species and specific habitat resources such as nesting or roosting habitat for dual credit species. Potential candidate species credit matters were identified in accordance with Section 6.3 and Section 6.4 of the BAM, based on:

- the results of the desktop assessment (see section 3.1)
- identification of PCTs at the study area
- initial BAM credit calculations
- fauna habitat assessment.

A likelihood of occurrence ranking was attributed to potential candidate species based on this information and used to compile lists of confirmed candidate species.

Confirmed candidate species credit matters that were considered to have a moderate potential to occur within the project site (refer to Appendix B) were targeted with specific survey techniques and are listed in Table 3.5.

Targeted surveys appropriate to each species credit matter must be planned and conducted with reference to the DEC (2004) threatened species survey guidelines and the various BAM threatened species survey and assessment guidelines. Surveys were planned and carried out using the following framework:

- habitat resource assessment to confirm the presence (or otherwise) and condition of habitat resources for the candidate species credit matter. This stage may be conducted at any time of year
- stratification of habitat resources based on extent and quality of habitat and planning of targeted seasonal survey techniques appropriate to each confirmed candidate species and habitat type
- delivery of targeted seasonal survey techniques appropriate to each confirmed candidate species.

Targeted fauna survey techniques and effort conducted in the study area are summarised in Table 3.5, and discussed further below. Survey effort was stratified across the entire study area where possible given property access constraints and noting that fauna species are mobile and may rely upon habitat resources in the project site even if not directly observed. Fauna survey effort is mapped on Figure 3.1.

Where possible, surveys were conducted in the survey season identified by the BAM calculator, however the large study area and access constraints meant that not all locations in the study area could be surveyed in detail for all target species. Small patches of vegetation on private land such as residential gardens, and landscaped areas within industrial sites were not accessed. Instead, surveys focused on areas that supported the largest and most intact areas of native vegetation, which were most likely to provide potential habitat for the target threatened species. Fauna observations were recorded on pro forma field data sheets or electronic data capture forms or apps.

Under the BAM, targeted surveys are not required for threatened fauna species that can be reliably predicted to occur at the project site based on habitat surrogates (predicted / ecosystem credit species). These species are assumed to be present within certain PCTs, given a certain patch size and condition. Nonetheless these species and their habitats were recorded along with fauna that are not listed as threatened, as a general guide to the condition and biodiversity value of the project site.

Table 3.5 Targeted fauna survey techniques

Survey technique	Survey methods	Key target species	Dates
Daytime traverses Active searches for scats and signs	Included dedicated searches for any signs of fauna occupation. Included searching for evidence of feeding, foraging and signs of bird presence (such as pellets, whitewash, nests etc.) and other biota (scats, scratchings, diggings, dens, roosts etc.).	Powerful Owl (*Ninox strenua*)	25 & 28 February 2019 12 March 2019 15 & 16 September 2021
Diurnal bird surveys	Dedicated bird surveys were conducted at many locations across the study area. Surveys generally consisted of area searches of 30 minutes to one hour, depending on patch size and habitat values. Birds were identified by sight and call.	White-bellied Sea-eagle (*Haliaeetus leucogaster*) Migratory waders	25 & 28 February 2019 12 March 2019 15 & 16 September 2021
Spotlighting	Walked spotlighting transects were conducted in various habitats, including mangroves, planted vegetation, and along road. Frogs were identified by sight and call when encountered opportunistically during surveys. Frog calls were recorded and verified using the Australian Museum's Frog ID app.	Green and Golden Bell Frog (*Litoria aurea*) Powerful Owl (*Ninox strenua*) Grey-headed Flying-fox (*Pteropus poliocephalus*)	25 & 28 February 2019 12 March 2019 12 October 2021 22 & 23 November 2021 7 December 2021 20 January 2022
Call playback	Calls of the Green and Golden Bell Frog were played at regular intervals while spotlighting along mangroves at Camellia. Calls were also broadcast near areas of potential habitat (ponds) in private property. Calls were broadcast for about two minutes following five minutes of silence when field staff listened for any responses. Calls of nocturnal birds were broadcast in all spotlighting periods, and dependent on the appropriate season. Calls were broadcast through a 15 watt megaphone for a minute each with gaps of about a minute between the call of each species. Calls were then repeated. A quiet listening period of ten minutes was held prior to and following call playback. Potential roost sites were scanned with a spotlight.	Green and Golden Bell Frog (*Litoria aurea*) Powerful Owl (*Ninox strenua*)	25 & 28 February 2019 12 March 2019 12 October 2021 22 & 23 November 2021 19 January 2022 20 January 2022
Ultrasonic call recordings (Anabat)	Anabat express units were located along flyways and waterbodies in the study area.	Southern Myotis (*Myotis macropus)* Large Bent-winged Bat (*Miniopterus orianae oceanensis*)	25 & 28 February 2019 12 March 2019 12 October 2021 7 December 2021 20 January 2022

Survey technique	Survey methods	Key target species	Dates
Opportunistic fauna surveys	Incidental observations of threatened species and habitat features were carried out at all times.	All species	25 & 28 February 2019 12 March 2019 15 & 16 September 2021 12 October 2021 22 & 23 November 2021 20 January 2022

Green and Golden Bell Frog surveys

No targeted Green and Golden Bell Frog surveys were conducted at Sydney Olympic Park as this area supports a known population that has been surveyed and assessed in detail.

Targeted surveys were conducted in Camellia to assess presence or absence of the species in this portion of the study area, as a coastal wetland about 200 metres south of Grand Avenue is known to support this species. Surveys focused on the mangroves along the Parramatta River that are connected to this wetland, as well as artificial habitat (ponds, detention basins and drains) associated with industrial areas along Grand Parade.

Surveys were generally conducted in accordance with the EPBC Act survey guidelines (DEWHA 2010a), which recommend surveys are conducted:

- between September and March
- within one week of heavy rainfall
- on warm and windless nights
- over four nights in ideal conditions.

Surveys were conducted with reference to the *NSW Survey Guide for Threatened Frogs* (DPIE 2020c). Aural-visual surveys were carried out by two ecologists on four evenings, within the recommended survey period, between November 2021 and January 2022. Quiet listening and call playback was conducted at regular intervals along the mangrove transect, an artificial pond, a detention basin, and drains.

Diurnal bird surveys

Detailed information on migratory waders and the White-bellied Sea-eagle is known for the Sydney Olympic Park and Newington Nature Reserve area due to regular surveys by the Sydney Olympic Park Authority and BirdLife Australia. Some additional surveys were conducted to gain an understanding of the habitat values of the project site.

Diurnal bird surveys were conducted throughout all fauna surveys, with birds identified by sight and call. Surveys generally comprised area searches along transects within vegetated portions of the study area.

Surveys for migratory shorebirds were conducted around the location where the project would cross the Parramatta River (near Ermington Boat Ramp and west of Homebush Bay Wharf). Surveys were carried out on 14 and 25 February 2019 at low tide and included:

- searches for waders foraging or resting at mudflats east of Ermington Boat Ramp
- searches for waders roosting in mangroves in the vicinity of Ermington Boat Ramp
- habitat assessment of the southern shore of the Parramatta River opposite Ermington Boat Ramp
- searches for waders at a nearby reference site (the Waterbird refuge at Sydney Olympic Park)
- incidental observations of other bird species at the various sites.

Microbat surveys

Surveys for microbats were conducted on multiple dates in 2019, 2021 and 2022. Surveys included assessment of foraging and roosting habitat (tree-hollows) within mangroves and watercourses, and use of microbat echolocation call detectors (Anabat devices). Additional data on microbats in the Sydney Olympic Park area was provided by the Sydney Olympic Park Authority. Anabat survey locations and effort is provided in Table 3.6.

Table 3.6 Anabat surveys

Date	Location	Effort
25/2/2019	Two locations near Narawang Wetland	2 units left overnight
28/02/2019	One unit at Melrose Park One unit carried during spotlighting at Camellia and Homebush	2 units for 4.5 hours
12/03/2019	Two locations near Hill Road	2 units for 3 hours
12/10/2021	One unit at Camellia	1 unit left overnight
07/12/2021	One unit carried during spotlighting at Camellia and Ken Newman Park	1 unit for 3 hours
19/01/2022	Two units carried during spotlighting at Camellia and Ken Newman Park	2 units for 3 hours

The recorded calls of microbats were identified using zero-crossing analysis and AnalookW software (version 4.2n, Chris Corben 2017) by visually comparing the time-frequency graph and call characteristics (e.g. characteristic frequency and call shape) with reference calls and/or species call descriptions from available reference material.

Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats (Pennay et al. 2004) was used to assist call analysis. Call identification was also assisted by consulting distribution information for possible species (Churchill 2008). No reference calls were collected during the survey.

A call (pass) was defined as a sequence of three or more consecutive pulses of similar frequency and shape. Calls with less than three defined consecutive pulses of similar frequency and shape were not unambiguously identified to a species but were used as part of the activity count for the survey area. Due to variability in the quality of calls and the difficulty in distinguishing some species the identification of each call was assigned a confidence rating (see Mills et al. 1996 & Duffy et al. 2000). Due to the absence of reference calls from the project site, the high level of variability within a bat call and overlap in call characteristics between some species, a conservative approach was taken when analysing calls. Species nomenclature follows van Dyck et al. (2013) and Reardon et al. (2014).

Spotlighting and call playback

Spotlighting was conducted for nocturnal birds and mammals over a range of survey periods with a particular focus on candidate species including the Powerful Owl (*Ninox strenua*) and Grey-headed Flying-fox (*Pteropus poliocephalus*). No Flying-fox roost camps are present in the study area, and no suitable nest trees for Powerful Owls are present. As such, only limited targeted survey effort was conducted for these candidate species.

3.2.4 Aquatic habitat assessment

An assessment of potential habitat for threatened aquatic species was based on the habitat assessments carried out during the field survey and published habitat preferences of threatened biota. Key fish habitat maps were reviewed and key fish habitat was identified according to the following classifications as detailed in DPI (2013):

– Type 1 – highly sensitive fish habitat (includes freshwater habitats that contain in-stream gravel beds, rocks greater than 500 millimetres in two dimensions, snags greater than 300 millimetres in diameter or three metres in length, or native aquatic plants; known or expected protected or threatened fish habitat; and areas of critical habitat)
– Type 2 – moderately sensitive key fish habitat (freshwater habitats other than those defined in Type 1)
– Type 3 – minimally sensitive key fish habitat (ephemeral aquatic habitat not supporting native aquatic or wetland vegetation)
– not key fish habitat (includes first and second order streams on gaining streams).

Areas of mangrove and saltmarsh habitat were mapped based on the PCT mapping (see section 3.2.2).

3.3 Survey conditions

The field surveys were carried out between February 2019 and January 2022. Bureau of Meteorology (BOM) records for the survey dates are outlined in Table 3.7. These records were taken at the Sydney Olympic Park (Archery Centre) weather station (066212) (BOM 2021b). The previous week's rainfall is provided for the dates when targeted Green and Golden Bell Frog surveys were completed.

Table 3.7 Daily weather observations during the survey period

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Previous week's rainfall (mm)
25 February 2019	17.7	25.5	0.2	22.8
28 February 2019	19.1	29.8	0.2	14.6
12 March 2019	19.8	35.9	0	3.0
29 May 2019	12.0	19.5	0	0
26 July 2019	5.1	19.0	0	0
15 September 2021	6.7	18.1	0	18.2
16 September 2021	6.5	17.7	0.2	18.2
12 October 2021	10.8	17.2	5.8	23.4
13 October 2021	13.0	19.0	6.8	17.4
22 November 2021	15.2	21.5	18.4	29.2
23 November 2021	16.2	22.1	0.6	29.8
7 December 2021	16.3	28.6	0	0.2
20 January 2022	18.9	24.1	2.8	53.6

3.4 Survey limitations

Access was available to properties owned by Transport for NSW and public land. The survey was constrained in some areas by access to private properties. Some sections of the study area overlap with private residential, commercial, or industrial properties, and these portions of the study area were not accessed during field surveys. Where access was not available, mapping of vegetation type and condition was based on extrapolated data, informed by visually scanning the site from public land using binoculars, aerial photo interpretation, existing regional and local vegetation mapping, and consideration of landscape position. Habitat assessments were completed for this land based on the extrapolated vegetation mapping. No surveys were conducted in the Parramatta CBD given the highly modified nature of the project site at that location, and existing information from previous studies.

Detailed fauna surveys were not completed within Sydney Olympic Park because Sydney Olympic Park Authority ecologists and BirdLife Australia have completed more than two decades of monitoring within this land, and it was considered appropriate to rely on their data where possible, given the extended period of time it is available for, across all seasons. Utilising this data minimised the need for human access to conduct additional surveys in sensitive environments such as the various ponds and waterways in Sydney Olympic Park that are known habitat for the Green and Golden Bell Frog and nesting habitat for threatened birds. Instead, fauna survey efforts in Sydney Olympic Park focussed on mapping the extent of habitat for the various threatened fauna species known to occur there, which is a low-impact activity.

For the above reasons, the impact assessment and conclusions of this report draw upon information obtained from a variety of sources in addition to the field survey data. Where it is considered that the likelihood of observing a particular threatened species was diminished due to the extent of survey effort or seasonal or climatic factors, then this has been indicated, and where appropriate, a species has been assumed present in accordance with the BAM. An assessment of the likelihood of occurrence of threatened species has been provided, on the basis of known distributional ranges, previous records in the locality, and habitat and resource availability within the site.

The assessment of impacts includes those threatened species recorded within the project site during the field surveys as well as those species not detected but considered likely to occur or to be impacted by the project.

Green and Golden Bell Frog targeted surveys were conducted following significant rainfall in late 2021 and early 2022; including the weekly totals preceding surveys presented in Table 3.7 and monthly rainfall of 73.8 millimetres in October 2021, 146.6 millimetres in November 2021, and 116.2 millimetres in January 2022 (BOM 2022b). However, mean daily temperature during days of surveys were below the average temperature for this time of year, which may have limited the detection of the species. Timing of surveys at Camellia was also constrained by tides, as much of the mangrove area was only accessible at low tide.

3.5 Geographic Information System (GIS) analysis

GIS was used to:

– confirm the relevant IBRA bioregion, IBRA subregion and Mitchell Landscape(s) for the site
– calculate the extent of native vegetation to be impacted
– plot the project site on a high-resolution aerial photo base and to map vegetation zones, survey effort, habitat resources and biodiversity values across the site.

Additional GIS analysis was used to plot a 500 metre buffer area surrounding the project site in which site context components were calculated. Native vegetation cover, extent and connectivity were assessed using aerial photography. Aerial photo interpretation was used to identify and record distinct vegetation patches, determine the broad condition state of vegetation types and the location and extent of vegetated habitat corridors. Aerial photography was examined at scales between 1:2,000 and 1:4,000.

The buffer area and GIS area calculations were used to enter information about landscape value and to determine the change in landscape value score by assessing the impact of the project on native vegetation cover and connectivity as well as the patch size.

3.6 BAM calculations

The project was assessed according to the methodology presented in the BAM (DPIE 2020a), and the Biodiversity Assessment Methods Calculator Users Guide (OEH 2017). The BAM calculator is a software application that is used to apply the BAM. Data is entered into the BAM calculator based on information collected in the desktop assessment, site surveys and from using GIS mapping software.

The BAM calculations were performed by Kath Chesnut and Kirsten Crosby using calculator version 1.4.0.00 (DPIE 2022a). The updated BDAR has used V1.2 BAM calculator benchmarks for credit calculations. Data entered into the BAM calculator is provided in Appendix E. The biodiversity credit reports are included in Appendix F.

One BAM calculator case was established for assessing direct impacts (00030218/BAAS17023/21/00030219 Revision 6), and another case was set up to assess shading impacts (00030218/BAAS17023/21/00030219 Revision 7).

Shading impacts have been calculated by using modelling data provided by Landscape Architects at RPS Group that show the worst-case scenarios for shading impacts, digitising the shaded areas using GIS software, and then calculating the area of impact of shade on surrounding vegetation, minus the direct impacts associated with the project site. Those area calculations have then been entered into the BAM calculator to provide an indication of the number and type of additional credits that should be provided for indirect impacts.

The Revised East Coast PCT Classifications (Eastern NSW PCTs) were deployed in the BAM-C on 14 April 2023. Transitional arrangements allow for the use of pre-Eastern NSW PCTs (legacy PCTs) in existing assessments. As the BAM-C case for this assessment was in progress prior to the deployment of the Eastern NSW PCTs, the legacy PCTs and associated vegetation zones and data were retained. To enable this, ‘legacy data’ was selected in the ‘reference data version’ drop down option in the ‘Site Context’ tab of the BAM-C.

3.6.1 Predicted threatened species (ecosystem credit entities)

Based on the bioregional context for the assessment and the PCTs, patch size, vegetation cover and habitat resources present at the project site, the BAM calculator generates a list of threatened fauna species that are predicted to utilise the project site (that is, potential 'predicted threatened species', or potential 'ecosystem credit entities'). The potential for these predicted threatened species to occur within the site was further refined based on the desktop assessment, habitat resources observed during field surveys, records during the surveys, and the knowledge and experience of the assessor. Targeted surveys are not required under the BAM for these species as they are assumed to be present.

Targeted surveys may, however, be required if the predicted species are also listed under the EPBC Act, to assess the significance of impacts in accordance with the *MNES Significant impact guidelines 1.1 – Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013). A range of methods were employed to ensure appropriate survey effort for EPBC Act threatened species.

3.6.2 Candidate threatened species (species credit entities)

Threatened species that cannot reliably be predicted to occur on a development site based on PCT, distribution and habitat criteria are identified by the Threatened Biodiversity Data Collection as 'species credit' entities. In some circumstances, the particular habitat components of species assessed for ecosystem credit species, such as the breeding habitat of a cave roosting bat or forest owls, are also assessed for species credits.

The credit calculator references geographic, vegetation and habitat data for the project site to generate a list of the species credit entities that are predicted to occur (i.e. the 'potential candidate threatened species'). Searches of threatened species databases were also completed to identify any additional potential candidate threatened species (to those generated by the credit calculator) that are known or predicted to occur in the locality. The likelihood of occurrence of potential candidate threatened species were reviewed, giving consideration to the habitats available in the study area (refer to likelihood of occurrence tables in Appendix B).

As outlined in section 6.3.2, candidate threatened flora species associated with PCT 1281 were considered unlikely to occur due to the degree of habitat degradation (i.e., the only occurrence of PCT 1281 within the footprint is a stand of planted vegetation that somewhat resembles PCT 1281). This stand of planted vegetation is on an artificial soil profile on an artificial landform, and there is no suitable habitat for any threatened flora species. To reflect this, the 'habitat degraded' button was ticked in the BAM calculator, indicating that all threatened flora species associated only with PCT 1281 are not confirmed candidate species-credit entities.

3.6.3 Assessor's use of judgement

The narrow, linear nature of the development footprint posed some challenges to siting vegetation integrity survey plots, as there was sometimes not a sufficient area of a particular vegetation zone within the project site to sample a 1000 metres squared plot. As a result, some plots were located in vegetation adjacent to the project site, or within other vegetation that was representative of the narrow patches of vegetation within the site itself. Table 3.8 provides a summary of the judgements made by accredited assessors while completing this BDAR.

Table 3.8 Justification for use of data from plots outside the project site

Vegetation zone	Plots outside the project site	Justification
PCT 1234 poor	Plot 5	Sampled on an alternative alignment.
	Plot 16	Sampled just outside the project site, within a connected patch of vegetation that is representative of vegetation in this zone being impacted by the project, as there was not enough accessible vegetation within the footprint to sample.
PCT 920 good	Plot 4	Sampled on an alternative alignment. Retained in calculations given linear nature of the project and varying condition of patches of vegetation.
	Plot 7, 10 and 11	Sampled just outside the project site, within a connected patch of vegetation that is representative of vegetation in this zone being impacted by the project, as there was not enough accessible vegetation within the footprint to sample.

Vegetation zone	Plots outside the project site	Justification
PCT 1126 moderate	Plot 8 and 12	Sampled just outside the project site, but within connected patches of vegetation that are representative of vegetation in this zone being impacted by the project.
PCT 1234 moderate	Plot 13a	Sampled just outside the project site, but within a patch of vegetation that may be indirectly impacted by the project.
PCT 1234 planted	Plot 20	Sampled just outside the project site, but within a connected patch of vegetation that is representative of vegetation in this zone being impacted by the project.
PCT 1071 moderate	Plot 14 and 25	Sampled just outside the project site, but within a connected patch of vegetation that is representative of vegetation in this zone being impacted by the project, as there was not enough accessible vegetation within the footprint to sample.
PCT 1281 planted	Plot 19	Sampled immediately adjacent to the project site within a connected patch of vegetation as there was not enough space within the footprint to sample the necessary number of plots.

3.7 Assumptions

A 'project site' polygon (that is, the construction or disturbance footprint) was prepared for the project. It is assumed that the description and spatial data accurately represent the extent of direct impacts arising from the project and so this data has been used to calculate the extent of removal of vegetation and habitat arising from the project using GIS. These calculations have in turn been relied upon in the BAM calculations and the determination of key thresholds such as whether the project would have a direct impact on a threatened species, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated project design and/or spatial data.

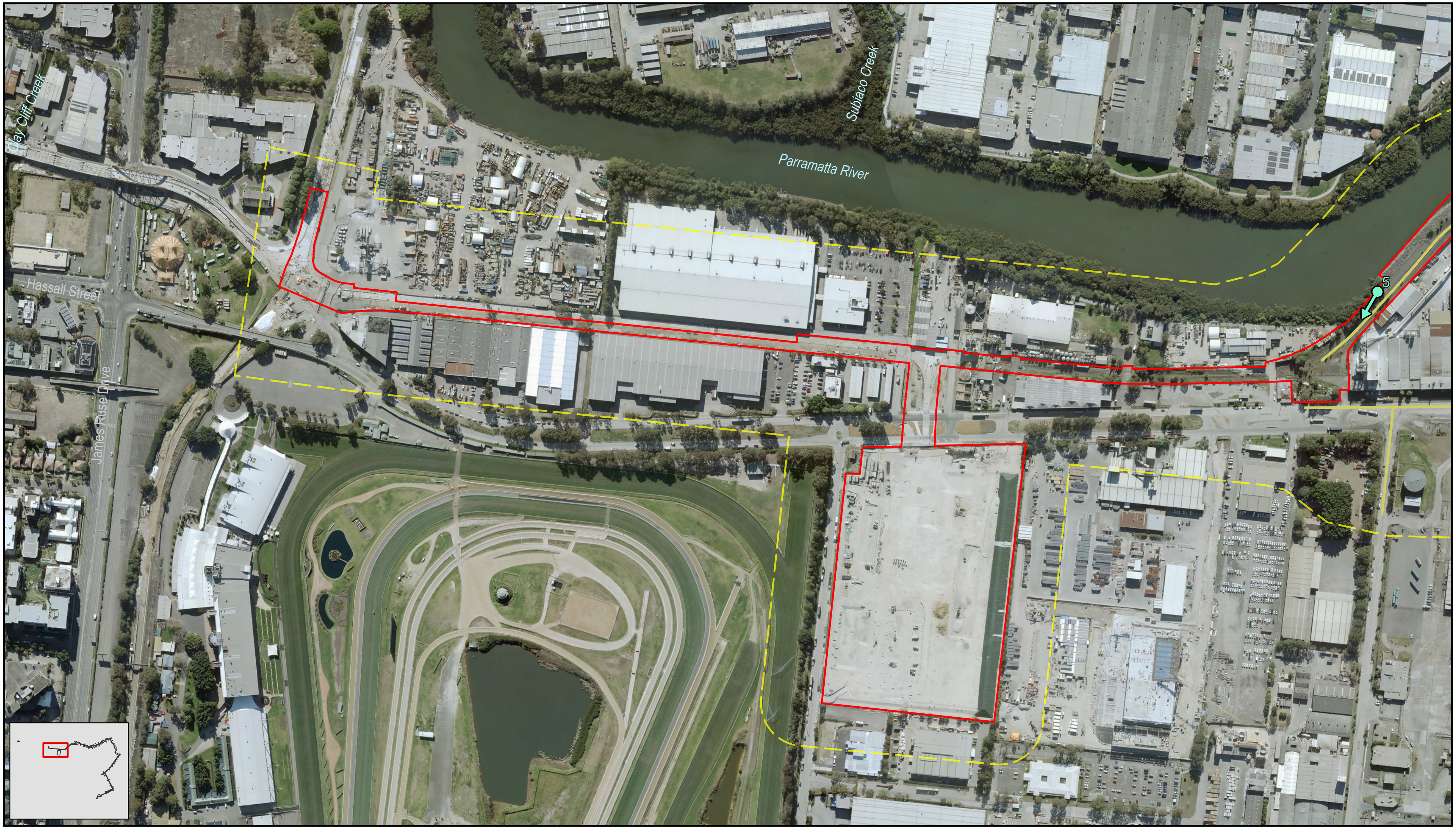
Justification for species polygons based on known habitat requirements, habitat values present in the study area and survey results are provided in Sections 6.3.3 and 11.1.2.

3.8 Staff qualifications

This BDAR was prepared by Kirsten Crosby (accredited assessor number BAAS17011) and Kath Chesnut (accredited assessor number BAAS17031) in accordance with the BAM. A technical review of the report and credit calculations was carried out by Ben Harrington (BAAS17023). Staff qualifications are presented in Table 3.9.

Table 3.9 GHD ecology staff qualifications and project role

Name	Position/project role	Qualifications	Relevant experience
Ben Harrington	Technical director – biodiversity – technical review of BDAR and credit calculations	BSc, MSc Accredited BAM Assessor (BAAS17023)	18+ years
Dr Kirsten Crosby	Fauna lead – fauna field surveys, credit calculations and lead author	BSc, PhD Accredited BAM Assessor (BAAS17011)	17+ years
Kath Chesnut	Flora lead – flora field surveys, credit calculations and lead author	BEnvSc (honours) Accredited BAM Assessor (BAAS17031)	11+ years
Gary Leonard	Senior Ecologist – flora field surveys	MSc, DipEd, Dip Horticulture	40+ years
Mal Weerakoon	Ecologist – fauna field surveys, co-author	BSc, Mphil by Research	7+ years
Fanny Stricher	Ecologist – flora field surveys, co-author	BSc, MSc (Ecology)	1+ years



Legend
Project site
Project study area
Spotlighting
Plot/transect

Paper Size ISO A4
0 50 100
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Survey Effort

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 3.1a

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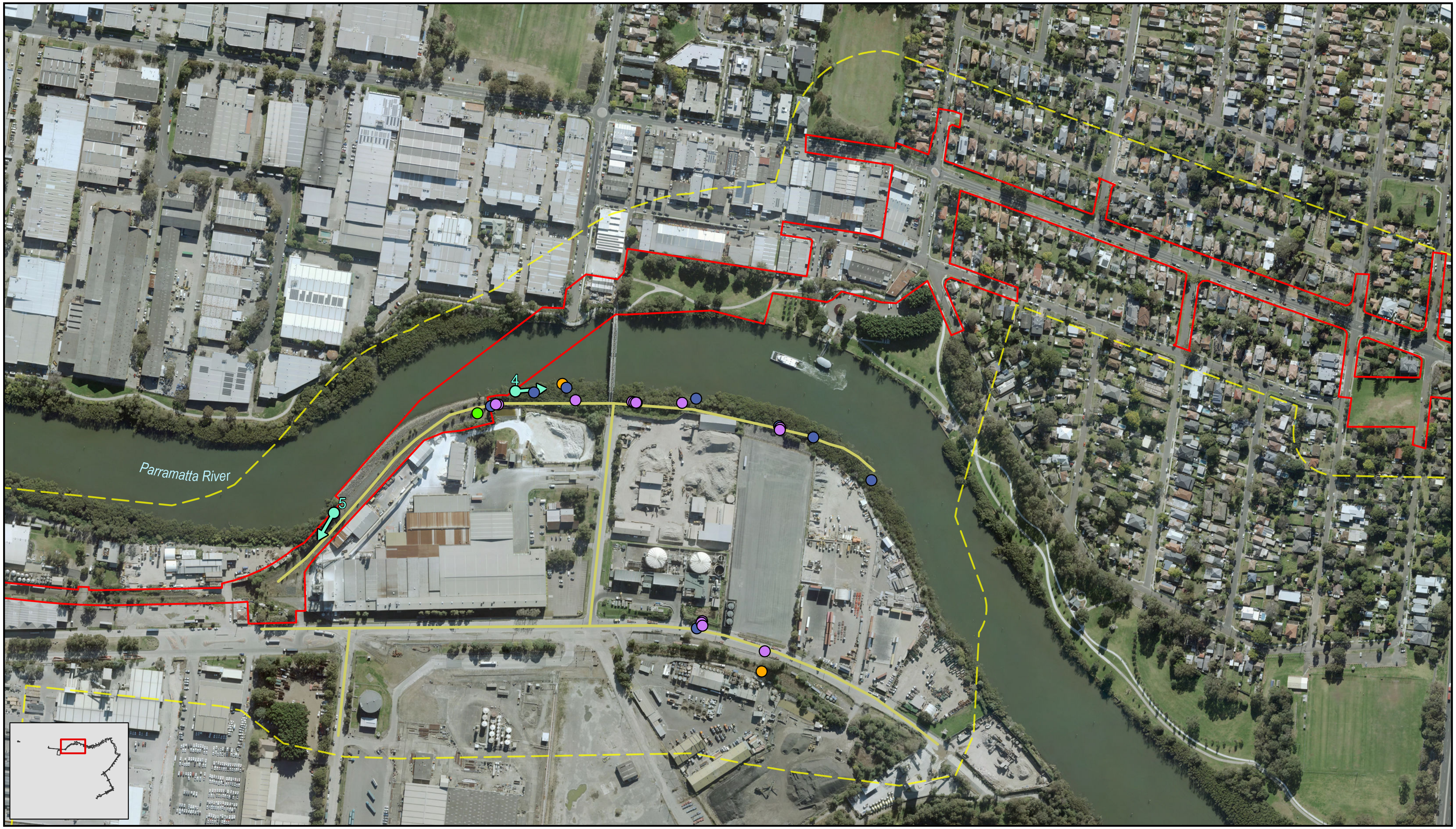

Legend
Project site
Project study area
Spotlighting
Plot/transect
Survey Effort
Anabat
Bird survey
Call playback
Frog survey

Paper Size ISO A4
0 50 100
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Survey Effort

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 3.1b

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Legend
- Project site
- Project study area
- Spotlighting
- Plot/transect
- Survey Effort
  - Bird survey
  - Call playback

Paper Size ISO A4

0 50 100

Metres

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

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Survey Effort

FIGURE 3.1c

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Print date: 11 Jul 2023 - 11:53

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: Imanasan

Legend
Project site
Project study area
Spotlighting
Plot/transect
Survey Effort
Anabat
Bird survey

Paper Size ISO A4
0 50 100
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

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Date **11/07/2023**

Survey Effort

FIGURE 3.1d

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Print date: 11 Jul 2023 - 11:53

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

Project site

Project study area

Spotlighting

Plot/transect

Survey Effort

Anabat

Bird survey

Frog survey (diurnal)

Threatened flora survey

Paper Size ISO A4

0 50 100

Metres

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

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
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Survey Effort

FIGURE 3.1e

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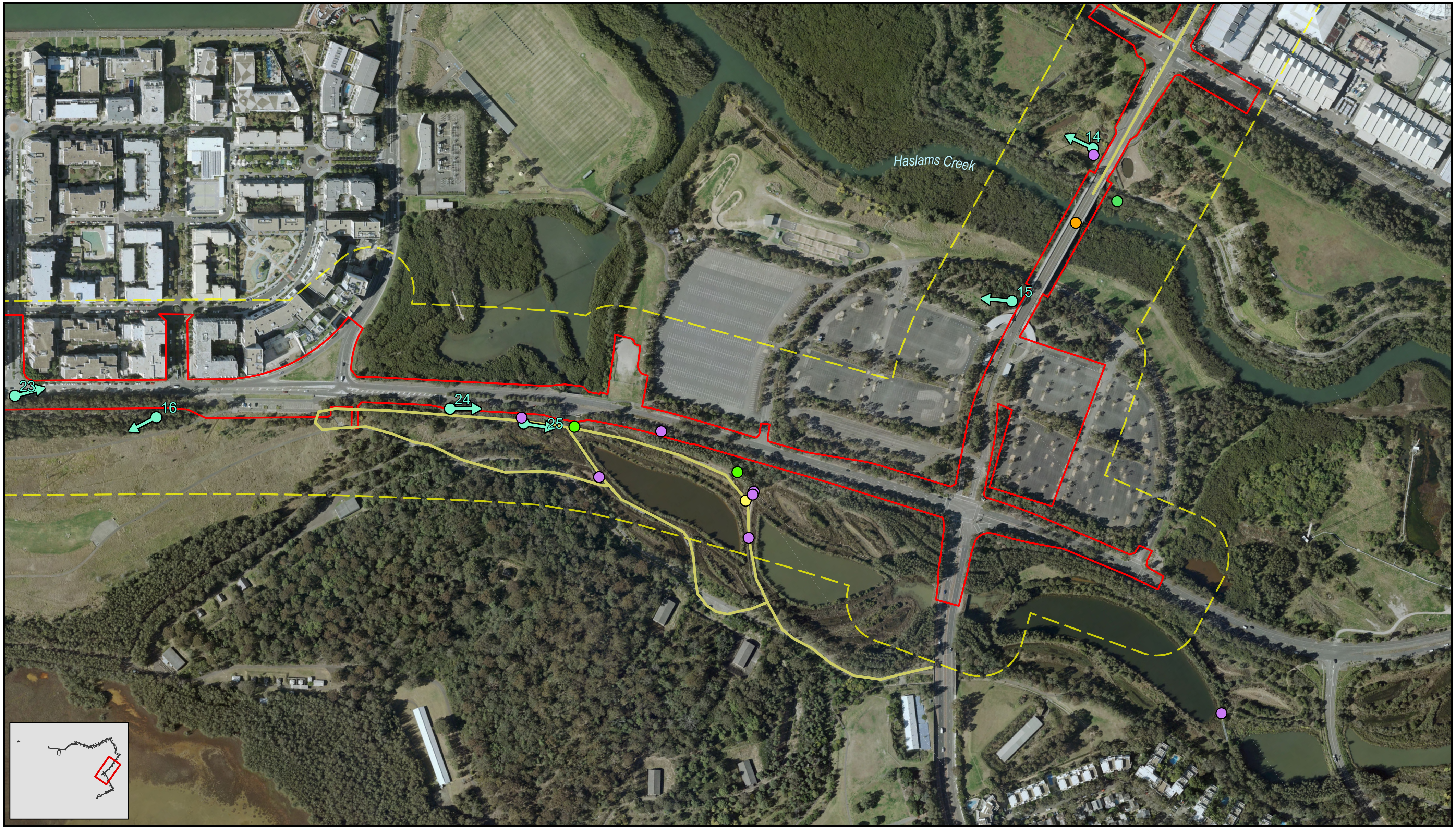

Legend

Project site

Project study area

Spotlighting

Plot/transect

Survey Effort

Anabat

Bird survey

Call playback

Frog survey (diurnal)

Threatened flora survey

Paper Size ISO A4

0 50 100

Metres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Survey Effort

FIGURE 3.1f

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Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

Project site

Project study area

Spotlighting

Plot/transect

Survey Effort

Bird survey

Call playback

Threatened flora survey

Paper Size ISO A4

0 50 100

Metres

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

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GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Survey Effort

Project No. 12557728
Revision No. A
Date 11/07/2023

FIGURE 3.1g

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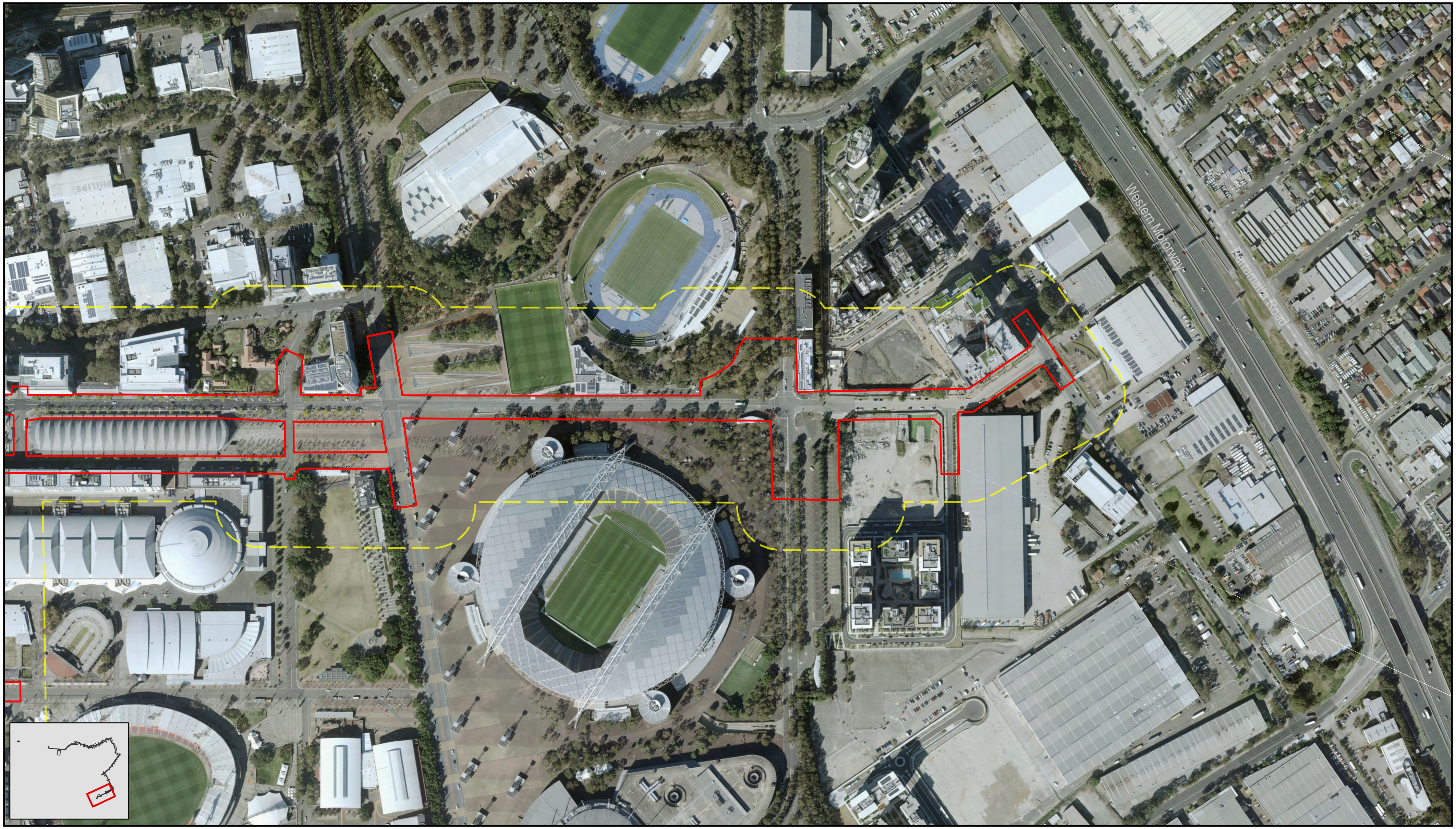

Legend

Project site

Project study area

Paper Size ISO A4

0 50 100

Metres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Survey Effort

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 3.1h

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Print date: 11 Jul 2023 - 11:54

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

4. Landscape context

The BAM requires the assessment of landscape features to help describe the biodiversity values of the project site and assess the impacts of the project. Landscape features for the construction and operation area relevant to the BAM calculations are discussed below.

4.1 Location and existing land uses

The project site is located within the Greater Sydney region, running from Parramatta in the west to Homebush in the south-east. The site is predominantly located within the Parramatta Local Government Area (LGA) and crosses the Parramatta River between Camellia and Rydalmere, and Melrose Park and Wentworth Point (refer to Figure 1.2).

The site and surrounds of the project include the localities of Parramatta, Camellia, Rydalmere, Ermington, Melrose Park, Wentworth Point and Sydney Olympic Park. At the western end of the project site, Camellia is predominantly an industrial precinct and is a major Sydney location for the manufacturing of building materials, the recycling of concrete, the storage and distribution of fuel and the production of essential food products.

Sydney Olympic Park is a 640-hectare residential, commercial, education and entertainment precinct, 14 kilometres west of Sydney's CBD and nine kilometres east of Parramatta. Over half of the 430 hectares of Sydney Olympic Park parklands is managed for nature conservation, supporting numerous native animal species, protected mangrove forest, and three threatened ecological communities. The parklands include:

– Newington Nature Reserve, which supports 47 hectares of critically endangered Sydney Turpentine Ironbark Forest, mangrove forest and endangered saltmarshes
– freshwater wetlands, estuarine wetlands and creek systems that support abundant wildlife including internationally migratory bird species and endangered frogs
– the Brickpit, which is important habitat for endangered frogs and other wildlife, and which contains a 300 megalitre water storage reservoir.

On the north side of the Parramatta River, in the localities of Rydalmere, Ermington and Melrose Park, the site is characterised by medium and high-density residential developments with some limited industrial areas and small urban parks and council reserves.

4.2 Geology and soils

4.2.1 Soil landscapes

The Disturbed terrain, Glenorie and Lucas Heights soil landscapes dominate the western portion of the study area, while the Blacktown and Birrong dominate the south-eastern portion (DPIE 2021d). Soil landscapes within the study area are described in Table 4.1.

Table 4.1 Soil landscapes

Soil landscape (DPIE 2021d)	Description
Disturbed terrain (xx)	Varied topography with soils disturbed by human activity to at least 100 cm. Original soil has been removed, buried or disturbed with large areas having been levelled to slopes <5%. Includes artificial fill with dredged sand or mud, rocks and local soil materials along with demolition rubble, industrial and household waste.
Lucas Heights (lh)	Gently undulating crests and ridges on plateau surfaces of the Mittagong formation, with slopes <10% and absent rock outcrop. Dry sclerophyll low forest and woodland is extensively or completely cleared. Soils moderately deep, including hardsetting yellow podzolic soils and yellow soloths with yellow earths on outer edges.

Soil landscape (DPIE 2021d)	Description
Blacktown (bt)	Gently undulating rises on Wianamatta Group shales and Hawkesbury shale with slopes usually <5%. Cleared eucalypt woodland and tall open-forest (wet sclerophyll forests). Soils are shallow to moderately deep soils and include red and brown Podzolic Soils on crests, upper slopes and well-drained areas and deep Yellow Podzolic Soils and Soloths on lower slopes and in areas of poor drainage.
Glenorie (gn)	Undulating to rolling low hills on Wianamatta Group shales. Local relief 50–80 metres, slopes 5-20%. Extensively cleared tall open-forest (wet sclerophyll forests). Shallow to moderately deep Red Podzolic Soils on crests; moderately deep Red and Brown Podzolic Soils on upper slopes; deep Yellow Podzolic Soils and Gleyed Podzolic Soils along drainage lines.
Birrong (bg)	Level to gently undulating alluvial floodplain draining Wianamatta Group shales with slopes <3%. Tall open-forest and woodland is extensively cleared. Soils comprises deep Yellow Podzolic Soils and Yellow Solodic Soils on older alluvial terraces and deep Solodic Soils and Yellow Solonetz on current floodplain.
Ettalong (et)	Found on level to very gently undulating coastal swamps with slopes <2%. Hummocky surface, shallow lakes and very shallow water tables. Closed-sedgeland and tall open-forest. Soils includes deep organic acid peats, peaty podzols and humus podzols often overlying buried siliceous sands.

4.2.2 Soil hazards

Soil landscapes reports pertaining to the study area indicate that most soil profiles contain podzolic and solodic soils with a low to moderate potential for erosion (DPIE 2021d). A description of erosion within each soil landscape is provided in Table 4.2

Coastal acid sulfate soils occur in every coastal estuary in NSW and are common to mangrove and saltmarsh areas. They comprise natural sediments that contain iron sulfides found less than a metre above sea level and affecting more than 260,000 hectares of land. If drained these soils oxidise and release acid sulfates which can reduce the pH of waterways, deoxygenate waterways, and kill off aquatic life such as fish and benthos (DECC 2007). Acid sulfate soil risk mapping of the study area indicates that there is a high probability of acid sulfate soil risk along the Parramatta River and Haslams Creek, as well as within Newington Nature Reserve and throughout much of Camellia (DPIE 2021d). Further assessment of potential impacts on habitats as a result of mobilisation of contaminants is provided in section 9.9. Mitigation measures to prevent movement of acid sulfate soils would be employed (see section 10).

Table 4.2 Soil hazards

Soil landscape (DPIE 2021d)	Hazards
Disturbed terrain (xx)	None identified.
Lucas Heights (lh)	Erosion on this unit is generally low. Minor gully and sheet erosion occurs occasionally along unpaved roads.
Blacktown (bt)	No appreciable erosion occurs on this unit as most of the surface is covered by tiles, concrete, bitumen or turf.
Glenorie (gn)	Minor gully erosion is evident along unpaved roads. Moderate sheet erosion occurs on disturbed areas (e.g. cultivated lands). Small areas of moderate to severe sheet erosion occur in overgrazed paddocks on many hobby farms. Evidence of previous erosion is commonplace, especially where eroded topsoil has been deposited against fences.
Birrong (bg)	Most drainage lines have been artificially lined with concrete preventing most erosion. Minor streambank erosion has occurred along remaining natural drainage lines.
Ettalong (et)	Erosion is absent. Swamps are almost entirely depositional sites, being very effective sediment traps. Dense sedge and rush vegetation effectively traps large volumes of sediment that enters as sheetwash, overbank flow or channel flow. Development in swamp catchments has led to increased sedimentation with detrimental effects on some species of swamp flora and fauna. The input of chemicals such as detergents, herbicides and garden fertilisers is likely to alter swamp environments.

The following main contamination matters occur in the study area:

– hexavalent chromium contamination in Camellia
– asbestos contamination associated with James Hardie's past operations in various areas
– general contamination in fill and associated with past industrial activities (including the former Shell Refinery currently operated by Viva Energy)
– Sydney Olympic Park – landfills and associated leachate management infrastructure
– potential or actual acid sulfate soils
– potential for contamination in other areas not yet identified (refer to the EIS Chapter 18 (Soils and contamination)).

4.2.3 Geology

No areas of geological significance are present in the study area.

4.3 Hydrology

4.3.1 Waterways

The study area is located within the Parramatta River catchment, which covers an area of about 266 square kilometres and is divided into 10 sub-catchments. The Parramatta River is the main tributary of the Sydney Harbour catchment and extends from Blacktown Creek to the confluence of Lane Cove River at Clarkes Point. The Parramatta River is tidal to Charles Street Weir in Parramatta. The geomorphology of this section of the river is influenced by waves, astronomical tides and river discharge resulting in the mixing of fresh and saline waters. The Parramatta River catchment is highly urbanised with a number of modified waterways and isolated areas of native vegetation, resulting in poor water quality and modified flow regimes. The tidal influence from the Parramatta River extends to the river's head at Parramatta, where Domain Creek, Darling Mills Creek and Toongabbie Creek channel freshwater. The Parramatta River becomes increasingly narrow to the west of the study area (see Technical Paper 10 (Hydrology, Flooding and Water Quality Assessment)). The Parramatta River is crossed by the light rail alignment in two locations, with bridges proposed between Camellia and Rydalmere, and Melrose Park and Wentworth Point.

Surface water in the project site mainly drains directly into the Parramatta River via Haslams Creek in the southern portion of the study area. Haslams Creek was previously a concrete-lined stormwater channel that was reconstructed in 2000, to replicate its natural geomorphology and character. The project would cross Haslams Creek using the existing bridge at Holker Busway.

A drainage system that intersects with Ken Newman Park in the northern portion of the study area collects stormwater and then drains into the Parramatta River. Aquatic habitat values are discussed further in section 5.7.

4.3.2 Wetlands

A series of wetlands occur south of the Parramatta River at Sydney Olympic Park and are associated with water flows from Haslams Creek and Powells Creek. The wetlands at Newington Nature Reserve, Millennium Parklands, Badu Wetlands, the Waterbird Refuge and Mason Park occur in close vicinity to the project and form part of the Parramatta River Catchment. The wetlands at Newington Nature Reserve and Millennium Parklands are drained by Haslams Creek, which is crossed by the project site at the existing Holker Busway. Construction would occur in close proximity to these wetlands at Wentworth Point and along Hill Road. The Badu Wetlands are located within Bicentennial Park and, at 65 hectares, are an ecological significant estuarine wetland listed on the Directory of Important Wetlands which is in close proximity to the project site (SOPA 2010). The Mason Park Wetlands and Badu Wetlands are drained by Powells Creek to the east of the project site and would not be directly impacted by the project.

The Narawang Wetland and Brickpit are artificial wetlands that function as floodplain habitat adjoining Haslams Creek. The Narawang Wetland comprises three irrigation ponds and 22 freshwater ponds over a 1.6 kilometre corridor. The irrigation ponds at Narawang Wetland collect stormwater runoff from adjoining residential areas and car parks and irrigate the adjacent parklands. A number of other constructed ponds are present at Sydney Olympic Park and were created to form additional breeding habitat for the Green and Golden Bell Frog.

4.4 Climate

The site has a warm and temperate climate. Based on data from the Sydney Olympic Park weather station the site has a mean annual rainfall of 911.8 millimetres, with the highest rainfall tending to occur in February. The mean daily maximum temperature is 23.6 degrees Celsius and mean daily minimum temperature is 13.9 degrees Celsius (BOM 2021b).

4.5 NSW (Mitchell) landscape

The project site crosses three NSW (Mitchell) Landscapes. The descriptions for these landscapes are reproduced in Table 4.3 from *Descriptions for NSW (Mitchell) Landscapes* (DECC 2008a). For the purposes of entering data into the BAM calculator, the Mitchell Landscape that overlaps with the majority of the project site was selected (Port Jackson Basin Mitchell Landscape).

Table 4.3 NSW landscapes

Landscape name	Description (DECC 2008a)
Port Jackson Basin	Deep elongated harbour with steep cliffed margins on horizontal Triassic quartz sandstone. Small pocket beaches and more extensive Quaternary estuary fill of muddy sand at the head of most tributary streams. General elevation 0 to 80 metres, local relief 10 to 50 metres. Sandstone slopes and cliffs have patches of uniform or gradational sandy soil on narrow benches and within joint crevices that support forest and woodland of Sydney Peppermint (*Eucalyptus piperita*), Smooth-barked Apple (*Angophora costata*), Red Bloodwood (*Corymbia gummifera*) and Blackbutt (*Eucalyptus pilularis*). Sheltered gullies contain some Turpentine (*Syncarpia glomulifera*), Coachwood (*Ceratopetalum apetalum*) and Water Gum (*Tristaniopsis laurina*). Estuarine sands were originally dominated by saltmarsh but have been taken over by grey mangrove (*Avicennia marina*) in the past century.
Pennant Hills Ridges	Rolling to moderately steep hills on horizontal Triassic shales and siltstones. General elevation 10 to 90 metres, local relief 60 metres. Deep red texture-contrast soils on narrow hillcrests, red and brown to yellow texture-contrast soils on slopes becoming slightly harsher in drainage lines. Tall open forest of Sydney Blue Gum (*Eucalyptus saligna*), Turpentine (*Syncarpia glomulifera*), Blackbutt (*Eucalyptus pilularis*), White Stringybark (*Eucalyptus globoidea*), Grey Ironbark (*Eucalyptus paniculata*), Forest Oak (*Allocasuarina torulosa*) and Rough-barked Apple (*Angophora floribunda*). Rainforest elements in protected moist gully heads with Sweet Pittosporum (*Pittosporum undulatum*), Cheese Tree (*Glochidion ferdinandi*), Sandpaper Fig (*Ficus coronata*) and Black Wattle (*Callicoma serratifolia*).
Ashfield Plains	Undulating hills and valleys on horizontal Triassic shale and siltstone, occasional quartz sandstones especially near the margin of the Port Jackson landscape. General elevation 0 to 45 metres, local relief <20 metres. Coastal extension of the Cumberland Plain landscape. Red and brown texture-contrast soils on crests grading to yellow harsh texture-contrast soils in valleys. Open forest of Broad-leaved Ironbark (*Eucalyptus fibrosa* ssp. *fibrosa*), Grey Box (*Eucalyptus moluccana*), with Tea-tree (*Leptospermum* sp.) along creeks and forests of Turpentine (*Syncarpis glomulifera*), Red Mahogany (*Eucalyptus resinifera*), Grey Gum *(Eucalyptus punctata*), Sydney Blue Gum (*Eucalyptus saligna*) and Blackbutt (*Eucalyptus pilularis*) with a grassy understorey of Kangaroo Grass (*Themeda triandra*) on moister sites.

4.6 Determining site context

To determine site context as required under Section 3 of the BAM, an assessment of native vegetation cover and patch size (Section 3.2 and sub-section 4.3.2) has been carried out and is outlined below.

4.6.1 Native vegetation cover

Native vegetation cover (woody and non-woody) was assessed on the project site and within a 500 metre buffer area surrounding the outside edge of the boundary of the project site using the approach for a linear development. Aerial photography was examined at scales between 1:2,000 and 1:4,000. The per cent native vegetation cover within the 500 metre buffer areas was assessed to be 8.5 per cent (see Table 4.4) and includes:

– remnant native vegetation types
– planted native vegetation types.

Areas that were excluded include:

– cleared areas
– non-native vegetation
– dams, ponds and other waterbodies
– buildings
– non-native plantings.

The identification of native vegetation (including derived native grasslands) in the buffer areas was based on review of the Native Vegetation of the Sydney Metropolitan Area – Version 3.1 VIS_ID 4489 (OEH 2016), in combination with aerial photograph interpretation and ground-truthing during field surveys.

Table 4.4 Native vegetation cover

Native vegetation cover unit	500 metre buffer area
Total assessment area	1386.95 hectares
Area of native vegetation cover (woody and non-woody)	99.92 hectares
Per cent native vegetation cover	7 per cent
Cover class	0-10 per cent

4.6.2 Patch size

Patch size is defined under the BAM (DPIE 2020a) as an area of native vegetation that:

– occurs on the development site or biodiversity stewardship site (i.e. project site)
– includes native vegetation that has a gap of less than 100 metres from the next area of native vegetation (or ≤ 30 metres for non-woody ecosystems).

Patch size may extend into adjoining land that is not part of a development site or a biodiversity stewardship site. Patch size area is assigned to each vegetation zone as a class, being < 5 hectares, 5-<25 hectares, 25-<100 hectares or ≥ 100 hectares, and is used by the BAM calculator as a filter to predict threatened species likely to occur in the project site.

Figure 4.1 shows the polygons used to establish patch size for BAM calculations. There are three patches of native vegetation that intersect the project site, and which have a gap of less than 100 metres from the nearest area of native vegetation, or a gap of less than 30 metres if the vegetation is non-woody. The three patches and their sizes are shown on Figure 4.1 and summarised in Table 4.5, with one in the western portion of the project site, one in the north, and one in the south.

Each of the vegetation zones in the project site intersect each of the three patches for the assessment. Therefore, a conservative approach has been taken, and the patch with the largest area (patch 3, 1,218 hectares) has been used for BAM calculations. This patch falls into the patch size class of ≥ 100 hectares, and as such, 101 hectares (as the number must be a whole number with no decimal places) has been entered as the patch size for all vegetation zones in the BAM calculator, and in Table 5.7 to Table 5.13.

Table 4.5 Patch size at the project site

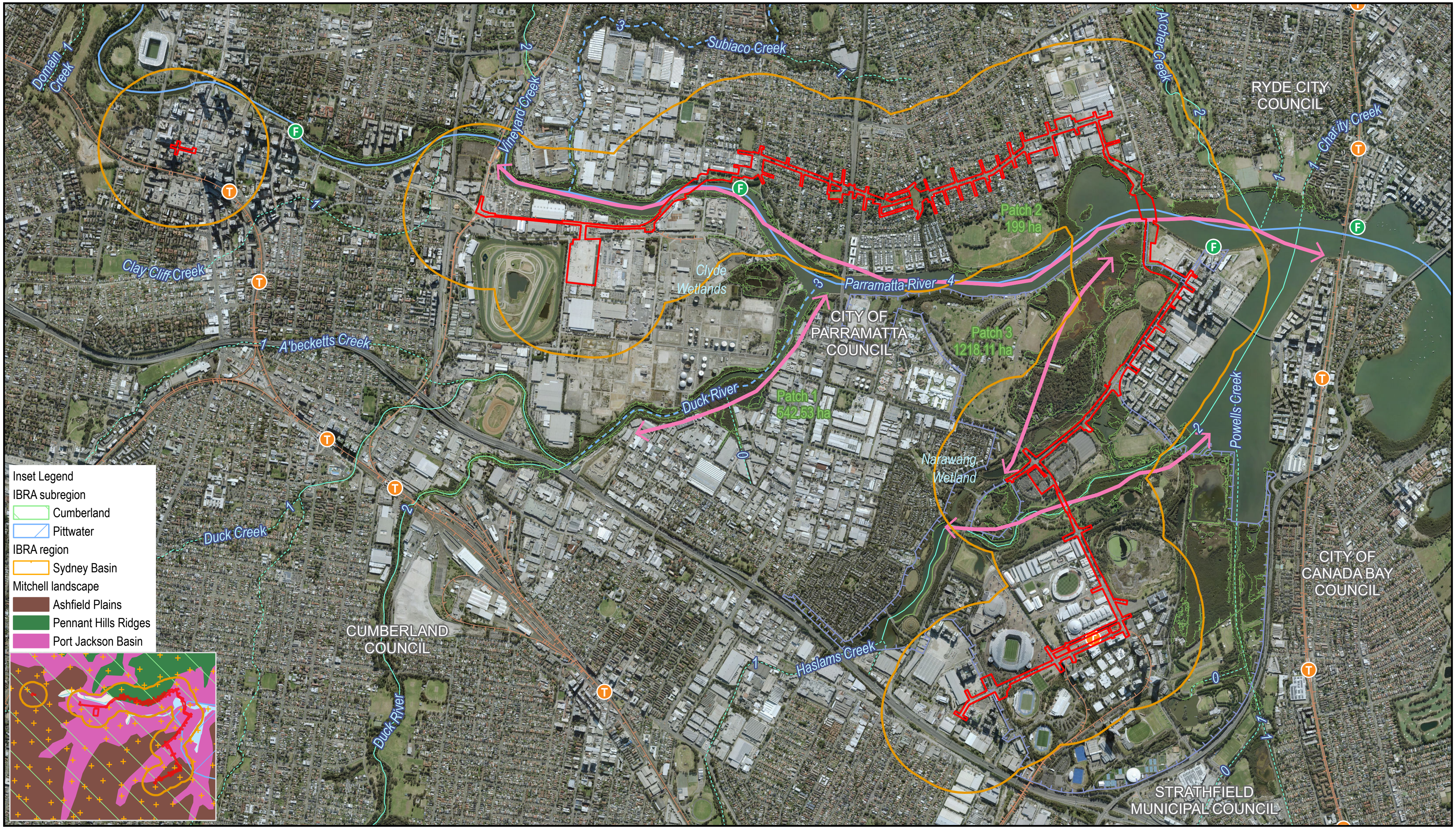
Patch	Size (nearest whole hectare)	Patch size class
1	543	≥100 hectares
2	199	≥100 hectares
3	1,218	≥100 hectares

4.7 Landscape features

Landscape features within the project site are summarised in Table 4.6 and shown in Figure 4.1 as required by Section 3.1 of the BAM.

Table 4.6 Landscape features

Landscape features	Study area
IBRA bioregions and subregions	Sydney Basin Bioregion, Cumberland Subregion
NSW (Mitchell) Landscape regions	Port Jackson Basin, Pennant Hills Ridges, Ashfield Plains (Port Jackson Basin selected in the BAM calculator)
Local Government Area (LGA)	Parramatta, Ryde
Rivers and streams	Parramatta River, Haslams Creek
Important wetlands	A number of coastal wetlands occur in or near the project site, including Newington Nature Reserve Wetland, Narawang Wetland, the Waterbird Refuge and Badu Mangroves.
Connectivity features	Key connectivity features include the Parramatta River and Haslams Creek, and their associated riparian zones. Connectivity is also provided by large patches of vegetation in Newington Nature Reserve and the Millennium Parklands at Sydney Olympic Park.
Areas of geological significance and soil hazard features	No areas of geological significance are within the project site. High probability of acid sulfate soils.
Areas of outstanding biodiversity value	No areas of outstanding biodiversity value are identified in the study area or IBRA subregion.
Landscape features listed in the SEARs	Newington Nature Reserve, Narawang Wetland



Legend

- Project site
- 500m buffer area
- Sydney Olympic Park
- Patch size

Stream Order

- 0th order
- 1st order
- 2nd order
- 3rd order
- 4th order

- Ferry Wharf
- Train Station
- Railway
- Connectivity

Paper Size ISO A4

0 0.5 1

Kilometres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. 12557728
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Location map

FIGURE 4.1

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Print date: 11 Jul 2023 - 11:50

Data source: World Topographic Map: Esri, HERE, Garmin, Foursquare, METI/NASA, USGS
Metromap Tile Service:
World Hillshade: Esri, Geoscience Australia, NASA, NGA, USGS: Base Imagery Extracted 11/07/2023. Created by: Imanasan

5. Vegetation and habitats

5.1 Native vegetation extent

The project site contains large areas of cleared and modified land that support urban plantings, as well as areas of native vegetation. Native vegetation is predominantly associated with riparian zones of the Parramatta River and areas of Sydney Olympic Park. No native vegetation is present within the Parramatta CBD section of the project site. Planted trees occur along much of the alignment, including the Parramatta CBD, Camellia, Rydalmere, Ermington, Melrose Park, Wentworth Point and Sydney Olympic Park.

Previous reports relating to the landscaping and revegetation work completed at Sydney Olympic Park were reviewed to ascertain if the intent of these works were to replicate the native vegetation types that would have once occurred in the area. To confirm whether the vegetation should be mapped as native or non-native, plot surveys were completed to identify the species that had been planted to allow comparison with locally occurring PCTs. Where the species present had been planted and the species did not align with any local PCT types, the vegetation was mapped as non-native or planted vegetation, and assessed in accordance with Appendix D of the BAM (Streamlined assessment module – planted native vegetation). The decision-making key in Appendix D.1 of the BAM was applied and planted native vegetation within the study area was considered to have been planted for functional and aesthetic purposes as part of landscaping works for the Millennium Parklands as well as for aesthetic purposes in council reserves and parks and street tree planting in residential areas (see section 6.2).

The extent of native vegetation, planted native vegetation, exotic vegetation and cleared land in the project site is summarised in Table 5.1. The native PCTs in the project site are described in section 5.3 and have been subject to the threatened species habitat, impact and biodiversity offsetting assessment requirements of the BAM.

Table 5.1 Extent of native vegetation and other land uses in the project site

Number	Area (hectares)
Native vegetation	2.43
Planted native vegetation	5.51
Cleared land / hardstand / infrastructure	50.95
Water	3.68
Total project site area	62.57

5.2 Planted native vegetation assessment

Planted native vegetation within the study area was compared with the decision-making key in Appendix D.1 of the BAM. A summary of the comparison is provided in Table 5.2 and justification is provided below.

Table 5.2 Planted native vegetation key

Number	Question	Answer
Question 1	Does the planted native vegetation occur within an area that contains a mosaic of planted and remnant native vegetation and which can be reasonably assigned to a PCT known to occur in the same IBRA subregion as the proposal?	No
Question 2	Is the planted native vegetation: – planted for the purpose of environmental rehabilitation or restoration under an existing conservation obligation listed in BAM Section 11.9(2.), and – the primary objective was to replace or regenerate a plant community type or a threatened plant species population or its habitat?	No

Number	Question	Answer
Question 3	Is the planted/translocated native vegetation individuals of a threatened species or other native species planted/translocated for the purpose of providing threatened species habitat under one of the following: – species recovery project – Saving our Species project – other types of government funded restoration project – condition of consent for a development approval that required those species to be planted or translocated for the purpose of providing threatened species habitat – legal obligation as part of a condition or ruling of court. This includes regulatory directed or ordered remedial plantings (e.g. Remediation Order for clearing without consent issued under the BC Act or the *Native Vegetation Act 2003*) – ecological rehabilitation to re-establish a PCT or TEC that was, or is carried out under a mine operations plan, or – approved vegetation management plan (e.g. as required as part of a Controlled Activity Approval for works on waterfront land under the NSW *Water Management Act 2000*)?	No
Question 4	Was the planted native vegetation (including individuals of a threatened flora species) undertaken voluntarily for revegetation, environmental rehabilitation or restoration without a legal obligation to secure or provide for management of the native vegetation?	No
Question 5	Is the native vegetation (including individuals of a threatened flora species) planted for functional, aesthetic, horticultural or plantation forestry purposes? This includes examples such as: windbreaks in agricultural landscapes, roadside plantings (including street trees, median strips, roadside batters), landscaping in parks, gardens and sport fields/complexes, macadamia plantations or teatree farms?	Yes

Planted native vegetation within Sydney Olympic Park was planted for functional and aesthetic purposes as part of the landscaping works for the Millennium Parklands in the 1990s. The Statement of Environmental Effects prepared for the Millennium Parklands (Perram and Partners 1997) notes that much of the parkland has modified soil structures and is an *“artificial environment”,* and as such, *“conditions will not necessarily be favourable to plant species indigenous to the Homebush Bay area*”. Instead, in areas that were subject to disturbance, “*it is proposed to select species from the broader Sydney region on the basis of their suitability for the types of conditions encountered in the parklands*”. This information was relied upon when mapping the vegetation types across the study area, to assist in determining which areas may need to be mapped as a vegetation type that was not a native PCT.

Planted vegetation elsewhere along the alignment, particularly in urban parklands such as near Rydalmere Wharf, Ken Newman Park and Archer Park has been planted for similar purposes (ie landscaping in parks and gardens etc). Vegetation within these areas has not been planted with species that resemble any locally occurring PCTs and cannot be reasonably assigned to a PCT known to occur in the same IBRA subregion as the project.

The BAM notes that vegetation that meets these criteria does not need to be assessed in line with Chapter 4 or 5 of the BAM, but Appendix D.2 must be applied, and the vegetation must be assessed for threatened species habitat (refer to section 6.2). As such, areas of planted vegetation have not been entered as a vegetation zone in the BAM calculator.

Any opportunistic or incidental sightings of threatened biota within planted native vegetation have been recorded during this assessment, and, where relevant, Section 8.4 of the BAM has been applied and mitigation measures have been recommended for impacts on these species as a result of the project. Species credits have not been calculated for any such impact, in line with the BAM.

In some instances, planted vegetation was able to be aligned with locally occurring PCTs, and it appeared that landscaping works had aimed to mimic these PCTs. In these cases, a PCT was assigned to the vegetation zone, and the condition was selected to include ‘planted’ to indicate the provenance of the PCT.

A description of planted vegetation within the project site that could not be appropriately matched to any locally occurring PCTs is provided in Table 5.3.

Table 5.3 Planted vegetation

<table>
<tr><th colspan="2">Planted vegetation</th></tr>
<tr><td>Plant community type (DPIE 2021c)</td><td>Non-native or planted vegetation</td></tr>
<tr><td>PCT ID</td><td>N/A</td></tr>
<tr><td>PCT justification</td><td>N/A. This vegetation could not be appropriately allocated to any locally occurring PCTs. The species assemblage did not match with any local PCT types, and the species that have been planted were selected based on likely survival, availability, density of foliage and aesthetics, rather than being characteristic of local PCTs. Planted vegetation occurs on modified landforms that do not support natural soil profiles, and include areas of reclaimed land and imported fill.</td></tr>
<tr><td>Photos</td><td>
Non-native or planted vegetation at Plot 6

Non-native or planted vegetation at Plot 21</td></tr>
<tr><td>Survey effort</td><td>Plot 6, 13, 15, 17, 21, 22, 23, and 24</td></tr>
<tr><td>Conservation significance</td><td>Not listed</td></tr>
<tr><td>Patch size</td><td>N/A</td></tr>
</table>

Planted vegetation	
Condition	This vegetation is in varying conditions across the study area. Some patches are maintained regularly, and are subject to regular 'tidying up' and landscaping, while others are weedy and subject to disturbance from surrounding land uses.
Current vegetation integrity score	N/A
Landscape position	Occurs on imported fill on highly modified landscapes throughout the study area.
Structure	Variable structure, depending on plant species composition and management regime. Some patches, particularly in Sydney Olympic Park and urban parkland and roadside plantings, are subject to routine ongoing maintenance, including weed spraying and tree trimming and have had no self-recruitment of understorey or midstorey species. These patches are generally restricted to even-aged, planted canopy species, with scattered planted understorey species. Some patches within Sydney Olympic Park have been planted to resemble native woodland vegetation, with a mixture of canopy, midstorey and understorey species. The species used are not characteristic of locally occurring PCTs, and there is limited regeneration or self-recruitment of species.
Over-storey	Rough-barked Apple (*Angophora floribunda*), Kurrajong (*Brachychiton populneus* subsp. *populneus*), River Oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*), Swamp Oak (*Casuarina glauca*), Spotted Gum (*Corymbia maculata*), Tuckeroo (*Cupaniopsis anacardioides*), Blue Box (*Eucalyptus baueriana*), Red Ironbark (*Eucalyptus fibrosa*), Grey Box *(Eucalyptus moluccana*), Grey Ironbark (*Eucalyptus paniculata*), Grey Gum (*Eucalyptus punctata*), Swamp Mahogany (*Eucalyptus robusta*), Sydney Blue Gum (*Eucalyptus saligna*), Forest Red Gum (*Eucalyptus tereticornis*), Turpentine (*Syncarpia glomulifera* subsp. *glomulifera*).
Mid-storey	Black Wattle (*Acacia decurrens*), Hickory Wattle (*Acacia implexa*), Sydney Golden Wattle (*Acacia longifolia* subsp. *longifolia*), Parramatta Wattle *(Acacia parramattensis*), Native Blackthorn (*Bursaria spinosa*), Large-leaf Hop-bush (*Dodonaea triquetra*), Silky Oak (*Grevillea robusta*), Willow-leaved Hakea (*Hakea salicifolia*), Needlebush (*Hakea sericea*), *Homalanthus populifolius*, Tick Bush (*Kunzea ambigua*), Tantoon (*Leptospermum polygalifolium*), *Melaleuca decora*, Prickly-leaved Tea Tree (*Melaleuca styphelioides*), White Dogwood (*Ozothamnus diosmifolius*), Sweet Pittosporum (*Pittosporum undulatum*).
Groundcover	Spiny-headed Mat-rush (*Lomandra longifolia*), a speargrass (*Austrostipa* spp.), Tall Sedge (*Carex appressa*), Native Grape (*Cayratia clematidea*), Indian Pennywort (*Centella asiatica*), Headache Vine (*Clematis glycinoides*), Native Wandering Jew (*Commelina cyanea*), Common Couch (*Cynodon dactylon*), Blue Flax-lily (*Dianella caerulea*), Kidney Weed (*Dichondra repens*), *Dietes* spp., Berry Saltbush (*Einadia hastata*), Bordered Panic (*Entolasia marginata*), *Entolasia stricta*, A Cudweed (*Euchiton* spp.) Wombat Berry (*Eustrephus latifolius*), Knobby Club-rush (*Ficinia nodosa*), Tall Saw-sedge (*Gahnia clarkei*), Maori Bedstraw (*Galium propinquum*), Scrambling Lily (*Geitonoplesium cymosum*), False Sarsaparilla (*Hardenbergia violacea*), Blady Grass (*Imperata cylindrica*), Rush (*Juncus australis*), Weeping Grass (*Microlaena stipoides* var. *stipoides*), Wonga Wonga Vine (*Pandorea pandorana*), *Plectranthus parviflorus*, Tussock (*Poa labillardierei* var. *labillardierei)*, Glossy Nightshade (*Solanum americanum*), Kangaroo Apple (*Solanum aviculare*).
Exotic species	Rambling Dock (*Acetosa sagittata*), Moth Vine (*Araujia sericifera*), Climbing Asparagus Fern (*Asparagus plumosus*), Onion Weed (*Asphodelus fistulosus*), Cobbler's Pegs (*Bidens pilosa*), Prairie Grass (*Bromus catharticus*), Japanese Hackberry (*Celtis sinensis*), Red Caustic Weed (*Chamaesyce prostrata*), Rhodes Grass (*Chloris gayana*), Spear Thistle (*Cirsium vulgare*), Flaxleaf Fleabane (*Conyza bonariensis*), Canadian Fleabane (*Conyza canadensis* var. *canadensis*), Tall fleabane (*Conyza sumatrensis*), Slender Celery (*Cyclospermum leptophyllum*), Umbrella Sedge (*Cyperus eragrostis*), Panic Veldtgrass (*Ehrharta erecta*), African Lovegrass (*Eragrostis curvula*), Petty Spurge (*Euphorbia peplus*), Lantana (*Lantana camara*), Small-flowered Mallow (*Malva parviflora*), Hexham Scent (*Melilotus indicus*), Onion Weed (*Nothoscordum borbonicum*), Mickey Mouse Plant (*Ochna serrulata*), Common Passionfruit (*Passiflora edulis*), Cork Passionfruit (*Passiflora suberosa*), Canary Island Date Palm (*Phoenix canariensis*), Lamb's Tongues (*Plantago lanceolata*), Blackberry complex (*Rubus fruticosus* sp. agg.), Fireweed (*Senecio madagascariensis*), Paddy's Lucerne (*Sida rhombifolia*), Black-berry Nightshade (*Solanum nigrum*), Common Sowthistle (*Sonchus oleraceus*), Rhus Tree (*Toxicodendron succedaneum*), Wandering Jew (*Tradescantia fluminensis*), Purpletop (*Verbena bonariensis*).

5.3 Plant community types

5.3.1 Previous studies

The remnant vegetation along the foreshore of the Parramatta River and downstream sections of its tributaries, from Homebush Bay to Parramatta, historically supported large areas of saltmarsh with smaller areas of mangroves (Hoskins 2015). Along some sections, such as at Duck River or Vineyard Creek, riparian forest supporting eucalypts, paperbarks and she-oaks occurred right down to the water's edge (Hoskins 2015). The riparian forests included species like Cabbage Gum (*Eucalyptus amplifolia*), Grey Box (*Eucalyptus moluccana*), Red Ironbark (*Eucalyptus fibrosa*), Red Mahogany (*Eucalyptus resinifera*), Prickly-leaved Tea Tree (*Melaleuca styphelioides*), *Melaleuca decora*, Rough-barked Apple (*Angophora floribunda*) and Swamp Oak (*Casuarina glauca*) (Benson and Howell 1990; Hoskins 2015).

The extant riverine landscape is characterised by mudflats and mangroves, flanked by narrow bands of swamp forests dominated by Swamp Oak (*Casuarina glauca*). Modification of the riverine landscape and surrounds began in the late 18th century, with land clearing taking place for agriculture due to the relatively flat terrain and rich soils. Ongoing land clearing and development followed during the industrialisation and then urbanisation of the surrounding landscape (Hoskins 2015).

Regional vegetation mapping (OEH 2016) shows three PCTs within the study area:

- PCT 1234: Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion
- PCT 920: Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion
- PCT 1126: Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion.

These vegetation types generally occur in a distinct pattern that is correlated to proximity to water and saline influence. Mangrove forest (PCT 920) is mapped as occurring along the banks of the Parramatta River and other waterways in the area. There are small patches of saltmarsh (PCT 1126) up-slope of patches of mangrove forest, and then scattered patches of Swamp Oak swamp forest (PCT 1234), farther from the river, behind areas of mangrove forest or saltmarsh (OEH 2016).

The previous studies and existing vegetation mapping of the study area were found to roughly align with the results of the current survey. The above listed PCTs were all identified within the study area, along with an additional two planted vegetation zones, that correspond with locally occurring PCTs. Vegetation commensurate with PCT 1281 Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion has been planted in Sydney Olympic Park. This vegetation zone lacks regeneration of canopy species and has been planted on an artificial landform and is unlikely to achieve self-recruitment of characteristic species. As such, it has been delegated a condition of 'planted'. Vegetation commensurate with PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion has been planted around the various wetland habitats constructed within Sydney Olympic Park. This vegetation zone has achieved a relatively natural series of processes, with self-recruitment and regeneration of characteristic species. As such, this zone has not been delegated a 'planted' condition, but instead has been considered native vegetation for the purposes of this assessment.

5.3.2 Survey results

Five PCTs have been identified in the project site. The BAM notes that any planted native vegetation that occurs within an area that contains a mosaic of planted and remnant native vegetation and which can be reasonably assigned to a PCT, must be allocated to the best-fit PCT. Planted vegetation along the alignment has been allocated to a PCT where the mix of native species could be reasonably fitted to a candidate PCT.

The PCTs mapped within the project site are summarised in Table 5.4. Vegetation profiles for the five PCTs identified in the project site and justification for selection of these PCTs are in section 5.3.3. PCTs are mapped in Figure 5.1. Further discussion of threatened ecological communities is provided in Sections 5.3.4 (BC Act) and 7.1 (EPBC Act).

Table 5.4 Plant community types in the project site

Vegetation type	BC Act status	EPBC Act status	FM Act status	Extent in project site (hectares)
PCT 920: Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Not listed	Not listed	Protected marine vegetation	0.72
PCT 1126: Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions (endangered ecological community (EEC))	Subtropical and Temperate Coastal Saltmarsh (vulnerable ecological community (VEC))	Protected marine vegetation	0.03
PCT 1234: Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (EEC)	Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland (EEC)	Not listed	0.62
PCT 1281: Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion (critically endangered ecological community, (CEEC))	Not listed	Not listed	1.05
PCT 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 (EEC)	Not listed	Not listed	0.01

5.3.3 Vegetation zones

PCTs identified within the study area during field surveys were further split into broad condition classes resulting in the vegetation zones as shown in Figure 5.1 and summarised in Table 5.5. Additional vegetation zones outside the project site are also described in detail as they provide habitat for threatened and migratory biota and may be subject to indirect and prescribed impacts.

The structure, species composition and condition of the vegetation zones within the study area are described below. Plant species lists are provided in Appendix C and plot data is provided in Appendix E along with benchmark values for each PCT.

As outlined in section 3.6, pre-Eastern NSW PCTs have been used in this assessment.

Table 5.5 Vegetation zones within the project site

Vegetation zone	PCT ID	PCT	Vegetation class	Condition	Area	Patch size (hectares)*	Patch size class	PCT percentage cleared	Vegetation integrity score
1	920	Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Mangrove Swamps	Good	0.72	1,216	>100	86%	34.8
2	1126	Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Saltmarshes	Moderate	0.03	1,216	>100	56%	96.5
3	1234	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Coastal Floodplain Wetlands	Poor	0.33	1,216	>100	90%	15.2
4	1234	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Coastal Floodplain Wetlands	Moderate	0.01	1,216	>100	90%	40.6
5	1234	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Coastal Floodplain Wetlands	Planted	0.28	1,216	>100	90%	40.8
6	1071	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Coastal Freshwater Lagoons	Moderate	0.01	1,216	>100	75%	31.4
7	1281	Sydney Turpentine - Ironbark forest in the Sydney Basin Bioregion	Northern Hinterland Wet Sclerophyll Forests	Planted	1.05	1,216	>100	90%	16.7

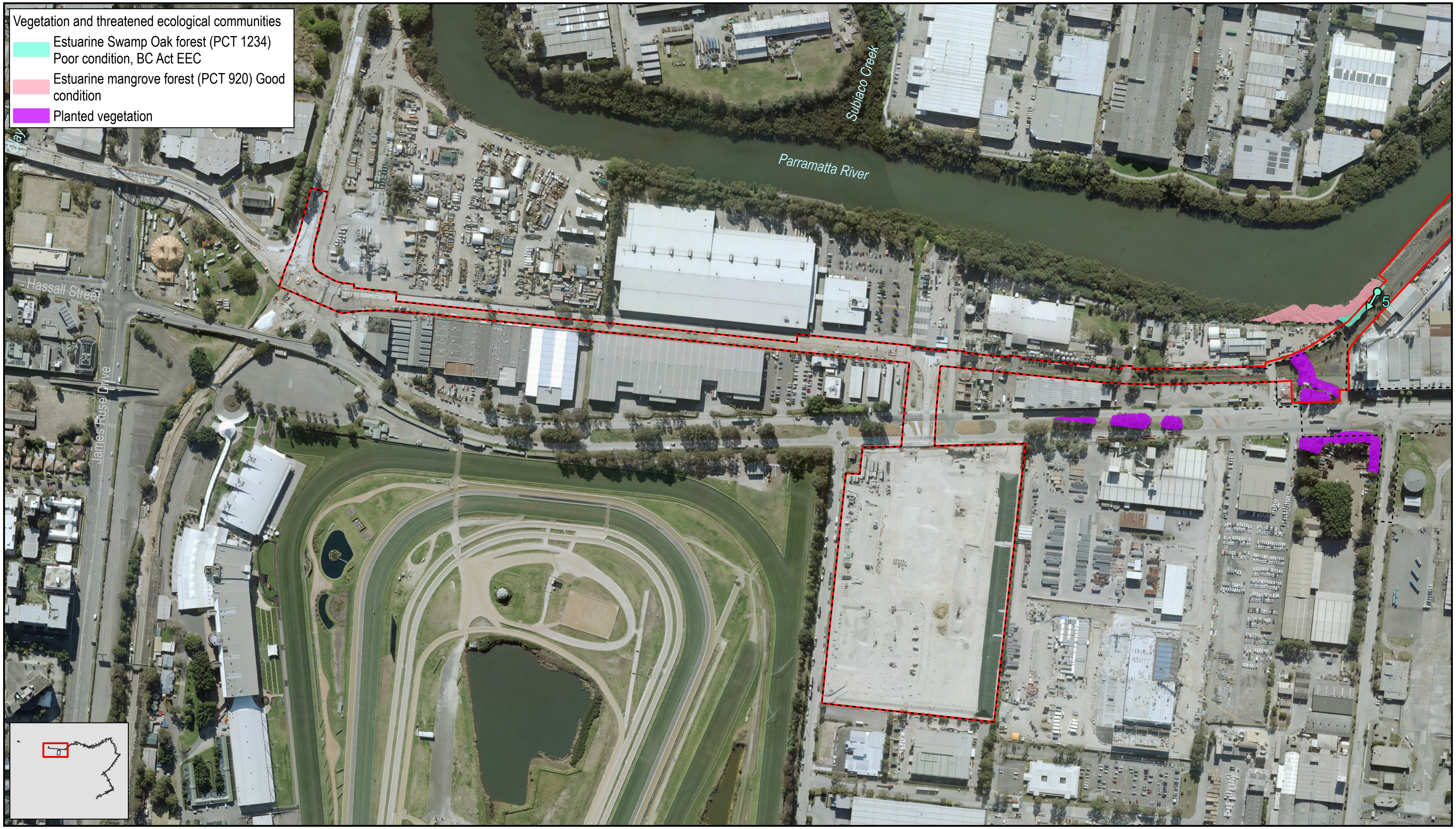
Note: * refer to section 4.6.2 for definition of patch sizes.

Table 5.6 provides a summary of the current vegetation integrity scores for each vegetation zone within the project site, the presence/absence of hollow bearing trees, as well as the composition, structure and function condition scores.

Table 5.6 Vegetation integrity summary of vegetation zones within project site

Vegetation zone	PCT ID	PCT	Condition	Current VI score	Composition condition score	Structure condition score	Function condition score	Hollow bearing trees present yes/no
1	920	Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Good	34.8	13.1	92.5	-	Yes (although no option to enter into BAM calculator for Saline Wetlands vegetation formation)
2	1126	Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Moderate	96.5	95.5	97.5	-	-
3	1234	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Poor	15.2	3	18.2	65	No
4	1234	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Moderate	40.6	18.9	55.4	63.8	No
5	1234	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Planted	40.8	41.3	25.8	63.8	No
6	1071	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Moderate	31.4	54.8	18.1	-	-
7	1281	Sydney Turpentine - Ironbark forest in the Sydney Basin Bioregion	Planted	16.7	13	21.8	16.4	No

Note: Function condition score is not calculated under the BAM for Saline Wetlands, Freshwater Wetlands or Forested Wetlands vegetation formations.



Legend
Project site (amended 13 Feb 2023)
Project site (superceded EIS)
Plot/transect

Paper Size ISO A4
0 50 100
Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Vegetation zones

FIGURE 5.1a

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Print date: 11 Jul 2023 - 11:51

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

- Project site (amended 13 Feb 2023)
- Project site (superceded EIS)
- Ferry Wharf
- Plot/transect

Paper Size ISO A4

0 50 100

Metres

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

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Date **11/07/2023**

Vegetation zones

FIGURE 5.1b

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Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend
- Project site (amended 13 Feb 2023)
- Project site (superceded EIS)
- Plot/transect

Paper Size ISO A4

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Metres

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

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Date **11/07/2023**

Vegetation zones

FIGURE 5.1c

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Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

Project site (amended 13 Feb 2023)

Project site (superceded EIS)

Plot/transect

Paper Size ISO A4

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Metres

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

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Vegetation zones

Project No. **12557728**
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Date **11/07/2023**

FIGURE 5.1d

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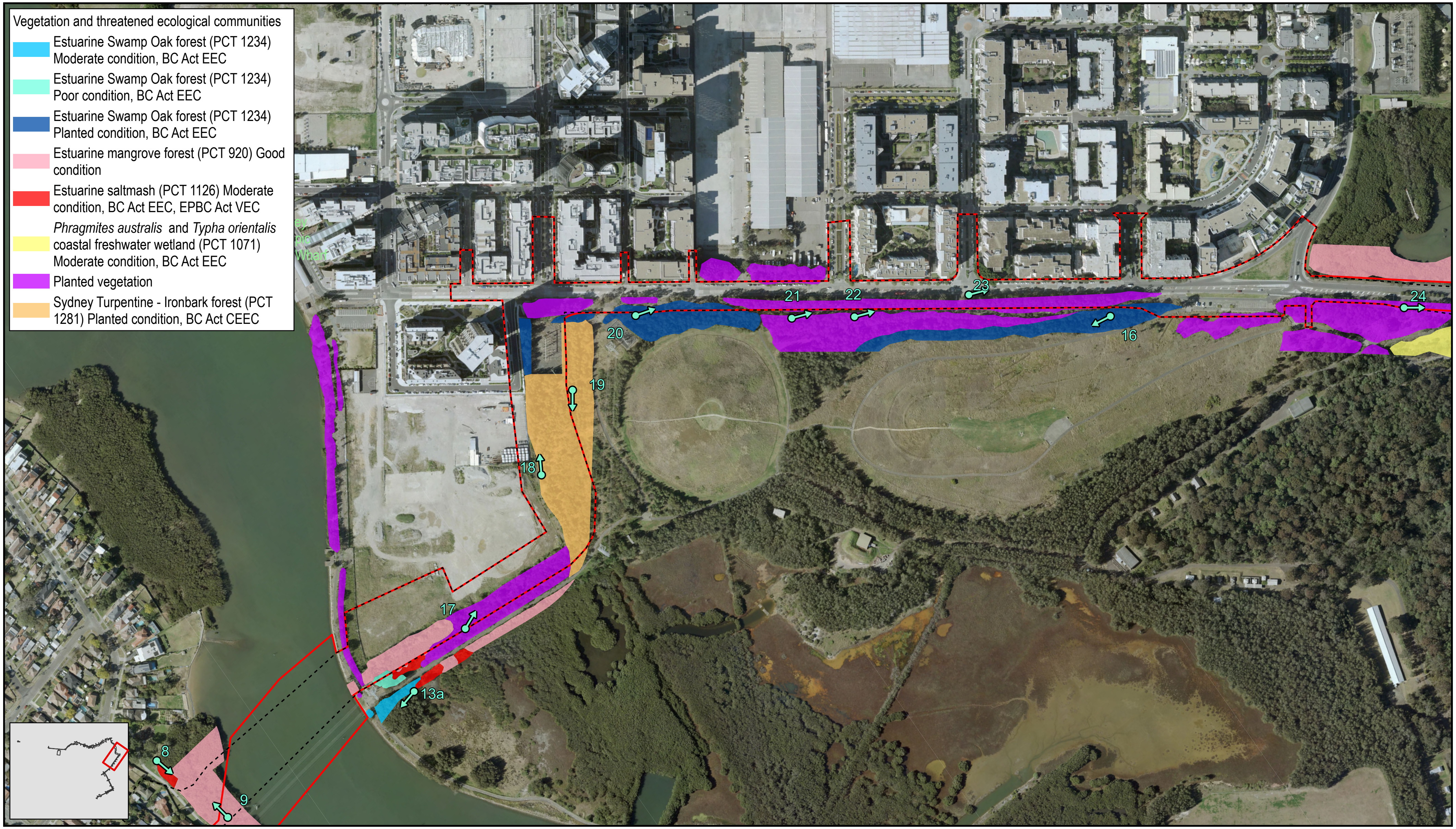

Legend
- Project site (amended 13 Feb 2023)
- Project site (superceded EIS)
- Ferry Wharf
- Plot/transect

Paper Size ISO A4

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Metres

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

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Parramatta Light Rail Stage 2 EIS

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Revision No. **A**
Date **11/07/2023**

Vegetation zones

FIGURE 5.1e

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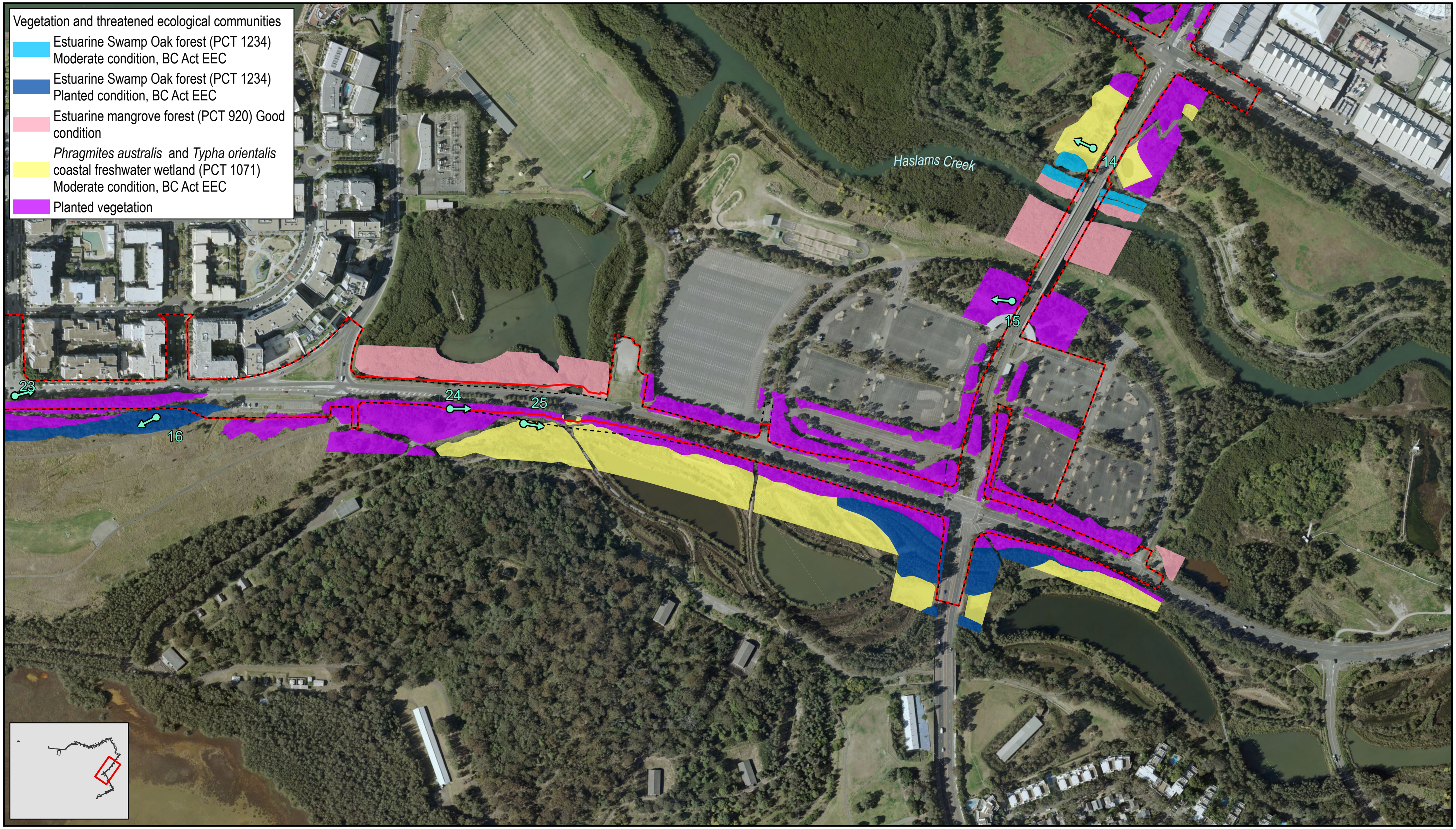

Legend
Project site (amended 13 Feb 2023)
Project site (superceded EIS)
Plot/transect

Paper Size ISO A4
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Metres

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

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Transport for NSW
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Vegetation zones

Project No. 12557728
Revision No. A
Date 11/07/2023

FIGURE 5.1f

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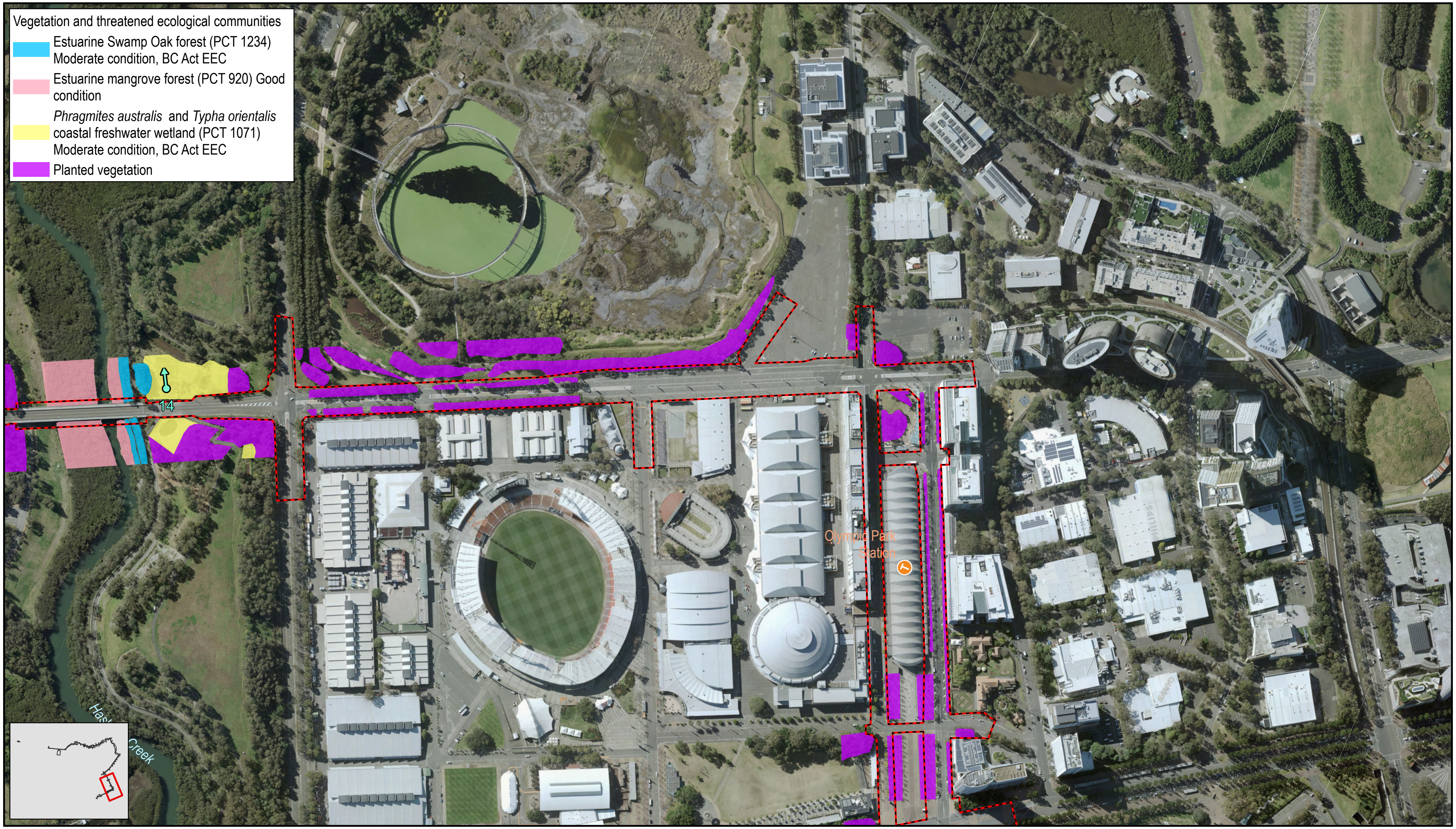

Legend
- Project site (amended 13 Feb 2023)
- Project site (superceded EIS)
- Train Station
- Plot/transect

Paper Size ISO A4

0 50 100

Metres

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

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Vegetation zones

FIGURE 5.1g

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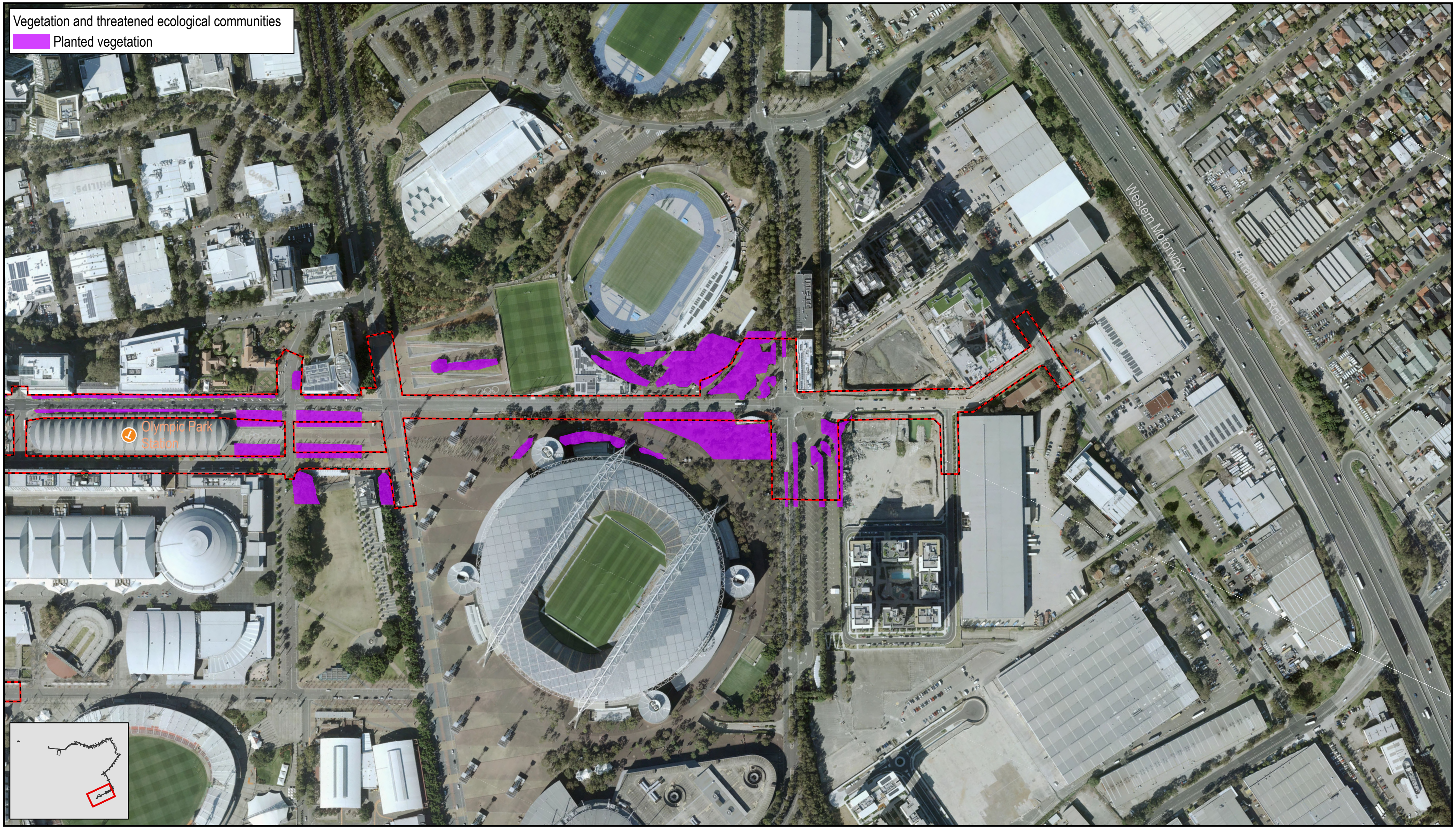

Legend

- Project site (amended 13 Feb 2023)
- Project site (superceded EIS)
- Train Station

Paper Size ISO A4

0 50 100

Metres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

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Revision No. **A**
Date **11/07/2023**

Vegetation zones

FIGURE 5.1h

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Legend
Project site (amended 13 Feb 2023)
Project site (superceded EIS)

Paper Size ISO A4
0 50 100
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. 12557728
Revision No. A
Date 11/07/2023

Vegetation zones

FIGURE 5.1i

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Print date: 11 Jul 2023 - 11:52

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: Imanasan

Vegetation zones in the project site

Table 5.7 Vegetation Zone 1: Estuarine mangrove forest (PCT 920) Good condition

Zone 1 – Estuarine mangrove forest (PCT 920) Good condition	
Plant community type (DPIE 2021c)	Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion
PCT ID	920
PCT justification	PCT 920 was selected as the most appropriate PCT for this vegetation zone given the dominance of *Avicennia marina* subsp. *australasica*, landscape position in the tidal zone of an estuary, topographic location, and correlation with existing regional vegetation mapping of the study area (OEH 2016).
Photos	 Zone 1 – Estuarine mangrove forest (PCT 920) Good condition at Plot 4 Photo of mangrove forest in good condition Zone 1 – Estuarine mangrove forest (PCT 920) Good condition at Plot 9
Survey effort	Plot 4, 9, 10 and 11
Conservation significance	Not listed as a TEC. Protected marine vegetation under the FM Act.
Patch size	>101 hectares (refer to Figure 4.1 and section 4.6.2)
Condition	This vegetation zone was in generally good condition, although native tree, shrub, grass like forb and other species richness was below benchmark in plots sampled, as was native tree and shrub cover. Hollow-bearing trees were recorded in three of the four plots sampled, and the number of large trees and fallen logs was above benchmark in all plots. Native canopy species present in the vegetation zone were observed regenerating in all plots.
Current vegetation integrity score	34.8
Landscape position	Occurs along the riparian corridor throughout the study area, in areas subject to tidal inundation.
Structure	Open forest on mudflat with occasional exotic groundcover species.
Over-storey	Grey Mangrove (*Avicennia marina* subsp. *australasica*)
Mid-storey	Absent
Groundcover	Absent
Exotic species	Pellitory (*Parietaria judaica*) and Panic Veldtgrass (*Ehrharta erecta*)

Table 5.8 Vegetation Zone 2: Estuarine saltmarsh (PCT 1126) Moderate condition

<table>
<tr><th colspan="2">Zone 2 – Estuarine saltmarsh (PCT 1126) Moderate condition, BC Act EEC, EPBC Act VEC</th></tr>
<tr><td>Plant community type (DPIE 2021c)</td><td>Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion</td></tr>
<tr><td>PCT ID</td><td>1126</td></tr>
<tr><td>PCT justification</td><td>PCT 1126 was selected as the most appropriate PCT for this vegetation zone given the dominance of characteristic saltmarsh species, landscape position on the landward side of mangrove stands at the height of the tidal zone in an estuary, topographic location, and correlation with existing regional vegetation mapping of the study area (OEH 2016).

Alternative PCTs considered for allocation include PCT 1125 and 1746. PCT 1125 was discounted as occurring given it is not known from the Sydney Basin Bioregion. PCT 1746 was discounted as it did not align with existing vegetation mapping of the study area (OEH 2016), and its lineage history indicates it is restricted to the old Hunter/Central Rivers catchment, although the PCTs are virtually identical otherwise (DPIE 2021c).</td></tr>
<tr><td>Photos</td><td>
Zone 2 – Estuarine saltmarsh (PCT 1126) Moderate condition at Plot 7

Zone 2 – Estuarine saltmash (PCT 1126) Moderate condition at Plot 12</td></tr>
<tr><td>Survey effort</td><td>Plot 7, 8 and 12</td></tr>
</table>

Zone 2 – Estuarine saltmarsh (PCT 1126) Moderate condition, BC Act EEC, EPBC Act VEC	
Conservation significance	Comprises an occurrence of an EEC listed under the BC Act: Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. Commensurate with a VEC listed under the EPBC Act: Subtropical and Temperate Coastal Saltmarsh. Protected marine vegetation under the FM Act.
Patch size	>101 hectares (refer to Figure 4.1 and section 4.6.2)
Condition	This vegetation zone is in moderate condition. Species richness was above benchmark in two of the three plots sampled for native tree, and forb species, while native shrub and grass-like species richness was below benchmark. Native tree and shrub cover was above benchmark in all plots sampled, which is likely indicative of mangrove and swamp oak encroachment on this vegetation zone. This vegetation zone is subject to increasing pressures resulting from surrounding land uses, with encroachment of mangroves from the river side, as well as encroachment of swamp oak and exotic species from the land side. With the exception of land within Sydney Olympic Park, patches of this vegetation zone within the study area are in areas prone to disturbance from unauthorised public access, and have, in places, substantial litter build up as a result of water-borne rubbish being deposited by tidal flows from the Parramatta River.
Current vegetation integrity score	96.5
Landscape position	This vegetation zone occurs on the landward side of stands of mangroves, along estuaries, within areas subject to tidal flows.
Structure	Saltmarsh with occasional overstorey dominated by understorey of low succulent forbs and rushes.
Over-storey	Grey Mangrove (*Avicennia marina* subsp. *australasica*), Swamp Oak (*Casuarina glauca*)
Mid-storey	Sweet Pittosporum (*Pittosporum undulatum*)
Groundcover	Creeping Brookweed (*Samolus repens*), *Sarcocornia quinqueflora* subsp. *quinqueflora*, *Suaeda australis*, New Zealand Spinach (*Tetragonia tetragonioides*), Prickly Couch (*Zoysia macrantha*), Lesser Sea-spurrey (*Spergularia marina*), Lesser Joyweed (*Alternanthera denticulata*), *Atriplex australasica*, Blue Flax-lily (*Dianella caerulea*), *Plectranthus parviflorus*, *Sporobolus virginicus,* Native Wandering Jew *(Commelina cyanea),* Sea Rush *(Juncus kraussii subsp. australiensis),* Spiny-headed Mar-rush *(Lomandra longifolia)*
Exotic species	Rambling Dock (*Acetosa sagittata*), Bridal Creeper (*Asparagus asparagoides*), Cobbler's Pegs (*Bidens pilosa*), Shivery Grass (*Briza minor*), Kikuyu Grass (*Cenchrus clandestinus*), Flaxleaf Fleabane (*Conyza bonariensis*), Slender Celery (*Cyclospermum leptophyllum*), Panic Veldtgrass (*Ehrharta erecta*), Petty Spurge (*Euphorbia peplus*), Wall Fumitory (*Fumaria muralis* subsp. *muralis*), Scarlet Pimpernel (*Lysimachia arvensis*), Red-flowered Mallow (*Modiola caroliniana*), Lamb's Tongues (*Plantago lanceolata*), Common Sowthistle (*Sonchus oleraceus*), Stagger Weed (*Stachys arvensis*), Hop Clover (*Trifolium campestre*).

Table 5.9 Vegetation Zone 3: Estuarine Swamp Oak forest (PCT 1234) Poor condition

Zone 3 – Estuarine Swamp Oak forest (PCT 1234) Poor condition, BC Act EEC	
Plant community type (DPIE 2021c)	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion
PCT ID	1234
PCT justification	PCT 1234 was selected for this community given the dominance of *Casuarina glauca*, landscape position along an estuary, topographic location, and correlation with existing regional vegetation mapping of the study area (OEH 2016).
Photo	 Zone 3 – Estuarine Swamp Oak forest (PCT 1234) Poor condition, BC Act EEC at Plot 5
Survey effort	Plot 5
Conservation significance	Commensurate with the BC Act-listed EEC Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. Is not commensurate with the EPBC Act EEC Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community as it fails to meet the minimum condition thresholds for the listed community, as the individual patch is less than 0.5 hectares in size (the patch is about 0.05 hectares) (DEE 2018).
Patch size	>101 hectares (refer to Figure 4.1 and section 4.6.2)
Condition	This vegetation zone is in generally poor condition, with below benchmark numbers of native tree, shrub, grass like forb, fern and other species richness. Native shrub, grass like forb, fern and other cover was also below benchmark. No hollow-bearing trees were recorded in the plot, and large trees were also below benchmark. Native tree cover, length of fallen logs and litter cover were all above benchmark. The native canopy species present in the vegetation zone was observed regenerating. This vegetation zone is subject to substantial edge effects and exists as a very narrow, linear band of vegetation.
Current vegetation integrity score	15.2
Landscape position	Located on the landward side of mangroves, with some tidal influence.
Structure	Open forest with a midstorey and understorey dominated by exotic species.
Over-storey	Swamp Oak (*Casuarina glauca*)
Mid-storey	Sweet Pittosporum (*Pittosporum undulatum*)
Groundcover	Spiny-headed Mat-rush (*Lomandra longifolia*)

Zone 3 – Estuarine Swamp Oak forest (PCT 1234) Poor condition, BC Act EEC	
Exotic species	Lantana (*Lantana camara*), African Olive (*Olea europaea* subsp. *cuspidata*), Large-leaved Privet (*Ligustrum lucidum*), Paspalum (*Paspalum dilatatum*), Common Morning Glory (*Ipomoea purpurea*), Cobbler's Pegs (*Bidens pilosa*), Balloon Vine (*Cardiospermum grandiflorum*), Crofton Weed (*Ageratina adenophora*), Red Natal Grass (*Melinis repens*), Lamb's Tongue (*Plantago lanceolata*), Panic Veldtgrass (*Ehrharta erecta*), Flaxleaf Fleabane (*Conyza bonariensis*), Purpletop (*Verbena bonariensis*), African Lovegrass (*Eragrostis curvula*)

Table 5.10 Vegetation Zone 4: Estuarine Swamp Oak forest (PCT 1234) Moderate condition

Zone 4 – Estuarine Swamp Oak forest (PCT 1234) Moderate condition, BC Act EEC	
Plant community type (DPIE 2021c)	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion
PCT ID	1234
PCT justification	PCT 1234 was selected for this community given the dominance of *Casuarina glauca*, landscape position along an estuary, topographic location, and correlation with existing regional vegetation mapping of the study area (OEH 2016) as well as Sydney Olympic Park Authority mapping of the area (SOPA 2019a).
Photo	 Zone 4 – Estuarine Swamp Oak forest (PCT 1234) Moderate condition at Plot 13a
Survey effort	Plot 13a
Conservation significance	Comprises an occurrence of an EEC under the BC Act; Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. Is not commensurate with the EPBC Act EEC Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community as it fails to meet the minimum condition thresholds for the listed community, as the individual patch is less than 0.5 hectares in size (the patch is about 0.25 hectares) (DEE 2018).
Patch size	>101 hectares (refer to Figure 4.1 and section 4.6.2)
Condition	This zone is in moderate condition. Within the study area, moderate condition PCT 1234 was only found within Newington Nature Reserve, whereas all other occurrences of the PCT were in poor or planted condition. This patch is likely to be in better condition due to the management regimes in place within the nature reserve, and the lack of public access to the reserve. There was a relatively low number of native species recorded, with only seven native species identified within the plot sampled; with native tree, shrub, grass like forb, fern and other species richness below benchmark. Native tree and forb cover was above benchmark, while native shrub, grass like fern and other cover was all below benchmark. No hollow-bearing trees were recorded in the plot, and there were no fallen logs recorded in the plot. All of the native canopy species present in the vegetation zone were observed regenerating.

Zone 4 – Estuarine Swamp Oak forest (PCT 1234) Moderate condition, BC Act EEC	
Current vegetation integrity score	40.6
Landscape position	Located on a patch of land with limited tidal influence, adjacent to mangrove and saltmarsh vegetation. Generally found on the landward side of mangrove and saltmarsh communities.
Structure	Open forest with a mixed understorey of native and exotic species
Over-storey	Swamp Oak (*Casuarina glauca*)
Mid-storey	Absent
Groundcover	Common Couch (*Cynodon dactylon*), *Suaeda australis*, New Zealand Spinach (*Tetragonia tetragonioides*), *Juncus usitatus*, Creeping Brookweed (*Samolus repens*), Bacopa (*Bacopa monnieri*)
Exotic species	Panic Veldtgrass (*Ehrharta erecta*), Buffalo Grass (*Stenotaphrum secundatum*), Asparagus Fern (*Asparagus aethiopicus*), Varegated Thistle (*Silybum marianum*), Toad Rush (*Juncus bufonius*)

Table 5.11 Vegetation Zone 5: Estuarine Swamp Oak forest (PCT 1234) Planted condition

Zone 5 – Estuarine Swamp Oak forest (PCT 1234) Planted condition, BC Act EEC	
Plant community type (DPIE 2021c)	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion
PCT ID	1234
PCT justification	PCT 1234 was selected for this community given the dominance of *Casuarina glauca*, landscape position close to an estuary, topographic location, and correlation with existing regional vegetation mapping of the study area (OEH 2016) as well as SOP mapping of the area (SOPA 2019a).
Photo	 Zone 5 – Estuarine Swamp Oak forest (PCT 1234) Planted condition at Plot 16
Survey effort	Plot 16 and 20
Conservation significance	Naturally occurring forms of this PCT comprises occurrences of the EEC listed under the BC Act as Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. A conservative approach has been taken for this assessment and planted forms of this PCT have also been considered as threatened ecological community vegetation, as the final determination for the EEC does not exclude them, and does not exclude occurrences on modified landforms and artificial soil profiles. Is not commensurate with the EPBC Act EEC Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community as it fails to meet the key diagnostic thresholds for the listed community, as the artificial soil profile within Sydney Olympic Park on which this vegetation zone occurs is not subject to inundation, and does not meet the soil profile requirements.

Zone 5 – Estuarine Swamp Oak forest (PCT 1234) Planted condition, BC Act EEC	
Patch size	>101 hectares (refer to Figure 4.1 and section 4.6.2)
Condition	This vegetation zone has been planted, however can be allocated into a locally occurring PCT. Species planted are characteristic of this PCT, and are self-recruiting and regenerating. A total of 22 native species were recorded in the two plots sampled, and native tree species richness was above benchmark in one plot. Native shrub, grass like, forb, fern and other species richness was below benchmark in all plots, as was native shrub, grass like, forb, fern and other cover. No hollow-bearing trees were recorded in the zone, and the number of large trees was below benchmark, which is expected given the young age of this vegetation. Litter cover was substantially above benchmark in all plots. *Casuarina glauca* was observed coppicing and regenerating, but no Eucalyptus species were observed to be regenerating.
Current vegetation integrity score	40.8
Landscape position	Occurs on artificial soil profiles along roadsides where it has been planted as part of landscaping works.
Structure	Planted open forest with a sparse mixed understorey of native and exotic species
Over-storey	Swamp Oak (*Casuarina glauca*), Blue Box (*Eucalyptus baueriana*), Grey Ironbark (*Eucalyptus paniculata*)
Mid-storey	Sydney Golden Wattle (*Acacia longifolia* subsp*. longifolia*), Swamp Paperbark (*Melaleuca ericifolia*), Flax-leaved Paperbark (*Melaleuca linariifolia*), *Melaleuca nodosa*, Broad-leaved Paperbark (*Melaleuca quinquenervia*), Prickly-leaved Tea Tree (*Melaleuca styphelioides*), *Myoporum boninense* subsp. *australe.*
Groundcover	*Bolboschoenus caldwellii*, Indian Pennywort (*Centella asiatica*), Native Wandering Jew (*Commelina cyanea*), Common Couch (*Cynodon dactylon*), Blue Flax-lily (*Dianella caerulea*), Kidney Weed (*Dichondra repens*), Forest Hedgehog Grass (*Echinopogon ovatus*), Spiny-headed Mat-rush (*Lomandra longifolia*), Mat-rush (*Lomandra* spp.), Weeping Grass (*Microlaena stipoides* var. *stipoides*), *Senecio diaschides*, Hill Fireweed (*Senecio hispidulus*)
Exotic species	Cobbler's Pegs (*Bidens pilosa*), Spear Thistle (*Cirsium vulgare*), Flaxleaf Fleabane (*Conyza bonariensis*), Tall fleabane (*Conyza sumatrensis*), Panic Veldtgrass (*Ehrharta erecta*), African Lovegrass (*Eragrostis curvula*), Paspalum (*Paspalum dilatatum*), Lamb's Tongues (*Plantago lanceolata*), Common Verbena (*Verbena officinalis*), Veined Verbena (*Verbena rigida* var. *rigida*)

Table 5.12 Vegetation Zone 6: Phragmites australis and Typha orientalis coastal freshwater wetland (PCT 1071) Moderate condition

Zone 6 – *Phragmites australis* and *Typha orientalis* coastal freshwater wetland (PCT 1071) Moderate condition, BC Act EEC	
Plant community type (DPIE 2021c)	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion
PCT ID	1071
PCT justification	Potential PCTs for this vegetation zone were PCT 781 and 1071. PCT 1071 was selected as the appropriate PCT as it is described as being associated with man-made water bodies, and modified former wetlands (DPIE 2021c), which aligns with the wetlands present within the study area. PCT 781 could be an appropriate choice if the wetlands were naturally occurring and had not been created.
Photos	 Zone 6 – *Phragmites australis* and *Typha orientalis* coastal freshwater wetland (PCT 1071) Moderate condition at Plot 14  Zone 6 – *Phragmites australis* and *Typha orientalis* coastal freshwater wetland (PCT 1071) Moderate condition at Plot 25
Survey effort	Plot 14 and 25

Zone 6 – *Phragmites australis* and *Typha orientalis* coastal freshwater wetland (PCT 1071) Moderate condition, BC Act EEC	
Conservation significance	A conservative approach has been taken, and these planted wetlands have been considered to comprise an occurrence of the EEC listed under the BC Act as Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, as they were created for habitat value as part of the Millennium Parklands development. It is noted that artificial wetlands are not included in the EEC if they are created on previously dry land, for purposes such a stormwater management etc, however it is understood that these wetlands were created to provide habitat for the Green and Golden Bell Frog.
Patch size	>101 hectares (refer to Figure 4.1 and section 4.6.2)
Condition	This vegetation zone is in moderate condition. These wetlands have been created via landform modification and revegetation works, but now function as a naturally occurring ecosystem, and as such, are treated as a native vegetation type not a planted one. A total of 23 native species were identified in the two plots sampled. Native tree species richness was below benchmark in one plot, while native shrubs species richness was above benchmark in one plot and below in the other plot. Native grass like species richness was above benchmark in both plots sampled, but native forb, fern and other species richness was below benchmark in both plots. Grass like cover was substantially below benchmark for both plots. No hollow-bearing trees were recorded in the plots and the number of large trees was below benchmark, which is expected given the relatively young age of this vegetation. The length of fallen logs was above benchmark in both plots, likely as a result of habitat creation work undertaken by the Sydney Olympic Park Authority, while litter cover was below benchmark in all plots. High-threat weed cover within the zone averaged five per cent.
Current vegetation integrity score	31.4
Landscape position	Occurs in the south-eastern section of the study area in Sydney Olympic Park.
Structure	Artificial wetlands containing native grass and rush species
Over-storey	Absent
Mid-storey	Sydney Golden Wattle (*Acacia longifolia* subsp. *longifolia*), Stiff Bottlebrush (*Callistemon rigidus*), Swamp Paperbark (*Melaleuca ericifolia*), Prickly-leaved Tea Tree (*Melaleuca styphelioides*), Boobialla (*Myoporum acuminatum*), *Myoporum boninense* subsp. *austral, Notelaea longifolia* f. *longifolia*
Groundcover	Slender Bamboo Grass (*Austrostipa verticillata*), Jointed Twig-rush (*Baumea articulata*), *Baumea rubiginosa*, Marsh Club-rush (*Bolboschoenus fluviatilis*), Tall Sedge (*Carex appressa*), Tassel Sedge (*Carex fascicularis*), Native Grape (*Cayratia clematidea*), *Cyperus exaltatus*, Blue Flax-lily (*Dianella caerulea*), *Juncus pallidus*, *Juncus usitatus*, *Lepironia articulata*, Spiny-headed Mat-rush (*Lomandra longifolia*), Water Couch (*Paspalum distichum*), *Schoenoplectus mucronatus*, *Themeda triandra*
Exotic species	Golden Wreath Wattle (*Acacia saligna*), Wild Oats (*Avena fatua*), Cobbler's Pegs (*Bidens pilosa*), Kikuyu Grass (*Cenchrus clandestinus*), Tall fleabane (*Conyza sumatrensis*), Catsear (*Hypochaeris radicata*), Toad Rush (*Juncus bufonius*), Paspalum (*Paspalum dilatatum*), Black-berry Nightshade (*Solanum nigrum*), Subterranean Clover (*Trifolium subterraneum*)

Table 5.13 Vegetation Zone 7: Sydney Turpentine-Ironbark Forest (PCT 1281) Planted condition

Zone 7 – Sydney Turpentine-Ironbark Forest (PCT 1281) Planted condition, BC Act CEEC	
Plant community type (DPIE 2021c)	Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion
PCT ID	1281
PCT justification	PCT 1281 was selected based on floristic assemblage and likely intent of revegetation works. Given the use of Turpentine (*Syncarpia glomulifera* subsp. *glomulifera*), it is assumed that this vegetation zone was planted in a manner presumably designed to replicate the remnant Sydney Turpentine Ironbark Forest that is present within Newington Nature Reserve. Regional vegetation mapping indicates the presence of PCT 1281 in a similar landscape position within the Newington Nature Reserve, and as such, this PCT has been allocated to this planted vegetation zone as it is the PCT that most closely matches the floristic assemblage present and the landscape context in which it occurs.
Photos	 Sydney Turpentine - Ironbark forest (PCT 1281) Planted condition at Plot 18  Sydney Turpentine - Ironbark forest (PCT 1281) Planted condition at Plot 19
Survey effort	Plot 18 and 19

Zone 7 – Sydney Turpentine-Ironbark Forest (PCT 1281) Planted condition, BC Act CEEC	
Conservation significance	Comprises an occurrence of the BC Act-listed CEEC Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion. This planted vegetation on an artificial landform is not commensurate with the EPBC Act listed ecological community.
Patch size	>101 hectares (refer to Figure 4.1 and section 4.6.2)
Condition	All components of this vegetation zone were below benchmark. This vegetation zone has been planted in an attempt to mimic the nearby remnant area of Sydney Turpentine Ironbark Forest.
Current vegetation integrity score	16.7
Landscape position	This zone occurs on a modified soil landscape on areas that have been subject to land forming works.
Structure	Open forest with a sparse, disturbed mid-storey and understorey.
Over-storey	Turpentine (*Syncarpia glomulifera* subsp. *glomulifera*)
Mid-storey	Black Wattle (*Acacia decurrens*), Sydney Golden Wattle (*Acacia longifolia* subsp. *longifolia*), Native Blackthorn (*Bursaria spinosa* subsp. *spinosa*), Tick Bush (*Kunzea ambigua*), Sweet Pittosporum (*Pittosporum undulatum*)
Groundcover	Native Grape (*Cayratia clematidea*), Native Wandering Jew (*Commelina cyanea*), Common Couch (*Cynodon dactylon*), *Desmodium rhytidophyllum*, Blue Flax-lily (*Dianella caerulea*), Kidney Weed (*Dichondra repens*), Wiry Panic (*Entolasia stricta*), Brown's Lovegrass (*Eragrostis brownii*), Weeping Grass (*Microlaena stipoides* var. *stipoides*), *Oxalis perennans*
Exotic species	Cobbler's Pegs (*Bidens pilosa*), Prairie Grass (*Bromus catharticus*), Tall fleabane (*Conyza sumatrensis*), Panic Veldtgrass (*Ehrharta erecta*), African Lovegrass (*Eragrostis curvula*), Catsear (*Hypochaeris radicata*), Lamb's Tongues (*Plantago lanceolata*), Black-berry Nightshade (*Solanum nigrum*), Yellow Suckling Clover (*Trifolium dubium*), Common Verbena (*Verbena officinalis*), Common Vetch (*Vicia sativa*), Wall Fescue (*Vulpia muralis*)

5.3.4 Threatened ecological communities

Five threatened ecological communities (TECs) were recorded in the study area during field surveys (see Table 5.14). TECs listed under the BC Act are mapped on Figure 5.2. TECs listed under the EPBC Act are discussed in section 7.1.

Multiple PCTs can be part of a TEC. Patch size, condition and landscape position of vegetation can also affect whether it conforms with the listing criteria of a TEC.

A TEC equivalency assessment has been prepared in accordance with the BAM for each PCT that occurs in the project site (see Table 5.14).

Table 5.14 Threatened ecological community consistency assessment

PCT ID	PCT name	TEC name	TEC assessment
920	Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Not listed	The BioNet Vegetation Classification database indicates that PCT 920 can be associated with the following TECs: – Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, BC Act, EEC – Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EPBC Act, VEC – The Shorebird Community occurring on the relict tidal delta sands at Taren Point, BC Act, EEC. Based on the descriptions provided in the final determinations for those TECs, PCT 920 as it occurs within the project site, is not commensurate with any TECs. The PCT does not align with Coastal Saltmarsh as the final determination for Coastal Saltmarsh indicates that the EEC is generally found in the zone landward of mangrove stands, and that while some scattered mangroves may occur within saltmarsh communities, the dominant species are saltmarsh species (NSW TSSC, 2019a). PCT 920 is characterised by dense stands of mangroves, and as such, does not align with the EEC descriptions. The Shorebird Community is restricted to the Georges River in Botany Bay.
1126	Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions (EEC, BC Act) Subtropical and Temperate Coastal Saltmarsh (Coastal Saltmarsh) (VEC, EPBC Act)	The BioNet Vegetation Classification database indicates that PCT 1126 is wholly a subset of the following TECs: – Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, BC Act, EEC – Subtropical and Temperate Coastal Saltmarsh (Coastal Saltmarsh) EPBC Act, VEC. The BioNet Vegetation Classification database indicates that PCT 1126 can be associated with the following TEC: – The Shorebird Community occurring on the relict tidal delta sands at Taren Point, BC Act, EEC. This PCT aligns well with the Coastal Saltmarsh EEC listed under the BC Act, and also Subtropical and Temperate Coastal Saltmarsh (Coastal Saltmarsh), which is listed as a VEC under the EPBC Act. The PCT occurs in one of the IBRA regions listed in the final determination, contains characteristic plant species, and is in the topographic and landscape position described by the final determination (NSW TSSC, 2019a). The Shorebird Community is restricted to the Georges River in Botany Bay.
1234	Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (EEC, BC Act)	The BioNet Vegetation Classification database indicates that PCT 1234 is largely equivalent to the TEC: – Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, BC Act, EEC. PCT 1234 aligns well with the Swamp Oak EEC listed under the BC Act. It occurs in the landscape and topographic position described by the final determination, and is comprised of characteristic species listed in the final determination. In particular, the PCT as it occurs within the project site is dominated by a canopy of *Casuarina glauca*, has a low abundance of *Eucalyptus* species, and occupies low-lying areas, including habitats where soils show some influence of saline ground water (NSW TSSC, 2019b). These attributes confirm the PCT is commensurate with the Swamp Oak Floodplain Forest EEC listed under the BC Act. PCT 1234 can be commensurate with Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community listed as an EEC under the EPBC Act. No patches in the study area meet the condition criteria for the EEC as listed under the EPBC Act as they fail to meet either the minimum condition thresholds or key diagnostic criteria for the EEC.

PCT ID	PCT name	TEC name	TEC assessment
1281	Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion (CEEC)	The BioNet Vegetation Classification database indicates that PCT 1281 is equivalent to the following TECs: – Turpentine-Ironbark Forest of the Sydney Basin Bioregion EPBC Act, CEEC – Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion, BC Act CEEC. PCT 1281 within the project site is commensurate with the BC Act-listed Sydney Turpentine Ironbark Forest CEEC, as it occurs within the IBRA region identified in the final determination, and, as per the determination, "*It is the intent of the NSW Threatened Species Scientific Committee that all occurrences of the ecological community (both recorded and as yet unrecorded, and independent of their condition) that occur within this bioregion be covered by this Determination*" (NSW TSSC, 2019), which indicates that planted examples are not excluded from the listing. Despite this, the occurrence of this PCT within the project site is on an artificial landform and does not reflect the typical soil landscapes or geology that the CEEC is associated with (NSW TSSC, 2019). However, a conservative approach has been taken, and the PCT has been assumed to form part of the TEC. Planted patches of PCT 1281 within the project site do not meet the condition criteria for the community listed under the EPBC Act. A large patch of remnant Sydney Turpentine-Ironbark Forest occurs in Newington Nature Reserve, adjacent to the project site, which does correspond to the EPBC Act-listed form of the community.
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 (EEC)	The BioNet Vegetation Classification database indicates that PCT 1071 can be associated with the following TECs: – Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, BC Act, EEC – Sydney Freshwater Wetlands in the Sydney Basin Bioregion, BC Act, EEC. PCT 1071 does not align with the Sydney Freshwater Wetlands EEC, as this community is limited to sand dunes and low nutrient sandplains, typically along the coast. Instead, this PCT aligns closely with the Freshwater Wetlands on Coastal Floodplains EEC, based on the description provided for the community in the final determination (NSW TSSC, 2019c), noting that it is understood that the wetlands were created to provide habitat, rather than for stormwater management or similar.

Legend
Project site

Paper Size ISO A4
0 50 100
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. 12557728
Revision No. A
Date 11/07/2023

Threatened ecological communities

FIGURE 5.2a

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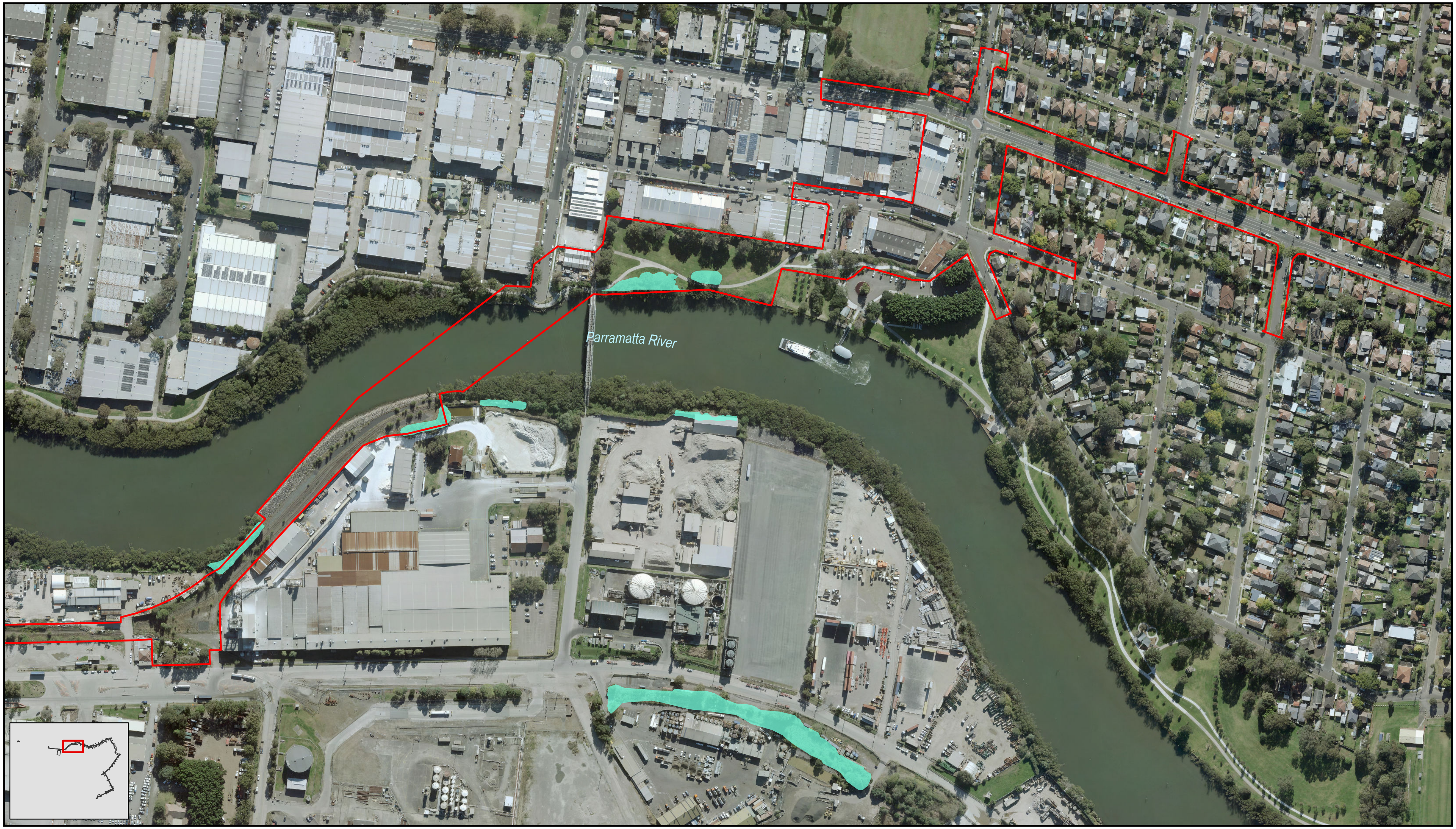
Print date: 11 Jul 2023 - 11:55

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan



Legend

Project site

Vegetation and threatened ecological communities

Estuarine Swamp Oak forest (PCT 1234)
Poor condition, BC Act EEC

Paper Size ISO A4

0 50 100

Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Threatened ecological communities

FIGURE 5.2b

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Print date: 11 Jul 2023 - 11:55

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend
Project site

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

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GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Threatened ecological communities

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 5.2c

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Print date: 11 Jul 2023 - 11:55

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

Project site

Vegetation and threatened ecological communities

Estuarine Swamp Oak forest (PCT 1234) Poor condition, BC Act EEC

Estuarine saltmash (PCT 1126) Moderate condition, BC Act EEC, EPBC Act VEC

Paper Size ISO A4

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Metres

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

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GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Threatened ecological communities

FIGURE 5.2d

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Print date: 11 Jul 2023 - 11:55

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: Imanasan

Legend

Project site

Vegetation and threatened ecological communities

Estuarine Swamp Oak forest (PCT 1234) Moderate condition, BC Act EEC

Estuarine Swamp Oak forest (PCT 1234) Poor condition, BC Act EEC

Estuarine saltmash (PCT 1126) Moderate condition, BC Act EEC, EPBC Act VEC

Sydney Turpentine - Ironbark forest (PCT 1281) Planted condition, BC Act CEEC

Paper Size ISO A4

0 50 100

Metres

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

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GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Threatened ecological communities

FIGURE 5.2e

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Print date: 11 Jul 2023 - 11:56

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

Project site

Vegetation and threatened ecological communities

Estuarine Swamp Oak forest (PCT 1234) Moderate condition, BC Act EEC

Phragmites australis and *Typha orientalis* coastal freshwater wetland (PCT 1071) Moderate condition, BC Act EEC

Paper Size ISO A4

0 50 100

Metres

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

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. 12557728
Revision No. A
Date 11/07/2023

Threatened ecological communities

FIGURE 5.2f

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Print date: 11 Jul 2023 - 11:56

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

Project site

Vegetation and threatened ecological communities

Estuarine Swamp Oak forest (PCT 1234) Moderate condition, BC Act EEC

Phragmites australis and *Typha orientalis* coastal freshwater wetland (PCT 1071) Moderate condition, BC Act EEC

Paper Size ISO A4

0 50 100

Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

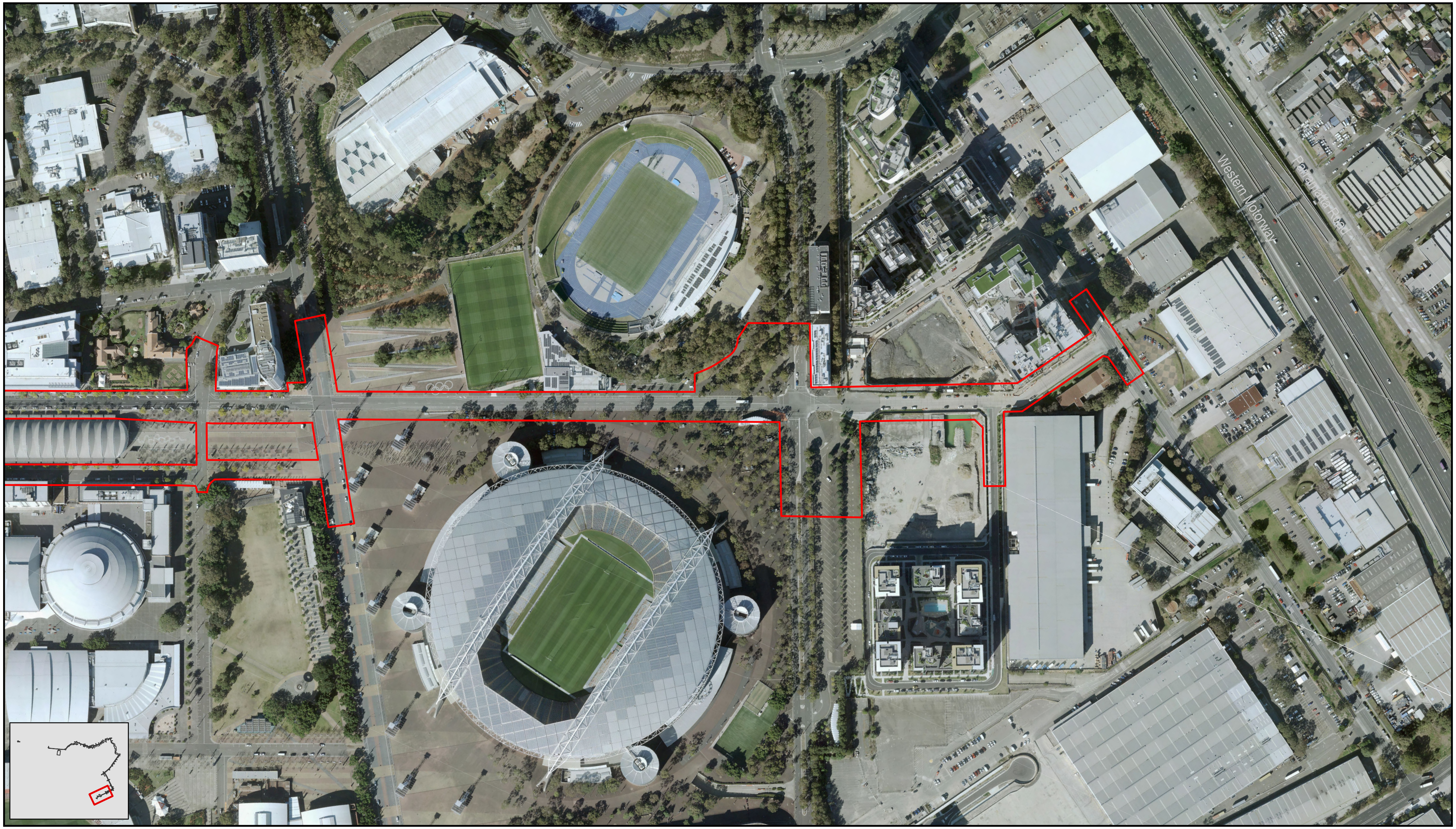
Project No. 12557728
Revision No. A
Date 11/07/2023

Threatened ecological communities

FIGURE 5.2g

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO010_BDAR_ThreatenedEcologicalCommunities
Print date: 11 Jul 2023 - 11:56

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan



Legend

Project site

Paper Size ISO A4

0 50 100

Metres

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

N

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Threatened ecological communities

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 5.2h

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Print date: 11 Jul 2023 - 11:56

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

5.4 Flora species

A total of 166 flora species from 51 families were recorded within the study area, comprising 101 native and 65 exotic species. The Poaceae (grasses, 25 species, 14 native), Myrtaceae (20 species, all native) Asteraceae (14 species, four native) and Fabaceae (shrubs and scramblers, 14 species, seven native) were the most diverse families recorded.

A full list of flora species recorded within the project site and adjoining study area is provided in Appendix C. Characteristic plant species are discussed above in relation to the vegetation zones occurring at the study area.

5.4.1 Weeds

Priority weeds

Five NSW priority weed species were recorded in the study area (see Table 5.15). All of these species have a general biosecurity duty under the *Biosecurity Act 2015* which requires any person who deals with the plant to ensure the biosecurity risk of the weed is prevented, eliminated or minimised, so far as is reasonably practicable. Regional measures for many species include the requirement that land managers should mitigate the risk of new weeds being introduced to their land. The full list of priority weeds is listed in Table 5.15.

Weeds of National Significance

Under the *Australian Weeds Strategy 2017 to 2027* (Invasive Plants and Animals Committee 2016), 32 introduced plants have been identified as Weeds of National Significance (WONS). These weeds are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts. Three WONS were recorded in the study area (see Table 5.15).

High threat weeds

Many weeds are also identified as high threat weeds within the BAM. These are plants not native to Australia that if not controlled will invade and outcompete native plant species. The cover of high threat weeds in a plot is entered into the BAM calculator. Twenty high threat weeds were recorded in the study area (see Table 5.15).

Table 5.15 Listed weed species recorded during surveys

Common name ***Scientific name***	**NSW Priority Weed**	**WONS**	**High Threat Weed**
African Olive *Olea europaea* subsp. *cuspidata*	Yes	No	Yes
Asparagus Fern *Asparagus aethiopicus*	No	No	Yes
Balloon Vine *Cardiospermum grandiflorum*	No	No	Yes
Blackberry *Rubus fruticosus* spp. aggregate	Yes	Yes	Yes
Bridal Creeper *Asparagus asparagoides*	Yes	Yes	Yes
Cape Ivy *Delairea odorata*	No	No	Yes
Castor Oil Plant *Ricinus communis*	No	No	Yes
Cobblers Pegs *Bidens pilosa*	No	No	Yes

Common name *Scientific name*	NSW Priority Weed	WONS	High Threat Weed
Crofton Weed *Ageratina adenophora*	No	No	Yes
Green Cestrum *Cestrum parqui*	Yes	No	Yes
Kikuyu Grass *Cenchrus clandestinus*	No	No	Yes
Lantana *Lantana camara*	Yes	Yes	Yes
Large-leaved Privet *Ligustrum lucidum*	No	No	Yes
Montpellier Broom *Genista monspessulana*	No	No	Yes
Morning Glory *Ipomoea indica*	No	No	Yes
Mother-of-millions *Bryophyllum delagoense*	No	No	Yes
Ochna *Ochna serrulata*	No	No	Yes
Panic Veldtgrass *Ehrharta erecta*	No	No	Yes
Rambling Dock *Acetosa sagittata*	No	No	Yes
Trad *Tradescantia fluminensis*	No	No	Yes

5.5 Groundwater dependent ecosystems

The *NSW State Groundwater Dependent Ecosystems Policy* defines groundwater dependent ecosystems (GDEs) as ecosystems which have their species composition, and their natural ecological processes determined by groundwater (DLWC 2002). Ecosystems vary dramatically in the degree of dependency of groundwater, from having no apparent dependence through to being entirely dependent on it (DLWC 2002).

Dependence (or interaction) of the vegetation communities identified within the project site on groundwater was determined by searching the Atlas of GDEs (BOM 2021a). This Atlas predicts the occurrence of groundwater dependent ecosystems and ecosystems that potentially use groundwater. It shows ecosystems that interact with the subsurface expression of groundwater (including vegetation ecosystems) or the surface expression of groundwater (such as rivers and wetlands. The Atlas also shows the likelihood that landscapes are accessing water in addition to rainfall, such as soil water, surface water or groundwater.

The Atlas identified patches of vegetation in the study area along the Parramatta River as ‘High potential GDE’. These comprise areas of mangroves. There are no aquatic or subterranean GDE mapped in the study area.

5.6 Fauna species and habitat resources

5.6.1 Fauna species

Field survey identified 76 fauna species in the project area and surrounds, comprising 64 bird species, five mammal species, five frog species and two reptile species (Appendix D). Fauna species are discussed below with regards to the habitat values present. Threatened species known or likely to occur in the study area are discussed in section 6.

5.6.2 Important habitat

For a small number of species, the habitat constraint information in the TBDC refers to an important habitat map (BAM Section 5.1.3). Important habitat maps identify areas that are considered essential to support critical life stages of the species, e.g. breeding areas or locations important for foraging/over-wintering for migratory species. Important habitat for the Bar-tailed Godwit (*Limosa lapponica*) and the Curlew Sandpiper (*Calidris ferruginea*) is mapped along the Parramatta River, Narawang Wetland and Haslams Creek within Sydney Olympic Park and the Millennium Parklands, and would be crossed by the project (see section 7.3.1).

5.6.3 Habitat features

The following specific geographic and habitat features were identified within the project site and indicate the potential presence of threatened species that could contribute to the credit calculations:

- within one kilometre of rivers, lakes, large dams or creeks, wetlands and coastlines
- semi-permanent/ephemeral wet areas
- land containing swamps, creek edges, shallow, open freshwater or saline wetlands or shallow edges of deeper wetlands within 300 metres of these swamps
- presence of *Allocasuarina* and *Casuarina* species
- hollow-bearing trees
- fallen/standing dead timber including logs
- dense shrub layer or alternatively high canopy cover exceeding 70 per cent.

5.6.4 Fauna habitat values

Terrestrial fauna habitat values associated with native and planted vegetation in the study area are described in Table 5.16 to Table 5.23. General habitats include:

- mangroves and saltmarsh
- Swamp Oak Forest
- Sydney Turpentine Ironbark forest
- planted trees
- exotic grassland
- wetlands
- human-made features including bridges and culverts.

Table 5.16 Fauna habitat: mangroves and saltmarsh

Habitat type: mangroves and saltmarsh	
Description	*Avicennia marina* (Grey Mangrove) forms a low closed to open forest along the banks of the Parramatta River and Haslams Creek. The understorey consists mainly of bare mud and pneumatophores. Scattered native saltmarsh herbs occur where more light reaches the ground at the edge of stands. Nuwi Wetland east of Hill Road contains a lagoon fringed with mangroves. It is an important component of the flood mitigation strategy due to its role in discharging diverted floodwaters from Narawang Wetland back into Haslams Creek. This wetland is the only remaining original shoreline of the former Wentworth Bay (SOPA 2010). A range of common bird species were observed in mangroves in the study area, including the Australian Raven (*Corvus coronoides*), Silvereyes (*Zosterops lateralis*), and Spotted Turtledove (*Streptopelia chinensis*). Several microchiropteran bats (likely the common Goulds Wattled Bat *Chalinolobus gouldii*) were observed roosting in a hollow spout in mangroves along the Parramatta River near Melrose Park.
Threatened species	Southern Myotis (*Myotis macropus*) may roost and breed in hollows in mangroves. The Bar-tailed Godwit (*Limosa lapponica*) and Curlew Sandpiper (*Calidris ferruginea*) may forage on mudflats adjacent to mangroves. Mangroves and saltmarsh in the area is mapped as important habitat for these species. The Australasian Bittern (*Botaurus poiciloptilus*) may shelter and forage in mangroves in the area. The Green and Golden Bell Frog (*Litoria aurea*) is known to occur in mangrove habitats at Newington Nature Reserve (in addition to freshwater wetland habitat at Sydney Olympic Park). No evidence of the species was recorded in mangroves at Camellia.
Migratory species	The Bar-tailed Godwit (*Limosa lapponica*), Curlew Sandpiper (*Calidris ferruginea*) and other migratory waders may forage on mudflats adjacent to mangroves
Photo: mangroves at Melrose Park	

Table 5.17 Fauna habitat: Swamp Oak forest

Habitat type: Swamp Oak forest	
Description	*Casuarina glauca* (Swamp Oak) forms dense monospecific stands above a thick ground cover of salt tolerant herbs, rushes and sedges. The midstory includes *Lagunaria patersonii* (Norfolk Island Hibiscus) and woody weeds such as *Lantana camara** (Lantana) and *Olea europaea* subsp. *cuspidata** (African Olive). Areas of saltmarsh occur adjacent to some patches of Swamp Oak forest. A range of common bird species were observed in Swamp Oak forest in the study area, including the Grey Fantail (*Rhipidura albiscapa*).
Threatened species	The Green and Golden Bell Frog (*Litoria aurea*) is known to occur in Swamp Oak forest at Newington Nature Reserve and Sydney Olympic Park
Migratory species	The White-throated Needltail (*Hirundapus caudacutus*) may occur in Swamp Oak forest.
Photo	

Table 5.18 Fauna habitat: Sydney Turpentine Ironbark Forest

Habitat type: Sydney Turpentine Ironbark Forest	
Description	A patch of Sydney Turpentine Ironbark Forest occurs in Newington Nature Reserve north-west of Narawang Wetland, outside the project site. No large hollow-bearing trees suitable for Powerful Owls were observed where this forest occurs near the project site. Small hollow suitable for microbats, possums and small parrots are present. A dense shrub layer is present and provides foraging and shelter habitat for small birds. Leaf litter provides habitat for common reptiles and frogs.
Threatened species	A resident pair of White-bellied Sea-eagle (*Haliaeetus leucogaster*) breed in Newington Nature Reserve. Powerful Owls (*Ninox strenua*) were recorded on three occasions in Newington Nature Reserve and Sydney Olympic Park in 2017. There are no records of breeding at the site (Bionet 2021, J. O'Meara *pers. comm*). Breeding pairs are known from Carlingford, Eastwood and North Parramatta and these individuals and their young may forage in the study area on occasion.
Migratory species	Terrestrial migratory species such as the Rufous Fantail and Satin Flycatcher are known to occur at Newington Nature Reserve.
Photo: Sydney Turpentine Ironbark Forest in Newington Nature Reserve	

Table 5.19 Fauna habitat: wetlands

Habitat type: wetlands	
Description	The Narawang Wetland was constructed on remediated land north of Haslams Creek. The wetland contains 22 large clay-based habitat ponds, three irrigation storages and an ornamental lake, and was planted with native reeds, grasses, shrubs and trees. Ponds were connected by a water recirculation system so that individual ponds could be pumped out and dried, and the water recirculated to other ponds (Darcovich and O'Meara 2008). The constructed habitat simulates a freshwater wetland on coastal floodplain by receiving floodwaters from Haslams Creek and a floodway under Hill Road linked to the Nuwi Wetland. Stormwater from a 105 hectare catchment comprising Newington, Parkland Junction and Hill Road also feeds into Narawang Wetland for water quality treatment, storage and subsequent irrigation re-use (SOPA 2010). Newington Nature Reserve Wetland is a highly modified estuarine wetland system within the Newington Nature Reserve. The hydrology of the wetland is managed by constructed flushing channels, adjustable weirs, bunding, stormwater pipes and drains (SOPA 2002). A range of waterbirds were observed, including Dusky Moorhens, Purple Swamphens, Eurasian Coot, White-faced Heron. One of the key local management challenges within Narawang Wetland is the existence of *Gambusia holbrooki,* a 'noxious fish' under the FM Act. Predation by this species is a key threatening process.
Threatened species	Green and Golden Bell Frog - Good quality Green and Golden Bell Frog habitat is associated with the Narawang Wetland. This species rapidly colonised this wetland following its construction (Darcovich and O'Meara 2008).
Migratory species	Latham's Snipe – Narawang Wetland are known to provide habitat for this species and together with other wetlands in the Sydney Olympic Park and Newington area provide important habitat for this species (as defined by DotE 2015a). Newington Nature Reserve Wetland provides habitat for 70 species of local and migratory waterbirds and shorebirds, of which 20 are listed in the Japan Australia Migratory Birds Agreement, and nineteen are listed in the China Australia Migratory Birds Agreement (SOPA 2002).
Photo: Narawang Wetland	

Table 5.20 Fauna habitat: planted trees and shrubs

Habitat type: planted trees and shrubs	
Description	Planted native tree and shrub species occur in parklands such as Ken Newman Park, the Millennium Parklands at Sydney Olympic Park and along the side of roads. The vegetation varies in species richness but would provide habitat resources for a range of native fauna, including mature canopy trees that provide nectar, fruits, leaves and foraging, roosting or nesting substrates, habitat trees with decorticating bark, patches of dense understorey shrubs. Areas where trees have been planted along road reserves tend to lack an understory.
Fauna recorded	These areas are likely to provide foraging habitat for common species typical of urban parklands and gardens, such as Noisy Miner (*Manorina melanocephala*), Australian White Ibis (*Threskiornis moluccus*) and Brushtail Possum (*Trichosurus vulpecula*).
Threatened species	The Grey-headed Flying-fox (*Pteropus poliocephalus*) would forage in planted eucalypts and other trees in the project site. The Powerful Owl may forage in planted vegetation that supports arboreal fauna such as Common Ringtailed Possums (*Pseudocheirus peregrinus*). Large Bentwing Bat (*Miniopterus orianae oceanensis*) would forage for insects above planted vegetation.
Migratory species	N/A
Photo: planted vegetation at Ken Newman Park	
Photo: planted Swamp Oak along Hill Road	

Table 5.21 Fauna habitat: exotic grassland

Habitat type: exotic grassland	
Description	Exotic grassland is present in parkland areas at Sydney Olympic Park and other suburbs, and along road verges in residential areas. Grassland tends to be mowed. Grassland provides habitat for a range of common bird species, including the Australian Magpie (*Cracticus tibicen*), which forages for small reptiles and invertebrates.
Threatened species	The Green and Golden Bell Frog may forage in grassland areas where they occur near ponds and wetlands at Sydney Olympic Park. This species may use grassland areas to disperse between breeding areas at Sydney Olympic Park.
Migratory species	Latham's Snipe may occur in grassland where it is left unmown near ponds and wetlands at Sydney Olympic Park.
Photo: grassed easement in Ermington	

Human-made features

Constructed habitat features such as culverts and artificial ponds occur at Sydney Olympic Park and Camellia (see Table 5.22 and Table 5.23).

Table 5.22 Fauna habitat: artificial ponds

Habitat type: artificial ponds	
Description	A number of constructed ponds are located in Sydney Olympic Park. These include repurposed sediment ponds and others that were purposefully created to provide habitat for the Green and Golden Bell Frog. These ponds were planted with macrophytes to provide frog habitat, supplemented by grassland and rocky areas to encourage movement between ponds (Darcovich and O'Meara 2008). These occur adjacent to Haslams Creek either side of Australia Avenue (see photo) and near Kevin Coombes Avenue. These constructed ponds provide habitat for waterbirds, common frogs such as the Eastern Dwarf Tree Frog (*Litoria fallax*), and reptiles such as Red-bellied Black-snakes (*Pseudechis porphyriacus)*.
Threatened species	Green and Golden Bell Frog – these ponds comprise purposefully constructed breeding habitat for this species. Southern Myotis – constructed ponds comprise foraging habitat, other than those which have been covered to limit predation of frogs.
Migratory species	Migratory shorebirds may forage in small ponds at Sydney Olympic Park on occasion.
Photo: Constructed ponds that provide breeding habitat for the Green and Golden Bell Frog (Kronos Hill)	

Table 5.23 Fauna habitat: bridges and culverts

Habitat type: bridges and culverts	
Description	A number of bridges and culverts occur in the study area. These include large culverts that connect sections of Narawang Wetland under Holker Street and Hill Road, as well as culverts under Holker Busway and Marjorie Jackson Parkway.
Threatened species	The Southern Myotis is known to roost in at least two culverts and three bridges at Sydney Olympic Park, with a maternity roost known from the Holker Street culverts (J. O'Meara pers comm., via email). Small culverts under Holker Busway and Marjorie Jackson Parkway have been constructed to connect Green and Golden Bell Frog habitat.

5.7 Aquatic habitats

Aquatic habitats are described in Table 5.24 and Table 5.25.

Table 5.24 Fauna habitat: Parramatta River

Habitat type: Parramatta River	
Description	The Parramatta River is a large, tidal estuary. Much of the river is vegetated with mangroves. Artificial rock seawalls are present at some locations at Wentworth Point and Camellia. Open mudflats are present in the Melrose Park area, east of the project site. The Parramatta River and its banks are regarded as contaminated with a wide variety of chemicals and substances over many decades. This contamination is understood to have been spread by various reclamation works which have removed contaminated silts from the river bed and used them as fill. Previous sampling within the Parramatta River has indicated the presence of heavy metals, total recoverable hydrocarbons and dioxins. This contamination is considered likely to be as a result of adjacent heavy industrial activity and is generally more problematic on the south bank of the river (refer to Technical Paper 10 (Hydrology, Flood and Water Quality Assessment)). The Parramatta River is mapped as Key Fish Habitat (DPI 2007). It is classified as Type 1 (Key Fish Habitat) and is also classified as Class 1 (major key fish habitat) as it is a permanently flowing river. Common fish species include Dusky Flathead (*Platycephalus fuscus*), Bream (*Acanthopagrus* sp.), Mulloway (*Argyrosomus japonicus*), Whiting (*Sillago ciliata*), Luderick (*Girella tricuspidata*), Mullet (*Mugil cephalus*) and Silver Trevally (*Pseudocaranx georgianus*). Waterbird species observed at the mudflats along the Parramatta River included Silver Gulls (*Chroicocephalus novaehollandiae*), Australian White Ibis (*Threskiornis moluccus*), Striated Heron (*Butorides striata*) and Little Black Cormorant (*Phalacrocorax sulcirostris*).
Threatened species	The White-bellied Sea-eagle forages along the Parramatta River and Haslams Creek. Southern Myotis may roost and breed in hollows in mangroves. The Bar-tailed Godwit (*Limosa lapponica*) and Curlew Sandpiper (*Calidris ferruginea*) may forage on mudflats adjacent to mangroves. The Parramatta River is mapped as important habitat for these species. The Green and Golden Bell Frog may occur in mangroves associated with the Parramatta River at Camellia. No threatened fish species listed under the FM Act or EPBC Act or marine species listed under the BC Act or EPBC Act are likely to occur (see Appendix B).
Migratory Species	Mudflats of the Parramatta River are important habitat for the Bar-tailed Godwit (*Limosa lapponica*) and Curlew Sandpiper (*Calidris ferruginea*). Other migratory waders may also occur in these areas on occasion.

Habitat type: Parramatta River	
Photo: Parramatta River at Camellia showing rock revetment in foreground and mangroves on far bank	
Photo: mudflats at Melrose Park, east of the project site	

Table 5.25 Fauna habitat: Haslams Creek

Habitat type: Haslams Creek	
Description	Haslams Creek runs from Berala, through Sydney Olympic Park, to Homebush Bay. This creek is a highly modified second order watercourse which drains into the Parramatta River at Homebush Bay. The catchment of Haslams Creek is highly urbanised (including the M4 Motorway) with the upper extents generally concrete lined opened channels and pipes (refer to Technical Paper 10 (Hydrology, Flooding and Water Quality Assessment)). The reach through the study area is tidal and vegetated with mangroves. Haslams Creek is mapped as Key Fish Habitat (DPI 2007). It is classified as Type 1 (Key Fish Habitat) and is also classified as Class 1 (major key fish habitat) as it is a permanently flowing river. Common fish species include Dusky Flathead (*Platycephalus fuscus*), Bream (*Acanthopagrus* sp.), Mulloway (*Argyrosomus japonicus*), Whiting (*Sillago ciliata*), Luderick (*Girella tricuspidata*), Mullet (*Mugil cephalus*) and Silver Trevally (*Pseudocaranx georgianus*). Species recorded along Haslams Creek included Eastern Great Egrets (*Ardea alba*), Little Pied Cormorants (*Microcarbo melanoleucos*), Pacific Black Ducks (*Anas superciliosa*).
Threatened species	The White-bellied Sea-eagle forages along the Parramatta River and Haslams Creek. Southern Myotis may roost and breed in hollows in mangroves. The Bar-tailed Godwit (*Limosa lapponica*) and Curlew Sandpiper (*Calidris ferruginea*) may forage on mudflats adjacent to mangroves. Haslams Creek is mapped as important habitat for these species. The Green and Golden Bell Frog is known to occur in vegetation associated with Haslams Creek.
Migratory species	Mudflats of Haslams Creek are important habitat for the Bar-tailed Godwit and Curlew Sandpiper. Other migratory waders may also occur in these areas on occasion.
Photo: Haslams Creek (view from Holker Busway)	

5.8 Protected and sensitive lands

Protected and sensitive lands in the study area are identified in Table 5.26.

Table 5.26 Protected and sensitive lands

Protected and sensitive lands	Detail
Coastal wetlands	The project site crosses areas mapped as coastal wetlands and proximity areas for coastal wetlands, and coastal environment areas, as originally mapped by the (now repealed) State Environmental Planning Policy (Coastal Management) 2018. Coastal wetlands occur in the following locations in the study area: – mangroves and mudflats along the Parramatta River and Haslams Creek (see Figure 5.3) – Newington Nature Reserve Wetland (see Figure 5.3).
High biodiversity values land	High biodiversity value land identified on the Biodiversity Values Map under the BC Act is present in the study area and includes the following: – important habitat for migratory waders subject to serious and irreversible impacts are associated with the Parramatta River, Haslams Creek and other waterbodies (see Figure 5.3) – coastal wetlands (see Figure 5.3).
Protected areas	– Protected areas (including land and water) managed under the *National Parks and Wildlife Act 1974* and the *Marine Estate Management Act 2014* present in the study area include: • Newington Nature Reserve (see Figure 5.3), protected under the NPW Act. – The Millennium Parklands are the parklands associated with Sydney Olympic Park, identified under Schedule 3 of the *Sydney Olympic Park Authority Act 2001.* These parklands were designed and built on land formerly used by government industries including the State Abattoirs, State Brickworks and Commonwealth Department of Defence, and cover an area of 430 hectares (SOPA 2019). They include: • Newington Armory • Newington Nature Reserve • Bicentennial Park, Blaxland Riverside Park and Wentworth Common • the Brickpit.
Key Fish Habitat	All large waterbodies in the study area (i.e. Parramatta River, Haslams Creek) are mapped as 'Key Fish Habitat' as defined in the Policy and guidelines for fish habitat conservation and management (Update 2013) and as shown on the NSW DPI Key Fish Habitat map for the Sydney area (DPI 2007).
Waterfront land	Waterfront land is defined in the *Water Management Act 2000* as the bed of any river, lake or estuary, and the land within 40 metres of the river banks, lake shore or estuary mean high water mark. Parts of the study area near the Parramatta River are within waterfront land.
Critical habitat	No land or waters identified as Critical Habitat under the FM Act or EPBC Act or areas of outstanding biodiversity value under the BC Act are present in the study area.
Offset sites	No biodiversity stewardship sites, or private conservation lands occur in the study area. Narawang Wetland, Kronos Hill area, Wentworth Common area and the Brickpit are zoned for environmental conservation. Information received from Sydney Olympic Park Authority staff indicate that the constructed habitats designed for the Green and Golden Bell Frogs were built in the 1990s to offset impacts associated with earlier development within Sydney Olympic Park, as a requirement of Development Application (DA) conditions. Narawang Wetland was constructed as compensatory habitat for Green and Golden Bell Frog habitat that was removed during the Newington Stage 2 redevelopment works in 1996. Details of the specific DA conditions are as follows: – Condition 36 of the Newington Stage 2 DA refers to permanent replacement habitat: '*Permanent replacement habitat shall be constructed in accordance with the Species Impact Statement*.' – Condition 29 of the Newington Stage 2 DA relates to ongoing ecological obligations for the wetlands: '*An "Adaptive Management/System Program" is to be developed for the new freshwater wetlands to ensure that they become a healthy and flourishing habitat for birds, the Green and Golden Bell Frog and other native species and are shaped and revegetated to be consistent with the Millennium Park concept plan. The program is to identify responsibilities for the tasks involved and to include monitoring and maintenance programs to facilitate the modification of elements to meet these objectives.'*

Legend
- Project site
- Nature Reserve
- Coastal Wetlands
- Important Habitat for Migratory Species
- Green and Golden Bell Frog habitat (from SOPA 2019)

Paper Size ISO A4
0 0.5 1
Kilometres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. 12557728
Revision No. A
Date 11/07/2023

Fauna habitat values

FIGURE 5.3

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Print date: 11 Jul 2023 - 11:57

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

6. Threatened species

6.1 Threatened species survey results

Threatened species recorded during surveys, or where key species are known to occur (for example at Sydney Olympic Park), are detailed in Table 6.2.

Threatened species recorded or likely to occur are discussed further in relation to the BAM (see section 1.1) and the EPBC Act (see section 7.2).

Table 6.1 Threatened species recorded during surveys

Common name	Scientific name	BC Act	EPBC Act	Record
Eucalyptus scoparia	*Eucalyptus scoparia*	E	V	Planted trees located in P5 car park within Sydney Olympic Park
Wilsonia backhousei	*Wilsonia backhousei*	V	-	Large population located in Newington Nature Reserve 'Saltmarsh Nursery' area
Green and Golden Bell Frog	*Litoria aurea*	E	V	Key populations present at Sydney Olympic Park and Camellia
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Recorded foraging at various locations in the study area
Southern Myotis	*Myotis macropus*	V	-	Breeding colony present at Sydney Olympic Park
White-bellied Sea-eagle	*Haliaeetus leucogaster*	V	-	Recorded foraging in the Parramatta River and known to nest at Newington Nature Reserve
Powerful Owl	*Ninox strenua*	V	-	Heard calling near Ken Newman Park

A group of 23 *Eucalyptus scoparia* trees are located within the P5 car park in Sydney Olympic Park (see Photo 6.1 and Figure 6.1). These trees had been planted as part of landscaping works. The natural range of this species in NSW is restricted to the Tenterfield area in the northern tablelands, and it does not naturally occur within the Sydney Basin. This species is a commonly planted street and landscaping tree. Within the study area, it is planted in formed garden beds within a car park, and there is no likelihood of self-recruitment.

Photo 6.1 Eucalyptus scoparia in P5 car park

Given these individuals of *Eucalyptus scoparia* have been planted well out of their natural range, for aesthetic and landscaping purposes, they cannot be assigned to a locally occurring PCT. They have been assessed as planted native vegetation and are not considered further in terms of being assessed as a threatened species. The project may result in direct impacts to three individuals, as a result of establishment of a construction compound.

There is a known population of the saltmarsh plant *Wilsonia backhousei* in the northern portion of Newington Nature Reserve. This population has been monitored by Sydney Olympic Park Authority for many years and is well-documented and surveyed. The population was mapped as part of this current assessment (refer to Photo 6.2 to Photo 6.4), and results of the field survey combined with information provided by Sydney Olympic Park ecologists was used to map the extent of the population (see Figure 6.2).

The extent of *Wilsonia backhousei* has been declining over recent years within the area known as the 'Saltmarsh Nursery', which is the northern tip of Newington Nature Reserve. It is believed that this decline is a result of a gradual "*freshening'* of the site, which is gradually converting to a freshwater wetland, combined with "*encroachment of invasive native and introduced plants*" (Pacific Wetlands 2019).

The mapped extent of *Wilsonia backhousei* shown on Figure 6.2 and used in this assessment has included areas where it was recorded in 2019 by Pacific Wetlands, in addition to the areas where it was recorded during the current survey.

Photo 6.2 Wilsonia backhousei – the bright green patches in the ground layer

Photo 6.3 Wilsonia backhousei – close up showing flower

Photo 6.4 Wilsonia backhousei – dense mat

Legend

- Indicative location of White-bellied Sea-eagle nest
- Green and Golden Bell Frog habitat (from SOPA 2019)
- Project site

Threatened flora

- *Wilsonia backhousei* (V, BC Act)

Threatened fauna

- Grey-headed Flying-fox (V, BC Act & EPBC Act)
- Powerful Owl (V, BC Act)
- Southern Myotis (V, BC Act)
- White-bellied Sea-eagle (V, BC Act)

Paper Size ISO A4

0 0.5 1

Kilometres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Threatened species recorded in the study area

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 6.1

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO012_BDAR_ThreatenedSpeciesRecorded
Print date: 11 Jul 2023 - 12:00

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

6.2 Assessment of planted native vegetation for threatened species habitat

This section provides an assessment of planted native vegetation within the project site for use by threatened species.

6.2.1 Threatened flora species

Planted vegetation within the project site that cannot be assigned to any locally occurring PCT does not provide suitable habitat for any threatened flora species. Vegetation in these areas has been planted from unknown provenance seed, typically on modified landforms where the natural seed bank and soil profile has been lost. There is no source of seed or propagation material from which any threatened species may germinate.

6.2.2 Threatened and migratory fauna species

Planted native species occur in parklands such as Ken Newman Park, the Millennium Parklands at Sydney Olympic Park and along roadsides. The vegetation varies in species richness but would provide habitat resources for a range of native fauna, including mature canopy trees that provide nectar, fruits, leaves and foraging, roosting or nesting substrates, habitat trees with decorticating bark, patches of dense understorey shrubs. Areas where trees have been planted along road reserves tend to lack an understory. Threatened species that may forage in planted native vegetation include the Grey-headed Flying-fox, Powerful Owl and Large Bentwing Bat. The Green and Golden Bell Frog may use planted native vegetation for foraging and dispersing between ponds. Further discussion is provided in section 8.2. Migratory species such as Latham's Snipe may forage and shelter in planted vegetation where it occurs adjacent to wetlands (see section 7.3 for further discussion).

6.3 Identification of threatened species under the BAM

6.3.1 Predicted threatened species (ecosystem credit entities)

Based on the vegetation types and habitat resources present within the site, the BAM calculator generates a list of threatened fauna species that are predicted to utilise the study area. The list was refined based on the habitat assessment and field surveys conducted (see Appendix B). The suite of threatened species associated with ecosystem credits required for the study area are listed in Table 6.2. For each predicted threatened species, a sensitivity class rating and vegetation zones they are predicted to be associated with are also provided. The BAM does not require targeted surveys for predicted threatened species.

Table 6.2 Confirmed predicted threatened species

Common name	Scientific name	Sensitivity to gain class	Vegetation zone association
Australasian Bittern	*Botaurus poiciloptilus*	Moderate	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Australian Painted Snipe	*Rostratula australis*	Moderate	1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Barking Owl (foraging)	*Ninox connivens*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest

Common name	Scientific name	Sensitivity to gain class	Vegetation zone association
Black Bittern	*Ixobrychus flavicollis*	Moderate	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	Moderate	1281 - Sydney Turpentine - Ironbark forest
Black-necked Stork	*Ephippiorhynchus asiaticus*	Moderate	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Black-tailed Godwit	*Limosa limosa*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Broad-billed Sandpiper	*Limicola falcinellus*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Brown Treecreeper	*Cimacteris picumnus victoriae*	High	1234 - Estuarine Swamp Oak forest
Comb-crested Jacana	*Irediparra gallinacea*	Moderate	1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Curlew Sandpiper	*Calidris ferruginea*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	Moderate	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Eastern Osprey (foraging)	*Pandion cristatus*	Moderate	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion

Common name	Scientific name	Sensitivity to gain class	Vegetation zone association
Flame Robin	*Petroica phoenicea*	Moderate	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Freckled Duck	*Stictonetta naevosa*	Moderate	1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Gang-gang Cockatoo (foraging)	*Callocephalon fimbriatum*	Moderate	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Greater Broad-nosed Bat	*Scoteanax rueppellii*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Grey-headed Flying-fox (foraging)	*Pteropus poliocephalus*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	Moderate	1281 - Sydney Turpentine - Ironbark forest
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Little Bent-winged Bat	*Miniopterus australis*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Little Eagle (foraging)	*Hieraaetus morphnoides*	Moderate	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Little Lorikeet	*Glossopsitta pusilla*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Masked Owl	*Tyto novaehollandiae*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
New Holland Mouse	*Pseudomys novaehollandiae*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Powerful Owl (foraging)	*Ninox strenua*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Regent Honeyeater (non-breeding)	*Anthochaera phrygia*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest

Common name	Scientific name	Sensitivity to gain class	Vegetation zone association
Rosenberg's Goanna	*Varanus rosenbergi*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Scarlet Robin	*Petroica boodang*	Moderate	1281 - Sydney Turpentine - Ironbark forest
Sooty Owl (foraging)	*Tyto tenebricosa*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Speckled Warbler	*Chthonicola sagittata*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Spotted Harrier	*Circus assimilis*	Moderate	1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
Spotted-tailed Quoll	*Dasyurus maculatus*	High	920 - Estuarine mangrove forest 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Square-tailed Kite (foraging)	*Lophoictinia isura*	Moderate	1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Superb Fruit-Dove	*Ptilinopus superbus*	Moderate	1234 - Estuarine Swamp Oak forest
Swift Parrot (non-important habitat)	*Lathamus discolor*	Moderate	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Turquoise Parrot	*Neophema pulchella*	High	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
Varied Sittella	*Daphoenositta chrysoptera*	Moderate	1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest
White-bellied Sea-eagle (foraging)	*Haliaeetus leucogaster*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
White-fronted Chat	*Epthianura albifrons*	Moderate	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion
White-throated Needletail	*Hirundapus caudacutus*	High	920 - Estuarine mangrove forest 1126 - Estuarine saltmarsh 1234 - Estuarine Swamp Oak forest 1071 - *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of Sydney Basin Bioregion 1281 - Sydney Turpentine - Ironbark forest
Yellow-bellied Sheathtail-Bat	*Saccolaimus flaviventris*	High	920 - Estuarine mangrove forest 1234 - Estuarine Swamp Oak forest 1281 - Sydney Turpentine - Ironbark forest

6.3.2 Candidate threatened species (species credit entities)

The list of potential candidate threatened species that could occur in the study area are assessed based on the habitat resources observed during field surveys. 'Confirmed' candidate threatened species require targeted survey in accordance with the BAM (DPIE 2020a). The list of confirmed candidate threatened species is presented in Table 6.3; these species were subjected to targeted survey. Threatened species recorded in the study area are mapped in Figure 6.1.

A number of species could be reliably discounted as occurring within the study area based on the habitat types present, known distribution of the species and/or vagrant nature of the species. Justification for the exclusion of these species is provided in Table 6.4. The 'habitat constraints', 'habitat degraded' and 'geographic limitations' fields in the credit calculator have been updated where relevant.

As indicated in previous sections, the 'habitat degraded' box was ticked for all threatened flora species associated only with PCT 1281, given the only occurrence of this PCT within the footprint is a stand of planted trees in an unnatural soil profile, on an artificial landform, with no source material for any threatened flora species.

Table 6.3 Confirmed candidate species credit species for which surveys were conducted

Common name	Scientific name	Survey months	Presence	Justification and location
Flora				
Square Raspwort	*Haloragis exalata* subsp. *exalata*	All year	No – surveyed	Not recorded during targeted surveys.
Maundia triglochinoides	*Maundia triglochinoides*	November - March	No – surveyed	Not recorded during targeted surveys.
Biconvex Paperbark	*Melaleuca biconvexa*	All year	No – surveyed	Not recorded during targeted surveys.
Tall Knotweed	*Persicaria elatior*	December - May	No – surveyed	Not recorded during targeted surveys.
Narrow-leafed Wilsonia	*Wilsonia backhousei*	All year	Yes – surveyed	Well documented and studied population in the northern portion of Newington Nature Reserve, in the area known as the 'Saltmarsh Nursery'. Extent within this area well-established, and limited to a narrow band within the saltmarsh nursery.
Zannichellia palustris	*Zannichellia palustris*	October - January	No – surveyed	Not recorded during targeted surveys.
Fauna				
Barking Owl (nesting)	*Ninox connivens*	May - December	Surveyed – not present	No candidate nest trees with suitably sized hollows.
Bar-tailed Godwit	*Limosa lapponica*	No specified survey schedule	Yes – assumed	Project site intersects mapped important habitat.
Black-tailed Godwit	*Limosa limosa*	No specified survey schedule	Yes – assumed	Occasional records in Homebush Bay, Bird Hide and Newington Nature Reserve (Birdata 2022). Not recorded during surveys for the project. No important habitat identified in the Parramatta River estuary.
Broad-billed Sandpiper	*Limicola falcinellus*	No specified survey schedule	No – surveyed	Not recorded during surveys. No records in the Parramatta River and associated wetlands. Known to occur at Botany Bay.
Bush Stone-curlew	*Burhinus grallarius*	All year	No – surveyed	Not recorded during targeted surveys.

Common name	Scientific name	Survey months	Presence	Justification and location
Cumberland Plain Land Snail	*Meridolum corneovirens*	All year	No – surveyed	No suitable habitat present. Sydney Turpentine Ironbark Forest in the project site is planted. No impact on good quality patches of this vegetation type in Newington Nature Reserve.
Curlew Sandpiper	*Calidris ferruginea*	No specified survey schedule	Yes – assumed	Project site intersects mapped important habitat.
Dural Land Snail	*Pommerhelix duralensis*	All year	No – surveyed	No suitable habitat present.
Eastern Osprey (nesting)	*Pandion cristatus*	April - November	No – surveyed	One large stick nest in Newington Nature Reserve is a known nest for the White-bellied Sea-eagle. No other large stick nests observed elsewhere in the study area. Few records in the locality, none of which include breeding data.
Eastern Pygmy-possum	*Cercartetus nanus*	October - March	No – surveyed	Not observed during spotlighting surveys. No local populations remain in the inner Sydney area. No connectivity to expanses of high quality forested habitat with a dense heathy understory.
Gang-gang Cockatoo (nesting)	*Callocephalon fimbriatum*	October - January	No – surveyed	No candidate nest trees with suitably sized hollows.
Glossy Black-Cockatoo (nesting)	*Calyptorhynchus lathami*	January - September	No – surveyed	No candidate nest trees with suitably sized hollows.
Green and Golden Bell Frog	*Litoria aurea*	November - March	Yes – assumed No – surveyed	Known population present at Sydney Olympic Park and Newington Nature Reserve. No evidence of the species during targeted surveys in Camellia.
Little Eagle (nesting)	*Hieraaetus morphnoides*	August - October	No – surveyed	One large stick nest in Newington Nature Reserve is a known nest for the White-bellied Sea-eagle. No other large stick nests observed elsewhere in the study area. All records in the area are of individual birds, not pairs.
Masked Owl (nesting)	*Tyto novaehollandiae*	May - August	No – surveyed	No candidate nest trees with suitably sized hollows.
Powerful Owl (nesting)	*Ninox strenua*	May - August	No – surveyed	No candidate nest trees with suitably sized hollows.
Southern Myotis	*Myotis macropus*	October - March	Yes – surveyed	Known breeding colony present at Sydney Olympic Park. Suitable habitat present throughout the project site.
Square-tailed Kite (nesting)	*Lophoictinia isura*	September - January	No – surveyed	No stick nests in or near project site, except that used by the White-bellied Sea-eagle.
White-bellied Sea-eagle (nesting)	*Haliaeetus leucogaster*	July - December	No – surveyed	Known nest in Newington Nature Reserve. Nest tree buffer is outside the project site (see Figure 6.1). Regularly recorded foraging along the Parramatta River and roosting in mangroves at Ermington and Melrose Park. No nests were observed in mangroves at Melrose Park in or near the project site during surveys.
White-fronted Chat population in the Sydney Metropolitan Catchment Management Area	*Epthianura albifrons* - endangered population	All year	No – surveyed	No evidence during surveys. Surveys concluded that in 2008, nine White-fronted Chats remained at Newington Nature Reserve (Jenner et al 2011). There have been no sightings at the Waterbird Refuge since 1997 (TSSC 2010).

Table 6.4 Excluded candidate species

Common name	Scientific name	Survey months	Justification
Flora and fungi			
Bynoe's Wattle	*Acacia bynoeana*	All year	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Gosford Wattle, Hurstville and Kogarah Local Government Areas	*Acacia prominens* - endangered population	All year	Geographic limitations – project site does not fall within the relevant LGAs of Hurstville, Kogarah or Georges River.
Downy Wattle	*Acacia pubescens*	All year	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Thick Lip Spider Orchid	*Caladenia tessellata*	September - October	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Camarophyllopsis kearneyi	*Camarophyllopsis kearneyi*	May - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Dwarf Kerrawang	*Commersonia prostrata*	All year	Habitat degraded – no suitable eucalypt forest or woodland habitat on sandy or peaty soils present.
Epacris purpurascens var. *purpurascens*	*Epacris purpurascens* var. *purpurascens*	September - October	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Small-flower Grevillea	*Grevillea parviflora* subsp. *parviflora*	August - November	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Grevillea parviflora subsp. *supplicans*	*Grevillea parviflora* subsp. *supplicans*	August - November	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Gyrostemon thesioides	*Gyrostemon thesioides*	All year	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hibbertia puberula	*Hibbertia puberula*	October - December	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hibbertia superans	*Hibbertia superans*	July - December	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hygrocybe anomala var. *ianthinomarginata*	*Hygrocybe anomala* var. *ianthinomarginata*	May - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hygrocybe aurantipes	*Hygrocybe aurantipes*	May - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.

Common name	Scientific name	Survey months	Justification
Hygrocybe austropratensis	*Hygrocybe austropratensis*	May - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hygrocybe collucera	*Hygrocybe collucera*	June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hygrocybe griseoramosa	*Hygrocybe griseoramosa*	May - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hygrocybe lanecovensis	*Hygrocybe lanecovensis*	May - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hygrocybe reesiae	*Hygrocybe reesiae*	May - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hygrocybe rubronivea	*Hygrocybe rubronivea*	May - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Hairy Geebung	*Persoonia hirsuta*	All year	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Austral Pillwort	*Pilularia novae-hollandiae*	October - December	Habitat degraded – no suitable swamp or waterway habitat present. Wetlands within the study area have been planted and no seed bank for this species exists, and waterways are saline or brackish and do not provide habitat for this species.
Pimelea curviflora var. *curviflora*	*Pimelea curviflora* var. *curviflora*	October - March	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
P. prunifolia in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas	*Pomaderris prunifolia* - endangered population	October	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Scrub Turpentine	*Rhodamnia rubescens*	All year	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Magenta Lilly Pilly	*Syzygium paniculatum*	April - June	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Tetratheca glandulosa	*Tetratheca glandulosa*	August - November	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.

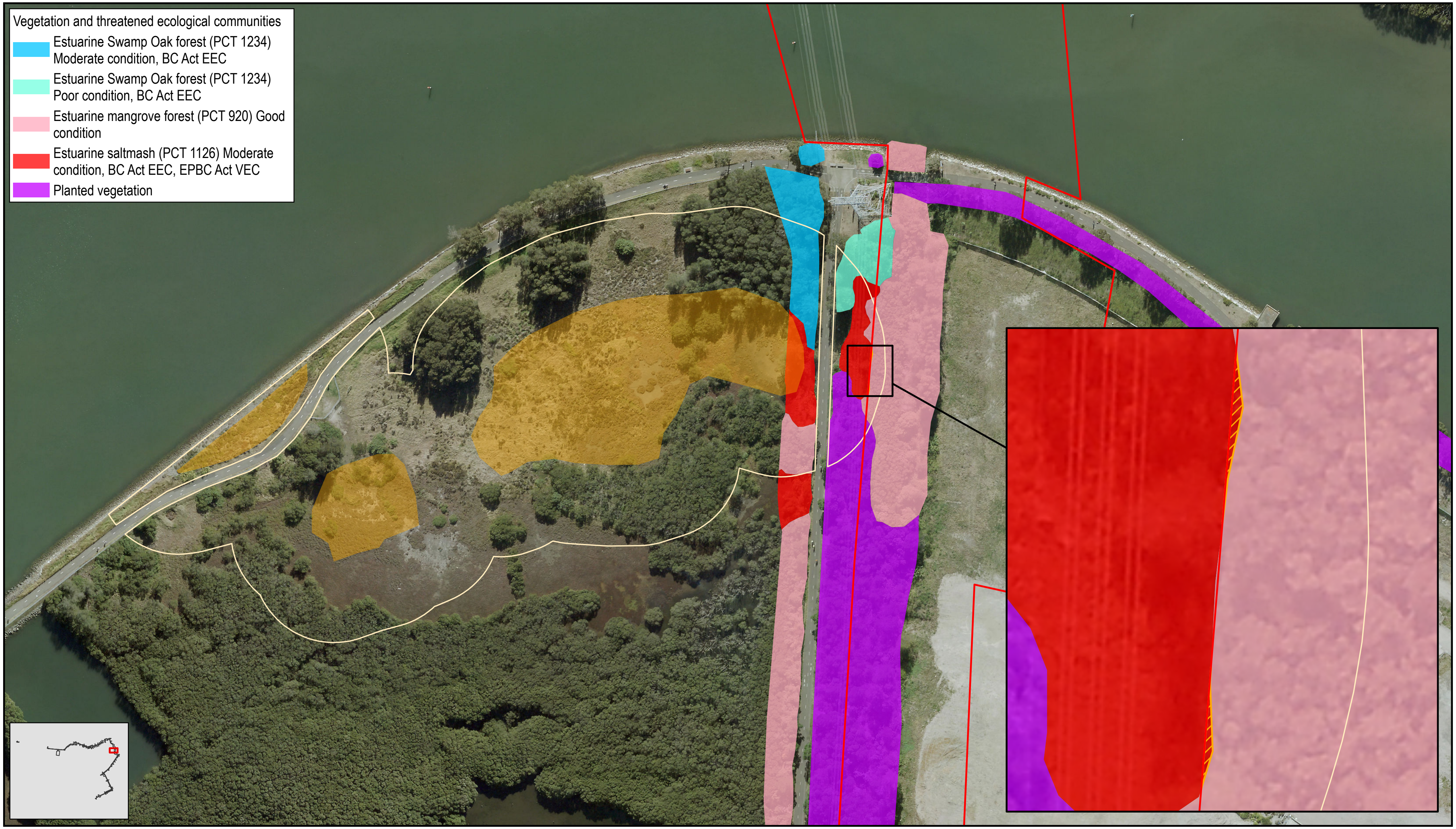
Common name	Scientific name	Survey months	Justification
Tadgell's Bluebell in the local government areas of Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield	*Wahlenbergia multicaulis* - endangered population	All year	Habitat degraded – associated only with PCT 1281, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species.
Fauna			
Broad-headed Snake (breeding)	*Hoplocephalus bungaroides*	August - September	Habitat constraints not present – no rocky areas including escarpments, outcrops of pagodas within Sydney sandstone geologies present.
Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas	*Callocephalon fimbriatum - endangered population*	All year	Geographic limitation – project is not within the Hornsby or Ku-ring-gai LGAs.
Giant Burrowing Frog	*Heleioporus australiacus*	September - May	Habitat degraded – no suitable sandstone habitat present.
Greater Glider	*Petauroides volans*	All year	Habitat degraded – no local populations remain in the inner Sydney area.
Grey-headed Flying-fox (roost camp)	*Pteropus poliocephalus*	All year	No breeding camps present.
Koala (important / breeding habitat)	*Phascolarctos cinereus*	All year	Habitat degraded – no local populations remain in the inner Sydney area.
Large-eared Pied Bat	*Chalinolobus dwyeri*	November - January	Habitat constraints not present – no cliffs, tunnels, mines or rocky areas within two kilometres.
Large Bent-winged Bat (Breeding)	*Miniopterus orianae oceanensis*	December - February	Habitat constraints not present – no cave, tunnel, mine, culvert or other structures present.
Little Bent-winged Bat (breeding)	*Miniopterus australis*	December - February	Habitat constraints not present – no cave, tunnel, mine, culvert or other structures present.
Regent Honeyeater (important / breeding habitat)	*Anthochaera phrygia*	NA	No mapped important habitat present.
Sooty Owl (breeding)	*Tyto tenebricosa*	April - August	Habitat constraints not present – no caves or clifflines or living or dead trees with hollows greater than 20 centimetres diameter.
Squirrel Glider	*Petaurus norfolcensis*	All year	Habitat degraded – no local populations remain in the inner Sydney area.
Swift Parrot (important habitat)	*Lathamus discolor*	NA	No mapped important habitat present.

6.3.3 Confirmed species credit entities

Species credit entities that have been confirmed in the project site through survey or assumed presence are identified in Table 6.5. Species polygons are mapped on Figure 6.2 to Figure 6.5.

Table 6.5 Species credit entities for which species polygons have been prepared

Common name	Scientific name	Species type	Biodiversity risk weighting	Location
Wilsonia backhousei	*Wilsonia backhousei*	Area	2	Saltmarsh vegetation at Wentworth Point, with the extent of occurrence buffered by 30 metres and then smoothed between patches, excluding hardstand and cleared areas.
Green and Golden Bell Frog	*Litoria aurea*	Area	2	All native vegetation within 200 metres of a waterbody at Camellia, Wentworth Point and Sydney Olympic Park.
Southern Myotis	*Myotis macropus*	Area	2	All native vegetation within 200 metres of a waterbody.
Bar-tailed Godwit	*Limosa lapponica*	Area	2	All native vegetation within the important habitat area.
Curlew Sandpiper	*Calidris ferruginea*	Area	3	All native vegetation within the important habitat area.



Legend
Wilsonia backhousei extent
Wilsonia backhousei species polygon
Wilsonia backhousei habitat
Project site

Paper Size ISO A4
0 50 100
Metres
N

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

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
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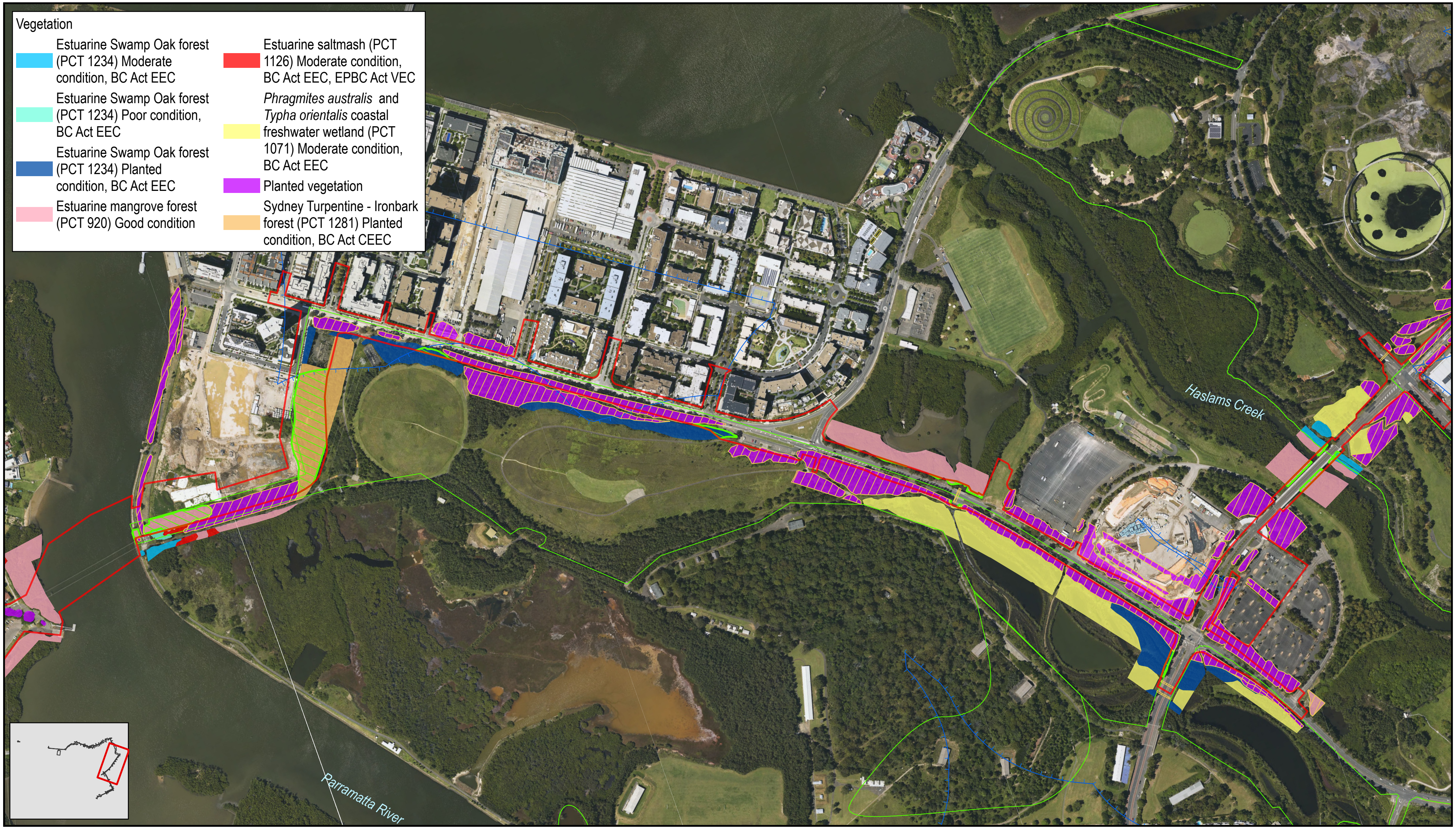
Threatened flora species polygons

FIGURE 6.2

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO013_BDAR_ThreatenedFloraSpeciesPolygon
Print date: 11 Jul 2023 - 12:00

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan



Legend

- Green and Golden Bell Frog species polygon
- Green and Golden Bell Frog movement habitat
- Green and Golden Bell Frog habitat (from SOPA 2019)
- Project site
- 200m buffer around waterbodies

Paper Size ISO A4

0 200 400

Metres

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

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Green and Golden Bell Frog species polygon

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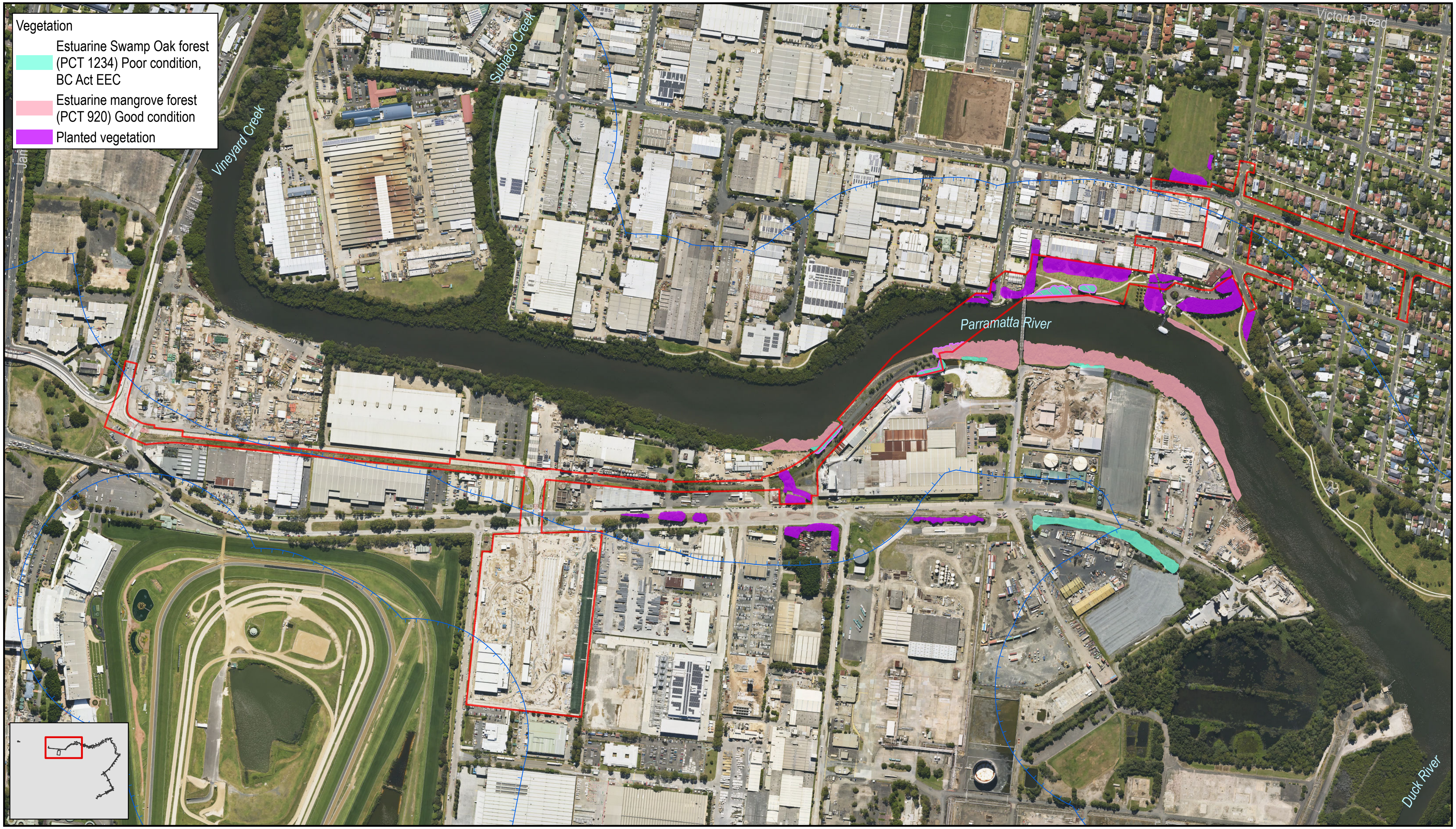
FIGURE 6.3

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO014_BDAR_GreenGoldenBellFrogSpecies
Print date: 11 Jul 2023 - 11:59

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan



Legend
- Southern Myotis species polygon
- Project site
- 200m buffer around waterbodies

Paper Size ISO A4

0 200 400

Metres

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

N

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Southern Myotis species polygon

Project No. **12557728**
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FIGURE 6.4a

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO015_BDAR_SouthernMyotisSpecies
Print date: 11 Jul 2023 - 12:00

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: Imanasan

Legend

- Southern Myotis species polygon
- Project site
- 200m buffer around waterbodies

Paper Size ISO A4

0 200 400

Metres

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

N

GHD

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Parramatta Light Rail Stage 2 EIS

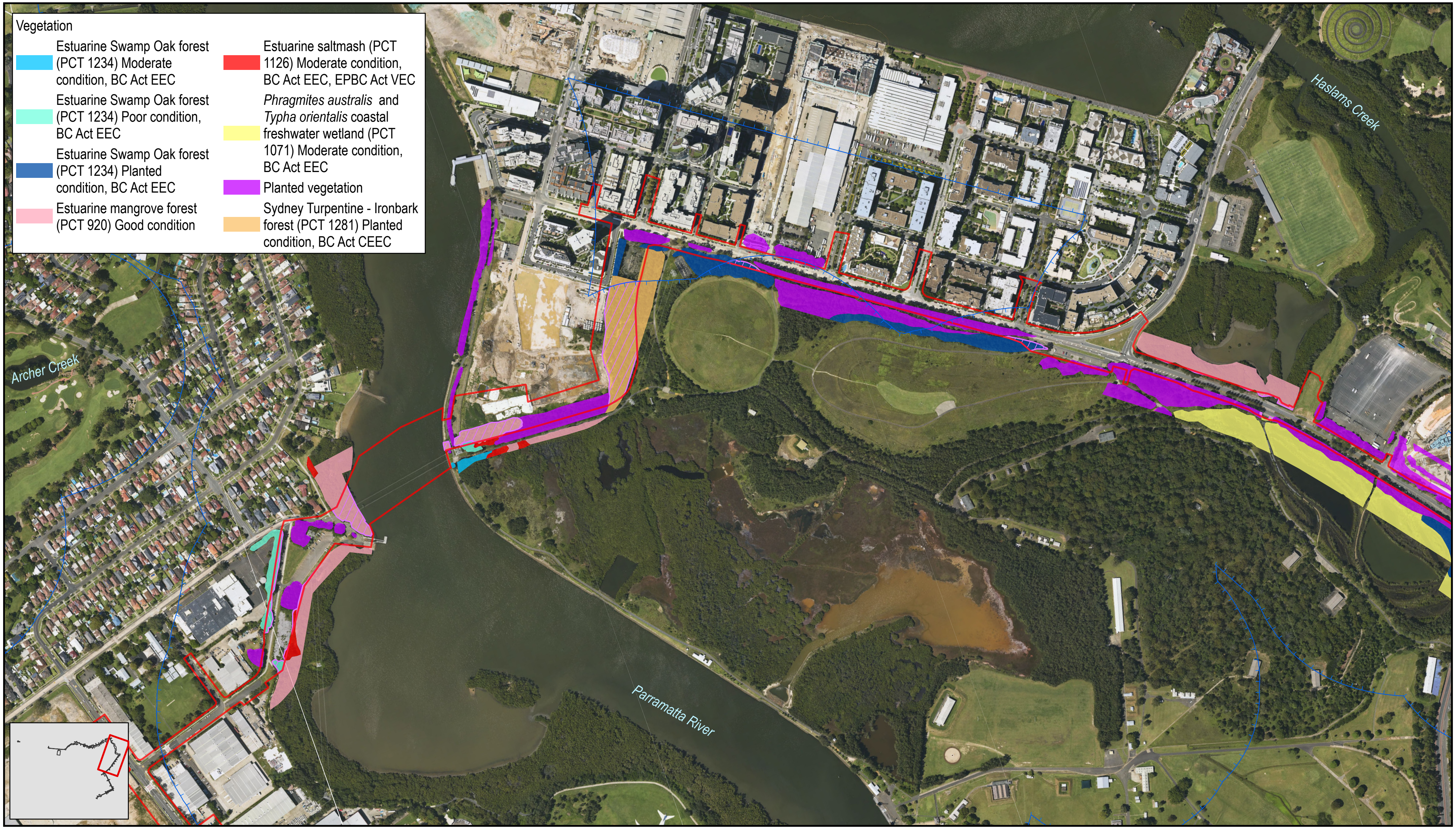
Southern Myotis species polygon

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 6.4b

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO015_BDAR_SouthernMyotisSpecies
Print date: 11 Jul 2023 - 12:01

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan



Legend
- Southern Myotis species polygon
- Project site
- 200m buffer around waterbodies

Paper Size ISO A4

0 200 400

Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Southern Myotis species polygon

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 6.4c

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO015_BDAR_SouthernMyotisSpecies
Print date: 11 Jul 2023 - 12:01

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

- Southern Myotis species polygon
- Project site
- 200m buffer around waterbodies

Paper Size ISO A4

0 200 400

Metres

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

Transport for NSW
Parramatta Light Rail Stage 2 EIS

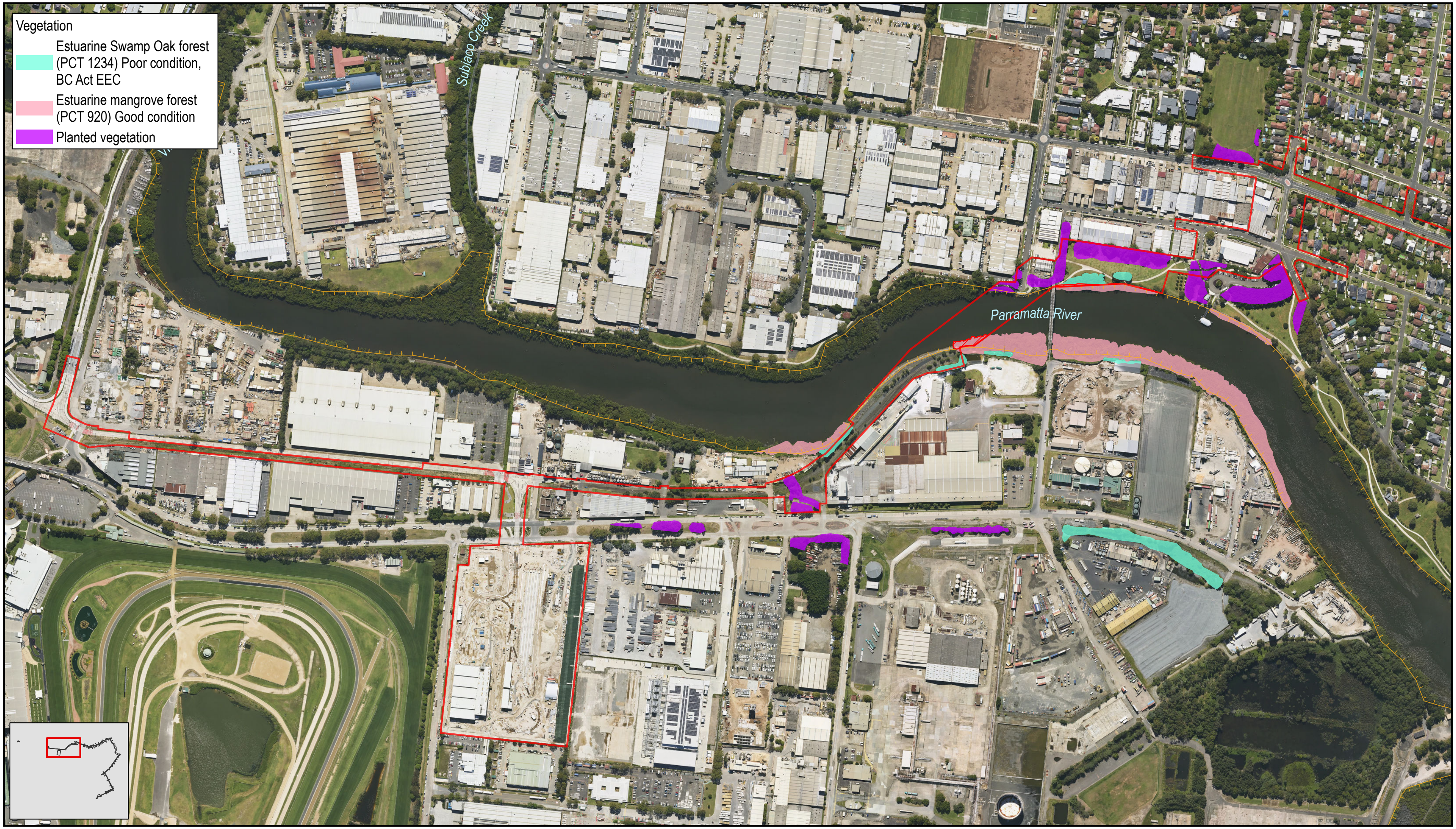
Southern Myotis species polygon

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 6.4d

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO015_BDAR_SouthernMyotisSpecies
Print date: 11 Jul 2023 - 12:01

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: Imanasan



Legend

Bar-tailed Godwit and Curlew Sandpiper species polygon

Important Habitat for Migratory Species

Project site

Paper Size ISO A4

0 200 400

Metres

N

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

GHD

Transport for NSW
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Migratory wader species polygon

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 6.5a

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO016_BDAR_MigratoryWaderSpecies
Print date: 11 Jul 2023 - 12:01

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend
- Bar-tailed Godwit and Curlew Sandpiper species polygon
- Important Habitat for Migratory Species
- Project site

Paper Size ISO A4

0 200 400

Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Migratory wader species polygon

Project No. 12557728
Revision No. A
Date 11/07/2023

FIGURE 6.5b

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO016_BDAR_MigratoryWaderSpecies
Print date: 11 Jul 2023 - 12:01

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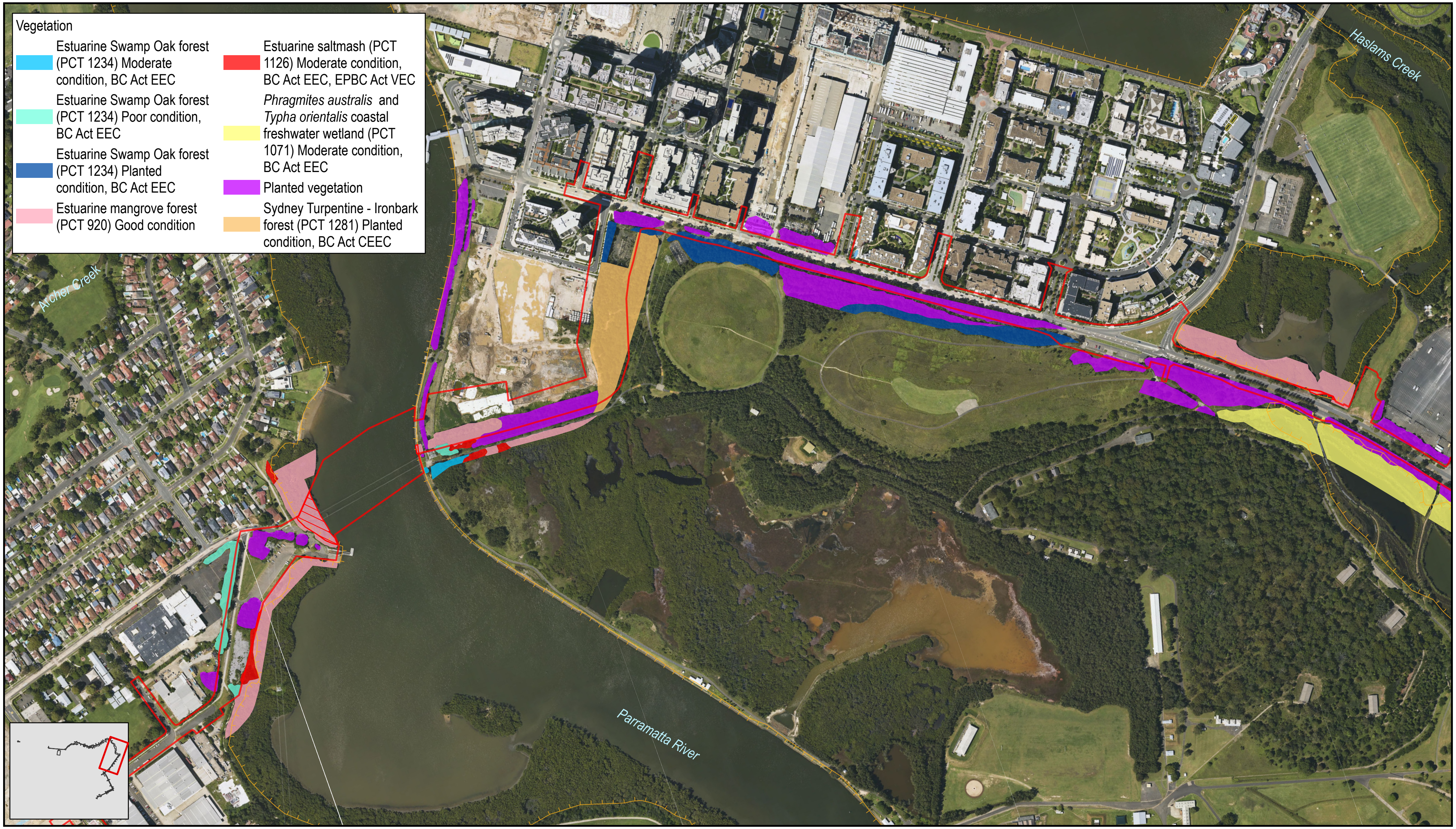

Legend
- Bar-tailed Godwit and Curlew Sandpiper species polygon
- Important Habitat for Migratory Species
- Project site

Paper Size ISO A4

0 200 400

Metres

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

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Migratory wader species polygon

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 6.5c

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO016_BDAR_MigratoryWaderSpecies
Print date: 11 Jul 2023 - 12:02

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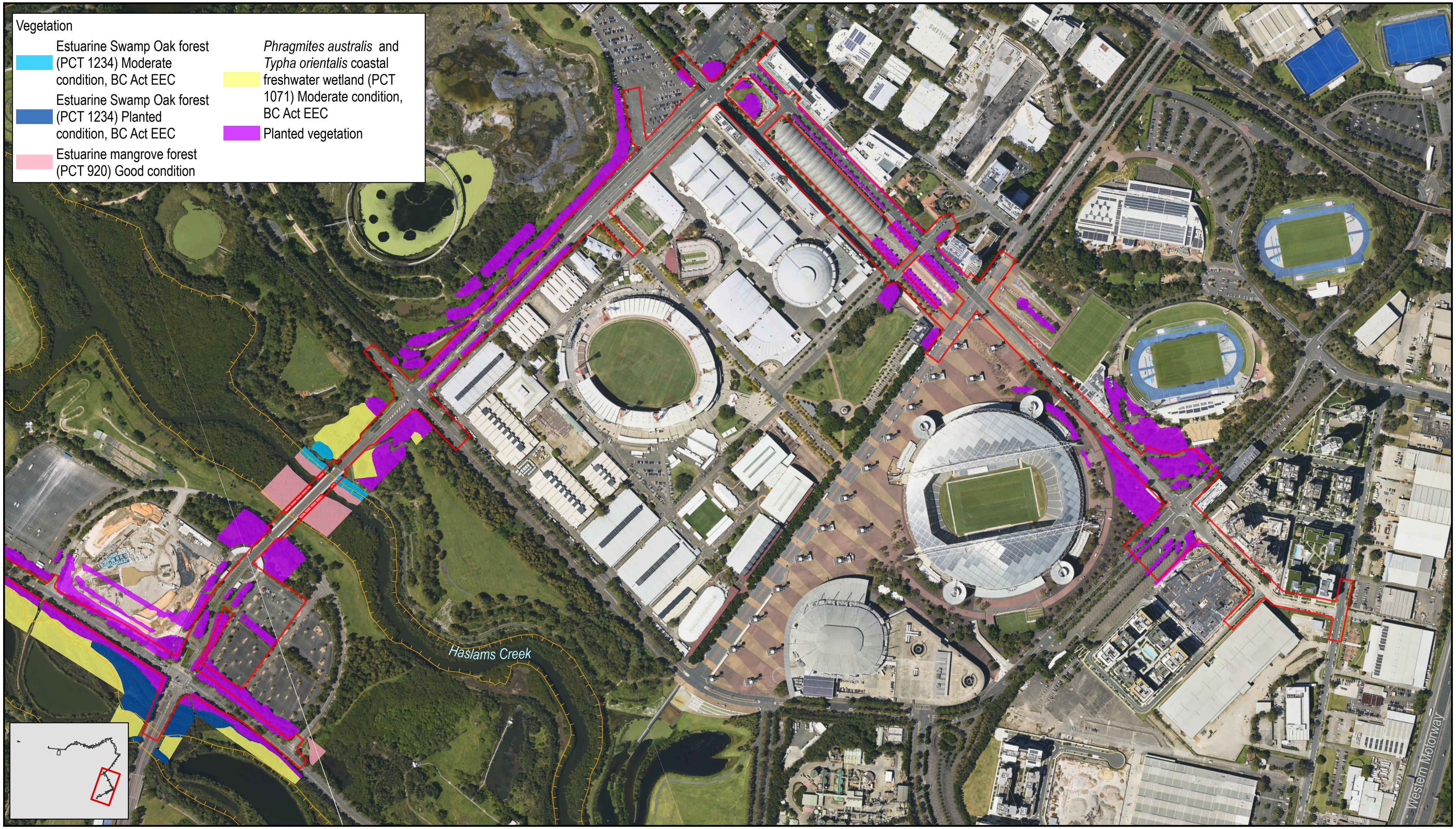

Legend
Bar-tailed Godwit and Curlew Sandpiper species polygon
Important Habitat for Migratory Species
Project site

Paper Size ISO A4
0 200 400
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Migratory wader species polygon

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 6.5d

N:\AU\Sydney\Projects\21\12557728\GIS\Maps\ECO_6.aprx\12557728_ECO016_BDAR_MigratoryWaderSpecies
Print date: 11 Jul 2023 - 12:02

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

7. Matters of National Environmental Significance

7.1 Threatened ecological communities

One TEC listed under the EPBC Act was confirmed in the study area: Subtropical and Temperate Coastal Saltmarsh (Coastal Saltmarsh), which is listed as a VEC. Coastal Saltmarsh was recorded at various locations in the project site, generally associated with the floodplains of the Parramatta River and Haslams Creek. Newington Nature Reserve, located adjacent to the project study area at Wentworth Point, contains the largest remaining stand of Coastal Saltmarsh on the Parramatta River. This area is located adjacent to the southern landing of the proposed bridge between Melrose Park and Wentworth Point.

7.2 Threatened species

Threatened fauna species listed under the EPBC Act that were positively identified during surveys of the project site are mapped on Figure 7.1. No threatened flora species listed under the EPBC were identified in the project site. Several additional fauna species and flora species have the potential to occur in the project site. These are summarised in Table 7.1. Various other species have been assessed to have a low potential to occur given lack of suitable habitat and few local records (Appendix C).

Table 7.1 Threatened species that are known or may occur in the study area

Common name	Scientific name	EPBC Act status	Likelihood of occurrence
Green and Golden Bell Frog	*Litoria aurea*	V	The Green and Golden Bell Frog is known to occur at Sydney Olympic Park. The project is also located in the vicinity of the Clyde/Rosehill key population.
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	The Grey-headed Flying-fox is known to forage in native and planted vegetation in the project site. No breeding camps are present in the project site.
Australasian Bittern	*Botaurus poiciloptilus*	E	There are several records of the Australasian Bittern at Sydney Olympic Park.
Australian Painted Snipe	*Rostratula australis*	E	There are several records of the Australian Painted Snipe at Sydney Olympic Park.
Bar-tailed Godwit	*Limosa lapponica baueri*	V	The Parramatta River between Rydalmere and Abbotsford, Haslams Creek and Narawang Wetland are mapped as important habitat for the Bar-tailed Godwit under the BAM. Groups of this species are regularly recorded within saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park, as well as the mudflats of the Parramatta River. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide foraging and roosting habitat for this species.
Curlew Sandpiper	*Calidris ferruginea*	CE	The Parramatta River between Rydalmere and Abbotsford, Haslams Creek and Narawang Wetland are mapped as important habitat for the Curlew Sandpiper under the BAM. Records for this species in the area are associated with saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide foraging and roosting habitat for this species.

Common name	Scientific name	EPBC Act status	Likelihood of occurrence
Eastern Curlew	*Numenius madagascariensis*	CE	There are occasional observations of individuals or small groups of this species at Newington Wetland and the Waterbird Refuge.
Great Knot	*Calidris tenuirostris*	CE	Two historic records of the species occur along the Parramatta River, with both records near Bennelong Parkway at Sydney Olympic Park (OEH 2021a). There are no other recent records in the locality.

Key: CE – critically endangered, E – endangered, V – vulnerable

7.3 Migratory biota

7.3.1 Shorebirds

Introduction

A critical consideration in assessing the significance of potential impacts on listed migratory shorebird species, according to the significant impact guidelines for migratory shorebird species (DEE 2017), is whether or not a proposed action is likely to affect 'important habitat'. Important habitat is defined separately for 36 of the migratory shorebird species and Latham's Snipe (*Gallinago hardwickii*). An area of 'important habitat' for the 36 migratory shorebird species is either:

– a site that is identified as internationally important
– a site that supports either:
  - at least 0.1 per cent of the flyway population of a single species, or
  - at least 2,000 migratory shorebirds, or
  - at least 15 shorebird species.

Important habitat for Latham's Snipe is described as:

– areas that have previously been identified as internationally important for the species, or
– sites that support at least 18 individuals of the species.

Identified species

Important habitat mapping by DPIE (2021) maps areas that support bird numbers exceeding the international and national significance thresholds as defined above and in the Wildlife Conservation Plan for Migratory Shorebirds (DotE 2015b). Important habitat boundaries were based on the DPIE estuary ecosystems shapefile and refined based on expert opinion and aerial imagery. Land areas critical for the birds feeding and roosting were included. This mapping identifies habitat along the Parramatta River, Haslams Creek and Narawang Wetland as important habitat for the following species:

– Bar-tailed Godwit (*Limosa lapponica*)
– Curlew Sandpiper (*Calidris ferruginea*).

Latham's Snipe are regularly observed at Sydney Olympic Park, including at Narawang Wetland, the Brickpit, Northern Water Feature and Newington Nature Reserve wetland. Regular monitoring of the population is undertaken by Sydney Olympic Park Authority, with Narawang Wetland identified as the preferred habitat of the species. Snipe numbers at Narawang Wetland exceed the Commonwealth threshold for Nationally Important Sites (18 birds, with at least 22 birds recorded). Due to proximity of the wetlands and observations of snipes moving between wetlands (e.g. Northern Water Feature to Narawang Wetland), the Park's snipes are considered to be one population (SOPA 2021b). As a whole, Sydney Olympic Park and Newington Nature Reserve provide important habitat for Latham's Snipe.

Table 7.2 Migratory (shorebird) species that are known or may occur in the study area

Common name	Scientific name	EPBC Act status	Records
Latham's Snipe	*Gallinago hardwickii*	M	Latham's Snipe is known to occur within Sydney Olympic Park. Annual monitoring of the species is conducted by the Sydney Olympic Park Authority. During 2020-2021 monitoring surveys (over non-consecutive three days), up to 22 Latham's Snipe were recorded within the Brickpit, Narawang Wetland, Northern Water Feature and Newington Nature Reserve wetland within Sydney Olympic Park. Up to 31 Latham's Snipe were recorded during the Spring Bird census at Sydney Olympic Park in the 2019-2020 period. The majority of Latham's Snipe recorded at Sydney Olympic Park occur within Narawang Wetland with other wetlands supporting small numbers of the species. Incidental sightings of the species have also occurred from pond 2 within Blaxland Riverside Park and also Armory Creek in Newington Armory (SOPA 2021b). Latham's Snipe have been irregularly recorded from Haslam Creek Flats, Wentworth Common Badu Mangroves and Bicentennial Park. The population of Latham's Snipe within Sydney Olympic Park exceeds the threshold as a Nationally Important Site for this species.
Bar-tailed Godwit Curlew Sandpiper	*Limosa lapponica baueri* *Calidris ferruginea*	V, M CE, M	The Parramatta River between Rydalmere and Abbotsford, Haslams Creek and Narawang Wetland are mapped as important habitat for these species under the BAM. Groups of these species are regularly recorded within saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park, as well as the mudflats of the Parramatta River. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide foraging and roosting habitat for this species.
Common Greenshank Marsh Sandpiper Pacific Golden Plover Pectoral Sandpiper Red-necked Stint Sharp-tailed Sandpiper	*Tringa nebularia* *Tringa stagnatillis* *Pluvialis fulva* *Calidris melanotis* *Calidris ruficollis* *Calidris acuminata*	M	Records for these species in the Homebush area are associated with saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide foraging and roosting habitat for this species.
Eastern Curlew Great Knot Broad-billed Sandpiper Double-banded Plover	*Numenius madagascariensis* *Calidris tenuirostris* *Limicola falcinellus* *Charadrius bicinctus*	CE, M CE, M M M	There are occasional observations of individuals or small groups of these species at Newington Wetland and the Waterbird Refuge.

Key: CE – critically endangered species, E – endangered species, M – migratory species, V – vulnerable species.

7.3.2 Migratory terrestrial species

Referral guidelines have been published for 14 migratory terrestrial species, such as the Rufous Fantail and Satin Flycatcher (DotE 2015a). Important habitat for these species generally relates to breeding habitat. Note that extremely uncommon migrants (e.g. Yellow Wagtail) are not included in this assessment as the numbers of individuals at any one site are so small relative to their global populations that no small group of individuals is likely to be significant for either the species in Australia or the ecological attributes of a site (DotE 2015a). Species that may occur in the project site are discussed in Table 7.3.

Table 7.3 Migratory (terrestrial) species that may occur in the study area

Common name	Scientific name	Important habitat (DotE 2015a)	Likelihood of occurrence
Black-faced Monarch	*Monarcha melanopsis*	The Black-faced Monarch is a wet forest specialist, occurring mainly in rainforests and riparian vegetation. In wet sclerophyll forest, the species mostly frequents sheltered gullies and slopes with a dense understorey of ferns and/or shrubs. The species has an extensive breeding range in south-eastern Australia from Cooktown to eastern Victoria.	Individuals are observed on occasion in Newington Nature Reserve and Sydney Olympic Park.
Eastern Osprey	*Pandion haliaetus*	Bays, estuaries, tidal stretches of large coastal rivers, mangrove swamps, coral and rock reefs, terrestrial wetlands and coastal lands.	Few records in the area. May forage on occasion along the Parramatta River. No known breeding pairs in the locality.
Fork-tailed Swift	*Apus pacificus*	Non-breeding visitor only: Found across a range of habitats, from inland open plains to wooded areas, where it is exclusively aerial. This species is believed to roost on the wing.	Would forage high above the project site on occasion.
Rufous Fantail	*Rhipidura rufifrons*	Moist, dense habitats, including mangroves, rainforest, riparian forests and thickets, and wet eucalypt forests with a dense understorey. When on passage a wider range of habitats are used including dry eucalypt forests and woodlands and Brigalow shrublands.	This species may forage and breed in the project site.
Satin Flycatcher	*Myiagra cyanoleuca*	Eucalypt forest and woodlands, at high elevations when breeding. They are particularly common in tall wet sclerophyll forest, often in gullies or along water courses. In woodlands they prefer open, grassy woodland types. During migration, habitat preferences expand, with the species recorded in most wooded habitats.	Individuals are observed on occasion in Newington Nature Reserve and Sydney Olympic Park.
White-throated Needletail	*Hirundapus caudacutus*	Non-breeding visitor only: Found across a range of habitats, more often over wooded areas, where it is almost exclusively aerial, though does roost in tree hollows and the foliage canopy. Large tracts of native vegetation, particularly forest, may be a key habitat requirement for species.	May forage above the project site. May roost on occasion in the project site.

Legend
- Project site
- Important Habitat for Migratory Species
- Green and Golden Bell Frog habitat (from SOPA 2019)
- Subtropical and Temperate Coastal Saltmarsh vulnerable ecological community
- Turpentine-Ironbark Forest of the Sydney Basin Bioregion critically endangered ecological community
- Grey-headed Flying-fox (V, BC Act & EPBC Act)

Paper Size ISO A4

0 0.5 1

Kilometres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Matters of national environmental significance

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 7.1

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Print date: 11 Jul 2023 - 12:02

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

8. Identification of prescribed additional biodiversity values

8.1 Introduction

The Biodiversity Conservation Regulation 2017 (BC Regulation) (clause 6.1) identifies additional biodiversity impacts to which the Biodiversity Offset Scheme (BOS) applies. These ‘prescribed impacts’ are the impacts on biodiversity values which are not related to, or are in addition to, native vegetation clearing and habitat loss. These types of impacts are used by the decision-maker to inform the determination and conditions of consent for developments. These include impacts:

– on the habitat of threatened entities including:
  - karst, caves, crevices, cliffs, rocks and other geological features of significance,
  - human-made structures, or
  - non-native vegetation
– on areas connecting threatened species habitat, such as movement corridors
– that affect water quality, water bodies and hydrological processes that sustain threatened entities
– on threatened and protected animals from turbine strikes from a wind farm (not relevant to this project)
– on threatened species or fauna that are part of a TEC from vehicle strikes.

The BDAR must identify the relevant prescribed impacts and the suite of threatened species that use or rely on the habitat values or would be affected by the impact, as specified in BAM Section 6. The likelihood, extent and magnitude of prescribed impacts must then be assessed using the approach specified in the BAM Section 8.3. Those of relevance to this project are described in the sections below.

8.2 Habitat of threatened species

No areas of karst, caves, crevices or cliffs are present in the project site. Habitats associated with human-made structures and non-native vegetation are described in Table 8.1 and Table 8.2 respectively.

Table 8.1 Habitats associated with human made structures

Criteria	Discussion
a. Provide a description of the type of human-made structure habitat	– Culverts, which provide roosting habitat for microbats – Detention ponds and drains, which provide habitat for frogs
b. Prepare a list of threatened species that use these features as habitat	– Southern Myotis – Large Bentwing Bat – Green and Golden Bell Frog
c. Describe how each threatened species could, or does, use the human-made structure as habitat (based on published literature and other reliable sources)	**Microbats** Cave-dwelling microbats are known to utilise buildings, bridges and culverts for roosting. The Southern Myotis is known to roost and breed in the Holker Street culverts. The Large Bentwing Bat is also known to roost in the Sydney Olympic Park area, but would not breed in culverts or bridges, as this species requires specific large limestone caves for breeding. **Green and Golden Bell Frog** Breeding habitat has been previously found within decommissioned ‘tank farms’ on the Shell Clyde Refinery and within a detention pond on the adjacent CSR Emoleum site. CSR constructed a breeding pond as part of that site’s redevelopment and the Shell refinery premises also have detention structures and drainage features that may operate from time to time as breeding habitat (DECC 2008). An artificial pond is present in private property adjacent to Grande Parade. No evidence of the species was found in mangroves along the foreshore at Camellia during targeted surveys for this project, or at roadside drains, ponds or detention basins.

Table 8.2 Habitats associated with non-native vegetation

Criteria	Discussion
a. Provide a description of the type of non-native vegetation habitat	Non-native vegetation in the project site includes planted vegetation (mapped on Figure 5.1) and exotic grassland.
b. Prepare a list of threatened species that use these features as habitat	– Green and Golden Bell Frog – Grey-headed Flying-fox – Other species associated with adjacent vegetation
c. Describe how each threatened species could, or does, use the non-native vegetation as habitat (based on published literature and other reliable sources)	**Green and Golden Bell Frog** The Green and Golden Bell Frog was first confirmed within the area now known as Sydney Olympic Park in 1992. The long-term conservation program during and after development of the site for the Olympics resulted in conservation of the original population, and establishment of two new self-sustaining sub-populations on newly-built habitats on remediated lands (Kronos Hill/Wentworth Common, and Narawang Wetland). In addition, frog underpasses were constructed under roads to link habitat areas (Darcovich and O'Meara 2008). Ponds were created from redundant sediment control ponds as well as purpose-built ponds and planted with suitable macrophytes. Narawang Wetland contains 22 large clay-based habitat ponds, three irrigation storages and an ornamental lake, constructed on remediated land. These ponds were planted with native reeds, grasses, shrubs and trees. Ponds were connected by a water recirculation system so that individual ponds could be pumped out and dried, and the water recirculated to other ponds (Darcovich and O'Meara 2008). Large populations of the Green and Golden Bell Frog now breed in these constructed ponds, and habitats continue to be managed for this species (DECC 2008). The Biodiversity Management Plan for Sydney Olympic Park identifies 126 hectares of habitat of relevance to the Green and Golden Bell Frog at Sydney Olympic Park and Newington Nature Reserve. As well as breeding habitat at the Brickpit, Kronos Hill/ Wentworth Common, Narawang Wetland and Newington Nature Reserve Wetland, grassed areas and planted vegetation such as is present alongside Hill Road at Woo-la-ra and Silverwater Marker as potential habitat (SOPA 2019). These areas may provide foraging and shelter habitat, as well as movement habitat between breeding areas. **Grey-headed Flying-fox** The Grey-headed Flying-fox forages on a range of fruiting and flowering trees, including street trees. These trees would contribute to the foraging habitat available to individuals from local roost camps. The Grey-headed Flying-fox forages up to 50 kilometres in a night and planted trees in the study area would form a small proportion of the foraging habitat for the local populations. **Other species associated with adjacent vegetation** A range of threatened fauna species are known to occur in adjacent native vegetation. Mobile species including small woodland birds and microbats are likely to use non-native vegetation on occasion for foraging.

8.3 Habitat connectivity

Connectivity is provided in the locality by:

- vegetated riparian corridors (e.g. Parramatta River, Duck River, Haslams Creek, Powells Creek)
- vegetation within Newington Nature Reserve
- small, isolated patches of urban parkland.

In general, vegetation in the locality is highly fragmented by the existing network of infrastructure and residential and industrial development. There are few large tracts of native vegetation outside of the limited reserve network, and all areas are subject to ongoing disturbance from surrounding land uses and impacts associated with edge effects.

An assessment of connectivity values for key species is provided in Table 8.3. Existing connectivity is mapped on Figure 4.1.

Table 8.3 Connectivity values

Criteria	Discussion
Where corridors or other areas of connectivity link habitat for threatened entities, the assessor must: (a) prepare a list of threatened entities that are likely to use or are a part of the connectivity or corridor	– Green and Golden Bell Frog – Southern Myotis – Other species associated with adjacent vegetation – Coastal Saltmarsh – Freshwater Wetlands – Swamp Oak Floodplain Forest – Sydney Turpentine Ironbark Forest
(b) describe the importance of the connectivity to threatened entities, particularly for maintaining movement that is crucial to the species' life cycle (based on published literature and other reliable sources).	**Green and Golden Bell Frog** Movement habitat for the Green and Golden Bell Frog in the study area is generally typified by wet areas such as creek lines, drains, stormwater canals, connecting or partially connecting vegetation, easements, laneways and open areas that do not restrict movement (DECC 2008). The Green and Golden Bell Frog occurs in a number of areas at Homebush, including the Brickpit, Kronos Hill/Wentworth Common, and Narawang Wetland. Substantial areas of habitat for the species was created in the 1990s in these areas. Ponds are generally connected by planted vegetation or grassy areas. In some locations, frog underpasses were constructed under roads to link habitat areas (Darcovich and O'Meara 2008). One underpass is a culvert that connects constructed ponds on either side of Holker Busway. Connectivity between Haslams Creek and Narawang Wetland is via Nuwi Wetland at the Hill Road bridge, where a flood control weir constructed with gabion is located west of the existing Hill Road Bridge. This bridge is mapped by Sydney Olympic Park Authority as a frog underpass. Narawang Wetland is located above the weir, and while it is possible that frogs may traverse the weir and Nuwi Wetland via this 'underpass', Nuwi Wetland and Haslams Creek are not mapped as preferred Green and Golden Bell Frog habitat by SOPA (2019d), given the more saline nature of the habitats present. Capture-mark-recapture surveys are regularly conducted at Sydney Olympic Park. Recent surveys found no evidence of movement of frogs between precincts (for example between Narawang Wetland and Kronos Hill), but some frogs were found to have moved between ponds within precincts (such as within the Kronos Hill area). Notably, one individual was found to have moved 50 lineal metres, but also up a hill, so the length of movement may have been substantially greater (Tactecol 2021). It is noted that some precincts are separated by roads and large waterways, making movement between some precincts difficult. In particular, it is not known if the populations at the Brickpit and Kronos Hill/Wentworth Common are genetically linked to those at Narawang Wetland and Newington Nature Reserve given the size of the gap created by Haslams Creek (Darcovich and O'Meara 2008). A separate population is known from a wetland at Camellia. In this area, Green and Golden Bell Frogs have been recorded in the wetland near the confluence of Duck and Parramatta Rivers (Clyde Wetland) as well as associated with artificial habitat provided by industrial site features and structures such as safety bunds around storage tanks. Foraging habitat is present in the surrounds of the Clyde Wetland and in stormwater drainage swales and other grassy vegetation on various sites at Camellia (DECC 2008). These latter habitat features may comprise movement corridors for the species. No evidence of the species was found in mangroves along the foreshore at Camellia during targeted surveys for this project, or at roadside drains. **Southern Myotis** The Southern Myotis forages along waterbodies for fish and insects. A breeding colony is known from the Holker Street culverts (J. O'Meara, pers comm., via email), and populations are known to occur throughout the Parramatta River estuary (Gonsalves and Law 2017). Channels were thought to be used for commuting between areas of foraging habitat such as sheltered bays (Gonsalves and Law 2017), and potentially wetlands such as Narawang Wetland. These wetlands in the study area are likely to be important for movement between roosting sites and foraging habitat.

Criteria	Discussion
	Other species associated with adjacent vegetation A range of threatened fauna and flora species are known to occur in the study area. Native vegetation in the project site provides connectivity between other patches in the study area and beyond, allowing species (or pollinators) to move between different areas of habitat, including foraging and breeding habitat. **Coastal Saltmarsh** Coastal saltmarsh relies on specific patterns of tidal inundation and maintenance of saltwater influence to remain in a landscape. Within the locality, this vegetation occurs in a very specific landscape position on the land-ward side of mangrove stands. There are very few stands of Coastal Saltmarsh within the locality, and it is at risk of competition from mangrove migration as well as increasing rates of freshwater inundation. Maintenance of connectivity of vegetative cover (particularly mangroves) along the river edge is likely to be important to the ongoing persistence of this vegetation type within the locality, as it provides protection from strong tidal impacts, and enables ongoing survival of stands of saltmarsh. **Freshwater Wetlands** Wetlands within the study area have been created as habitat for threatened species. They have been constructed and vegetated during establishment of the Millennium Parklands, and are now maintained by Sydney Olympic Park Authority. There is limited connectivity between patches, given existing infrastructure within the study area, and limited opportunities for interaction with other areas of wetlands in the locality. Stands of planted native vegetation contribute to the overall connectivity between stands of freshwater wetlands, however water flows are likely to influence the continued persistence of this vegetation type, as the seeds of these species are likely carried by wind and water, rather than relying on pollination for recruitment. **Swamp Oak Floodplain Forest** Swamp Oak Floodplain Forest occurs in three different conditions within the study area: – planted along Hill Road – remnant vegetation in the northern portion of Newington Nature Reserve – poor condition vegetation on the landward side of mangroves along the Camellia foreshore. Naturally occurring stands of this community are likely to be influenced somewhat by slightly saline conditions, which encourage growth of Casuarina glauca, whereas the planted form of the community is comprised of both planted and juvenile self-recruiting individuals, with other species unlikely to be successful because of some allelopathy under the Casuarina glauca canopy. **Sydney Turpentine Ironbark Forest** Sydney Turpentine Ironbark Forest occurs in two different conditions within the study area; firstly as a remnant patch of vegetation within Newington Nature Reserve, that is largely isolated from other tracts of native forest (with the exclusion of mangrove and wetland vegetation) by existing infrastructure and historical clearing. This patch of bushland is managed by Sydney Olympic Park Authority through a program of bush regeneration to remove exotic species, and revegetation works as required to supplement existing soil seed banks. This patch is unlikely to rely on any connectivity with surrounding vegetation for its continued persistence. A second smaller patch occurs as a patch of revegetation on an artificial landform close to the residential areas of Wentworth Point, next to an electricity transmission tower. This patch is adjacent to areas of high disturbance that have been cleared for easement maintenance, and future development. This patch is not naturally occurring, and there would be no soil seed bank in the artificial soil profile on which it occurs. This patch is entirely reliant on revegetation works for its existence, and regular and ongoing maintenance is likely to be necessary for it to persist in the local area. This patch is unlikely to rely on any connectivity with surrounding vegetation for its continued persistence.

8.4 Water quality, water bodies and hydrological processes

An assessment of water bodies relevant to threatened species is provided in Table 8.4. Key wetlands are mapped on Figure 5.3.

Table 8.4 Habitats and species that depend on waterbodies

Criteria	Discussion
a. prepare a list of threatened entities that may use or depend on water bodies or hydrological processes for all or part of their life cycle or b. prepare a list of threatened entities that will be, or are likely to be impacted by changes to existing water bodies or hydrological processes or the construction of a new water body	– Green and Golden Bell Frog – White-bellied Sea-eagle – Southern Myotis – Australian Bittern and Australian Painted Snipe – Migratory waders – *Wilsonia backhousei* – Coastal Saltmarsh – Swamp Oak Floodplain Forest – Freshwater Wetlands – Sydney Turpentine Ironbark Forest
c. describe the habitat provided for each threatened entity by the water body or hydrological process, including consideration of water quality, volume, flow paths and seasonal patterns (based on published literature and other reliable sources)	**Green and Golden Bell Frog** Habitat for the Green and Golden Bell Frog is present at Narawang Wetland, Newington Nature Reserve Wetland, constructed ponds at Sydney Olympic Park and the Brickpit. The Narawang Wetland was constructed on remediated land north of Haslams Creek and was planted with native reeds, grasses, shrubs and trees. The constructed habitat simulates a freshwater wetland on coastal floodplain by receiving floodwaters from Haslams Creek and a floodway under Hill Road linked to the Nuwi Wetland. Stormwater also feeds into Narawang Wetland for water quality treatment, storage and subsequent irrigation re-use (SOPA 2010). Ponds are connected by a water recirculation system so that individual ponds can be pumped out and dried, and the water recirculated to other ponds (Darcovich and O'Meara 2008). The annual cyclic draining program ensures the control of *Gambusia holbrooki* (SOPA Policy 2019). Newington Nature Reserve Wetland is a highly modified estuarine wetland system within the nature reserve. The hydrology of the wetland is managed by constructed flushing channels, adjustable weirs, bunding, stormwater pipes and drains (SOPA 2002). A number of constructed ponds are also located in Sydney Olympic Park. These include repurposed sediment ponds and others that were purposefully created to provide habitat for the Green and Golden Bell Frog. These ponds were planted with macrophytes to provide frog habitat. Some habitat is also present for the Green and Golden Bell Frog at the Camellia. Clyde Wetland, located about 200 metres to the south of the project site is the key waterbody of value for this species. The species may also utilise drains, constructed ponds and detention basins in the area. The drainage line alongside Grand Avenue is ephemeral and would mainly have water present during and after rain. No evidence of the species was recorded in the project site at Camellia during targeted surveys. **White-bellied Sea-eagle** A breeding pair of the White-bellied Sea-eagle nest in Newington Nature Reserve, to the west of the project site. The White-bellied Sea-eagle forages in waterways in the area, including the Parramatta River, Haslams Creek, Newington Wetland and Narawang Wetland. This species is susceptible to changes in water quality, particularly any changes that affect its prey. Breeding success of these individuals has been affected on a number of years, potentially due to infertility of eggs as a result of elevated levels of persistent organic pollutants (Harrington et al 2013).

Criteria	Discussion
	Southern Myotis The Southern Myotis forages along waterbodies for fish and insects. A breeding colony is known from the Holker Street culverts (J. O'Meara pers. comm., via email), and populations are known to occur throughout the Parramatta River estuary (Gonsalves and Law 2017). Activity and feeding has been found to be variable across the Parramatta River estuary but tended to be low in tributaries and increased down the estuary towards the ocean, with a number of 'hot spots' identified in several bays. Channels were thought to be used for commuting between areas of foraging habitat such as sheltered bays (Gonsalves and Law 2017). Across the Port Jackson estuary, Southern Myotis activity and feeding was positively associated with mangrove and seagrass cover, and negatively associated with water extent. Harbour bays/coves can provide calmer water surfaces that are more suited to a trawling foraging strategy in which bats detect acoustic glints reflected by prey on water surfaces (Gonsalves and Law 2017). Other habitats may experience greater exposure to wind and provide turbulent water which is associated with reduced activity by trawling bats in upland river systems (Warren et al. 2000). Homebush Bay was not identified as a hotspot and it is likely that the species forages within Narawang Wetland and Newington Nature Reserve Wetland rather than the bay. There was a trend for greater Southern Myotis activity in sites with historically lower concentrations of zinc in surficial sediments of the Port Jackson estuary. This species occupies high trophic levels and is sensitive to accumulations of pesticides and water pollution, and can thus be considered bioindicators (Jones et al. 2009). **Australian Bittern and Australian Painted Snipe** The Australian Bittern and Australian Painted Snipe rely on shallow wetlands for foraging and breeding. Water quality is important for providing suitable foraging habitat. The constructed habitat at Narawang Wetland simulates a freshwater wetland on coastal floodplain by receiving floodwaters from Haslams Creek and a floodway under Hill Road linked to the Nuwi Wetland (SOPA 2010). Ponds are connected by a water recirculation system so that individual ponds can be pumped out and dried, and the water recirculated to other ponds (Darcovich and O'Meara 2008). Water level management ensures wet marshy foraging habitat is available for Latham's Snipe during the summer months (SOPA Policy 2019), and this may also benefit these species. **Migratory waders** Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The Parramatta River between Rydalmere and Abbotsford, Haslams Creek and Narawang Wetland are mapped as important habitat for the Bar-tailed Godwit and Curlew Sandpiper under the BAM. Key hydrodynamic processes in the Parramatta River estuary include ocean tides (tidal flushing), freshwater inflows, and wind and wave driven flows. Maintenance of tidal inundation is an important factor in the function of intertidal habitats and their associated flora and fauna, including prey species for these waders (see Technical Paper 10 (Hydrology, Flooding and Water Quality Assessment)). Water level management at Narawang Wetland ensures wet marshy foraging habitat is available for Latham's Snipe during the summer months (SOPA Policy 2019), and this may also benefit these species. ***Wilsonia backhousei*** Newington Nature Reserve Wetland, located adjacent to the project site at Wentworth Point, is known habitat for a population of *Wilsonia backhousei. Wilsonia backhousei*, like many saltmarsh plants, is limited in its distribution within a saltmarsh community by abiotic factors such as micro-topography (often occurring slightly higher in the landscape than some other species), inundation regime and salinity. This species is generally found on the edges of saltmarshes (DPIE 2021b). There has been a decline in the extent of the species within the 'Saltmarsh Nursery' portion of Newington Nature Reserve, suspected to be a result of an increase in tidal amplitude and competition from native and exotic species (Pacific Wetlands 2019). The species is also noted to be likely declining over the long term within Newington Nature Reserve as a result of alterations to the hydrology of the area in the late 1990s. Newington Nature Reserve Wetland is a highly modified estuarine wetland system within the nature reserve. The hydrology of the wetland is managed by constructed flushing channels, adjustable weirs, bunding, stormwater pipes and drains (SOPA 2002).

Criteria	Discussion
	Coastal Saltmarsh A number of small patches of Coastal Saltmarsh occur in the project site. Newington Nature Reserve contains a large area of this TEC in the area known as the 'Saltmarsh Nursery', in the northern portion of the Nature Reserve. Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. As noted above, the hydrology of Newington Nature Reserve Wetland is managed. Other small patches of saltmarsh in the study area would be subject to tidal influence from the Parramatta River. Saltmarsh is highly dependent on a specific regime of inundation and tidal influence, and changes to this regime, or an increase in inundation by fresh water, may pose a risk to this community. **Swamp Oak Floodplain Forest** Swamp Oak Floodplain Forest occurs in various locations in the study area. This community is found in close proximity to rivers and estuaries and is generally found on soils with a saline influence. The soils of the community may be quite wet and as such the composition of species at different sites will depend on the level of salinity and water-logging (DECC 2007). **Freshwater Wetlands** Freshwater Wetlands EEC occurs in coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years (DPIE 2021b). Narawang Wetland have been constructed and are managed to simulate a freshwater wetland. As noted above, water levels are managed, with some ponds being drained seasonally (Darcovich and O'Meara 2008). **Sydney Turpentine Ironbark Forest** Remnant Sydney Turpentine Ironbark Forest occurs in Newington Nature Reserve, and as a planted stand on an artificial landform in the Millennium Parklands. This community is an open-forest association occurring on moderately wet sites, with an annual rainfall of 800-1,100 millimetres per year, growing on clay soils derived from Wianamatta shale (DECC 2008). This community is not dependent on hydrological processes in surrounding rivers and creeks, but has the potential to be impacted if hydrological processes (e.g. flooding from Parramatta River) change as a result of the project.

8.5 Vehicle strike

Key species at risk of vehicle strike is provided in Table 8.5.

Table 8.5 Vehicle strike risk

Criteria	Discussion
a. identify potential impact locations on the Site Map, and	Construction of the project would increase the risk of vehicle strike through the movement of construction vehicles, particularly in areas where vehicles currently do not generally travel (i.e. parkland areas). Operation of the project has the potential to result in injury and mortality through light rail vehicle strike along the length of the light rail line.
b. prepare a list of threatened fauna or animals that are part of a TEC at risk of vehicle strike.	– Green and Golden Bell Frog – White-bellied Sea-eagle – Migratory waders

9. Impact assessment

9.1 Avoidance and minimisation of impacts

The approach to design development has included a focus on avoiding and/or minimising the potential for impacts during all key phases of the design process. An options assessment was carried out to decide on the final alignment. This considered constructability, construction costs, land purchase costs, biodiversity values and possible offset obligations. In some parts of the study area there were no feasible route alternatives. Refer to the EIS for more detailed information on options and design development.

Detailed environmental investigations have been conducted for the project. These investigations included an initial broader study area to identify key constraints early in the design process and assist with avoiding and minimising impacts where possible.

The project was purposefully modified to avoid impacts to biodiversity values in particular locations and especially threatened biota as follows:

- utilisation of existing road corridors and highly disturbed areas with no or limited native vegetation
- ensuring the preferred alignment did not encroach on the Newington Nature Reserve in order to avoid vegetation clearing and indirect impacts on the wetland.

Impacts on native vegetation and habitats have been minimised through the following:

- not progressing an alignment option that would have extended along the length of the Parramatta River foreshore at Camellia resulting in substantial impacts on mangroves and key fish habitat (see option 2 in Figure 9.1 and EIS Chapter 5 (Design development, alternatives and options)).
- developing bridge design principles requiring that the bridges be environmentally sensitive, and minimise the impact to the environment through the placement of bridge elements and consideration of construction impacts. The design requirements for this principle include:
  - minimise impacts to the sensitive ecological areas, particularly foreshore areas and mature trees impacted by the bridge locations and construction
  - consider ways the bridge design can enhance the ecology of the river, parks and residual land through rehabilitation and habitat creation
- the selection and use of construction methodologies that minimise impacts on contaminated soils, habitat for flora and fauna, and key fish habitat
- proposed balanced cantilever concrete box girder bridge options that have fewer piers impacting the Parramatta River when compared to other bridge types
- siting temporary compounds away from sensitive sites, e.g. to avoid impacts on wetland habitat, and to avoid impacts to constructed frog habitat near Holker Busway.

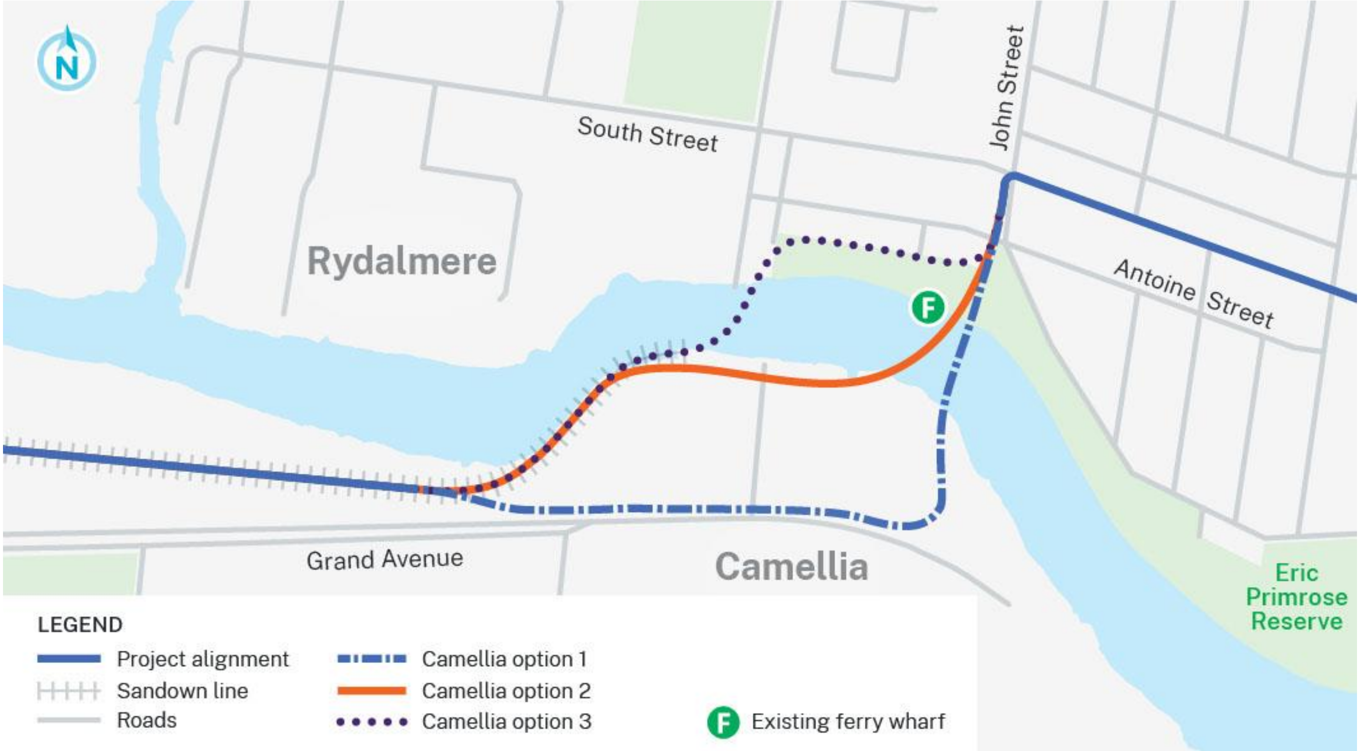

Figure 9.1 ***Bridge route options at Camellia***

Transport for NSW is proposing amendments to the two bridges over Parramatta River (see Table 1.1). The amended Camellia foreshore to Rydalmere bridge and alignment (see Figure 9.2) and amended bridge between Melrose and Wentworth Point (Figure 9.3) are proposed as they would provide better project outcomes across a range of aspects including biodiversity, and would reduce impacts to riparian vegetation compared to the bridges described in the EIS.

The Camellia foreshore to Rydalmere amendment would maintain a continuous corridor of mangrove vegetation along the southern foreshore, thereby avoiding connectivity impacts of the project on riparian vegetation in this area. There have also been reductions in impacts on mangroves due to the realignment of the bridge between Melrose Park and Wentworth Point. A summary of the changes from the exhibited project to the amended project with respect to biodiversity impacts is provided in section 9.2.

With respect to biodiversity, the duplication of the Hill Road Bridge was assessed in the EIS and Technical Paper 9 (Biodiversity Development Assessment Report) however Transport for NSW is proposing to instead remove the existing Hill Road bridge and construct a new bridge over Hill Road which widens the project site further east than that proposed in the EIS, to minimise direct biodiversity impacts to the Narawang Wetland (see Figure 9.4).

The amended project site at this location is predominantly located in the road reserve of Hill Road near Narawang Wetland and Holker Busway, limiting direct impacts on Green and Golden Bell Frog habitat. The amended alignment and bridge would also avoid direct impacts to existing ponds that are an important habitat for the Green and Golden Bell Frog, Latham's Snipe and other local fauna. The project site boundary has been revised, reducing the area on the western side of Hill Road (Narawang Wetland) with a small increase on the eastern side (Nuwi Wetland) to accommodate the new bridge arrangement. The eastern side of Hill Road is not mapped as preferred Green and Golden Bell Frog habitat by Sydney Olympic Park Authority (2019d).

Mitigation measures are Transport's ongoing commitments to further avoid, minimise and offset impacts and are detailed in section 10. Key mitigation measures include:

- design of appropriate stormwater controls to prevent contaminants entering adjacent waterways and wetlands during operation
- management of contaminated soils and the risk of generation of acid sulfate soils during construction, to prevent indirect impacts on adjacent waterways and wetlands
- demarcation of clearing extents to prevent accidental clearing in sensitive areas

- management of fauna and habitat features during clearing, with particular attention to the protection of Green and Golden Bell Frog and migratory wader habitat outside the project site
- protocols would be developed in conjunction with Sydney Olympic Park Authority ecologists for hygiene and biosecurity during minor works and construction phases, particularly in sensitive areas within Sydney Olympic Park
- pre-clearing surveys during minor works and construction phases
- a Green and Golden Bell Frog management plan will be prepared as part of the biodiversity management plan by a qualified herpetologist, in consultation with Sydney Olympic Park Authority ecologists
- preparation of a microbat management plan, which would include construction methodologies including timing of construction works to minimise impacts on threatened microbats at roosting at Holker Street or other culverts, and installation of nest boxes or inclusion of bat-friendly roosts in the design of bridge structures to mitigate the loss of hollows as a result of mangrove clearing
- investigate the minimisation of overhead wiring adjacent to Newington Nature Reserve, along Holker Busway and Hill Road to limit impacts on the Grey-headed Flying-fox and other fauna. Where overhead wiring is required adjacent to the Newington Nature Reserve other measures to minimise impacts to fauna should be implemented
- bridge design to further minimise impacts to fish habitat and mangroves
- consideration of maintenance of connectivity for Green and Golden Frog habitat, with replacement frog underpasses and other measures, to be designed based on advice from Sydney Olympic Park Authority ecologists.

9.2 Summary of changes between the exhibited project and the amended project

As discussed above, there have been a number of changes from the exhibited project to the amended project, and this updated BDAR has been updated to assess the potential impacts of the project's construction and operation including the proposed amendments. The amendments comprise changes to the project site and bridge locations as a result of:

- realignment of the project along the Camellia foreshore and realignment of the bridge between Camellia and Ermington (Figure 9.2)
- realignment of the bridge between Melrose Park and Wentworth Point (Figure 9.3)
- changes to the design of the Hill Road bridge and refinement of the alignment along Hill Road (Figure 9.4)
- a slight increase in the project site at Holker Street.

A comparison of clearing areas provided in Technical Paper 9 (Biodiversity Development Assessment Report) and the updated BDAR (this report) are provided in Table 9.1 and Table 9.2.

Key changes include:

- The area of impact on native vegetation has reduced from 2.55 hectares in the exhibited project, to 2.43 hectares, as a result of changes to the project site.
- Changes to bridge locations have resulted in reductions in clearing of Estuarine Mangrove Forest (PCT 920) from 0.91 hectares to 0.72 hectares, and clearing of Saltmarsh (PCT 1126) from 0.05 to 0.03 hectares.
- Impacts on *Phragmites australis* and *Typha orientalis* coast freshwater wetland (PCT 1071) at Narawang Wetland have reduced from 0.07 hectares to less than 0.01 hectares as a result of the proposed Hill Road bridge amendment.
- There would be some additional impacts on Estuarine Swamp Oak forest (PCT 1234) at Camellia due to the amended alignment along the foreshore, and at Holker Street (with a total increase from 0.47 hectares to 0.62 hectares).
- Impacts on planted vegetation have also reduced, from 5.79 hectares to 5.51 hectares.
- Direct impacts on important habitat for migratory waders have reduced from 0.58 hectares to 0.35 hectares.
- Direct impacts on habitat for the Southern Myotis have reduced from 2.27 hectares to 2.19 hectares.

- There has been an increase in the total area of impact on the Green and Golden Bell Frog species polygon. Reductions in direct impacts on mangrove and freshwater wetland habitat have been countered by increases in impacts on planted Swamp Oak forest.
- Indirect impacts on native vegetation and threatened species habitat from shading from bridges have reduced due to changes in the bridge locations.

The updated BDAR has used V1.2 BAM calculator benchmarks for credit calculations.

Legend

- Amended project site
- EIS project site
- EPBC_locations

Paper Size ISO A4

0 50 100

Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

EIS project site VS amended project site at Camellia and Rydalmere

Project No. **12557728**
Revision No. **-**
Date **02/05/2023**

FIGURE 9.2

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Print date: 02 May 2023 - 17:58

Data source: Metromap Tile Service: Extracted: 02/05/2023. Created by: lmanasan

Legend

Amended project site

EIS project site

EPBC_locations

Paper Size ISO A4

0 50 100

Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

EIS project site VS amended project site at Melrose Park and Wenthworth Point

Project No. **12557728**
Revision No. **-**
Date **02/05/2023**

FIGURE 9.3

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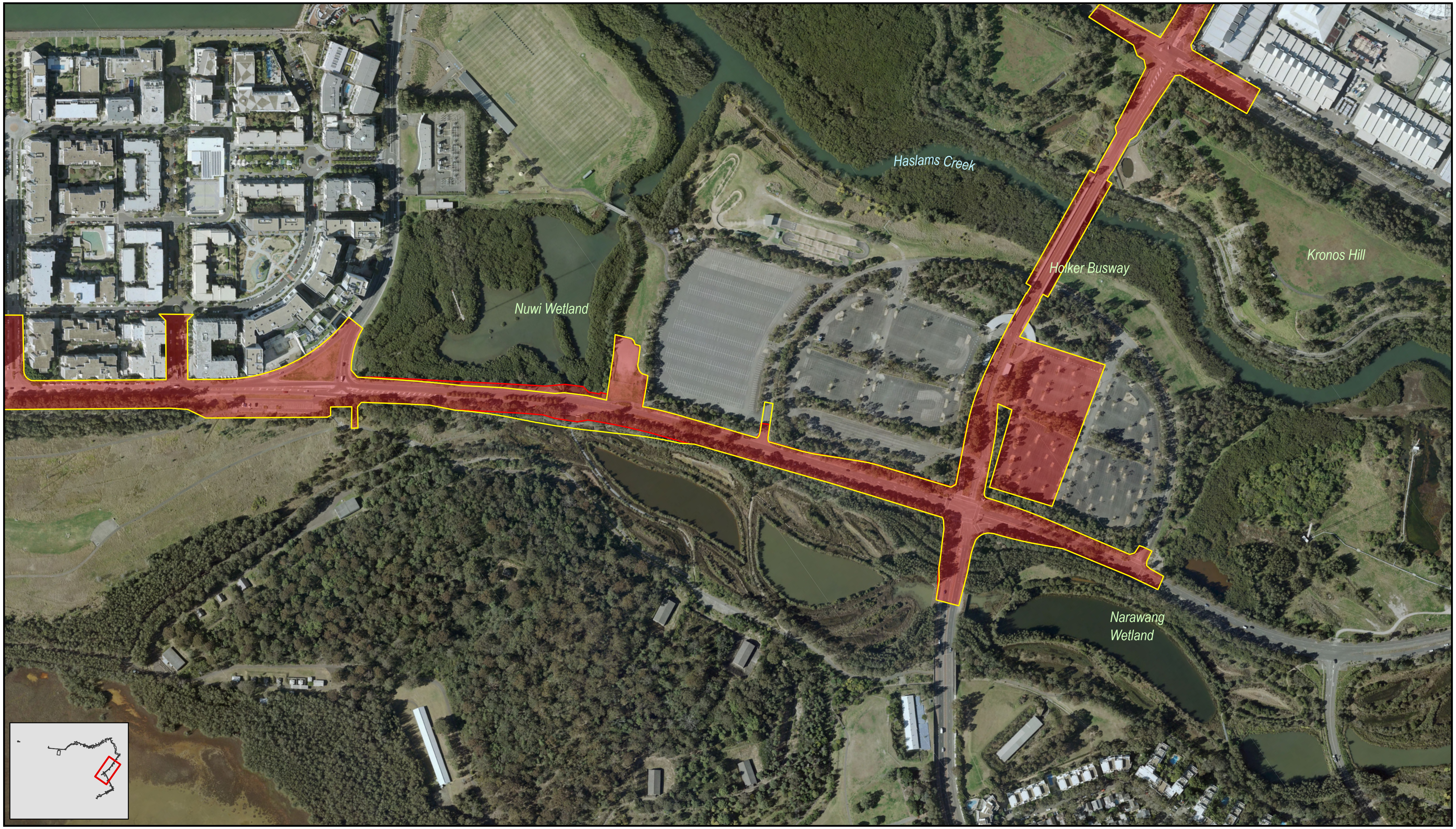
Print date: 02 May 2023 - 17:59

Data source: Metromap Tile Service: Extracted: 02/05/2023. Created by: lmanasan



Legend
Amended project site
EIS project site
EPBC_locations

Paper Size ISO A4
0 50 100
Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

EIS project site VS amended project site at Hill Road, Sydney Olympic Park

Project No. **12557728**
Revision No. **-**
Date **02/05/2023**

FIGURE 9.4

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Print date: 02 May 2023 - 17:59

Data source: Metromap Tile Service: Extracted: 02/05/2023. Created by: lmanasan

9.3 Direct impacts

9.3.1 Removal or modification of vegetation

Land clearance is listed as a Key Threatening Process (KTP) under the BC Act and EPBC Act. Land clearance consists of the destruction of the above ground biomass of native vegetation and its substantial replacement by non-local species or by human artefacts. Construction of the project would require the removal of 2.43 hectares of native vegetation (Table 9.1), which would constitute an increase in the operation of this KTP in the locality. The removal of native vegetation for construction of the project would predominantly be permanent and irreversible. For the purposes of the BDAR and calculation of credits, it is assumed that all vegetation within the project site would be permanently removed. Disturbed areas of the project site not required for operation of the project or future uses will be rehabilitated (see section 10.2). A comparison of clearing areas provided in Technical Paper 9 (Biodiversity Development Assessment Report) and the updated areas for the amended project provided in this report are provided in Table 9.1.

The project site contains a mixture of native estuarine forest, alluvial forest, and saline wetlands associated with the foreshores of the Parramatta River and Haslams Creek. These areas provide habitat for a range of threatened flora and fauna species, and migratory fauna. The total area of native vegetation removal is spread along a 10 kilometre linear alignment and would remove a small proportion of individuals and plant species in any given patch of vegetation.

The project site also contains disturbed land with landscaped trees along more highly modified areas. These areas contain little native vegetation cover and have limited habitat value for native plants. Vegetation clearing required in these areas would remove non-threatened native plants from locally occurring communities and introduced plant species including priority and high threat weeds. This reduction in the extent of native vegetation is less significant at the regional scale and is unlikely to threaten the persistence of any populations of native plants and vegetation communities. It is unlikely that an ecologically significant proportion of any regional plant populations would be located entirely within the project site.

Table 9.1 Direct impacts on native vegetation

Vegetation zone	Threatened ecological community	Area in project site (exhibited) (hectares)	Area in project site (amended) (hectares)
PCT 920 Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Not listed Protected marine vegetation (FM Act)	0.91	0.72
PCT 1126 Saltmarsh in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions (EEC, BC Act; VEC, EPBC Act) Protected marine vegetation (FM Act)	0.05	0.03
PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion (poor)	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (EEC, BC Act)	0.20	0.33
PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion (moderate)	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (EEC, BC Act)	0.01	0.01
PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion (planted)	Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (EEC, BC Act)	0.26	0.28

Vegetation zone	Threatened ecological community	Area in project site (exhibited) (hectares)	Area in project site (amended) (hectares)
PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (moderate)	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC, BC Act)	0.07	0.01
PCT 1281 Sydney Turpentine-Ironbark Forest (planted)	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion (CEEC, BC Act)	1.05	1.05
Total native vegetation		**2.55**	**2.43**
Non-native vegetation (planted vegetation)		5.79	5.51
Water		2.59	3.68
Cleared land and infrastructure		56.14	50.95
Total project site		**67.07**	**62.57**

9.3.2 Removal of habitat and habitat resources

The project would remove up to 2.43 hectares of native vegetation from within the project site. Additional areas of grassland and planted trees would also be impacted.

The 0.62 hectares of Swamp Oak Forest, 1.05 hectares of planted Sydney Turpentine – Ironbark Forest and 5.51 hectares of planted vegetation in the study area include habitat features of relevance for native fauna species, including fallen timber, accumulations of leaf litter, and patches of dense shrubs. Fauna habitat resources that would be removed include foraging and shelter resources that would mainly be utilised by common native fauna typical of urban environments. The project would remove forage trees for the Grey-headed Flying-fox and foraging habitat for threatened microbats. The total area of habitat removal is spread along a 10 kilometre linear alignment and would remove a small proportion of the resources available in any given patch of habitat. It is likely that not all vegetation at Ken Newman Park would be removed, and the total area of planted native vegetation removal is an overestimate.

The project would remove around 20 hollow-bearing trees from planted vegetation. These are detailed in the Amendment Report. Given the nature of planted vegetation, most hollows are small, with some medium sized hollows to be lost. Many small hollows are present in mangroves. Based on plot data, which found an average of six hollow-bearing mangroves per plot, around 40 mangroves with small hollows suitable for microbats or exotic species such as rats may be removed. No hollow-bearing trees or stags with large hollows suitable for owls or cockatoos would be removed from the project site. Many alternative hollows are present in mangroves in adjacent areas, including along the Parramatta River, Haslams Creek and the Badu Mangroves. Large hollow-bearing trees suitable for birds and possums that are present within Newington Nature Reserve would not be affected. The project would remove nests of common bird species, including a raven nest located on a transmission tower at Melrose Park. While Eastern Ospreys (*Pandion cristatus*) have been observed in the area, no nests are present. The project would not directly impact the White-bellied Sea-eagle nest in Newington Nature Reserve.

The project would remove areas of mangroves and saltmarsh which provide foraging and shelter habitat for shorebirds and wetland birds, and foraging and breeding habitat microbats, frogs, and reptiles.

Mitigation measures are proposed in section 10.2 to minimise the impact on fauna as a result of clearing and loss or disturbance of habitat. A habitat restoration and revegetation plan will guide rehabilitation planning, implementation, monitoring and maintenance of disturbed areas including local, native plantings in conjunction with other landscape treatments to minimise impacts to local ecosystems.

A summary of impacts on fauna habitat types, including a comparison between the impacts presented in Technical Paper 9 (Biodiversity Development Assessment Report) for the exhibited project and the impacts presented in this report for the amended project, is provided in Table 9.2.

Table 9.2 Direct impacts on fauna habitats

Habitat type	Area in project site (exhibited) (hectares)	Area in project site (amended) (hectares)
Mangroves	0.91	0.72
Saltmarsh	0.05	0.03
Freshwater wetland	0.07	0.01
Swamp Oak Forest	0.47	0.62
Sydney Turpentine-Ironbark Forest	1.05	1.05
Planted vegetation	5.79	5.51

9.3.3 Fauna injury and mortality

Construction works have the potential to result in the injury or mortality of some individuals of less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the site during clearing activities and unable to move out of the area. This could include roosting microbats, nestlings, small lizards and frogs. Fauna management measures will be implemented during construction in order to minimise the risk of injury to resident fauna (see Table 10.1). More mobile native fauna such as native birds, bats, terrestrial and arboreal mammals that may be sheltering in vegetation within the project site are likely to evade injury during works as they are likely to move away into adjoining areas.

9.3.4 Fragmentation or isolation of habitat

Much of the project is located along existing roads, and there would be limited impacts on connectivity. Construction of the bridges across the Parramatta River would reduce riparian connectivity through the removal of mangroves. Most fauna that occurs in the study area are highly mobile, and the project is unlikely to isolate areas of habitat. It is unlikely that the project would create barriers to the movement of pollinator and seed dispersal vectors, such as insects and birds. Construction of the bridges may temporarily prevent the movement of terrestrial fauna along riverbanks, although limited movement habitat is present in some locations, such as the Camellia foreshore, which is a constructed rock wall. Realignment of the bridge at this location as part of the proposed amendments has reduced impacts on connectivity, with no fragmentation of mangrove habitat occurring at Camellia. Similarly, realignment of the bridge at Melrose Park has reduced impacts on mangrove habitat at that location. Disturbed areas not required for operation of the project would be rehabilitated where possible. Some revegetation of mangroves is also possible, for example at Melrose Park, however rehabilitation along the rock wall at Camellia is unlikely due to contamination issues.

Construction would temporarily impact some Green and Golden Bell Frog underpasses, specifically the underpass between Kronos Hill and Wentworth Common at Holker Busway, and the culvert between Narawang Wetland and Nuwi Wetland. Works may impact movement of frogs during construction due to noise, vibration and lighting; however, no underpasses would be removed, and no physical blockage of underpasses would occur. Permanent impacts on the population are unlikely as these underpasses would be retained for operation. Connectivity would continue to exist adjacent to the project site throughout the Narawang Wetland and Newington Nature Reserve, and between Kronos Hill, Wentworth Common and the Brickpit areas, although these areas may also be affected to some degree by noise and lighting during construction.

Further discussion of impacts on connectivity are provided in section 9.7.

9.3.5 Aquatic habitats

Two new bridges across the Parramatta River would be constructed: one between Camellia and Rydalmere, and the second between Wentworth Point and Melrose Park. Bridge piers would be designed and orientated to avoid the formation of large-scale turbulence or the erosion of the bed and banks of the waterway (NSW Fisheries 2003).

A temporary work platform is proposed from both the north bank and south bank for both bridges to minimise impacts on mangroves and key fish habitat. This would enable the pier and the pile cap to be formed and poured. Construction of box girder unit zero would also be supported from this temporary work platform in some instances. Bridge abutments and piles for the northern and southern bridge abutments would be constructed from dry land. Any excavated contaminated materials would be removed from the banks of the Parramatta River. Silt curtains and coffer dams would be used to limit the potential for movement of sediments as a result of construction. Bridge construction methodologies would continue to be refined throughout the design process. These design changes would continue to focus on methodologies that minimise impacts on contaminated soils, habitat for flora and fauna, and key fish habitat.

Works in the Parramatta River would impact Key Fish Habitat. Construction of watercourse crossings also has the potential to create instream barriers, impact mangroves, increase erosion and interfere with natural flow regimes. Removal of mangroves may lead to localised foreshore erosion and riverbank destabilisation. Following the completion of the construction works, it is likely that the mangroves will regenerate in some disturbed areas. Disturbed areas not required for operation of the project would be rehabilitated in accordance with the habitat restoration and revegetation plan (see section 10.2). Further rehabilitation in the wider area will be undertaken as part of the offsets for impacts on marine vegetation (see section 11.2).

9.3.6 Groundwater-dependent ecosystems

The potential impacts on GDEs located in close proximity to the project footprint are discussed in Table 9.3 as summarised from Technical Paper 10 (Hydrology, Flooding and Water Quality Assessment). Potential impacts are generally minor and mitigation measures would be implemented to prevent indirect impacts.

Table 9.3 Impacts on GDEs

Proximity risk zone	Location	Description
1	Mangroves at Melrose Park	Natural groundwater and surface water drainage would be downslope through the project towards the GDE. The project would be elevated above the water table and have no impacts on groundwater flow directions. Design and mitigation measures would prevent contaminants entering the GDE.
2	Sydney Turpentine Ironbark Forest and mangroves near Hill Road	This area overlies acid sulfate soils, the underlying groundwater contamination risks are moderate and salinity hazards are very high. Design and mitigation measures would prevent contaminants entering the GDE. Further measures would be introduced to minimise any impacts on risks associated with the acid sulfate soils.
3	Mangroves at Haslams Creek/ Holker Busway	Construction at this location is generally within the road corridor. Contamination risks due accidental spillages and similarly the generation of sediments would be minimised to protect the water quality in the creek and minimise potential impacts on aquatic ecosystems and riverine vegetation. The Acid Sulfate Soil Management Plan would be implemented.
4	Mangroves at Haslams Creek/ Hill Road	The project is unlikely to impact groundwater levels but impacts on water quality (surface and groundwater) due to accidental contaminant spillages or acid sulfate soils would be mitigated through management measures.

9.4 Indirect impacts

Potential indirect impacts resulting from construction of the project are discussed in Table 9.4.

Table 9.4 Indirect impacts

Impact	Description
Edge effects	'Edge effects' can include increased noise and light or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Edge effects would result from construction activities and then continue to affect vegetation and habitats adjoining the development area. Altered environmental conditions along new edges can allow invasion by pest animals specialising in edge habitats and/or change the behaviour of resident animals. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators. Vegetation within and adjoining the project site varies in condition. Weeds are prevalent around existing disturbed edges and in cleared areas. There are exotic species present throughout the project site, including Blackberry, Lantana and African Olive among others. There is a moderate to high risk of construction activities spreading new weeds into adjoining vegetation. Management measures including the development of a flora and fauna management sub-plan as part of the project CEMP would be implemented to mitigate these potential impacts (refer to section 10.2). Other relevant mitigation measures to reduce the impacts of edge effects include lighting design to minimise light spill, dust suppression, and erosion and sediment measures during construction.
Introduction and spread of weeds, pests and pathogens	Disturbance associated with vegetation clearing and vehicle traffic during construction increases the potential for the spread, introduction and establishment of weed and pest species, and diseases and pathogens. Weed species are effective competitors for food and habitat resources and have the potential to exclude native species and modify the composition and structure of vegetation communities and can decrease habitat values for native fauna. Construction activities within the project site may, in general, have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into adjacent native vegetation through vegetation disturbance and increased visitation. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus may harm frog populations once introduced into an area and is a key concern for the Green and Golden Bell Frog population known to occur at Sydney Olympic Park. Diseases and pathogens can be introduced or spread to site via dirt or organic material attached to machinery, vehicles, equipment and employees. The potential for significant or new impacts associated with these pathogens is relatively low, given the existing development presence and extent of human visitation across the project site and surrounding study area. To help mitigate the risk of pathogens being brought onto and/or spread through the site all machinery brought to site will be washed down and inspected to be free of soils, seeds and other organic material in accordance with section 10.2.
Noise and light impacts on fauna	Noise levels during the construction period would result in an increase above existing background levels for the duration of construction. Noise levels would vary during the construction period, with some activities being louder and producing higher levels of vibration than others. Noise, vibration, and light have been shown to have a variety of impacts on fauna, including changing foraging behaviour, impacting breeding success and changing species occurrences. The following construction activities are predicted to result in highest level of impacts at sensitive receivers with regards to extent and duration (majority of the construction period): – mainline trackworks from Camellia to Carter Street – highly noise-affected receivers are expected during noise intensive works (e.g. concrete breaking) – bridge works – highly-noise affected receivers are expected during noise intensive works (e.g. impact piling) – roadworks – highly noise-affected receivers are expected during noise intensive works (e.g. asphalt milling). The following construction activities are predicted to result in 'moderate' and 'high' impacts at sensitive receivers, although noise intensive activities would be relatively short-term: – demolition works – highly noise affected receivers are expected during noise intensive works (e.g. use of a concrete breaker)

Impact	Description
	– compound sites – for the majority of the time, noise at compound sites would be minimal except during deliveries to and from the site. Highly noise affected receivers are expected during noise intensive works (e.g. use of a concrete saw) – construction of stops – highly noise affected receivers are expected during noise intensive works (e.g. use of a concrete breaker). Fauna most at risk would be those residing near the works area, and in particular any species that may be nesting, roosting or denning adjacent to moderate and high impact activities. Some fauna may vacate areas in proximity to the project site during construction. Hollow-bearing trees in adjacent areas may provide nesting habitat for species, including a variety of threatened microbat species. The Holker Street culverts are known to support roosting and breeding Southern Myotis. White-bellied Sea-eagles are known to nest in Newington Nature Reserve. Disturbance has the potential to interrupt breeding activities for some individuals. Demolition or roadworks have the potential to impact the Southern Myotis. This species can be sensitive to noise, particularly during the breeding season or if in torpor (a type of hibernation). This species is currently known to roost in culverts and bridges in the Sydney Olympic Park area and would be subject to background noise from vehicles, but construction would increase noise and vibration levels beyond background levels. Mitigation measures are proposed to minimise high impact activities during the breeding season. The White-bellied Sea-eagle nest is located over 300 metres from the project site. This is outside the buffer distance recommended in the TBDC for this species (250 metres in urban areas). The aim of this buffer is to minimise disturbance impacts on this species' breeding. Given the many developments that have been constructed in recent years and continued breeding by the resident sea-eagles, and distance from the project site, it is unlikely that construction for the project would affect breeding of this pair. Monitoring is proposed to assess whether any activities during the breeding season are affecting this species. Noise and vibration have the potential to impact calling of the Green and Golden Bell Frog, which may then affect breeding success. Construction work hours would generally be between 7am-7pm, although there is potential for night work. Construction of the bridge over Hill Road may take around 18 months, which could affect one or two breeding periods, if works occur during the calling period. There is evidence that noise can induce a physiological stress response in frogs and impair mate attraction in the natural environment (Tennessen et al 2014), and that anthropogenic noise may negatively affect calling males by shifting the timing of sexual signalling, while artificial noise and light may increase calling intensity (Cronin et al 2022). The Green and Golden Bell Frog may live over 10 years in captivity, however its life span in the wild is not certain. Noise and light during construction has the potential to impact some individual's entire adulthood, while for others it may affect part of the lifecycle. Ongoing noise and light during operation may further exacerbate these impacts. Other more resilient fauna species are likely to become accustomed to noise and light, and this increased or novel impact is unlikely to result in a decrease in population numbers or diversity of these species. Given the temporary nature of the works, and the availability of alternate habitat in surrounding areas, it is unlikely the temporary increase in noise during construction of the project would significantly impact on fauna that occur in the project site. Mitigation measures relating to noise and light are detailed in section 10.2.
Aquatic disturbance	Construction of the project has the potential to result in sedimentation and erosion within the construction sites and adjoining native vegetation and aquatic habitats, through soil excavation, stockpiling and transport. Discharge of sediment laden runoff to waterways can alter water quality and adversely affect aquatic life. Construction of the project has the potential to result in the mobilisation of contaminated sediments into waterways, or chemical spills from vehicles or plant. The introduction of pollutants from the project into the surrounding environment, if uncontrolled, could potentially impact on water quality further downstream. Concreting activities could result in the discharge of concrete dust, concrete slurries or washout water to downstream waterways. This could potentially increase the pH of downstream waterbodies which can be harmful to aquatic life. Concrete solids contained in the discharge also have the potential to cause increased turbidity. Habitats of particular concern include key fish habitat associated with the Parramatta River and Haslams Creek, and wetland areas that support threatened and migratory biota.

Impact	Description
	Erosion and sediment control would focus on areas of surface disturbance, particularly near waterways including Sydney Olympic Park precinct construction site and bridge and water crossing construction sites. These impacts would be appropriately managed through the implementation of standard mitigation measures including progressive erosion and sediment controls, and on-site management protocols within the Transport for NSW *Water Discharge and Reuse Guideline*. These controls would be used to manage and minimise residual risks of impacts to water quality (see Technical Paper 10 (Hydrology, Flooding and Water Quality Assessment)).
Dust	Construction of the project could result in the generation of dust. High dust levels could reduce habitat quality for flora and fauna species by reducing plant and animal health in adjacent areas of vegetation. Dust may affect photosynthesis, respiration and transpiration in plants and allow the penetration of gaseous pollutants. This then leads to decreased productivity, and in the long-term can alter community structure (Farmer 1993). Dust could also impact the health of fauna, such as through respiratory disease, and the reduction in health of animals would be exacerbated by changes to plant health and community structure. Mitigation measures would reduce the risk of residual impacts.
Fire	Construction of the project presents a potential risk of fire, for example from storage of combustible fuels or ignition from works areas. Small fires can spread very quickly in unfavourable conditions to become large wildfires. In drought conditions, this risk would be increased due to the dry nature of the vegetation. Much of Australia's biodiversity is adapted to and relies upon bushfire as a natural ecosystem process. However, fires can lead to mortality of fauna, and destruction of habitat resources, especially if too regular or intense. Bushfires of high to extreme intensity can result in significant modification of vegetation structure and composition such that the original vegetation type and condition is no longer identifiable. Given the location of the project in a predominantly urban and industrialised area, the risk of accidental fire is low, although impacts of fire on vegetation in Newington Nature Reserve and areas of grasslands in the Millennium Parklands could be considerable if one was to occur. The risk of fires spreading to adjacent areas would be minimised through the implementation an incident and emergency response plan and would include measures to contain and control the outbreak of fire.

9.5 Operational impacts

Operational impacts resulting from the project are discussed in Table 9.5.

Table 9.5 Operational impacts

Impact	Description
Aquatic impacts	Following construction, the temporary work platforms and barges would be removed from site. The bridge piles, pile caps, piers, beams and decking will remain in place during the operational life of the project. During operation, it is likely that the bridge pier piles and the pile caps will lead to very localised scour with no wider impacts. Channel migration may change the position of the low flow path and localised changes to the bed and instream habitat may occur (see the Supplementary Flooding Report). Increases in impervious surfaces could result in the build-up of contaminants in dry weather, which during rainfall events, could be transported to surrounding watercourses by stormwater and wastewater. Trapping suspended solids is the primary focus of the water quality management strategy for the operational phase of the project. Proposed controls included Gross Pollutant Traps in conjunction with tertiary cartridge filtration devices, a water quality basin, dry bio-filtration basins and swales (see the Supplementary Flooding Report). Water sensitive urban design is a key component of the Parramatta River Masterplan (PRCG 2022). During operation increased impervious areas causing an increase in surface runoff volumes and peak flows may result in increased flood levels. The two new bridges would cause small increases in flood levels at properties which are already impacted by flooding, including foreshore properties on the Parramatta River near the bridge at Wentworth Point and immediately to the west of the bridge between Camellia and Rydalmere. The presence of piles, pile caps and piers in the Parramatta River floodplain reduce the efficiency of the floodplain in conveying flood water downstream. This results in slightly higher flood levels on the upstream side of the bridge structures. The current flood regime results in flood levels of between 0.5-1 metre increase in water levels in Newington Nature Reserve Wetland in the one per cent AEP flood event. The increase in flood levels as a result of the project is limited to an additional 10-20 millimetre above the current levels in a one per cent AEP event, and 10-50 millimetres in a five per cent AEP flood event. The floods are

Impact	Description
	the result of stormwater entering the system from further up the catchment and would be less saline than usual tidal flows into the wetland (see the Supplementary Flooding Report). This may have some effect in the long-term on saltmarsh and mangrove extent and floristic composition, particularly in combination with impacts from climate change, due to the increase in freshwater occurring in the wetland. Although these impacts are relatively minor, over time, these impacts may result in changes to the composition of the saltmarsh in the northern portion of Newington Nature Reserve and may lead to further reductions in the extent of *Wilsonia backhousei*, which is noted by Pacific Wetlands (2019) to be undergoing declines as a result of increasing freshwater influence. Changes from flooding may also affect breeding habitat for the Green and Golden Bell Frog, and foraging habitat for migratory waders. Given the large areas of suitable habitat in the area, and the small predicted increase in flooding, this is unlikely to be a substantial impact on these species. A flood management strategy would be prepared to build on the flood assessment in the Supplementary Flooding Report and inform design development by minimising flooding impacts to flood sensitive areas and infrastructure within Sydney Olympic Park, including the Narawang Wetland, the Brick Pit and the existing leachate management system This would help to limit the potential for movement of *Gambusia holbrooki* into breeding ponds where it does not currently occur. Operation of the project is expected to have minimal impact on coastal processes with minimal impact to the overall current and wave conditions within the Parramatta River estuary. Riparian and mudflat habitat outside the project site is unlikely to be affected by changes to currents or wave conditions. There is potential for scour around the two proposed bridge piers caused from localised changes in flow currents and turbulence around this section of the river. Change in river flow velocities as a result of the structure are considered minor and localised, with detailed erosion protection measures to be incorporated into the project design, where required. Scour due to the proposed bridges is expected to be localised in nature and confined to areas in the direct vicinity of the flood flow-exposed piers (see Chapter 18 (Soils and contamination) of the EIS). The abutments of the two proposed bridges would encroach in the main channel system of the river but the tidal waterway blockage caused by the new bridges would be small in comparison to the unrestricted waterway area, and would not block fish passage.
Shading	The proposed new bridges over the Parramatta River would result in the creation of shade in areas adjacent to the project site that are not currently subject to shade. Chronic shading may have a greater impact on overall structure and function of mangroves and saltmarsh than the initial construction of the bridges, as shading by structures may adversely affect vegetation and overall net primary production (Struck et al 2004). Modelling of the predicted shade impacts as a result of the proposed bridges has been completed and is discussed in greater detail in section 11.1.3. In summary, the project is likely to result in shading impacts to: – 0.73 hectares of PCT 920 Mangrove Forests in estuaries – 0.03 hectares of PCT 1126 Saltmarsh in estuaries – 0.15 hectares of PCT 1234 Swamp Oak swamp forest fringing estuaries. This native vegetation that would be subject to shade impacts also comprises: – 0.03 hectares of habitat for *Wilsonia backhousei* (assuming impacts to Saltmarsh vegetation only) – 0.14 hectares of habitat for the Green and Golden Bell Frog – 0.91 hectares of habitat for the Southern Myotis – 0.56 hectares of habitat for the Curlew Sandpiper and Bar-tailed Godwit. A conservative approach has been taken, and it is assumed that any areas of vegetation that receive more shading once the bridges are built than they do now, are likely to die off or undergo substantial floristic or structural changes, rendering them in a poorer ecological state than they are now. This is discussed further in section 11.1.3.
Vehicle strike	Operation of the project has the potential to result in injury and mortality through light rail vehicle strike along the length of the light rail line. Vehicle strike is discussed further in section 9.7.

Impact	Description
Noise and lighting	Artificial light at night provides for human safety, amenity and increased productivity, but can disrupt critical behaviour and cause physiological changes in wildlife. Lights can disorient flying birds, particularly during migration, and cause them to divert from efficient migratory routes or collide with infrastructure (DEE 2020). Studies in Australia have suggested that urbanisation and human-induced disturbances have major implications for bat species richness, and artificial lighting has been shown to reduce bat activity (Linley 2016). Noise and vibration has the potential to impact calling of the Green and Golden Bell Frog, which may then affect breeding success (Tennessen et al 2014;Cronin et al 2022). While fauna in the area are habituated to current anthropogenic noise, the light rail would create a novel and ongoing noise impact. Impacts of noise on fauna are discussed in section 9.4. Operation of the light rail would occur between 5am to 1am each day, which has the potential to affect calling intensity, frequency and timing of Green and Golden Bell Frogs in the evening. Operational noise levels would fluctuate, rather than being continuous, with noise levels increasing as light rail vehicles pass by, and then decreasing again to ambient noise levels. Fauna in the vicinity of the project site are habituated to lighting, given the location of the project in an urban area. However, the presence of additional lighting may further impact fauna activity in the study area, particularly in areas adjacent to native vegetation and parklands. Lighting is to be designed to minimise light spill near areas with high biodiversity value, such as the Sydney Olympic Park and Newington Nature Reserve and on the bridges over the Parramatta River (see section 10.2).
Overhead wiring	Overhead wiring can lead to injury and mortality of birds and bats. Raptors may collide with wires as they focus their attention on the ground when foraging while maintaining their flight path. Migratory birds can often fall victim to power line collisions, especially when such power lines cross their natural migration pathways. This may be more pronounced near waterways or coastlines. Grey-headed flying-foxes may rest on powerlines near forage trees. As they spread their wings to take flight their wings can make contact with live wires, resulting in electrocution. Power would be distributed from traction power substations to the light rail vehicles typically via overhead wiring strung on poles however wire-free power supply would be provided along Dawn Fraser Avenue between the Jacaranda Square and Carter Street stops. Further investigations would be conducted during design development in consultation with key stakeholders to assess the potential to incorporate wire-free power in other locations, such as along Hill Road and on bridges over the Parramatta River. The White-bellied Sea-eagle predominantly forages over water. As the majority of the project is located along existing road corridors, there are limited opportunities for collisions with over-head wires. There is, however, a risk of collision with wires where individuals are travelling between roosting and foraging locations, and when foraging along the Parramatta River, where the new bridges and associated wires would pose a new obstacle. Powerline spans may pose a higher collision risk if located directly along flight paths between the nest and foraging areas (Rollan et al, 2010). This risk is potentially higher in early phases of operation as the structures would be novel, although these would pose an ongoing danger to fledgling White-bellied Sea-eagles as they learn to fly, increasing the cumulative impacts of the project on this species. During long distance migration flights in familiar territory, most birds fly at altitudes well above the height of power lines. Collisions mostly occur when birds cross power lines in their local, daily movements. In contrast to flying in familiar territory, during long distance migration into unfamiliar terrain, birds tend to form large aggregations, fly at lower altitudes near stopover areas and therefore can increase their probability of collision with power lines (Bernadino et al 2018). Open areas like bogs or pastures allow birds to fly closer to the ground than forested habitats, and consequently can pose higher collision risk when crossed by power lines (Bernadino et al 2018). The use of overhead wiring near Narawang Wetland and Newington Nature Reserve Wetland would increase the risk of collision and mortality of migratory waders that utilise these areas. Wiring used to power light rail vehicles (i.e. catenary wires) are not expected to pose a significant risk to Grey-headed Flying-foxes, as this is a single wire rather than two parallel wires, and so would not conduct electricity through roosting individuals. Overhead wiring and/or other built structures occur throughout all or portions of the project site, and the increase in overhead wiring would further increase the operation of this impact. Mitigation measures relating to overhead wiring are provided in section 10.2, including minimising overhead wiring in sensitive areas.

9.6 Assessment of serious and irreversible impacts

The concept of serious and irreversible impacts is fundamentally about protecting threatened entities that are most at risk of extinction from potential development. The Biodiversity Offsets Scheme recognises that there are some types of serious and irreversible impacts (SAII) that the community expects will not occur except where the consent authority considers that this type of impact is outweighed by the social and economic benefits that the development will deliver to the State (DPIE 2019).

Under the BC Act, a determination of whether an impact is serious and irreversible must be made in accordance with the principles set out in section 6.7 of the BC Regulation. The principles are aimed at capturing impacts which are likely to contribute significantly to the risk of extinction of a threatened species or ecological community in NSW.

The decision-maker must determine whether or not an impact on biodiversity values is likely to be a SAII. The framework allows for decision-makers to take into account the scale of an impact and the potential for avoidance and mitigation. These factors are weighed against the status and vulnerabilities of the potential SAII entity to ultimately determine if a proposal will indeed have a SAII (DPIE 2019). Data relating to the assessment of SAII entity has been requested and obtained from BAM Support.

9.6.1 Threatened ecological communities

Of the threatened ecological communities considered as part of this BDAR, only one is an entity as risk of SAII: Sydney Turpentine Ironbark Forest. The other threatened ecological communities are not candidate SAII entities. Detailed assessments of the potential for SAII on Sydney Turpentine Ironbark Forest are provided in Table 9.6 in accordance with the BAM. A threshold of impacts has not been identified for this community. Figure 9.5 shows the location of stands of remnant and planted Sydney Turpentine Ironbark Forest in the area.

Table 9.6 Assessment of potential for serious and irreversible impacts for Sydney Turpentine Ironbark Forest

Criteria	Assessment
1. Current status	
a. evidence of rapid decline (Principle 1, clause 6.7(2)(a) BC Regulation) as the current total geographic extent of the TEC in NSW AND the estimated reduction in geographic extent of the TEC since 1970 (not including impacts of the proposal)	Sydney Turpentine Ironbark Forest is restricted to the Sydney Basin bioregion and is identified as being heavily fragmented, with only 0.5 per cent of its original extent remaining (DPIE 2021d). The community is known only from the LGAs (or former LGAs) of Ashfield, Auburn, Canterbury, Concord, Drummoyne, Leichhardt, Marrickville, Bankstown, Ryde, Hunters Hill, Baulkham Hills, Ku-ring-gai, Hornsby, Parramatta, Bankstown, Rockdale, Kogarah, Hurstville, Sutherland, however in some of these areas, only single remnant trees remain (DPIE 2021d). Information provided by BAM Support indicates that the community meets the criteria for a reduction in geographic extent of ≥90% since 1750 or ≥80 per cent since 1970, with a reduction in extent of more than 90 per cent since 1750 the most likely (NSW TSSC 2019).
b. extent of reduction in ecological function for the TEC using evidence that describes the degree of environmental degradation or disruption to biotic processes (Principle 2, clause 6.7(2)(b) BC Regulation) indicated by: i. change in community structure ii. change in species composition iii. disruption of ecological processes iv. invasion and establishment of exotic species v. degradation of habitat, and vi. fragmentation of habitat	Information provided by BAM Support indicates that this SAII entity meets this criterion, as remnants of Sydney Turpentine-Ironbark Forest have historically been subjected to a range of anthropogenic disturbances as identified in Benson and Howell (1994). Further, these disturbances have affected the structure and likely the composition of remnants, which are often small and fragmented, making them susceptible to continuing losses through ongoing vegetation clearing and land management (Benson and Howell 1994; Tozer 2003). Remnants of Sydney Turpentine-Ironbark Forest are also subject to ongoing invasion by naturalized and exotic plant species. BAM Support notes that "*the threats to Sydney Turpentine-Ironbark Forest listed above are ongoing and likely to cause continuing decline in geographic distribution and disruption of biotic processes and interactions*".

Criteria	Assessment
c. evidence of restricted geographic distribution for the threatened species s (Principle 3, clause 6.7(2)I BC Regulation) presented by: i. extent of occurrence ii. area of occupancy iii. number of threat-defined locations	Information provided by BAM Support indicates that this SAII entity does not meet this criterion. The estimated extent of occurrence is 3,818.28 square kilometres and the estimated area of occupancy is 1,100 square kilometres. The estimated total current extent is 3,228.79 hectares. No threat-defined locations are indicated for this entity.
d. evidence that the TEC is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation)	BAM Support did not provide any information relating to this criterion. No information is provided in the Final Determination for the community either (NSW TSSC 2019).
Impact assessment	
a. the impact on the geographic extent of the TEC (Principles 1 and 3) by estimating the total area of the TEC to be impacted by the project: i. in hectares, and	A total of 16.24 hectares of good condition Sydney Turpentine-Ironbark Forest is present in Newington Nature Reserve, based on OEH (2016) regional vegetation mapping, or 22 hectares according to NSW TSSC (2019). The project would not result in any direct or indirect impacts on this remnant patch. Conservative mapping completed as part of this assessments indicates up to 1.5 hectares of planted vegetation adjacent to the project site (between the Millennium Parklands and Sanctuary Wentworth Point development) may also be broadly commensurate with the TEC, noting that the final determination for the CEEC does not exclude planted forms of the community, nor does it require specific soil profiles to be present for a stand of vegetation to be classified as the BC Act-listed CEEC. The project would remove 1.05 hectares of this planted vegetation. Loss of a small area of planted vegetation is broadly consistent with the description of the CEEC and is unlikely to result in a substantial impact to the natural geographic extent of the community, given the landscape context in which the planted stand occurs. This vegetation has been planted on an artificial soil profile, on a human-made landform, with species of unknown provenance. There is no intact soil profile, no natural soil seed bank, and the stand is unlikely to be contributing to the overall ecological function of any natural remnants of this community.
ii. as a percentage of the current geographic extent of the TEC in NSW	The project would result in the removal of 1.05 hectares of planted vegetation on an artificial landform that is broadly aligned with Sydney Turpentine Ironbark Forest, but would not result in any impacts to naturally occurring stands of this community. Information provided by BAM Support indicates that the estimated total current extent of this SAII entity is 3,228.79 hectares. Removal of 1.05 hectares of planted vegetation would not reduce the current geographic extent of the community, given planted vegetation is not typically recognised in the current extent of vegetation comprising a TEC. If this planted vegetation was included in projections of current extent, the removal of 1.05 hectares would represent a reduction of 0.03 per cent.
b. the extent that the proposed impacts are likely to contribute to further environmental degradation or the disruption of biotic processes (Principle 2) of the TEC by: i. estimating the size of any remaining, but now isolated, areas of the TEC; including areas of the TEC within 500 metres of the development footprint or equivalent area for other types of proposals	The project would not remove, fragment or isolate any remnant or naturally occurring areas of the community. As outlined previously, a total of 16.24 hectares of good condition remnant Sydney Turpentine-Ironbark Forest is present in Newington Nature Reserve, based on OEH (2016) regional vegetation mapping, or 22 hectares according to NSW TSSC (2019). Conservative mapping completed as part of this assessments indicates up to 1.05 hectares of planted vegetation that would be removed adjacent to the project site may also be commensurate with the TEC, between the Millennium Parklands and Sanctuary Wentworth Point development. The patch of remnant Sydney Turpentine-Ironbark Forest is within 500 metres of the project site, but would not be impacted by the project.

Criteria	Assessment
	The patch of planted vegetation that is broadly comparable with the floristic description of the Sydney Turpentine-Ironbark Forest TEC is unlikely to contribute to biotic processes that help to maintain or promote the ongoing presence of this TEC within the local area. The planted vegetation is comprised of sub-mature canopy species of unknown provenance, with no signs of self-recruitment of any native understorey or midstorey species. There is no intact soil seed bank, and no natural soil profile. About 0.35 hectares of planted vegetation that is broadly commensurate with the TEC would remain following construction, within a disturbed patch of land between an electricity substation and transmission line and associated easement.
ii. describing the impacts on connectivity and fragmentation of the remaining areas of TEC measured by: distance between isolated areas of the TEC, presented as the average distance if the remnant is retained AND the average distance if the remnant is removed as proposed, and estimated maximum dispersal distance for native flora species characteristic of the TEC, and other information relevant to describing the impact on connectivity and fragmentation, such as the area to perimeter ratio for remaining areas of the TEC as a result of the development.	The project would not remove, fragment or isolate any remnant or naturally occurring areas of the TEC. About 1.05 hectares of planted vegetation that is broadly equivalent to the floristic description of the community would be removed as a result of the proposal. This removal would result in an increase to the degree of fragmentation, or an increase in the distance between any other patches of the community, as clearing would take place on the edge of a larger patch of vegetation, adjacent to an existing construction zone. The distance between any other patches of the community would be equivalent to that currently on site, with or without construction of the project.
iii. describing the condition of the TEC according to the vegetation integrity score for the relevant vegetation zone(s) (section 4.3) including the relevant composition, structure and function condition scores for each vegetation zone	The remnant stand of Sydney Turpentine Ironbark Forest within Newington Nature Reserve was not surveyed as part of this assessment, as it was outside the study area considered as part of the field surveys, and outside the project site. The small planted stand of vegetation commensurate with this TEC was sampled, and is described in section 5.3.3.

Legend
- Sydney Turpentine - Ironbark forest (PCT 1281) Planted condition, BC Act CEEC
- Sydney Turpentine - Ironbark forest (PCT 1281) Good condition, BC Act/EPBC Act CEEC
- 500m Buffer Area
- Project Site

Paper Size ISO A4
0 0.5 1
Kilometres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

SAII assessment:
Sydney Turpentine Ironbark Forest

Project No. 12557728
Revision No. A
Date 11/07/2023

FIGURE 9.5

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Print date: 11 Jul 2023 - 12:02

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: Imanasan

9.6.2 Threatened species

Of the threatened species considered as part of this BDAR, only one is an entity as risk of SAII: Curlew Sandpiper. The other threatened species are not candidate SAII entities. An assessment of the potential for SAII on the species is provided in Table 9.7.

Table 9.7 Assessment of potential for serious and irreversible impacts for Curlew Sandpiper

Criteria	Assessment
1. Current status	
a. evidence of rapid decline (Principle 1, clause 6.7(2)(a) BC Regulation) presented by an estimate of the: i. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer), or ii. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer) as indicated by: an index of abundance appropriate to the species; decline in geographic distribution and/or habitat quality; exploitation; effect of introduced species, pathogens, pollutants, competitors or parasites	Information provided by BAM Support indicates that this SAII entity meets this criterion. Justification = Data collected by the Australian Wader Study Group indicates that there has been a 94% decline in maximum annual counts of the New South Wales population between 1982 and 2010 (NSW TSSC 2011). Final Determination = This is equivalent to a decline of 89 per cent over three generations, the period recommended by IUCN (2010) for calculating population reduction (NSW TSSC 2011).
b. evidence of small population size (Principle 2, clause 6.7(2)(b) BC Regulation) presented by: i. an estimate of the species' current population size in NSW, and ii. an estimate of the decline in the species' population size in NSW in three years or one generation (whichever is longer), and iii. where such data is available, an estimate of the number of mature individuals in each subpopulation, or the percentage of mature individuals in each subpopulation, or whether the species is likely to undergo extreme fluctuations	Information provided by BAM Support indicates that this SAII entity does not meet this criterion. The current population in NSW is <2,500 mature individuals.
c. evidence of limited geographic range for the threatened species s (Principle 3, clause 6.7(2)I BC Regulation) presented by: i. extent of occurrence ii. area of occupancy iii. number of threat-defined locations (geographically or ecologically distinct areas in which a single threatening event may rapidly affect all species occurrences), and iv. whether the species' population is likely to undergo extreme fluctuations	Information provided by BAM Support indicates that this SAII entity does not meet this criterion. Estimated extent of occurrence = 7,600,000 square kilometres Estimated area of occupancy = 6,800 square kilometres Number of locations = 4 In NSW, this species is widespread east of the Great Divide, especially in coastal regions, with sparsely scattered records inland (DAWE 2021b).
d. evidence that the species is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation) because: i. known reproductive characteristics severely limit the ability to increase the existing population on, or occupy new habitat (eg species is clonal) on, a biodiversity stewardship site ii. the species is reliant on abiotic habitats which cannot be restored or replaced (eg karst systems) on a biodiversity stewardship site, or iii. life history traits and/or ecology is known but the ability to control key threatening processes at a biodiversity stewardship site is currently negligible (eg frogs severely impacted by chytrid fungus).	BAM Support did not provide any information relating to this criterion. There has been a very widespread and large population decline in southern Australia since the 1980s, probably due to threats in breeding areas that are outside Australia. In non-breeding grounds in Australia, this species mostly occurs in highly populated areas and is therefore vulnerable to possible habitat alteration. It is necessary to maintain undisturbed feeding and roosting habitat along the south-east coast and at sites on the north-west coasts used during migration for the species to survive at current population levels (DAWE 2021b). Increased levels of habitat protection, and in some cases restoration, are recommended throughout the East Asian-Australasian Flyway in order to maintain shorebird populations (DotE 2015).

Criteria	Assessment
2. Impact assessment	
a. the impact on the species' population (Principles 1 and 2) presented by: i. an estimate of the number of individuals (mature and immature) present in the subpopulation on the subject land (the site may intersect or encompass the subpopulation) and as a percentage of the total NSW population, and	The total population in NSW is likely to consist of fewer than 2,500 individuals (NSW TSSC 2011). It is difficult to ascertain how many individuals may be impacted by the proposed development due to the highly mobile nature of the species. However, shorebird monitoring completed by Avifauna Research & Services (2019) found a single Curlew Sandpiper in the Parramatta River estuary In the 2016-2017 season. No Curlew Sandpipers were seen in 2017-2018 season (Avifauna Research & Services 2019). Records for this species in the area are associated with Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park (Birdata 2021). There are few records are from the Newington Wetlands (although this may be a result of differences in survey effort). Approximately 4km to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide foraging and roosting habitat for this species (Birdata 2021). The species tends to occur in low numbers, often one or two individuals, occasionally six individuals (Birdata 2021). For the purposes of this assessment, it is assumed that up to 10 individuals may occur in the study area, which is 0.4 per cent of the NSW population. Most of these individuals would predominantly occur in wetland and mudflat habitat that is not being directly impacted by the project (eg Homebush Bay, Waterbird Refuge etc). Given the low likelihood of the species occupying the project site or its close vicinity, there is a minimal risk of direct, indirect, vehicle strike or other operational impacts on the species' population.
ii. an estimate of the number of individuals (mature and immature) to be impacted by the project and as a percentage of the total NSW population, or	For the purposes of this assessment, it is assumed that up to 10 individuals may occur in the study area, which is 0.4 per cent of the NSW population. Most of these individuals would predominantly occur in wetland and mudflat habitat that is not being impacted by the project (e.g. Homebush Bay, Waterbird Refuge etc). The project would result in the removal of seasonal foraging habitat through the loss of 0.72 hectares of mangroves, 0.05 hectares of saltmarsh and 0.01 hectares of freshwater wetland. The value of this small area of potential habitat to be removed is relatively low, particularly given that the availability of high-quality habitat presents in the Homebush Bay and Sydney Olympic Park area. The project would not involve the removal of large mudflats and there would be no direct impact on any high-quality habitat that these species are known to occupy, such as the Waterbird Refuge or Badu Wetlands. Construction and operation of the project would increase the extent of flooding in the one per cent AEP flood event in a number of locations, including within Newington Nature Reserve Wetland and the Narawang Wetland. Entry of water into both wetlands are controlled by a variety of weirs, bunds and gates. The change in flooding regimes is unlikely to substantially affect foraging habitat for this species in these locations.

Criteria	Assessment
iii. if the species' unit of measure is area, provide data on the number of individuals on the site, and the estimated number that will be impacted, along with the area of habitat to be impacted by the project	For the purposes of this assessment, it is assumed that up to 10 individuals may occur on the subject land, which is 0.4 per cent of the NSW population. Most of these individuals would predominantly occur in wetland and mudflat habitat that is not being impacted by the project (e.g. Homebush Bay, Waterbird Refuge etc). The project would result in an impact on the Curlew Sandpiper through the proposed removal of 0.35 hectares of land within the area mapped as important habitat. This comprises small patches of mangroves, and linear fragments of saltmarsh and freshwater wetlands located alongside roads and paths. No large expanse of good quality mudflat habitat would be removed. The habitat to be impacted is a small portion of available habitat in the area, and individuals would still be able to forage in the wider area.
b. impact on geographic range (Principles 1 and 3) presented by: i. the area of the species' geographic range to be impacted by the project in hectares, and a percentage of the total AOO, or EOO within NSW	In Australia, Curlew Sandpipers occur around the coasts and are also widespread inland, though erratic in their appearance across much of the interior (DoE 2015). The extent of occurrence in Australia is estimated to be 7,600,000 square kilometres and area occupied 6,800 square kilometres (Garnett et al. 2011). In NSW, they are widespread east of the Great Divide, especially in coastal regions (DoE 2015). The species occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland (NSW TSSC 2011). The Parramatta River between Rydalmere and Abbotsford is mapped as important habitat for the Curlew Sandpiper under the BAM and includes Haslams Creek and associated wetlands (DPIE 2021). Important habitat for the Curlew Sandpiper is also mapped within the Shoalhaven Estuary, Hunter Estuary, Worimi Nature Reserve, and Richmond River Estuary. The project would remove 0.35 hectares of mapped important habitat, which represents a negligible proportion of the species' geographic range. The project is unlikely to substantially reduce the area of occupancy (AOO) or extent of occurrence (EOO) for this species.
ii. the impact on the subpopulation as either: all individuals will be impacted (subpopulation eliminated); OR impact will affect some individuals and habitat; OR impact will affect some habitat, but no individuals of the species will be directly impacted	The project would result in an impact on a potential SAII entity through the proposed removal of 0.35 hectares land mapped as important habitat by DPIE (2021). This comprises small patches of mangroves, and linear fragments of saltmarsh and freshwater wetlands located alongside roads and paths. There would be no direct impact on high quality habitat for the species within Sydney Olympic Park such as the Waterbird Refuge and Badu Mangroves. A small portion of seasonal foraging habitat at Melrose Park may be removed as part of the project. The project has the potential to indirectly impact on wetland habitat at Newington Wetlands and Narawang Wetland during construction and operation. Mitigation measures are recommended to minimize sedimentation, erosion and mobilization of contaminants during construction. The stormwater system has been designed to treat and minimize runoff of contaminants during operation.

Criteria	Assessment
	Flooding is predicted to increase by up to 50 millimetres in the Newington Nature Reserve Wetland as a result of the location of new bridge piers in the Parramatta River. This may alter the extent and condition of foraging habitat for this species in this wetland. There would be no change to flooding regimes in Homebush Bay, the Badu Mangroves or Bird Refuge. Internationally important migratory shorebird habitat at Towra Point Nature Reserve in southern Sydney is not in the same catchment as the study area.
iii. to determine if the persisting subpopulation that is fragmented will remain viable, estimate (based on published and unpublished sources such as scientific publications, technical reports, databases or documented field observations) the habitat area required to support the remaining population, and habitat available within dispersal distance, and distance over which genetic exchange can occur (e.g. seed dispersal) and pollination distance for the species	Persisting populations of Curlew Sandpiper are unlikely to be fragmented as they are a highly mobile, migratory species. The project would not result in any gaps in habitat, structures or barriers that would tangibly increase the risk or energy cost of the movement of the species. Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves. A small area of suitable foraging habitat for Curlew Sandpiper is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project alignment. Other suitable habitat includes intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) approximately four kilometres east of the site. Additionally, the nearest internationally important migratory shorebird habitat located at Towra Point Nature Reserve, approximately 20 kilometres south-east of Wentworth Point, would provide suitable habitat.
iv. to determine changes in threats affecting remaining subpopulations and habitat if the proposed impact proceeds, estimate changes in environmental factors including changes to fire regimes (frequency, severity); hydrology, pollutants; species interactions (increased competition and effects on pollinators or dispersal); fragmentation, increased edge effects, likelihood of disturbance; and disease, pathogens and parasites.	Threats to the Curlew Sandpiper include ongoing human disturbance, habitat loss and degradation from pollution, changes to the water regime and invasive plants (Department of the Environment 2015). Construction of the project has the potential to result in sedimentation, erosion and mobilisation of sediments within the construction sites and adjoining native vegetation and aquatic habitats, through soil disturbance and construction activities. Sediment laden runoff and contaminants in waterways can alter water quality and adversely affect aquatic life. Concreting activities could result in the discharge of concrete dust, concrete slurries or washout water to downstream waterways. This could potentially increase the pH of downstream waterbodies which can be harmful to aquatic life. Concrete solids contained in the discharge also have the potential to cause increased turbidity. Erosion and sediment control would focus on areas of surface disturbance, particularly near waterways including Sydney Olympic Park precinct construction site and bridge and water crossing construction sites. These impacts would be adequately managed through the implementation of standard mitigation measures including progressive erosion and sediment controls, and on-site management protocols. Proposed operational controls include Gross Pollutant Traps in conjunction with tertiary cartridge filtration devices, as well as a water quality basin, dry bio-filtration basins and swales. Given these controls, it is unlikely that there would be substantial impacts on adjacent wetland habitats that would affect foraging habitat of the Curlew Sandpiper.

Criteria	Assessment
	During long distance migration flights in familiar territory, most birds fly at altitudes well above the height of power lines. Collisions mostly occur when birds cross power lines in their local, daily movements. In contrast to flying in familiar territory, during long distance migration into unfamiliar terrain, birds tend to form large aggregations and fly at lower altitudes near stopover areas and therefore can increase their probability of collision with power lines (Bernadino et al 2018). Open areas like bogs or pastures allow birds to fly closer to the ground than forested habitats, and consequently can pose higher collision risk when crossed by power lines (Bernadino et al 2018). The use of overhead wiring near Narawang Wetland and Newington Nature Reserve Wetland would increase the risk of collision and mortality of migratory waders that utilise these areas. Minimising the use of overhead wiring would be investigated in these areas to limit this impact on this species (see section 10.2). Impacts of vehicle strike during construction or operation are unlikely to substantially impact the Curlew Sandpiper in the local areas and region as a whole, given the location of much of the project along existing roads. This species occurs in low densities and has a low risk of vehicle strike. However, the construction and operation of the light rail would add novel vehicle strike risks for this species along Hill Road and the Holker Busway, and near Newington Nature Reserve Wetland.

9.7 Prescribed impacts

Prescribed impacts are the impacts on biodiversity values which are not related to, or are in addition to, native vegetation clearing and habitat loss (Section 6.7 of the BAM). These types of impacts are used by the decision-maker to inform the determination and conditions of consent for developments. In general, these types of impacts affect habitat or features of the environment that are irreplaceable or otherwise important to the maintenance of biodiversity values.

The BC Regulation (clause 6.1) identifies actions that are prescribed as impacts to be assessed under the biodiversity offsets scheme. The likelihood, extent and magnitude of prescribed impacts must be assessed using the approach specified in the BAM Section 8.3. Those of relevance to this project are discussed in the sections below.

9.7.1 Human made structures and non-native vegetation

Assessments of prescribed impacts are provided below for non-native vegetation present in the project site (Table 9.8).

Table 9.8 Impacts on human-made structures

Criteria	Assessment
a. describe the nature, extent and duration of short-term and long-term impacts (during operation, during construction, that are uncertain)	Construction works near Holker Street have the potential to impact the breeding colony of Southern Myotis and non-breeding colonies of Large Bentwing Bats. There would be no construction immediately above the culverts, however noise and vibration from works on Hill Road would carry across to the culverts. Construction near Holker Street is likely to continue for some months. The microbats that roost in the Holker Street culverts are habituated to existing vehicle noise and vibration. The removal of buildings/structures, particularly disused buildings or bridges and culverts, has the potential to result in the loss of roosting habitat for microbats. It is possible that microbats may roost in some buildings/structures that would require removal as a result of the project's land requirements, and microbats would lose these roost sites.
b. predict the consequences of impacts on threatened entities identified in sub-section 6.1.2 c. justify predictions of impacts with relevant literature and other published sources of information or advice from experts	**Impacts relating to construction near culverts** Disturbance of a roost at critical times can result in the abandonment or death of a high proportion of the colony (Gration 2006). Disturbance at a maternity site can lead to premature births and subsequent death of the young or to massive death among juveniles. Similarly, disturbance of bats during hibernation (torpor) can lead to depletion of fat reserves and subsequent death from starvation (Hamilton-Smith 1970). Any bats that leave a roost site during the day are at high risk of predation by birds such as eagles and kites, as well as other species (Mikula et al. 2016). Disturbance that causes bats to attempt to move roost sites during the day is thus very dangerous for individuals, as they are at greater predation risk. Although the central nervous system of microbats continues to function at low body temperatures, the peripheral and brainstem auditory systems become less responsive as body temperature declines. Laboratory tests on bats that roost under bridges have shown that torpid individuals show increasing responses to noise from morning towards evening (i.e. towards the onset of the active phase), but torpid bats rapidly habituate to repeated and prolonged noise exposure (Luo et al. 2014). California Transport's (Caltrans) (2016) *Technical Guidance for Assessment and Mitigation of the Effects of Traffic Noise and Road Construction Noise on Bats* noted that construction noise can potentially affect bats in the following ways: – sudden, loud noises can potentially disturb bats and cause abandonment of roosts – sudden, loud noises can potentially cause temporary or permanent hearing loss in bats, affecting echolocation and passive listening – chronic disturbance may also alter important colony activity patterns, particularly during the breeding season, and could also disrupt critical torpor cycles of hibernating/overwintering bats, forcing them to overuse critical energy resources – young in-maternity colonies are particularly susceptible to noise induced hearing loss during sensitive development periods (Caltrans 2016). If works are undertaken during the breeding season, there is the potential to impact the lifecycle of the species through disturbance of females when pregnant or when there are dependant young. Noise and vibration can also impact individuals in torpor. Demolition or roadworks at or near the Holker Street culverts have the potential for impacts on these species as described above. Mitigation measures are proposed to minimise high impact activities during the breeding season and during winter. **Impacts from building/structure demolition** The demolition of buildings has the potential to result in the loss of roost habitat for microbats. Gould's Wattled Bat (*Chalinolobus gouldii*) is the only species that has been regularly recorded roosting in buildings in the Sydney area. If occupied, the project could disrupt roosting of a colony of common bats. Threatened species such as the Large Bentwing Bat and Southern Myotis are more likely to roost in disused rail tunnels and stormwater culverts (Sydney Bats 2017). It is possible that microbats may roost in some structures that would require removal as a result of the project, and microbats would lose these roost sites. Replacement roost habitat is recommended as part of the design of the bridges over the Parramatta River.

Table 9.9 Impacts on non-native vegetation

Criteria	Assessment
a. describe the nature, extent and duration of short-term and long-term impacts (during operation, during construction, that are uncertain)	The project would remove 5.51 hectares of planted vegetation. It is assumed that this would comprise a permanent loss of this vegetation. The project would have limited direct impacts on mudflats along the Parramatta River that provide foraging habitat for migratory waders. Bridge construction and shading during operation may result in increased areas of mudflats near the bridges as a result of removal or dieback of mangroves.
b. predict the consequences of impacts on threatened entities identified in sub-section 6.1.2 c. justify predictions of impacts with relevant literature and other published sources of information or advice from experts	**Planted vegetation** Planted vegetation includes foraging habitat for the Grey-headed Flying-fox and microbats. The shrub and ground layer may also provide some foraging or shelter habitat for the Australasian Bittern, Australian Painted Snipe and Green and Golden Bell Frog. Habitat to be impacted tends to occur on the edge of existing roads and is subject to noise and disturbance from vehicles and pedestrians. Large areas of similar foraging habitat is present throughout Newington Nature Reserve and the Millennium Parklands, as well as planted trees and garden plants in surrounding suburbs. This vegetation is not likely to be important to these species. The loss of a relatively small total area of planted vegetation as small patches spread along a 10 kilometre linear alignment is unlikely to substantially impact the habitat resources available for these species. Exotic grassland may provide some foraging habitat for the Green and Golden Bell Frog. Individuals may only occur in these areas on occasion when moving between ponds. Given the exposed nature of this habitat type, and location adjacent to existing roads, it is not likely to be important to the survival of the local population. **Mudflats** The project would not involve the removal of large mudflats and there would be no direct impact on any high-quality habitat that migratory waders are known to occupy, such as the Waterbird Refuge or Badu Wetlands. The inadvertent increase in the mudflats around the bridge structures following construction may result in more mudflat being exposed for a greater amount of time, and thus increased the foraging opportunities for shorebirds (Bonnington and Smith 2018).

9.7.2 Habitat connectivity

Assessments of prescribed impacts are provided below for impacts on connectivity (Table 9.10).

Table 9.10 Impacts on connectivity

Criteria	Assessment
a. describe the nature, extent and duration of short and long-term impacts (during operation, during construction, that are uncertain)	The majority of the project is located along existing roads in a highly disturbed urban setting. Impacts on connectivity by clearing vegetation along the edges of Hill Road and Holker Street are likely to be minimal. No works are proposed within constructed ponds at Narawang Wetland or Kronos Hill. However, works are in close proximity to some ponds, in particular pond N17 near the existing Hill Road Bridge, and ponds on either side of Holker Busway at Kronos Hill. The project would remove thin, linear strips of vegetation from the edge of Hill Road, Holker Street and Holker Busway. Connectivity would remain throughout the Narawang Wetland and surrounds for fauna. Clearing of vegetation for bridge construction would result in the creation of a gap in riparian vegetation, impacting connectivity along the riparian zone. The new bridges will create novel barriers across the Parramatta River, which could impact movement of birds and bats in the short term. The project would temporarily impact frog underpasses, the flood control weir/culvert between Narawang Wetland and Nuwi Wetland, and the dedicated frog underpass at Kronos Hill Wentworth Common at Holker Busway, through construction noise, lighting and vibration. The proposed bridge over Hill Road in particular would require extensive construction works including utilities, relocations, piling, bridge and road construction, with works likely to last around 18 months. This construction work may impact the movement of frogs during their dispersal period.

Criteria	Assessment
b. predict the consequences of the impacts for the persistence of the threatened entities identified in sub-section 6.1.3, taking into consideration mobility, abundance, range and other relevant life history factors. c. justify predictions of impacts with relevant literature and other published sources of information and describe any limitations to data, assumptions and predictions about impacts on biodiversity).	**Impacts from bridge construction** New bridges would be constructed between Camellia and Rydalmere and between Melrose Park and Wentworth Point. The barrier effect of the bridge abutments may prevent movement of some species along the riparian corridor. Mangroves may regrow under the bridges, providing some connectivity. Passage for terrestrial fauna would be provided at the abutments and would continue to provide connectivity along the river's edge. Movement of birds and bats may initially be impacted when the new bridges are constructed across the Parramatta River. These species are likely to habituate to these structures, as they have with other bridges in the local area. **Impacts on culverts and underpasses** Construction may impact some Green and Golden Bell Frog 'underpasses', specifically the frog underpass between Kronos Hill and Wentworth Common at Holker Busway, and the flood control weir/culvert between Narawang Wetland and Nuwi Wetland. No direct impact (ie. removal/replacement) of the underpass between Kronos Hill and Wentworth Common is proposed, however noise and vibration during construction in this area may affect movement of frogs through this underpass. Frog movements would mainly occur at night during the breeding and dispersal period. Construction work hours would generally be between 7am-7pm, although there is potential for night work. Noise and vibration may affect movement of frogs during their migration and dispersal, if noisy works are occurring during these periods. Currently, it is understood there is no evidence that the Green and Golden Bell Frog uses either underpass for movement. The proposed bridge over Hill Road would require extensive construction works including utilities, relocations, piling, bridge and road construction, with works likely to last around 18 months. The project may impact movement of frogs during construction, however no permanent impacts are likely. The culvert at this location is near constructed ponds N17 and N18 in the Narawang Wetland. Noise, light and vibration may limit movement of frogs within Narawang Wetland. Nuwi Wetland is not mapped as Green and Golden Bell Frog habitat by the Sydney Olympic Park Authority. While the bridge is mapped as a frog underpass, there is limited potential for impacts on movement of frogs to or from Nuwi Wetland and Haslams Creek into Narawang Wetland, given the lack of good quality habitat in these areas. There would be no permanent blocking of this underpass, and the underpass would continue to exist following construction. Operational impacts are likely to be of a lesser magnitude than construction. Light rail vehicles would be a novel impact, creating additional noise and vibration during the day and night, compared to current conditions. Hill Road and Holker Street and Holker Busway currently allow movement of vehicles including cars, buses and trucks in the area. Additional noise and vibration in the long term has the potential to impact movement of frogs. Discussion of the potential impact of vehicle strike on connectivity is provided in Table 9.12.

9.7.3 Water bodies, water quality and hydrological processes

Assessments of prescribed impacts are provided below for impacts on water bodies, water quality and hydrological processes (Table 9.11).

Table 9.11 Impacts on water quality, water bodies and hydrology

Criteria	Assessment
a. describe the nature, extent and duration of short-term and long-term impacts	**Construction** Works in the Parramatta River would impact Key Fish Habitat. Construction of watercourse crossings also has the potential to impact mangroves, increase erosion and interfere with natural flow regimes. Removal of mangroves is likely to lead to localised foreshore erosion and riverbank destabilization, which may affect mudflats in the immediate area of the bridge piers. Following the completion of the construction works, it is likely that the mangroves will regenerate in some disturbed areas. Construction of the project has the potential to result in sedimentation, erosion and mobilisation of contaminants within the construction sites and adjoining native vegetation and aquatic habitats. Habitats of particular concern include key fish habitat associated with the Parramatta River and Haslams Creek, and wetland areas that support threatened and migratory biota. These impacts would be adequately managed through the implementation of standard mitigation measures including progressive erosion and sediment controls, and on-site management protocols within the Transport for NSW *Water Discharge and Reuse Guideline*. These controls would be used to manage and minimise risks of impacts to water quality. **Operation** During operation, it is likely that the bridge pier piles and the pile caps will lead to very localised scour with no wider impacts. Channel migration may change the position of the low flow path and localised changes to the bed and instream habitat may occur. Increases in impervious surfaces could result in the build-up of contaminants in dry weather, which during rainfall events, could be transported to surrounding watercourses by stormwater and wastewater. Changes in runoff volumes are anticipated to be minor, due to the small footprint of disturbed land required for construction, and like-for-like replacement of road pavement with provision for the light rail, resulting in the existing flow regimes being largely maintained. Trapping suspended solids is the primary focus of the water quality management strategy for the operational phase of the project. Proposed controls include Gross Pollutant Traps in conjunction with tertiary cartridge filtration devices, a water quality basin, dry bio-filtration basins and swales. The two new bridges would cause small increases in flood levels at properties which are already impacted by flooding, including foreshore properties on the Parramatta River at Wentworth Point near the proposed bridge and immediately to the west of the proposed bridge between Camellia and Rydalmere. The presence of piles, pile caps and piers in the Parramatta River floodplain reduce the efficiency of the floodplain in conveying flood water downstream. This results in slightly higher flood levels on the upstream side of the bridge structures. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. Changes to hydrology have the potential to impact on the persistence of Saltmarsh vegetation, and in particular, the presence and extent of *Wilsonia backhousei* within the Saltmarsh at the northern end of Newington Nature Reserve. Flood modelling indicates that there would likely be an increase in the height of flooding in Newington Nature Reserve as a result of the proposal, however no change to the frequency of flood events is anticipated. The increase in flood level is likely to be minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places), and the increase being between 10 to 50 millimetres. The duration of flooding may be incrementally longer, which over time may influence the extent of Saltmarsh and *Wilsonia backhousei*. With this slight increase in flood level, there may be longer periods of freshwater inundation, which is identified by Pacific Wetlands (2019) as a likely cause for *Wilsonia* decline in the Saltmarsh Nursery. Further information on potential hydrological changes is provided in Technical Paper 10 (Hydrology, Flooding and Water Quality Assessment) and the Supplementary Flooding Report.

Criteria	Assessment
b. predict the consequences to the threatened entities identified in sub-section d. justify predictions of impacts with appropriate modelling (if available), relevant literature and other published sources of information, or consultation with species experts	**White-bellied Sea-eagle and Southern Myotis** Sedimentation, erosion and mobilisation of contaminants may impact the White-bellied Sea-eagle. Raptors are particularly vulnerable as an apex predator to the chronic effects of organochlorine pesticides and heavy metal contamination (Olsen et al. 1993; Kurosawa 2000). Levels of dioxins have been implicated in breeding success and deaths of White-bellied Sea-eagles at Sydney Olympic Park (Manning et al. 2008). Similarly, microbats such as the genus *Myotis*, which is also an apex predator, have been suggested as potential bioindicators in determining environmental pollution (Kuzukiran et al. 2021). Mobilisation of contaminants would be managed through the implementation of standard mitigation measures during construction including implementation of an acid sulfate soil management plan, and operational management through the trapping and filtration of stormwater. Given existing levels of contaminants in the area and proposed mitigation, the project is unlikely to significantly increase the risk of poisoning of this species. **Green and Golden Bell Frog, Australian Bittern and Australian Painted Snipe, and Migratory waders** The Green and Golden Bell Frog relies on wetland habitats for breeding, foraging and shelter. This species is known to tolerate a wide range of turbidity, pH, salinity, oxygen and temperature levels (Pyke and White 1996). Pyke and White (1996) showed that tadpoles can tolerate salinity levels of up to six parts per thousand (ppt) without any apparent effects on their development, while salinity of eight ppt or higher will decrease growth and increase mortality. Mass tadpole death has been observed in breeding ponds on Broughton Island off Port Stephens when salinity has increased above 7.8 ppt through intrusion of seawater into the breeding habitat during storms (Pyke et al 2002). Raised salinity may afford an improved survivorship for developing tadpoles exposed to the frog chytrid pathogen (Clulow et al 2017), assuming salinity levels are not too high. Migratory waders forage on mudflats and associated areas. Estuaries are typically important feeding areas for wading birds but are also often subject to historic and current chemical contamination by heavy metals. Estuarine sediments commonly form major sinks for contaminants released during industrial activity (Smith et al 2009). Some metals and persistent organic pollutants can accumulate in shorebirds, by means of biomagnifications along the food chains. Many chemicals can cause changes to the avian thyroid gland and/or disruptions in the reproductive system, although acute mortality has rarely been reported (Tang et al 2015). It is not certain what impacts previous overwinter exposures to may have on subsequent breeding success (Smith et al 2009). The Australasian Bittern and Australian Painted Snipe prefer dense wetland vegetation for shelter (DAWE 2020b). Changes to water quality has the potential to impact growth of wetland vegetation. Contaminants such as heavy metals and dioxins would accumulate in these species and may affect breeding. Mobilisation of sediments and contaminants would be managed through the implementation of standard mitigation measures during construction including implementation of an acid sulfate soil management plan, and operational management through the trapping and filtration of stormwater. Given existing levels of contaminants in the area and proposed mitigation, the project is unlikely to significantly increase the risk of sediments and contaminants entering these communities or affecting these species. Construction and operation of the project would slightly increase the extent of flooding in the one per cent AEP flood event in a number of locations, including upstream of the bridge between Melrose Park and Wentworth Point and within the Narawang Wetland. Entry of water into Narawang Wetland and Newington Nature Reserve Wetlands are controlled by a variety of weirs, bunds and gates. Given the large areas of suitable habitat in the area, a small increase in flooding, this is unlikely to be a substantial impact on these species.

Criteria	Assessment
	Wilsonia backhousei Changes to hydrology have the potential to impact on the persistence of Saltmarsh vegetation, and in particular, an increase in flooding frequency, duration or flood height has the potential to result in reductions to the extent of *Wilsonia backhousei* within Saltmarsh vegetation at the northern end of Newington Nature Reserve. Flood modelling indicates that there would likely be a slight increase in the height of flooding in Newington Nature Reserve as a result of the project. The increase in flood level is likely to be minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places), and the increase being between 10 to 50 millimetres. The duration of flooding may be incrementally longer, which over time may influence the extent of Saltmarsh and *Wilsonia backhousei*. With this slight increase in flood level, there may be longer periods of freshwater inundation, which is identified by Pacific Wetlands (2019) as a likely cause for *Wilsonia* decline in the Saltmarsh Nursery. **Coastal Saltmarsh** Coastal Saltmarsh is at risk of change to floristic composition if there are changes to hydrology and flooding extent and duration, with some saltmarsh plants highly influenced in their distribution within a saltmarsh community by abiotic factors such as micro-topography, inundation regime and salinity. As outlined above, flood modelling indicates that there would likely be a slight increase in the height of flooding in Newington Nature Reserve as a result of the project. The increase in flood level is likely to be minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places), and the increase being between 10 to 50 millimetres. These changes may result in a loss of floristic diversity within the saltmarsh assemblage, as species that can persist in more freshwater environments are able to persist, while species that require higher levels of salinity are unable to persist. **Swamp Oak Floodplain Forest** The predicted changes in hydrology are unlikely to result in changes to the persistence of this community, which is capable of surviving in highly modified environments subject to substantial hydrological modification (pers obs.). This community is known to occur on waterlogged soils, with the degree of salinity, inundation and flooding likely to influence the composition of species (DECC 2007). This community had generally low floristic diversity within the study area, and this is unlikely to change as a result of the project. **Freshwater Wetlands** The Freshwater Wetlands within the study area are highly modified, constructed systems, and their hydrological processes are largely by constructed flushing channels, adjustable weirs, bunding, stormwater pipes and drains (SOPA 2002). This community relies on the persistence of standing fresh water for at least part of the year in most years (DPIE 2021b). The project will likely result in minor increases in flood heights, which is unlikely to impact the ongoing persistence of Freshwater Wetlands in the locality, especially given the management options available to existing wetlands, with some ponds being drained seasonally (Darcovich and O'Meara 2008). **Sydney Turpentine Ironbark Forest** The project is unlikely to impact the occurrence of remnant Sydney Turpentine Ironbark Forest in Newington Nature Reserve. This community is located upslope of Narawang Wetland and is unlikely to be impacted by any sedimentation or mobilisation of contaminants. The predicted increase in flooding extent in Newington Nature Reserve Wetland does not intersect with this community.

9.7.4 Vehicle strike

Fauna is already at risk from vehicle movements on roads and on private property in the project site. Increased movement of vehicles in the area during construction increases the risk of vehicle strike for fauna species. An assessment of the risk of vehicle strike during construction is provided in Table 9.12.

Table 9.12 Impacts of vehicle strike

Criteria	Assessment
a. predict the likelihood of vehicle strike to each relevant species, taking into consideration mobility, abundance, range and other relevant life cycle factors	All threatened fauna in the study area is currently at risk of vehicle strike. The introduction of the light rail would not provide a novel risk but would create a change in the quantum of risk. Few of the threatened fauna species known or likely to occur at the project site are at particular risk of road-kill, however construction traffic has the potential to injure or kill terrestrial species such as the Green and Golden Bell Frog. Given the low densities at which these species occur and the fidelity of local populations to suitable wetland habitat, the risk of light rail vehicle strike is likely to be low. Vehicle strike during construction and operation of more mobile species such as migratory waders and microbats is relatively low. Some birds may be at higher risk if foraging in wetlands immediately adjacent to the light rail corridor.
b. estimate vehicle strike rates with supporting data or literature, where available	Given the location of the project in a generally urban area, without substantial areas of habitat that would support substantial populations of native fauna, vehicle strike rates are likely to be relatively low for much of the project site. High risk areas are located in the Millennium Parklands and Parramatta River, where wetland and riparian vegetation provides habitat and movement corridors for fauna. The current road network is an existing risk to fauna including waterbirds, the White-bellied Sea-eagle and the Green and Golden Bell Frog, particularly where the project is located alongside Narawang Wetland and Haslams Creek. The construction and operation of the light rail would add novel vehicle strike risks in locations such as alongside Newington Nature Reserve, where no roads exist, and increased risk along existing roads, such as Hill Road.
c. predict the consequences of the impacts for the persistence of the relevant species	Impacts of vehicle strike during construction are unlikely to substantially impact threatened species in the local areas and region as a whole, given the location of much of the project site along existing roads. Most threatened species in the study area occur in low densities and have a low risk of vehicle strike. Terrestrial and slow-moving species such as the Green and Golden Bell Frog are at risk of vehicle strike, as are migratory waders and the White-bellied Sea-eagle (particularly fledglings). Vehicle strike is a risk for the Green and Golden Bell Frog along Hill Road and the Holker Busway, and near Newington Nature Reserve Wetland. The project would not be creating new gaps in any high-quality areas of breeding or foraging habitat for the Green and Golden Bell Frog, rather the light rail would be located alongside these areas, predominantly within the current road reserve. High quality habitat areas for this species are currently fenced, to minimize the risk of this species access roads and being subject to vehicle strike. Fencing replacement or upgrades are recommended during construction and operation of the project. Despite this, there is potential for occasional individuals to attempt to cross the alignment and adjacent roads and may be subject to injury and mortality. Migratory waders and the White-bellied Sea-eagle are mobile species, and may be subject to injury and mortality when flying between foraging and roosting sites. As the light rail is generally located alongside wetlands, rather than traversing them, waders may be less likely to traverse the rail corridor on a regular basis. The White-bellied Sea-eagle may however traverse the rail corridor regularly, particularly when foraging along the Parramatta River. The project has the potential to impact occasional individuals, which is of higher consequence for species such as raptors which have a low reproductive rate and small size of local population.

9.8 Key threatening processes

A key threatening process (KTP) is a process that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community.

KTPs are listed under the BC Act, FM Act and EPBC Act. Some KTPs are listed under more than one Act. KTPs of relevance to the project are discussed in Table 9.13. Mitigation measures to limit the impacts of these KTPs are discussed in section 10.2.

Table 9.13 Key threatening processes of relevance to the project

KTP	Status	Comment
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	BC Act	Construction of watercourse crossings in the Parramatta River has the potential to create instream barriers, impact mangroves, increase erosion and interfere with natural flow regimes. Removal of mangroves is likely to lead to localised foreshore erosion and river bank destabilisation. During operation, it is likely that the bridge pier piles and the pile caps will lead to localised scour with no wider impacts. Channel migration may change the position of the low flow path and localised changes to the bed and instream habitat may occur. The presence of piles, pile caps and piers in the Parramatta River floodplain reduce the efficiency of the floodplain in conveying flood water downstream. This would result in higher flood levels on the upstream side of the bridge structures. Mitigation measures are recommended to minimise impacts on aquatic habitats (see section 10.2).
Clearing of native vegetation	BC Act; EPBC Act	Clearing of native vegetation refers to the removal of one or more strata within a stand of native vegetation. There are numerous impacts as a result of clearing native vegetation, including: destruction of habitat causing a loss of biological diversity; fragmentation of populations; riparian zone degradation; disturbed habitat which may permit the establishment and spread of exotic species; and loss of leaf litter, removing habitat for a wide variety of vertebrates and invertebrates (DPIE 2022b). Clearing of native vegetation has occurred historically within and around the study area. The project would result in the clearing of up to 2.43 hectares of native vegetation, some of which is commensurate with threatened ecological communities listed under the BC Act. Implementation of vegetation management measures would help to minimise impacts to retained vegetation outside of the project site (see section 10.2).
Loss of hollow-bearing trees	BC Act	Tree hollows are cavities formed in the trunk or branches of a living or dead tree. Hollows are usually more characteristic of older, mature to over mature trees. Hollows occur primarily in old eucalypts trees and are uncommon in many other native and introduced species. The presence, abundance and size of hollows is positively correlated with tree trunk diameter, which is an index of age. As such, large old hollow-bearing trees are relatively more valuable to hollow-using fauna than younger hollow-bearing trees. The latter are important as a future resource (DPIE 2022b). The project would result in the removal of hollow-bearing trees, including around 20 hollow-bearing trees from planted vegetation and around 40 from mangroves. No large hollows suitable for owls or cockatoos would be removed. The implementation of fauna management measures would minimise potential impacts on fauna as a result of the removal of hollow-bearing trees (see section 10.2).
Removal of dead wood and dead trees	BC Act	Fallen timber and hollow-bearing stags provide important habitat for a range of native species and are important to ecosystem health. The project may result in the removal of stag trees and fallen timber during construction. The implementation of fauna management measures would minimise potential impacts on fauna as a result of removal of dead wood and stag trees (see section 10.2).
Invasion of plant communities by perennial exotic grasses	BC Act	Exotic perennial grasses of concern include *Hyparrhenia hirta*, *Cortaderia* spp., *Sporobolus fertilis*, *Nassella neesiana*, *Nassella trichotoma* and *Eragrostis curvula*. There is evidence that these perennial grass species have significant adverse impacts on biodiversity, including increases to fuel loads that result in changes to fire regimes that can alter the structure of native vegetation communities and lead to local extinctions of some native species (DPIE 2022b). *Eragrostis curvula* is present in the study area. The study area has been subject to historical disturbance, with creation of artificial landforms, extensive landscaping work, residential and industrial development, and creation of parkland and open spaces. Exotic perennial grasses are already established throughout the study area, including in many stands of native vegetation. Weed management procedures would be implemented to limit any further spread of weeds as a result of the project (see section 10.2).

KTP	Status	Comment
Invasion and establishment of exotic vines and scramblers	BC Act	Exotic vines can have a significant effect on biodiversity, through smothering native vegetation and seedlings, and preventing natural recruitment, particularly in riparian areas (DPIE 2022b). Patches of vegetation within the study area already support infestations of exotic vines and scramblers, including Common Morning Glory, Balloon Vine, Bridal Creeper and Moth Vine. The project has the potential to increase disturbance in areas of vegetation that are not infested with exotic vines, resulting in new infestations. Similarly, the project has the potential to spread propagules and vegetative material from invasive species within the study area, which may also result in new infestations. The implementation of vegetation management measures would minimise the potential impacts on native vegetation as a result of this KTP (see section 10.2).
Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata*	BC Act	African Olive has the ability to significantly alter ecosystem structure through the formation of a dense mid-canopy in native vegetation communities, preventing the growth of native grasses and herbs (DPIE 2022b). African Olive was recorded within the study area and increased disturbance associated with the project has the potential to increase the spread of this species within the local area. The implementation of vegetation management measures would minimise the potential impacts on native vegetation as a result of this KTP (see section 10.2).
Invasion, establishment and spread of Lantana *(Lantana camara L. sens. lat)*	BC Act	Lantana can suppress native vegetation and seedling recruitment through shading and competition. The species often responds favourably to disturbance, including edges and canopy breaks in woodland (DPIE 2022b). Lantana is scattered throughout the study area, and increased disturbance has the potential to allow infestation of additional areas and spread into adjacent lands. The implementation of vegetation management measures would minimise the potential impacts on native vegetation as a result of this KTP (see section 10.2).
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	BC Act	Construction activities have the potential to increase the extent or the impact of Myrtle Rust in the study area. The fungus infects leaves of susceptible plants producing spore-filled lesions on young actively growing leaves, shoots, flower buds and fruits. Leaves may become buckled or twisted and may die as a result of infection. Infection on highly susceptible plants may result in plant death. Implementation of hygiene protocols would minimise the risk of introduction or spread of this pathogen (see section 10.2).
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	BC Act; EPBC Act	Construction activities have the potential to increase the extent or the impact of amphibian chytrid in the study area. Chytrid fungus has been implicated in the dramatic decline of many amphibians worldwide and is an identified threat to a number of native frogs (DPIE 2022b). The fungus can be introduced in spores in water, moist soil or other debris. This KTP is of particular relevance given the proximity of known important populations of the Green and Golden Bell Frog. Implementation of hygiene protocols would minimise the risk of introduction or spread of this pathogen (see section 10.2).
Infection of native plants by *Phytophthora cinnamomi*	BC Act, EPBC Act	*Phytophthora cinnamomi* is a soil borne pathogen that occurs in warm, moist conditions. Infected species may show a range of symptoms, and some plants may be killed and lead to areas of dieback (DPIE 2022b). The project has the potential to increase the extent or the impact of this pathogen throughout the study area, through the transport and movement of plant, machinery and vehicles, as well as through any landscaping works following construction. Implementation of hygiene protocols would minimise the risk of introduction or spread of this pathogen (see section 10.2).
Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams	FM Act	Construction of bridges over the Parramatta River has the potential to create instream barriers, impact mangroves, increase erosion and interfere with natural flow regimes. During operation, it is likely that the bridge pier piles and the pile caps would lead to localised scour with no wider impacts. Channel migration may change the position of the low flow path and localised changes to the bed and instream habitat may occur. The presence of piles, pile caps and piers in the Parramatta River floodplain reduce the efficiency of the floodplain in conveying flood water downstream. This results in higher flood levels on the upstream side of the bridge structures. Mitigation measures are recommended to minimise impacts on aquatic habitats (see section 10.2).

KTP	Status	Comment
Degradation of native riparian vegetation along NSW water courses	FM Act	The project would remove a total 2.43 hectares of native riparian or floodplain vegetation, including mangroves (0.72 hectares), saltmarsh (0.03 hectares), Swamp Oak Forest (0.62 hectares) and Freshwater Wetlands (0.01 hectares). Degradation of some riparian vegetation has already occurred within the study area, due to the location of the project in a highly urbanized area. Indirect impacts may further impact riparian vegetation downstream of the project site. Construction of bridges over the Parramatta River would impact mangroves and increase erosion. Removal of mangroves is likely to lead to localised foreshore erosion and riverbank destabilisation. The presence of piles, pile caps and piers in the Parramatta River floodplain reduce the efficiency of the floodplain in conveying flood water downstream. This would result in higher flood levels on the upstream side of the bridge structures, which may affect riparian vegetation and adjacent wetlands. The implementation of weed management measures, erosion and sediment control measures and aquatic management measures is recommended to limit impacts on retained riparian vegetation or further reduction in water quality (see section 10.2).
The removal of large woody debris from NSW rivers and streams	FM Act	Construction work in waterways and riparian areas has the potential to disturb large woody debris, increasing the impact of the KTP and removing important aquatic habitat and shelter features. General mitigation measures are recommended to minimise impacts on aquatic habitats in section 10.2.
Predation by the Plague Minnow (*Gambusia holbrooki*)	BC Act	*Gambusia holbrooki* is widespread throughout NSW and is an aggressive predator of native fauna, particularly threatened frogs, as well as on non-threatened frog species, freshwater fishes and other aquatic organisms such as macro-invertebrates. Presence of *Gambusia holbrooki* has been linked to the decline of several threatened frog species (DPIE 2022b). *Gambusia holbrooki* occur in wetlands in the study area, and populations in Sydney Olympic Park area controlled by management of water levels in ponds. The project has the potential to spread the noxious fish *Gambusia holbrooki* into currently fish-free breeding ponds as a result of changes to flooding regimes. This could impact breeding of frogs within these ponds, as this fish species feeds on frog eggs and tadpoles, reducing suitability of some ponds for breeding. A flood management strategy would be prepared to build on the flood assessment (see Technical Paper 10 (Hydrology, Flooding and Water Quality Assessment) and the Supplementary Flooding Report) and inform design development by minimising flooding impacts to flood sensitive areas and infrastructure within Sydney Olympic Park, including the Narawang Wetland, the Brick Pit and the existing leachate management system This would help to limit the potential for movement of *Gambusia holbrooki* into breeding ponds where it does not currently occur.

9.9 Impacts on protected and sensitive lands

Protected and sensitive lands in the study area are identified in Table 9.14.

Table 9.14 Protected and sensitive lands

Protected and sensitive lands	Detail	Further assessment
Newington Nature Reserve	No construction activities would occur in Newington Nature Reserve. Construction of the bridge between Melrose Park and Wentworth Point would occur in close proximity to Newington Nature Reserve Wetland. Flood modelling indicates that there would likely be a slight increase in the height of flooding in Newington Nature Reserve as a result of the proposal, however no change to the frequency of flood events is anticipated. The increase in flood level is likely to be minimal, with current flood depths being upwards of 0.5 metres (up to one to two metres in places), and the increase being between 10 to 50 millimetres. The duration of flooding may be incrementally longer, which over time may influence the extent of Saltmarsh and *Wilsonia backhousei*. Further optimisation of the bridge foundations and particularly the pile cap is recommended with a view to minimise these flood impacts (see Technical Paper 10 (Hydrology, Flooding and Water Quality Assessment) and the Supplementary Flooding Report). The proposed new bridge over the Parramatta River would result in the creation of shade in areas adjacent to the project site that are not currently subject to shade, including a small area within the Newington Nature Reserve wetland. Chronic shading by structures may adversely affect vegetation and overall net primary production (Struck et al 2004).	Further assessment of impacts on aquatic habitats is provided in sections 9.3.5, 9.3.6, Table 9.4 and section 9.5. Further assessment of indirect and prescribed impacts relating to wetlands is provided in sections 7.3, 8.3, 8.4,9.5 and 9.7 Further assessment of shade impacts is provided in sections 9.5 and 11.1.3.
Coastal wetlands Newington Nature Reserve Wetland Narawang Wetland	The project would result in the removal of native vegetation within mapped coastal wetlands along the Parramatta River, and narrow linear fragments along the edge of Narawang Wetland. Construction of the bridge between Melrose Park and Wentworth Point would occur in close proximity to Newington Nature Reserve Wetland. Impacts would include: – clearing of 2.43 hectares of native vegetation, including mangroves, saltmarsh, Swamp Oak Forest, Freshwater Wetlands and planted Sydney Turpentine Ironbark Forest – potential indirect impacts including erosion and sedimentation, and mobilisation of contaminants – changes to flow regimes, particularly with regards to flooding immediately upstream of the bridge between Melrose Park and Wentworth Point, that would result in changes to flooding in the Newington Nature Reserve Wetland. This would have flow-on effects on saltmarsh, mangroves and associated habitats for wetland species, as noted above.	An assessment of direct impacts of the project is provided in section 9.2 Further assessment of impacts on aquatic habitats is provided in sections 9.3.5, 9.3.6, Table 9.4 and section 9.5. Further assessment of indirect and prescribed impacts relating to wetlands is provided in sections 7.3, 8.3, 8.4, 9.5 and 9.7.
Important habitat for migratory waders	The project would remove 0.35 hectares of mapped important habitat for the Bar-tailed Godwit and Curlew Sandpiper. This comprises patches of mangroves, saltmarsh, Swamp Oak Forest and rushland. No large mudflats would be removed.	Further assessment of impacts on important habitat is provided in sections 9.7, 9.10 and Appendix G. Offset requirements for impacts on important habitat are discussed in section 11.

Protected and sensitive lands	Detail	Further assessment
Key Fish Habitat Waterfront land	Parramatta River and Haslams Creek are mapped as 'Key Fish Habitat'. Waterfront land occurs within 40 metres of the riverbanks of the Parramatta River and Haslams Creek. Impacts would include: – clearing of marine vegetation (0.72 hectares of mangroves and 0.03 hectares of saltmarsh) and riparian vegetation (0.62 hectares of Swamp Oak Forest) for construction of the two bridges over the Parramatta River – removal of large woody debris – construction of instream structures (piers) within the Parramatta River – potential indirect impacts including erosion and sedimentation, and mobilisation of contaminants – changes to flow regimes, particularly with regards to flooding immediately upstream of the bridges.	Further assessment of impacts on aquatic habitats is provided in sections 9.3.5, 9.3.6, Table 9.4 and section 9.5. Offset requirements for impacts on key fish habitat are discussed in section 11.2.
Offset sites	No biodiversity stewardship sites, or private conservation lands occur in the study area. Parts of the Millennium Parklands are zoned for conservation, with habitats created as compensatory habitat for impacts on the Green and Golden Bell Frog. The alignment runs alongside Narawang Wetland and ponds adjacent to Holker Busway. Impacts on these wetlands constructed to provide habitat for the Green and Golden Bell Frog have been avoided as far as practical. There would be no temporary or permanent removal of ponds. Clearing of vegetation would remove areas of foraging and movement habitat for this species. No ponds would become permanently isolated as a result of the project, however construction may temporarily impact connectivity between ponds. Impacts on native vegetation and habitat for the Green and Golden Bell Frog would be offset in accordance with the BAM. The project would remove 1.05 hectares of planted vegetation that has been assigned to Sydney Turpentine Ironbark Forest, located at the northern end of the Millennium Parklands. This vegetation was specifically planted to provide habitat for small woodland birds. Mitigation measures are proposed to minimize impacts on this vegetation through the next stages of design and limiting vegetation clearing where practicable. The loss of planted vegetation in the Millennium Parklands impacts habitats created to provide habitat for a range of fauna. These habitats are still relatively young and have not yet gained their full value. For example, mature trees with hollows are generally lacking in this area, as hollows take decades to form. The removal of this vegetation reduces the area for creation of future habitat features such as hollows, which are a critical resource for many fauna species.	Further assessment of impacts on habitat for the Green and Golden Bell Frog is provided in sections 9.3, 9.4, 9.5, 9.7 and Appendix G.

9.10 Considerations on MNES

9.10.1 Threatened ecological communities

One vulnerable ecological community (Coastal Saltmarsh) would be impacted by the project. An assessment of significance is not required for vulnerable communities.

There would be no direct impacts on good quality patches of Sydney Turpentine Ironbark Forest of Coastal Swamp Oak Forest that meet the EPBC Act condition criteria. As such no assessment of significance has been prepared for this TEC.

9.10.2 Threatened species

Impacts on threatened species have been assessed in Sections 9.3 to 9.9 of this report. Assessments of significance have been prepared and are provided in Appendix G. A summary of potential impacts and likely significance of impacts is provided in Table 9.15.

Table 9.15 Impacts on threatened species listed under the EPBC Act

Species	EPBC Act Status	Potential impacts	Significant impact likely?
Green and Golden Bell Frog	V	Construction of the project will remove 1.52 hectares of habitat for this species, comprising 0.01 hectares of *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands, located immediately adjacent to Hill Road and Holker Street, as well as areas of saltmarsh, mangroves, Swamp Oak Forest and eucalypt forest. These would provide foraging habitat for this species. Breeding in these patches is unlikely given the high levels of disturbance from vehicles and pedestrians. The species may breed further in Narawang Wetland. There would be no impact on good quality habitat at the Brickpit. The project has the potential to spread the noxious fish *Gambusia holbrooki* into currently fish-free breeding ponds as a result of changes to flooding regimes. This could impact breeding within these ponds, as this fish species feeds on frog eggs and tadpoles, reducing suitability of some ponds for breeding. Construction of the project has the potential for indirect impacts on breeding habitat through sedimentation and changes to water quality, and through noise, vibration and lighting. Mitigation and design measures are proposed to minimise the risk of these impacts. The project would remove linear strips of potential foraging and movement habitat for the Green and Golden Bell Frog from adjacent to Newington Nature Reserve at the southern landing of the bridge between Melrose Park and Wentworth Point, along Hill Road (including areas adjacent to the Narawang Wetland), alongside the Holker Busway (e.g. Kronos Hill), and adjacent to Australia Avenue (the area near the Brickpit). These tend to be disturbed areas adjacent to roads and footpaths. The piers of the bridge between Melrose Park and Wentworth Point would result in slightly higher flood levels on the upstream side of the bridge structures. The increase in flood levels is limited to 50 millimetres in the one per cent Annual Exceedance Probability (AEP) flood event and extends into the Newington Nature Reserve. This increase in flood level is likely to be minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places). This may impact Green and Golden Bell Frog habitat in this location, although this species is tolerant of a wide range of salinity levels.	Yes

Species	EPBC Act Status	Potential impacts	Significant impact likely?
		Given the presence of the key population of the Green and Golden Bell Frog in the Millennium Parklands and Newington Nature Reserve, removal of habitat and changes in hydrology are considered likely to have a significant impact on this species. A flood management strategy would be prepared to build on the flood assessment in Technical Paper 10 (Hydrology, Flooding and Water Quality) and inform design development by minimising flooding impacts to flood sensitive areas and infrastructure within Sydney Olympic Park, including the Narawang Wetland, the Brick Pit and the existing leachate management system This would help to limit the potential for movement of *Gambusia holbrooki* into breeding ponds where it does not currently occur.	
Grey-headed Flying-fox	V	The project would not directly impact on any known roost camps in the locality. The project would result in the proposed clearing of up to 7.23 hectares of foraging habitat for Grey-headed Flying-fox, predominantly comprising planted street trees and eucalypt forest or mangroves. Foraging habitat in the project site would be a negligible proportion of available foraging habitat used by individuals from camps in the Sydney region and thus would not be habitat critical to the survival of the species.	No
Australasian Bittern Australian Painted Snipe	E E	Construction of the project will remove 0.01 hectares of *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands, located immediately adjacent to Hill Road and Holker Street. These would provide foraging habitat for these species. Breeding in these patches is unlikely given the high levels of disturbance from vehicles and pedestrians. These species may breed further in Narawang Wetland. There would be no impact on good quality habitat at the Brickpit. Construction has the potential for indirect impacts on breeding habitat at Narawang Wetland and Newington Nature Reserve Wetland through sedimentation and changes to water quality. Mitigation and design measures are proposed to minimise the risk of these impacts. The project would remove linear strips of potential foraging and movement habitat for these wetland bird species from adjacent to Newington Nature Reserve at the southern landing of the bridge between Melrose Park and Wentworth Point, along Hill Road (including areas adjacent to the Narawang Wetland), alongside the Holker Busway (eg Kronos Hill), and adjacent to Australia Avenue (the area near the Brickpit). These tend to be disturbed areas adjacent to roads and footpaths and would have limited value for these wetland bird species. The project is unlikely to substantially affect habitat for these species as there is limited clearing of habitat, indirect impacts on good quality habitat would be minimised through design and mitigation, and large areas of foraging habitat are present in the area, such as at the Waterbird Refuge, and these areas would not be impacted by the project.	No

Species	EPBC Act Status	Potential impacts	Significant impact likely?
Bar-tailed Godwit Curlew Sandpiper	V CE	The Parramatta River between Rydalmere and Abbotsford, Haslams Creek and Narawang Wetland are mapped as important habitat for the Bar-tailed Godwit and Curlew Sandpiper under the BAM. Records for these and other species in the area are associated with saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park The project would remove 0.35 hectares of mapped important habitat for these species. There would be no direct impact on high quality habitat for the species within Sydney Olympic Park. Construction of the project may result in indirect impacts on water quality within Newington Wetland and Narawang Wetland. Mitigation and design measures are proposed to minimise the risk of these impacts. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent too Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. The piers of the bridge between Melrose Park and Wentworth Point would result in slightly higher flood levels on the upstream side of the bridge structures. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. This increase in flood level is likely to be minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places). Noting the limited frequency and magnitude of the likely increase in flood levels, this change in flooding regimes is unlikely to substantially affect foraging habitat for these species in Newington Wetlands and Narawang Wetland. The project is unlikely to substantially affect foraging habitat for these species as there is limited clearing of habitat, impacts of flooding are unlikely to substantially change foraging habitat, and large areas of foraging habitat are present in the area, such as at the Waterbird Refuge, and these areas would not be impacted by the project.	No
Eastern Curlew Great Knot	CE	There are only occasional observations of individuals or small groups of these species at Newington Wetland and the Waterbird Refuge. The project would remove up to 0.72 hectares of potential foraging and shelter habitat for these species (mangroves and saltmarsh). There would be no direct impact on high quality habitat for the species within Sydney Olympic Park. Construction of the project may result in indirect impacts on water quality within Newington Wetland and Narawang Wetland. Mitigation and design measures are proposed to minimise the risk of these impacts. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent too Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. The piers of the bridge between Melrose Park and Wentworth Point would result in slightly higher flood levels on the upstream side of the bridge structures. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. This increase in flood level is likely to be minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places). Noting the limited frequency and magnitude of the likely increase in flood levels, this change in flooding regimes is unlikely to substantially affect foraging habitat for these species in Newington Wetlands and Narawang Wetland.	No

Species	EPBC Act Status	Potential impacts	Significant impact likely?
		The project is unlikely to substantially affect foraging habitat for these species as there are few records of these species at this location, there is limited clearing of habitat, impacts of flooding are unlikely to substantially change foraging habitat, and large areas of foraging habitat are present in the area, such as at the Waterbird Refuge, and these areas would not be impacted by the project.	

9.10.3 Migratory species

Impacts on migratory species have been assessed in sections 9.3 to 9.7 of this report. Assessments of significance have been prepared for migratory waders and are provided in Appendix G. A summary of potential impacts and likely significance of impacts is provided in Table 9.16. No assessments of significance have been prepared for migratory terrestrial species or aquatic species.

Table 9.16 Impacts on migratory species listed under the EPBC Act

Species	Potential impacts	Significant impact likely?
Latham's Snipe	The majority of Latham's Snipe recorded at Sydney Olympic Park occur within Narawang Wetland with other wetlands supporting small numbers of the species. The project would remove 0.06 hectares of potential habitat for this species (saltmarsh and freshwater wetlands). There would be no direct impact on high quality habitat for the species within Sydney Olympic Park. Construction of the project may result in indirect impacts on water quality within Newington Wetland and Narawang Wetland. Mitigation and design measures are proposed to minimise the risk of these impacts. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent too Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. The piers of the bridge between Melrose Park and Wentworth Point would result in slightly higher flood levels on the upstream side of the bridge structures. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. Noting the limited frequency and magnitude of the likely increase in flood levels, this change in flooding regimes is unlikely to substantially affect foraging habitat for these species in Newington Wetlands and Narawang Wetland.	No
Bar-tailed Godwit Curlew Sandpiper Common Greenshank Marsh Sandpiper Pacific Golden Plover Pectoral Sandpiper Red-necked Stint Sharp-tailed Sandpiper	The Parramatta River between Rydalmere and Abbotsford, Haslams Creek and Narawang Wetland are mapped as important habitat for the Bar-tailed Godwit and Curlew Sandpiper under the BAM. Records for these and other species in the area are associated with saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park.	No
Eastern Curlew Great Knot Broad-billed Sandpiper Double-banded Plover	There are only occasional observations of individuals or small groups of these species at Newington Wetland and the Waterbird Refuge. The project would remove up to 0.72 hectares of potential foraging and shelter habitat for these species (mangroves and saltmarsh). There would be no direct impact on high quality habitat for the species within Sydney Olympic Park. Construction of the project may result in indirect impacts on water quality within Newington Wetland and Narawang Wetland. Mitigation and design measures are proposed to minimise the risk of these impacts.	

Species	Potential impacts	Significant impact likely?
	Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent too Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. The piers of the bridge between Melrose Park and Wentworth Point would cause slightly higher flood levels on the upstream side of the bridge structures. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. Noting the limited frequency and magnitude of the likely increase in flood levels, this change in flooding regimes is unlikely to substantially affect foraging habitat for these species in Newington Wetlands and Narawang Wetland.	

9.11 Cumulative impacts

The project is located within an urban area, surrounded by land with a history of disturbance, vegetation clearing and landform modification. The nature of the landscape context in which the project sits and the future plans for the Camellia and Wentworth Point areas mean there are numerous other developments taking place and planned within the local area.

Key developments in the surrounding areas are shown in Figure 9.6. Of those shown, the following have the potential to result in cumulative biodiversity impacts:

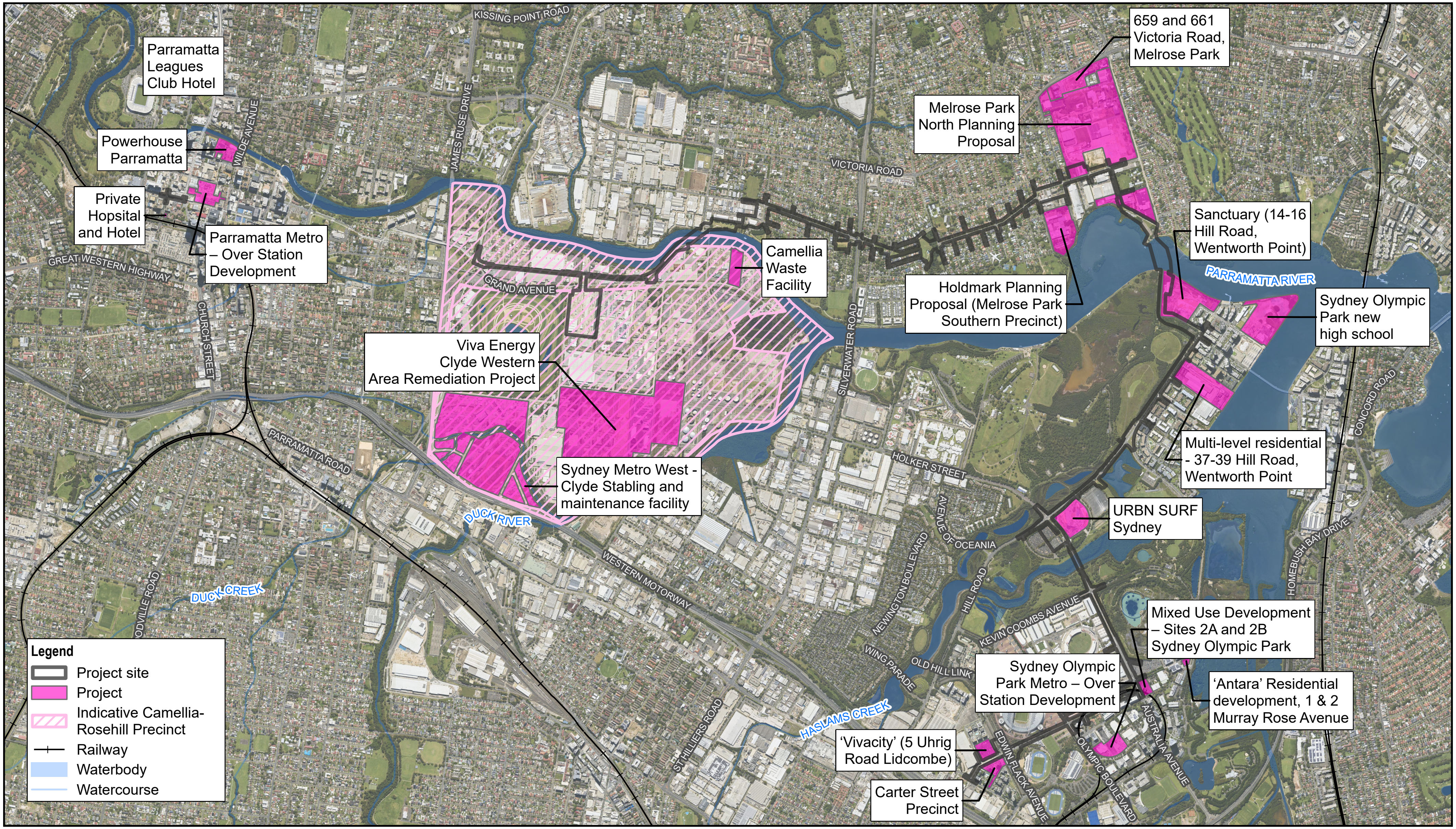
– Sydney Metro West Stage 1 – major civil construction between Westmead and The Bays
  - removal of 0.03 hectares of PCT 849 Grey Box-Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (no credits required)
  - removal of 0.15 hectares of PCT 920 Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (3 ecosystem credits)
  - removal of 0.15 hectares of habitat for the Southern Myotis (3 species credits) (Jacobs 2020)

– Parramatta Leagues Club Hotel
  - removal of 0.04 hectares of PCT 835 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (1 ecosystem credit) (Cumberland Ecology 2018).

The remainder of the projects either do not yet have a defined impact area and as such, cumulative impacts cannot be calculated, or are situated on already cleared or hardstand land and will not result in any additional impacts to biodiversity values.

The Paramatta Light Rail Stage 2 project would result in the greatest impact to biodiversity values, compared to the other projects listed above, however a relatively minor quantum of impact compared to other State significant projects of a similar scale or capital value in NSW. The project site is within a highly modified environment, dominated by residential, commercial and industrial land uses. The project would require the removal of small areas of native vegetation, as well as the removal of small patches of planted vegetation, and associated fauna habitats. The projects listed above would affect similarly fragmented habitat within highly modified, urban areas. Overall, these projects, and any other projects within the local area, would result in the further loss of modified habitat and vegetation from a highly developed area with limited natural biodiversity values.

The greatest risk of substantial cumulative impacts would be associated with projects resulting in impacts to vegetation along the Parramatta River and its tributaries, as well as to areas of threatened fauna habitat within Sydney Olympic Park.



Paper Size ISO A4

0 250 500 750

Metres

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

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GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Key developments in the study area

FIGURE 9.6

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Print date: 11 Jul 2023 - 12:03

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

10. Mitigation and management of impacts

10.1 Overview

A Construction Environmental Management Plan (CEMP) would be required for the construction phase of the project. The CEMP would include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures, including the procedures outlined below.

The safeguards and management measures detailed in Table 10.1 would be implemented during the construction period to minimise the impacts of the project on the biodiversity of the study area.

No additional mitigation measures are proposed for the operation phase of the project. The project is expected to have minimal operational impacts.

10.2 Mitigation of impacts

The proposed mitigation measures, timing, responsibility and likely effectiveness for biodiversity measures are detailed in Table 10.1. Mitigation and management measures proposed in other technical reports (such as management of erosion, sedimentation and contaminated or acid sulfate soils) are also relevant to biodiversity.

Table 10.1 Recommended mitigation measures

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness	Justification
General biodiversity impacts	A Biodiversity Management Plan (BMP) would be prepared and implemented for the project. It would include measures, processes, and responsibilities to minimise the potential for biodiversity impacts during construction, incorporating these mitigation measures and expanding on specific details where necessary. The BMP would include details of specific protocols relating to biosecurity matters, as outlined further below. The BMP would include a Green and Golden Bell Frog management plan prepared by a suitably qualified herpetologist, a microbat management plan, and a fauna monitoring plan. The plan will be developed in accordance with the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority (RTA), 2011) and the *Policy and guidelines for fish habitat conservation and management (update 2013)* (DPI, 2013). The plan would include management measures, including changes to measures to respond to monitoring outcomes, for works undertaken in Sydney Olympic Park, Millennium Parklands and adjacent to the Newington Nature Reserve and be prepared in consultation with Sydney Olympic Park Authority ecologists.	Pre-construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects
Flooding impacts	A Flood Management Strategy (FMS) would be prepared to demonstrate how the risk of flooding to the project would be minimised, as well as how the impacts of the project on flood behaviour would be mitigated. The FMS would build on the flood assessment presented in Technical Paper 10 (Hydrology, Flooding and Water Quality) and would demonstrate how the project achieves the Flood Management Objectives and Flood Immunity Standards.	Flooding specialist	Likely to be effective	Measures meet best practice management of flooding impacts.
Biosecurity matters	The BMP would include protocols for the following matters related to biosecurity: **Protocol to prevent pathogen spread and establishment** – Protocols to prevent introduction or spread of chytrid fungus would be implemented following the NSW hygiene guidelines for wildlife (DPIE 2020d). Additional mitigation measures in the protocol would be developed in consultation with Sydney Olympic Park Authority ecologists for work completed in Sydney Olympic Park.	Construction / post-construction construction contractor	Effective	Measures meet best practice management of flora and fauna on construction projects.

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness	Justification
	Plant/machinery and vehicle wash-down protocols – All plant/machinery and vehicles entering ecologically sensitive areas of the project site must be appropriately washed down and disinfected prior to working in these areas to prevent the potential spread of weeds, Cinnamon Fungus (*Phytophthora cinnamomi*) and Myrtle Rust (*Pucciniales fungi*) in accordance with the national best practice guidelines for Phytophthora (O'Gara et al. 2005), the Myrtle Rust factsheet (DPI 2015b) for hygiene control and the NSW hygiene guidelines for wildlife (DPIE 2020d). – All plant/machinery and vehicles must be subject to the same controls while moving about ecologically sensitive parts of the project site, with wash-down to occur when working between different parts of Sydney Olympic Park, as determined in consultation with Sydney Olympic Park Authority ecologists. **Weed species protocols** – Weed species would be managed in accordance with *Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011). Any weed management works within Sydney Olympic Park would occur in consultation with Sydney Olympic Park Authority ecologists, including regarding constraints to herbicide or chemical usage in areas close to aquatic habitats or areas of Green and Golden Bell Frog habitat. Management of weeds in disturbed areas would continue during the establishment and maintenance period.			
Timing	Construction measures to avoid impacts on breeding of fauna, including threatened and migratory fauna such as the White-bellied Sea-eagle, Southern Myotis and migratory waders, would be implemented. Such measures, including timing of construction, quieter construction methods, appropriate siting of lighting, and/or the use of temporary noise barriers would be implemented for works at: – Holker Busway (to minimise impacts on the breeding of the Southern Myotis during October to April) – Hill Road near the White-bellied Sea-eagle nest (breeding season from July to January) – Hill Road adjacent to Narawang Wetland, Newington Nature Reserve Wetland and Kronos Hill (to minimise impacts on migratory waders and the Green and Golden Bell Frog during spring and summer). Measures would be developed further through the preparation of specific threatened species plans as necessary.	Pre-construction / Construction contractor	Potentially effective	Measures where reasonable and feasible to implement, would meet best practice management of flora and fauna on construction projects

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness	Justification
General	All workers would be provided with an environmental induction prior to starting work on site. This would include information on the ecological values of the site, protection measures to be implemented to protect biodiversity and penalties for breaches. The induction must also include details of the various biosecurity protocols included in the BMP.	Construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects
Aquatic habitat	Aquatic habitat would be protected in accordance with *Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011) and section 3.3.2 Standard precautions and mitigation measures of the *Policy and guidelines for fish habitat conservation and management Update 2013* (DPI (Fisheries NSW) 2013). Further design refinement of the pile caps for new bridges would be undertaken to identify opportunities for reduced impact to the conveyance capacity of the bridges, and to minimise impacts on Newington Nature Reserve wetland (e.g. *Wilsonia backhousei* habitat, Saltmarsh (PCT 1126, Mangrove Forest (PCT.920) and Swamp Oak Forest (PCT 1234). The flood management strategy prepared would consider measures to minimise flooding impacts on flood sensitive areas and infrastructure within Sydney Olympic Park, including the Narawang Wetland, the Brick Pit, and the existing leachate management system. This would help to limit the potential for movement of *Gambusia holbrooki* into breeding ponds where it does not currently occur.	Design, pre-construction, Construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
Pre-clearing surveys	Pre-clearing surveys would be undertaken in accordance with *Guide 1: Pre-clearing process* and *Guide 9 (Fauna handling)* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011). Pre-clearing surveys would be completed in areas identified by the Project ecologist as supporting known or potential habitat, for ground-dwelling and arboreal species. Pre-clearing surveys would be completed prior to any works taking place (including minor works) within sensitive areas such as any vegetated land within Sydney Olympic Park; or within areas of mangrove, saltmarsh or other riparian vegetation; areas identified by the Project ecologist as supporting known or potential habitat, for ground-dwelling and arboreal species; buildings/structures to be removed (for roosting microbats).	Pre-construction, Construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness	Justification
	Pre-clearing surveys of vegetated land within Sydney Olympic Park will be conducted in accordance with the *Sydney Olympic Park Biodiversity Strategy and Management* Plan (SOPA, 2022), in particular Section 3 (Frog habitat clearance) of Environmental Procedure 3 (Works in and near habitats).			
Vegetation clearing	Habitat removal would be minimised through further design development and construction planning. Design development would minimise/rationalise wherever possible the size and impact of pier construction and minimise shading impacts through architectural form/bulk and material selection. Micro-siting of infrastructure would be undertaken during each design and construction planning phase to further minimise or avoid impacts on native vegetation, fauna movement and habitat as far as practicable.	At each design stage, Pre-construction, Construction / Designers, Construction contractor, Project ecologist	Potentially effective	Measures where reasonable and feasible to implement, would meet best practice management of flora and fauna on construction projects.
	Impacts on estuarine mangrove vegetation at Haslams Creek would be avoided or minimised as far as practicable. Works on the Holker Busway bridge would be undertaken via scaffolding attached to the bridge as far as practicable, rather than from the ground, to minimise impacts on estuarine mangrove vegetation.	Pre-construction, Construction / Designers, Construction contractor	Potentially effective	Measures where reasonable and feasible to implement, would meet best practice management of flora and fauna on construction projects.
	Exclusion zones would be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011). This would include areas of Sydney Olympic Park and Newington Nature Reserve adjacent to and outside the project site as a minimum.	Pre-construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects
	Vegetation removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011). Reuse of removed trees would be considered in consultation with Sydney Olympic Park Authority ecologists and the NSW National Parks and Wildlife Service.	Pre-construction, construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness	Justification
Edge effects	Mitigation of edge effects on patches of native vegetation would be addressed through use of native landscaping to buffer the light rail alignment at the completion of the project. This native landscaping would use locally indigenous species (as selected by the Project ecologist and in consultation with Sydney Olympic Park Authority), rather than commercially sold "native Australian" species. Areas where native landscaping would be employed include Hill Road, Holker Busway, and land adjacent to Newington Nature Reserve. Additional rehabilitation works may also be appropriate adjacent to any areas of mangroves that are cleared, including to provide buffer zones at Narawang Wetland, and Newington Nature Reserve and wetland.	Each design stage, Post-construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
Unexpected finds	The unexpected species find procedure would be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011) if threatened fauna, not assessed in the biodiversity assessment, are identified in the subject site	Construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
Fauna management	Fauna would be managed in accordance with *Guide 9: Fauna handling* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).	Construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
	Where existing frog-proof fencing within Sydney Olympic Park or the Millennium Parklands is impacted by construction of the project, temporary frog-proof fencing would be installed in its place. Permanent frog-proof fencing would be reinstated following the completion of construction in that area.	Construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
	Bridges would include microbat-friendly roost features in the design of the structures to replace lost roost habitat, particularly, the bridges over the Parramatta River and Haslams Creek. Bat-friendly roost features may also be considered for new culverts if height allows (e.g. leaving lift holes unfilled). The use of nest boxes appropriate for use by microbats may also be investigated as an option, however, needs to take into account durability of nest boxes and appropriate location of installation. Additional nest boxes for microbats and other small fauna are recommended in the Millennium Parklands to replace lost habitat along Hill Road and Holker Busway, and the Parramatta River foreshores, with details to be determined in consultation with Sydney Olympic Park Authority ecologists and the National Parks and Wildlife Service.	Each design stage, Pre-construction, Construction / Construction contractor, Project ecologist	Potentially effective	Measures meet best practice management of flora and fauna on construction projects.

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness	Justification
	The need for overhead wiring would be carefully considered at each stage, and where possible, alternative power options would be implemented in areas adjoining Grey-headed Flying-fox foraging habitat, or flight paths of the White-bellied Sea-eagle and migratory waders. Opportunities to minimise overhead wiring through ecologically sensitive areas would be investigated, with a particular focus on areas adjacent to Newington Nature Reserve and Narawang Wetland, along Holker Busway, and the bridges over the Parramatta River.	Each design stage, Construction / Construction contractor, Project ecologist	Potentially effective	Measures, where reasonable and feasible to implement, would meet best practice management of flora and fauna on construction projects.
	Fauna monitoring would be undertaken during construction. This would include monitoring of frog fencing during construction, monitoring of microbat roosts if construction is occurring near Holker Street in the breeding season, and monitoring of the response of the White-bellied Sea-eagle to construction noise during the breeding season. The monitoring methods and program would be developed in consultation with Sydney Olympic Park Authority ecologists, EHG and/or Birdlife Australia, using available baseline data. Monitoring would continue during the first two years of operation, with an option to extend for a further three years, based on advice from a suitably qualified ecologist, as to whether sufficient data has been obtained. Monitoring data and results should be published in annual reports made available online, and in the scientific literature, where relevant.	Construction / post-construction Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
Rehabilitation of vegetation subject to temporary disturbance	A habitat restoration and revegetation plan would be prepared to guide rehabilitation planning, implementation, monitoring and maintenance for disturbed areas outside of the operational footprint (such as compounds and temporary workforce accommodation). Any impacted riparian land or disturbed areas within the Millennium Parklands should be replanted with locally native species typical of the vegetation types present, or historically present. It would include clear objectives for the rehabilitation of native vegetation of local provenance in temporary disturbance areas. Active revegetation of mangroves at the two Parramatta River bridges would be undertaken following construction, taking into account future shading impacts. Monitoring of indirect impacts on mangroves, saltmarsh and the *Wilsonia backhousei* population would be undertaken during and following construction. If an incident occurs which directly or indirectly impacts *Wilsonia backhousei* habitat areas during and post-construction, monitoring by a suitably qualified expert is required to determine the severity and potential need for additional offsets under the BAM as a result of additional, unanticipated impacts.	Construction, post-construction / Construction contractor, Project ecologist	Likely to be effective	Measures meet best practice management of flora and fauna on construction projects.

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness	Justification
Reinstatement of habitat	Native vegetation would be re-established in accordance with *Guide 3: Re-establishment of native vegetation* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011). Habitat replacement would be undertaken in accordance with *Guide 5: Re-use of woody debris and bushrock.*	Post-construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
	Planting of feed trees for the Grey-headed Flying-fox in landscaping would be considered to improve habitat, with a particular focus on locally indigenous winter-flowering species, such as Forest Red Gum (*Eucalyptus tereticornis*), Spotted Gum (*Corymbia maculata*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*).	At each design stage, Post-construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
	Habitat connectivity for the Green and Golden Bell Frog would be considered in the project design.	At each design stage Pre-construction, Construction / Construction contractor, Project ecologist	Effective	Measures meet best practice management of flora and fauna on construction projects.
Lighting	Opportunities to minimise light spill to ecologically sensitive areas along Hill Road, the Holker Busway and adjacent to the Newington Nature Reserve would be investigated and implemented, with regard to the *National Light Pollution Guidelines for Wildlife* (Department of the Environment and Energy 2020), SOPA environmental guidelines, the Parklands Plan of Management, and Biodiversity Management Plan. Any new lighting should use adaptive light controls where possible to manage timing, intensity and colour of light, as follows: – use vegetation screening to reduce light spill where possible – use lights with reduced or filtered blue, violet and ultra-violet wavelengths – light only the object or area intended for the duration required – keep lights close to the ground, directed and shielded to avoid light spill. Avoid upward floodlights to illuminate buildings, bridges, billboards and monuments – use the lowest intensity lighting appropriate for the task; and – use non-reflective, dark-coloured surfaces.	Design	Potentially effective	Measures, where reasonable and feasible to implement, would meet best practice management of flora and fauna on construction projects.

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness	Justification
Noise	During construction a temporary noise barrier should be installed near Newington Nature Reserve wetland, Narawang Wetland, and Kronos Hill to minimise noise impacts on the Green and Golden Bell Frog. This would have multiple purposes, including reduction in noise and dust, and exclusion of frogs from the construction area. It must not exclude daylight. Monitoring of noise impacts on the calling timing, frequency and intensity of the Green and Golden Bell Frog should be undertaken prior to and during construction, and during the first two years of operation, with an option to extend for a further three years (based on advice from a suitably qualified ecologist as to whether sufficient data has been obtained). The monitoring methods (including the need for baseline data), reporting requirements, and adaptive management would be set out in the BMP.	At each design stage Pre-construction, Construction / Construction contractor, Project ecologist	Potentially effective	Measures meet best practice management of flora and fauna on construction projects.

11. Offsetting

11.1 BC Act offset requirements

11.1.1 Impacts not requiring offset

The majority of the project site contains non-native vegetation or other site features that do not comprise habitat for threatened biota and do not require assessment or calculation of biodiversity offsets under the BAM. The project would result in direct impacts to:

- 5.51 hectares of planted vegetation and exotic grassland, which has been subject to historical and ongoing disturbances
- 50.95 hectares of buildings, infrastructure and hardstand
- 3.68 hectares of water.

Impacts within the project site not requiring offsetting are shown on Figure 11.1.

11.1.2 Impacts requiring offset

Impacts within the project site requiring offsetting are shown on Figure 11.1.

Ecosystem credits

The data from the fieldwork and mapping was entered into version 1.4.0.00 of the BAM credit calculator (version 50) as a 'Development Assessment' to determine the number and type of biodiversity credits that would be required to offset direct impacts of the project (Assessment ID00030218/BAAS17031/21/00030219_revision 6). The biodiversity credit report is included in Appendix F and summarised below.

Impacts associated with the project that require offsetting comprise the removal of 2.43 hectares of native vegetation, and associated habitat for threatened biota. It is assumed that the construction and operation of the rail line will necessitate the removal of all vegetation layers and so the 'future vegetation integrity score' for all vegetation zones and associated management zones was entered as 0.

Ecosystem credits that would be required to offset the impacts of the project are shown in Table 11.1 and credit trading groups to ensure 'like for like' provision of biodiversity offsets are summarised in Table 11.2.

Table 11.1 Ecosystem credits required to offset direct impacts of the project

PCT	Vegetation zone	Area (hectares)	Current vegetation integrity score	Future vegetation integrity score	Change in VI score	Potential SAII	Ecosystem credits required
Estuarine mangrove forest	920_good	0.72	34.8	0	34.8	False	13*
Estuarine saltmarsh	1126_moderate	0.03	96.5	0	96.5	False	1*
Estuarine Swamp Oak forest	1234_poor	0.33	15.2	0	15.2	False	3
	1234_moderate	0.01	40.6	0	40.6	False	1
	1234_planted	0.28	40.8	0	40.8	False	6

PCT	Vegetation zone	Area (hectares)	Current vegetation integrity score	Future vegetation integrity score	Change in VI score	Potential SAII	Ecosystem credits required
Phragmites australis and *Typha orientalis* coastal freshwater wetland	1071_moderate	0.01	31.4	0	31.4	False	1
Sydney Turpentine – Ironbark Forest	1281_planted	1.05	16.7	0	16.7	True	11
Total credits							36
Total credits not including mangroves and saltmarsh							22

Table 11.2 ‘Like-for-like’ ecosystem credits required to offset impacts of the project

Credit class	Like-for-like options	Containing hollow-bearing trees	In the below IBRA subregions
920	Mangrove Swamps - ≥ 70% - <90% cleared group (including Tier 2 or higher threat status). This includes PCTs: 915, 916, 917, 918, 919, 920	No	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.
1126	Saltmarshes - ≥ 50% - < 70% cleared group (including Tier 3 or higher threat status). This includes PCTs: 1125, 1126	No	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.
1234	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. This includes PCTs: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808	No	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.
1071	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions. This includes PCTs: 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 kilometres of the outer edge of the impacted site.
1281	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion. This includes PCTs: 1183, 1281, 1284	No	Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site

Species credits

The project site is known or assumed to support five species credit entities. Species credit obligations are detailed in Table 11.3 with justifications provided below.

Table 11.3 Species credits required to offset direct impacts of the project

Species	BC Act	EPBC Act	Habitat impact (hectares)	Potential SAII	Species credits required
Wilsonia backhousei / Narrow-leafed Wilsonia	V	-	0.01 (actual number is 0.00020 ha, but has been rounded up to 0.01 to calculate credits)	False	1
Litoria aurea / Green and Golden Bell Frog	E	V	1.52	False	20
Myotis macropus / Southern Myotis	V	-	2.19	False	28
Calidris ferruginea / Curlew Sandpiper	E	CE	0.35	True	9
Limosa lapponica baueri / Bar-tailed Godwit (baueri)	-	V	0.35	False	6

Wilsonia backhousei species polygon

The area of suitable habitat for *Wilsonia backhousei* that would be impacted by the project was defined based on previously surveyed records of the species (Pacific Wetlands 2019), combined with the results of the field surveys completed as part of this assessment. The known locations of the species were buffered by 30 metres, and any boundaries of buffer areas that intersected were joined if they were 30 metres or less from the next buffer area to create a '*Wilsonia backhousei* habitat' polygon layer. This species' (as with most Saltmarsh species) distribution is dependent on microhabitat and historical factors as indicated by presence of above ground plant material. The portion of suitable habitat at the site that comprises occupied habitat has been mapped in a 0.00020 hectare species polygon as shown on Figure 6.2. This number has been rounded up to 0.01 to allow calculation of species credits in the BAM-Calculator. Additional credits have been calculated for areas of known habitat impacted by shading (see section 11.1.3). The only area of suitable habitat within the project site are areas of saltmarsh vegetation, and the population at Newington Nature Reserve has been studied over several years. The species polygon has been established only over areas of Saltmarsh.

Saltmarsh species are generally known to inhabit one of four structural saltmarsh forms, with *Wilsonia backhousei* generally occurring in the form that is dominated by herbs (DSEWPaC 2013). *Wilsonia backhousei* is generally capable of occurring in environments that range from highly saline to extremely saline and has a good to high tolerance for waterlogging (Victorian Resources Online 2020). In most instances, occurrences of the species are limited in extent (NSW TSSC 2000). Many saltmarsh species occupy specific microhabitats, based on the frequency of inundation, salinity and soil moisture gradients. The species is not known as being cryptic and does not require specific abiotic conditions such as rainfall, fire etc to be detectable. Taking this into account, along with the regular and targeted survey of the 'Saltmarsh Nursery' portion of Newington Nature Reserve (Pacific Wetlands 2019), it is unlikely that the species occurs elsewhere and has not been detected or mapped.

Green and Golden Bell Frog

The Green and Golden Bell Frog is known to occur at Sydney Olympic Park, Newington Nature Reserve and the Millennium Parklands. A population occurs at Clyde Wetlands near Camellia, however no evidence of the species was recorded in potential habitat in mangroves or Swamp Oak forest in nearby portions of the project site during targeted surveys. The species is not known to occur on the north shore of the Parramatta River, and no suitable breeding habitat is located in this area.

All PCTs in the project site are associated with this species. All native vegetation within 200 metres of a waterbody in the project site in the Sydney Olympic Park area has been included in the species polygon, in accordance with the *NSW Survey Guide for Threatened Frogs: A guide for the survey of threatened frogs and their habitats for the Biodiversity Assessment Method* (DPIE 2020c). This includes areas of Estuarine Swamp Oak Forest (PCT 1234), Estuarine Mangrove Forest (PCT 920), and *Phragmites australis* and *Typha orientalis* freshwater wetland (PCT 1071) that are within the project site in the Sydney Olympic Park area. This includes impacts on narrow linear strips of native vegetation alongside Hill Road and Holker Street. There would be no direct impact on constructed breeding ponds near Holker Busway, and only limited direct impact within the Narawang Wetland (along the very edge of Hill Road, including at the culvert under Hill Road). The species polygon is mapped on Figure 6.3. Additional credits have been calculated for areas of these PCTs impacted by shading from the bridge between Melrose Park and Wentworth Point (see section 11.1.3).

Areas of non-native and planted vegetation have been categorised as movement habitat and assessed for prescribed impacts and are not included in the species polygon.

Southern Myotis

The Southern Myotis is known to roost in culverts under Holker Street. These would not be removed for the project, but may be subject to noise and vibration from construction works on Hill Road. The Southern Myotis was also recorded (as a species group) during Anabat surveys in 2019 and 2021 for the project. Research has shown that this species roosts and forages in riparian areas of the Parramatta River.

All PCTs in the project site are associated with this species. All native vegetation within 200 metres of a waterbody in the project site has been included in the species polygon, in accordance with the *‘Species credit’ threatened bats and their habitats: NSW survey guide for the Biodiversity Assessment Method* (OEH 2018). The species polygon is mapped on Figure 6.4.

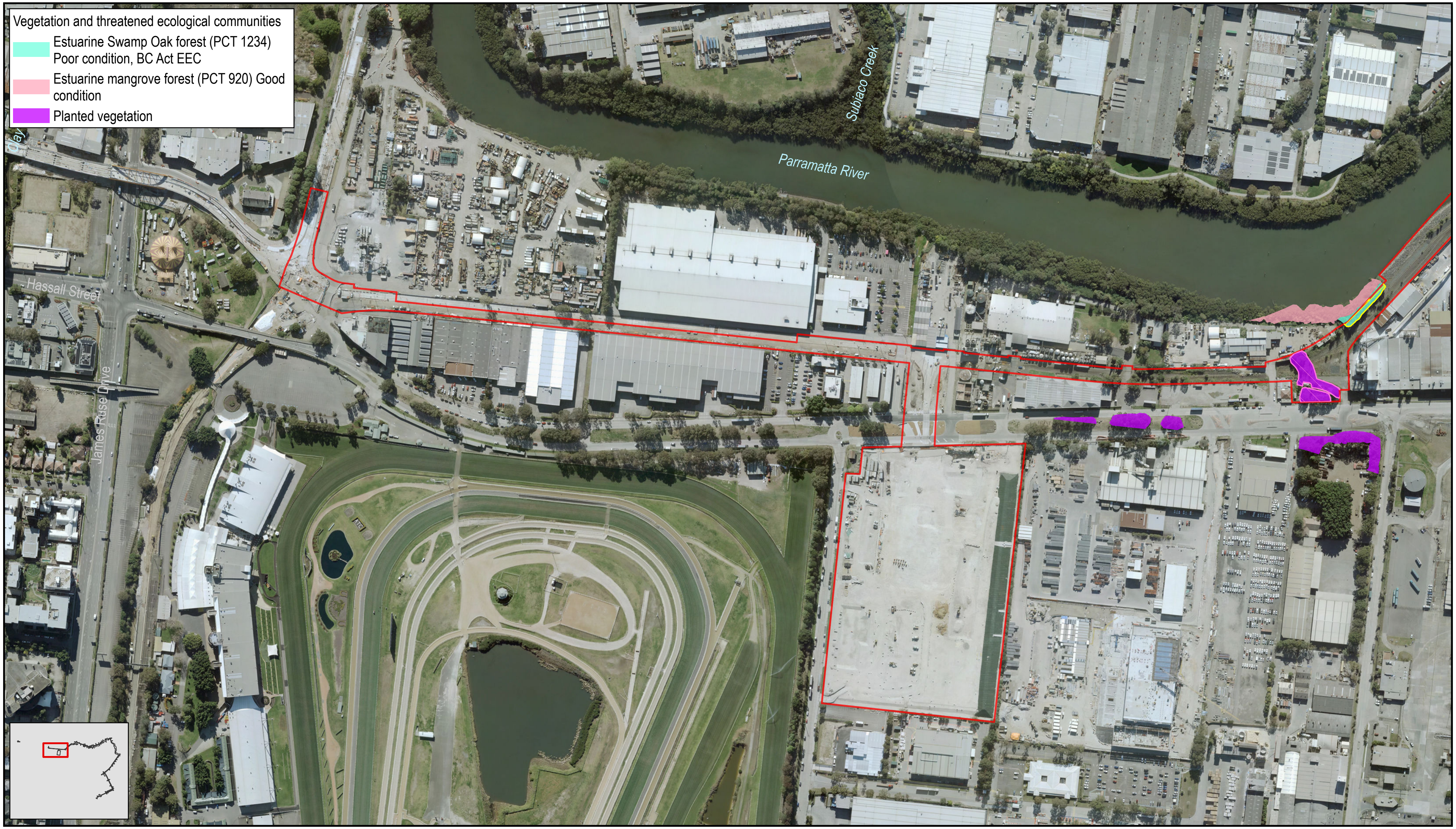
Bar-tailed Godwit and Curlew Sandpiper

The project site intersects areas mapped as important habitat for these species. Important habitat maps are generally restricted to species that are highly mobile and difficult to reliably detect by survey, and where long-term location data exists. If the project site is within a mapped area, no survey is required for that species and it is assumed present. The part of the project site within the important habitat map forms the species polygon used to generate species credits. Where only part of the project site is mapped as important habitat, the remaining areas are assessed for ecosystem credits (DPIE 2021e).

All areas of mangroves, saltmarsh, and freshwater wetland habitat that is within the mapped important habitat and intersected by the project site is included in the species polygon. The species polygon is mapped on Figure 6.5.

Man-made hard structures such as seawalls at Wentworth Point are not habitat for these species and have been excluded from the species polygon. Impacts on water are assessed as a prescribed impact (see section 9.7.3). Additional credits have been calculated for areas of habitat impacted by shading (see section 11.1.3).

No species credits have been calculated for other migratory species (e.g. Black-tailed Godwit) as no important habitat is mapped in the project site for these species (DPIE 2021e).



Legend
- Project site
- Areas requiring offset
- Areas not requiring offset

Paper Size ISO A4

0 50 100

Metres

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

N

GHD

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Areas requiring biodiversity offset

FIGURE 11.1a

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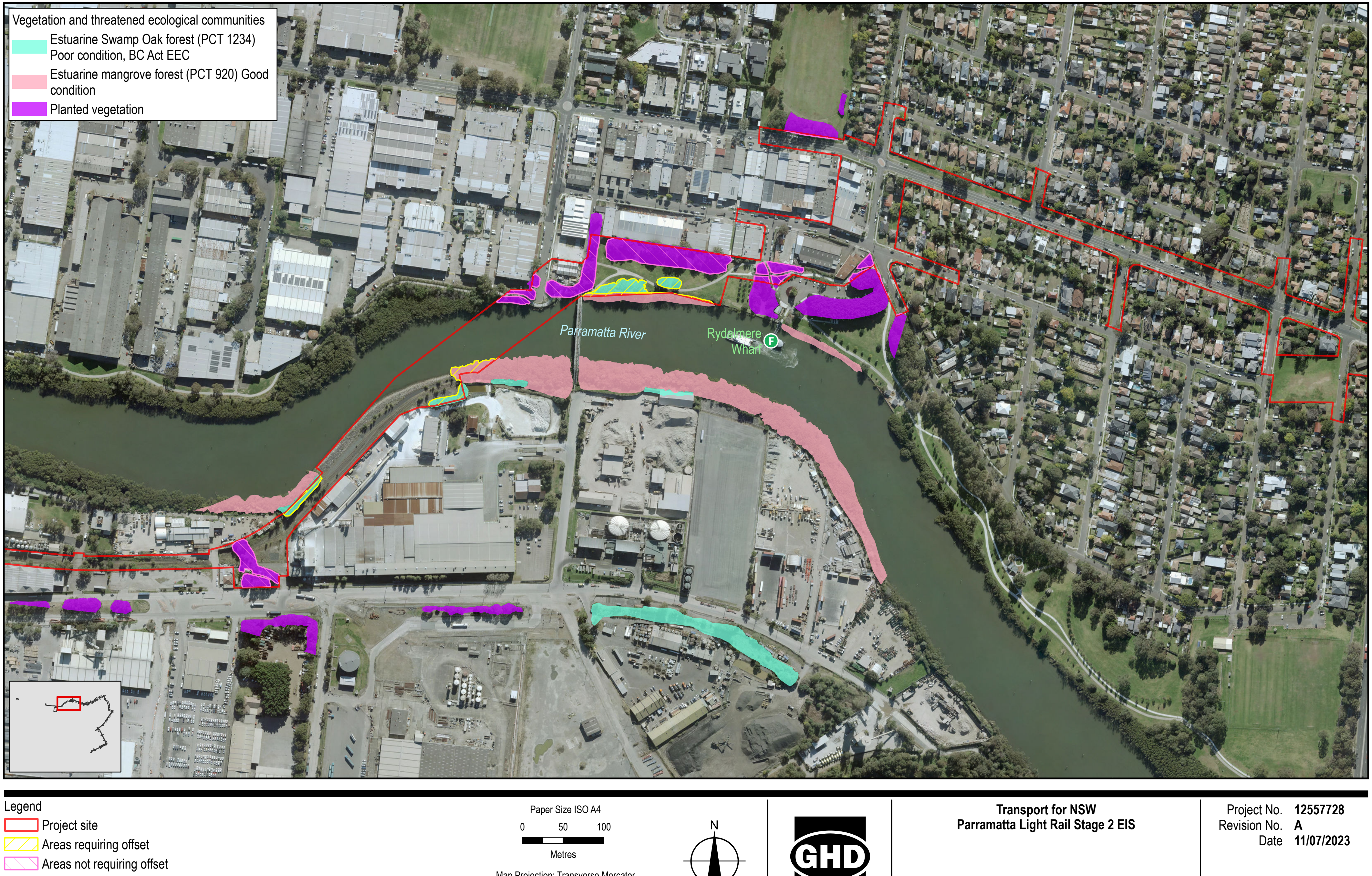
Print date: 11 Jul 2023 - 11:57

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan



Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Areas requiring biodiversity offset

FIGURE 11.1b

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Print date: 11 Jul 2023 - 11:57

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

Project site

Areas not requiring offset

Paper Size ISO A4

0 50 100

Metres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Areas requiring biodiversity offset

FIGURE 11.1c

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Print date: 11 Jul 2023 - 11:58

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend

- Project site
- Areas requiring offset
- Areas not requiring offset

Paper Size ISO A4

0 50 100

Metres

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

N

Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Areas requiring biodiversity offset

FIGURE 11.1d

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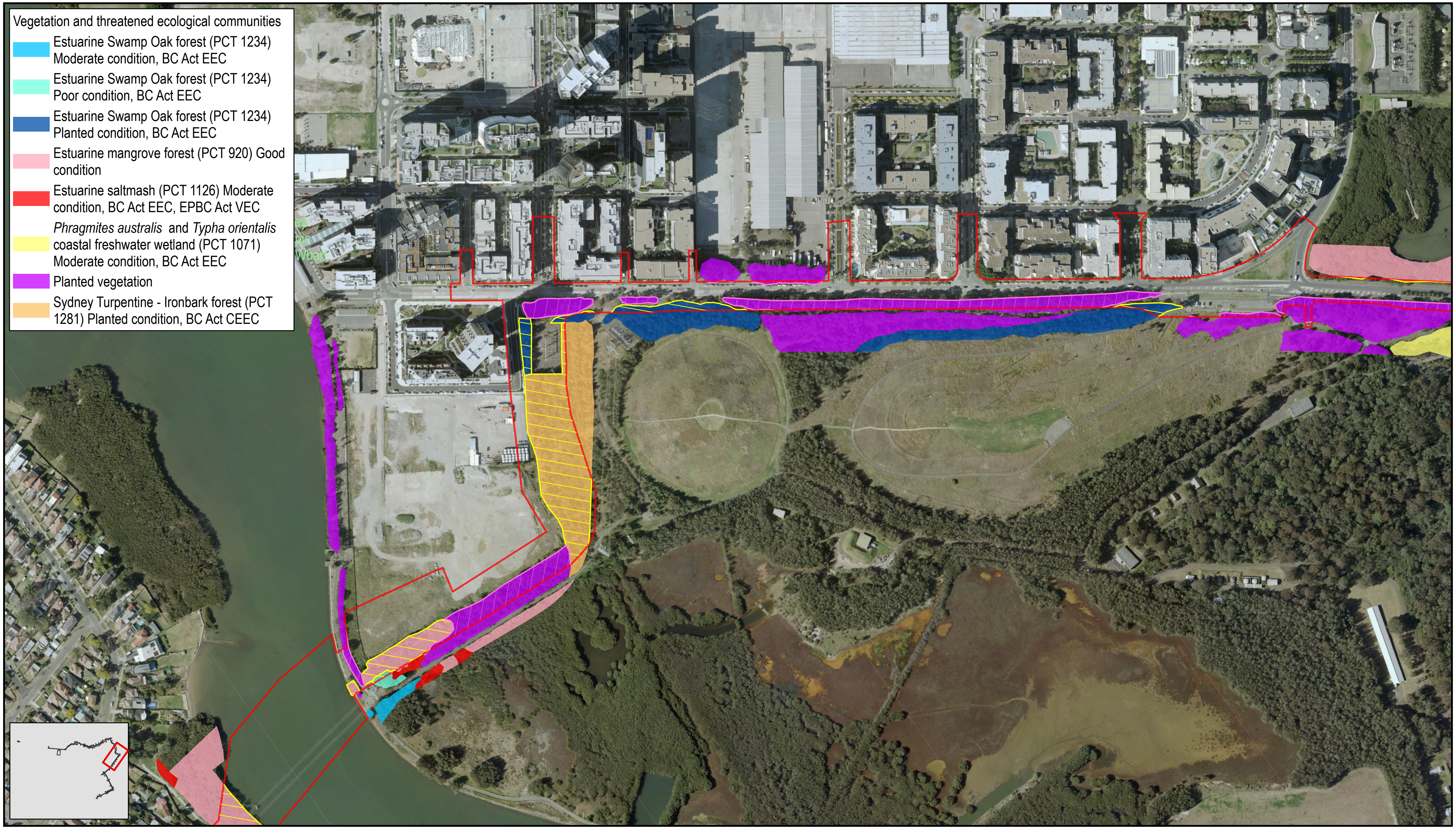
Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan



Legend
- Project site
- Areas requiring offset
- Areas not requiring offset

Paper Size ISO A4
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Metres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Areas requiring biodiversity offset

FIGURE 11.1e

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Print date: 11 Jul 2023 - 11:58

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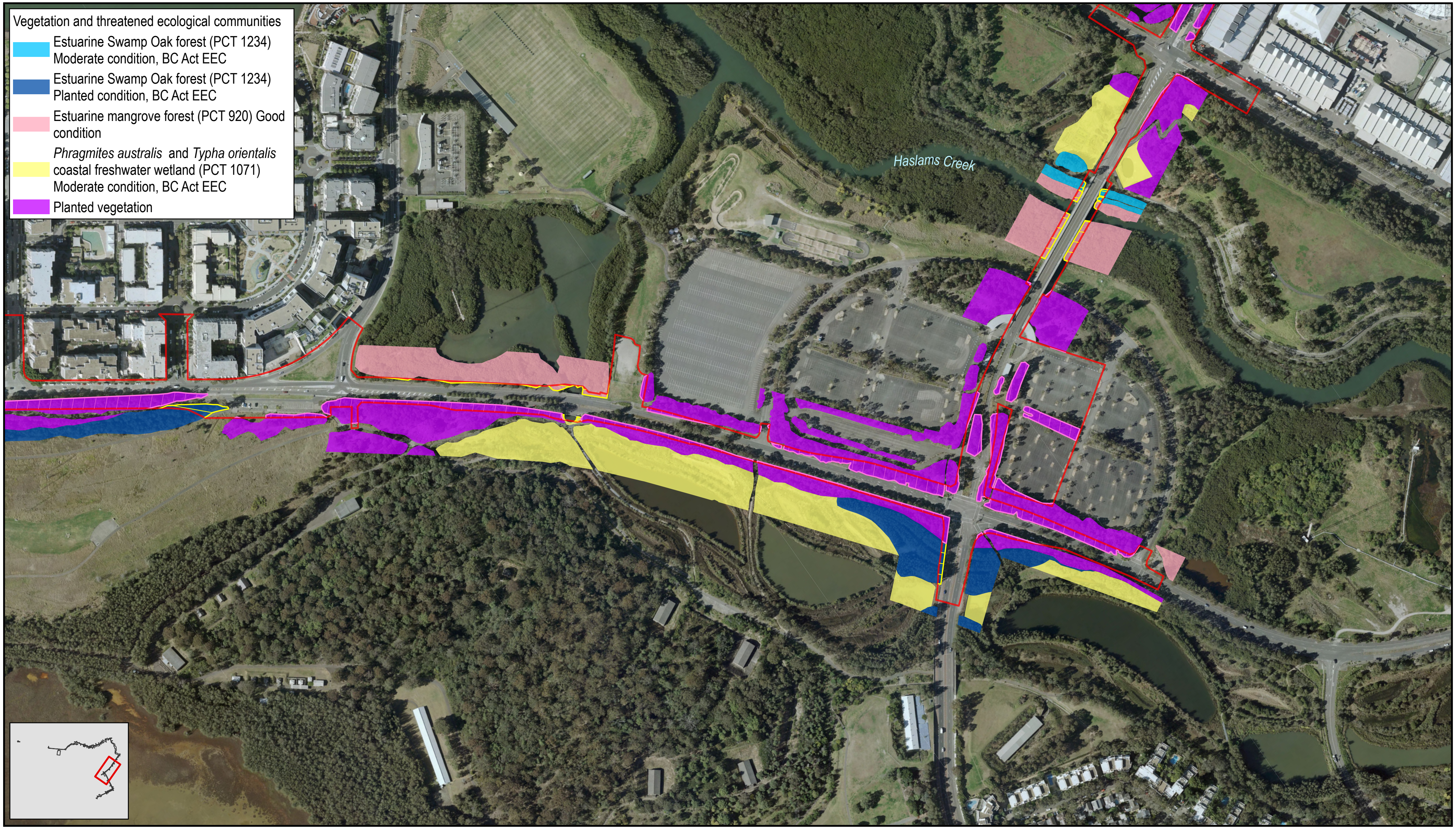

Legend
Project site
Areas requiring offset
Areas not requiring offset

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. 12557728
Revision No. A
Date 11/07/2023

Areas requiring biodiversity offset

FIGURE 11.1f

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Print date: 11 Jul 2023 - 11:58

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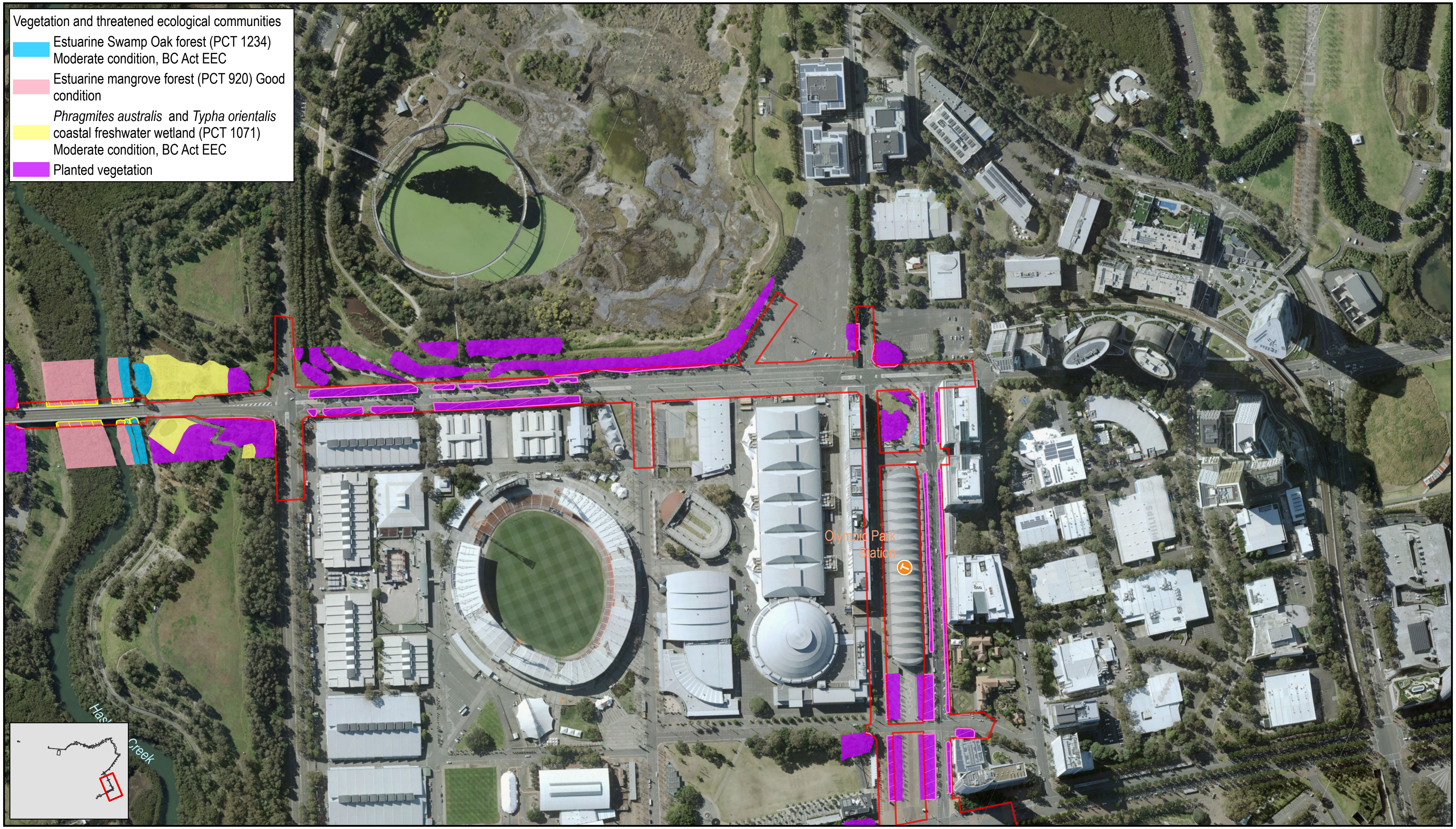

Legend
- Project site
- Areas requiring offset
- Areas not requiring offset

Paper Size ISO A4
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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Areas requiring biodiversity offset

FIGURE 11.1g

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Print date: 11 Jul 2023 - 11:59

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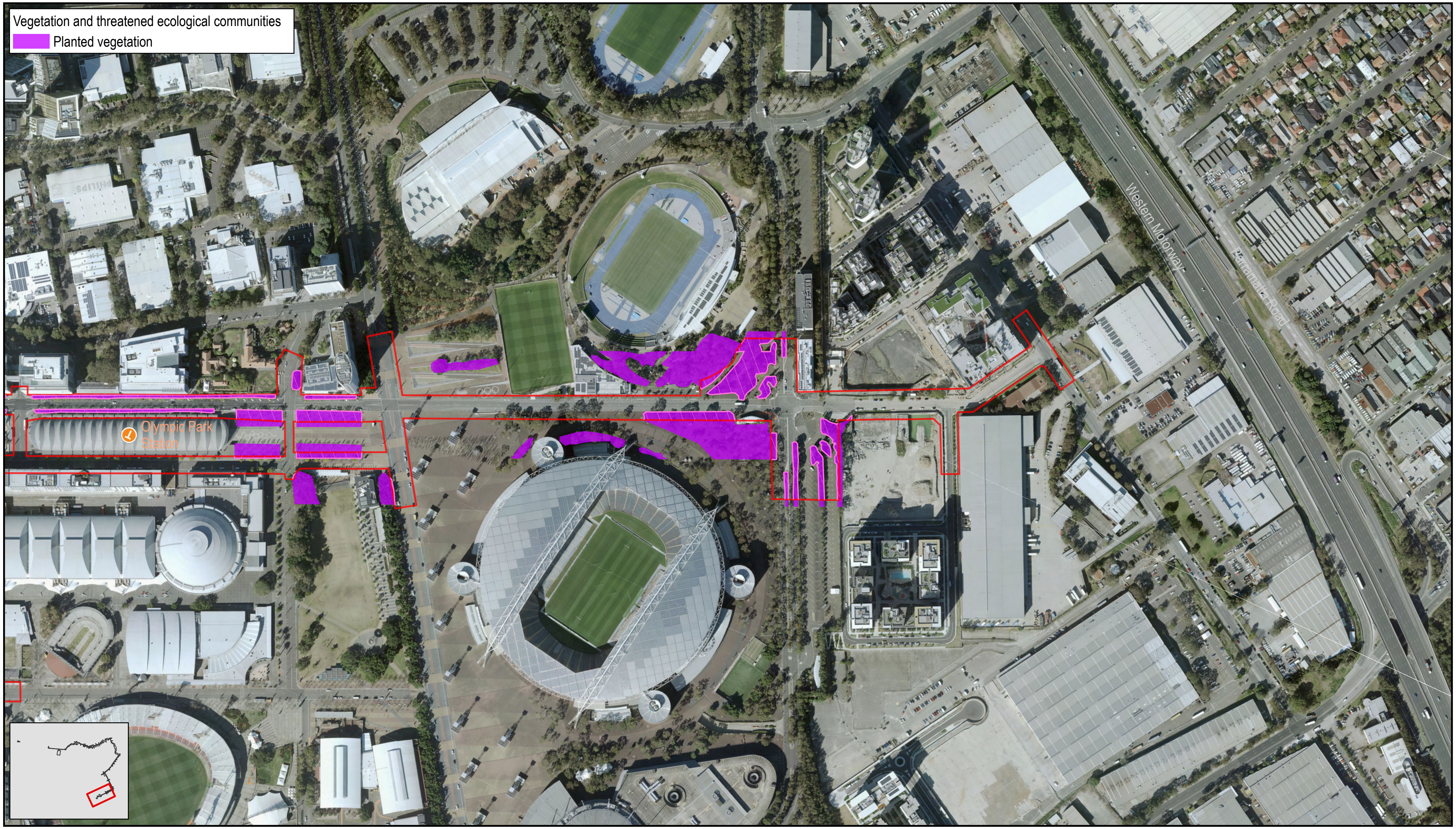

Legend

Project site

Areas not requiring offset

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Metres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

Areas requiring biodiversity offset

FIGURE 11.1h

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Print date: 11 Jul 2023 - 11:59

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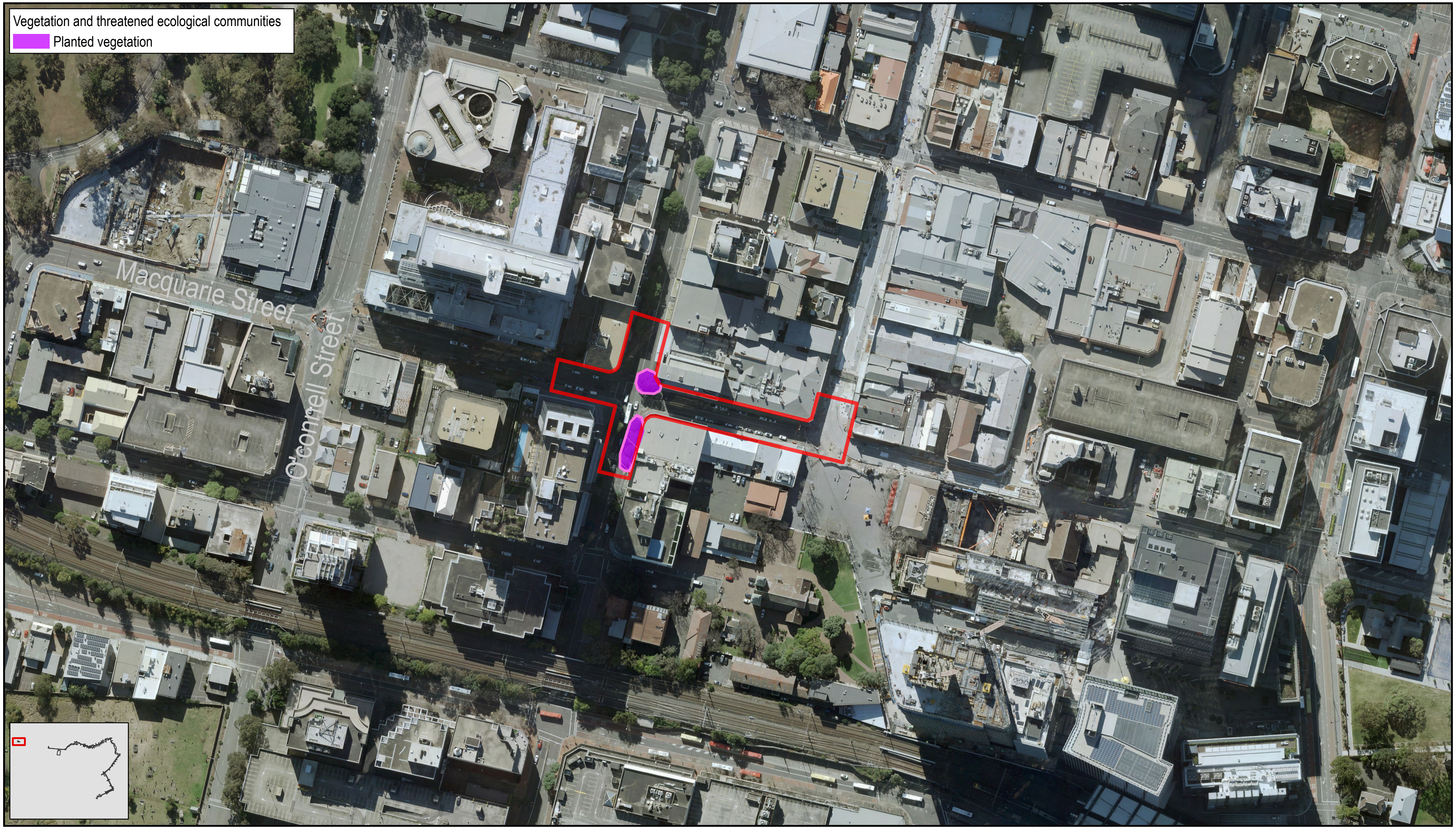

Legend

Project site

Areas not requiring offset

Paper Size ISO A4

0 50 100

Metres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Areas requiring biodiversity offset

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 11.1i

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Print date: 11 Jul 2023 - 11:59

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

11.1.3 Offsets for operational or prescribed impacts on threatened biota

Operational or prescribed impacts are difficult to quantify compared to direct, or even indirect, impacts (DPIE 2019b). The consent authority has the discretion to increase the number of biodiversity credits to be retired (or other conservation measures to be undertaken), if the justification is due to environmental, social and economic impacts of the proposed development (see Section 7.13(4) BC Act and clause 6.1.2 (b) BC Regulation). Given there is no set method for determining a suitable quantum of credits to offset a prescribed impact, the assessor should clearly document the decision pathway and justification for suggested credit numbers or other compensatory actions in the BDAR. Any biodiversity credits proposed are then additional to the baseline number of biodiversity credits determined by the BAM (DPIE 2019b).

The two new bridges over the Parramatta River would result in patches of vegetation surrounding the base of these bridges receiving less sunlight. This operational impact is likely to result in impacts to the health of this vegetation, ranging from death or dieback, through to changes in structural or floristic composition and diversity. To account for these potential impacts, a worst case scenario has been assumed, and all vegetation that will receive new shade as a result of bridge construction have been considered unlikely to survive.

Table 11.4 provides a summary of the increased hours of shading that is expected to be experienced by vegetation surrounding the bridges. Shadow modelling was provided by RPS Landscape Architects and considered whether vegetation would be subject to shade at four different times of year (March 21, June 21, September 21 and December 21), between 8am and 6pm. Any increase to the amount of shade (i.e. one hour or more) was taken to mean vegetation subject to increased shade would not survive. The worst case extent of shade was taken to be the limit of impacts, and the area of each vegetation type within the shaded area calculated. Figure 11.2 provides a summary of the area of impact to each vegetation type impacted by shading, based on the time of day and year when the area experiences the most shading.

To account for the impacts of shading over the operational life of the project, it is recommended that biodiversity offsets be provided.

Mitigation measures are proposed for each of the other potential indirect, operational or prescribed impacts arising from the project and, as described in section 10 these measures are likely to be effective. No additional residual impacts that would require the calculation of biodiversity impacts are anticipated.

Table 11.4 Change in hours of sunlight to vegetation at each bridge

Vegetation type	Date	Hours of sunlight without bridge		Hours of sunlight with bridge		Change in hours of sunlight	
Wentworth Point		West of bridge	East of bridge	West of bridge	East of bridge	West of bridge	East of bridge
Swamp Oak	21-Jun	8	10	7	9	-1	-1
Mangrove	21-Jun	8	10	5	10	-3	0
Saltmarsh	21-Jun	8	10	7	10	-1	0
Swamp Oak	21-Sep	9	10	8	10	-1	0
Mangrove	21-Sep	9	10	6	10	-3	0
Saltmarsh	21-Sep	9	10	9	10	0	0
Swamp Oak	21-Dec	10	10	9	10	-1	0
Mangrove	21-Dec	10	10	6	10	-4	0
Saltmarsh	21-Dec	10	10	9	10	-1	0
Swamp Oak	21-Mar	9	10	7	9	-2	-1
Mangrove	21-Mar	9	10	5	10	-4	0
Saltmarsh	21-Mar	9	10	8	10	-1	0

Vegetation type	Date	Hours of sunlight without bridge		Hours of sunlight with bridge		Change in hours of sunlight	
Melrose Park		West of bridge	East of bridge	West of bridge	East of bridge	West of bridge	East of bridge
Swamp Oak	21-Jun	9	9	9	9	0	0
Mangrove	21-Jun	9	9	0	4	-9	-5
Saltmarsh	21-Jun	9	9	8	9	-1	0
Swamp Oak	21-Sep	10	10	10	10	0	0
Mangrove	21-Sep	10	10	2	3	-8	-7
Saltmarsh	21-Sep	10	10	9	10	-1	0
Swamp Oak	21-Dec	10	10	10	10	0	0
Mangrove	21-Dec	10	10	1	2	-9	-8
Saltmarsh	21-Dec	10	10	10	10	0	0
Swamp Oak	21-Mar	10	10	10	10	0	0
Mangrove	21-Mar	10	10	1	3	-9	-7
Saltmarsh	21-Mar	10	10	9	10	-1	0
Camellia		West of bridge	East of bridge	West of bridge	East of bridge	West of bridge	East of bridge
Swamp Oak	21-Jun	9	9	9	1	0	-8
Mangrove	21-Jun	9	9	9	0	0	-9
Saltmarsh	21-Jun	10	10	10	10	0	0
Swamp Oak	21-Sep	10	10	10	5	0	-5
Mangrove	21-Sep	10	10	10	0	0	-10
Saltmarsh	21-Sep	10	10	10	10	0	0
Swamp Oak	21-Dec	10	10	10	8	0	-2
Mangrove	21-Dec	10	10	10	0	0	-10
Saltmarsh	21-Dec	10	10	10	10	0	0
Swamp Oak	21-Mar	10	10	10	5	0	-5
Mangrove	21-Mar	10	10	10	0	0	-10
Saltmarsh	21-Mar	10	10	10	10	0	0
Rydalmere		West of bridge	East of bridge	West of bridge	East of bridge	West of bridge	East of bridge
Swamp Oak	21-Jun	10	9	10	9	0	0
Mangrove	21-Jun	10	9	10	6	0	-3
Saltmarsh	21-Jun	10	10	10	10	0	0
Swamp Oak	21-Sep	10	10	10	10	0	0
Mangrove	21-Sep	10	10	10	9	0	-1
Saltmarsh	21-Sep	10	10	10	10	0	0
Swamp Oak	21-Dec	10	10	10	10	0	0
Mangrove	21-Dec	10	10	10	10	0	0
Saltmarsh	21-Dec	10	10	10	10	0	0
Swamp Oak	21-Mar	10	10	10	10	0	0

Vegetation type	Date	Hours of sunlight without bridge		Hours of sunlight with bridge		Change in hours of sunlight	
Mangrove	21-Mar	10	10	10	9	0	-1
Saltmarsh	21-Mar	10	10	10	10	0	0

Shading impacts have been calculated by using modelling data provided by Landscape Architects at RPS Group, that show the worst case scenarios for shading impacts, digitising the shaded areas using GIS software, and then calculating the area of impact of shade on surrounding vegetation, minus the direct impacts associated with the project site. Those area calculations have then been entered into the BAM calculator (Assessment ID00030218/BAAS17031/21/00030219_revision 7_shading impacts) to provide an indication of the number and type of additional credits that should be provided for indirect impacts.

Ecosystem credits were calculated for all vegetation zones within the estimated areas of shading, as shown on Figure 11.2. Additional species credits were calculated for confirmed candidate species known or with the potential to occur within the shade-impacted areas. Consistent with the approach for direct impacts, the Green and Golden Bell Frog was considered likely to occur only at the Wentworth Point portion of the project site.

Ecosystem credits that would be required to offset indirect impacts of the project are shown in Table 11.1 and credit trading groups to ensure 'like for like' provision of biodiversity offsets are summarised in Table 11.2.

Table 11.5 Ecosystem credits required to offset shading impacts of the project

Vegetation zone / PCT	Area (hectares)	Current vegetation integrity score	Future vegetation integrity score	Change in VI score	Potential SAII	Ecosystem credits required
920_good	0.73	34.8	0	34.8	False	13
1126_moderate	0.03	96.5	0	96.5	False	1
1234_moderate	0.07	40.6	0	40.6	False	1
1234_poor	0.08	15.2	0	15.2	False	1
Total credits						**16**

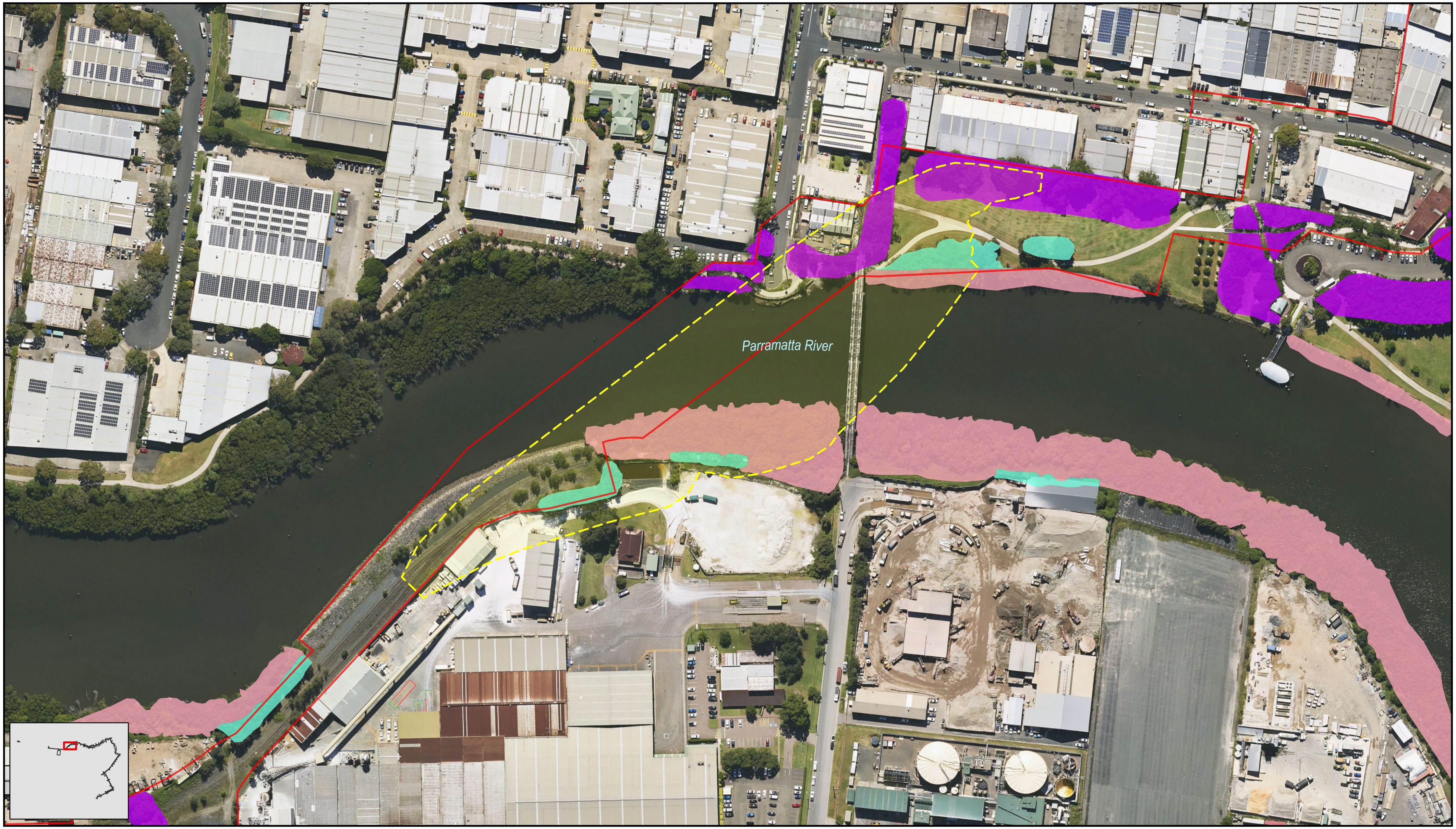
The areas impacted by shading are known or assumed to support five species credit entities. Species credit obligations are detailed in Table 11.6.

Table 11.6 Species credits required to offset shading impacts of the project

Species	BC Act	EPBC Act	Habitat impact (hectares)	Potential SAII	Species credits required
Wilsonia backhousei / Narrow-leafed Wilsonia	V	-	0.03*	False	1
Litoria aurea / Green and Golden Bell Frog	E	V	0.14	False	4
Myotis macropus / Southern Myotis	V	-	0.91	False	16
Calidris ferruginea / Curlew Sandpiper	E	CE	0.56	True	15
Limosa lapponica baueri / Bar-tailed Godwit (baueri)	-	V	0.56	False	10

Note: *Comprising all mapped occurrences of estuarine saltmarsh (PCT 1126) vegetation within the shade impacted areas.

These biodiversity offsets should be included in the total credit obligation for the project.



Legend

- Shade impacted areas
- Project site

Vegetation and threatened ecological communities

- Estuarine Swamp Oak forest (PCT 1234) Poor condition, BC Act EEC
- Estuarine mangrove forest (PCT 920) Good condition
- Planted vegetation

Paper Size ISO A4

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Metres

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Shade impact area - bridge between Camellia foreshore and Rydalmere

Project No. 12557728
Revision No. A
Date 11/07/2023

FIGURE 11.2a

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Print date: 11 Jul 2023 - 12:02

Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

Legend
Shade impacted areas
Project site

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

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Transport for NSW
Parramatta Light Rail Stage 2 EIS

Shade impact area - bridge between Melrose Park and Wentworth Point

Project No. **12557728**
Revision No. **A**
Date **11/07/2023**

FIGURE 11.2b

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Data source: Metromap Tile Service: Base Imagery Extracted 11/07/2023. Created by: lmanasan

11.1.4 Option to meet offset obligations/approach to delivering offsets

In accordance with the offset rules established by the Biodiversity Conservation Regulation 2017 (BC Regulation) there are various means by which offset obligations can be met. These include:

– retiring like for like credits from an established Biodiversity Stewardship Site
– retiring biodiversity credits in accordance with the 'variation rule' in clause 6.4 of the BC Regulation
– monetary payment directly into the Biodiversity Conservation Fund (BCF) or
– funding an approved biodiversity action.

Transport for NSW's preferred approach is to purchase existing credits where possible, with payment into the BCF for any shortfalls as necessary.

Despite the biodiversity credit output displayed for any EPBC Act-only listed entity, biodiversity credits cannot be created or traded under the NSW biodiversity offsets scheme and payments cannot be made into the Biodiversity Conservation Fund for any EPBC Act only listed entity. Transport for NSW should contact DCCEEW as the relevant agency for meeting any requirements of an EPBC Act approval for impacts on the Bar-tailed Godwit, which is not listed under the BC Act.

11.2 Offsets for impacts on key fish habitat

Under the *Policy and guidelines for fish habitat conservation and management* (DPI 2013) impacts to key fish habitat are to be offset to ensure no net loss. DPI (2013) calculates habitat compensation on a minimum 2:1 basis for all key fish habitat lost; a greater compensation ratio may be considered if offsets cannot be sourced in the vicinity of the impact or are not of the same habitat type as that impacted. A rate of $52 per square metre was identified in DPI (2013) for offset payments, with an updated offset cost of $56.75 per square metre provided by DPI Fisheries in December 2021. This rate is consistent with aquatic ecosystem services rates calculated by Costanza et al. (1997, cited in DPI 2013), and is subject to annual inflation from 1 July each financial year. It is noted, however, that DPI prefers on-ground rehabilitation in the local area.

The project would impact the following key fish habitat:

– removal of 0.72 hectares of mangroves (7,214 square metres)
– removal of 0.03 hectares of saltmarsh (265 square metres)
– construction of piers in the Parramatta River.

There would also be shading impacts on mangroves and saltmarsh, which may increase the offset liability for these communities. A calculation of offsets for pier construction would be undertaken once the design is confirmed, and should include the area of impact of the piles and associated scour protection.

Transport for NSW is investigating options for on-ground works to offset biodiversity liabilities under the FM Act. This includes investigating projects in Newington Nature Reserve and the Badu Mangroves in Bicentennial Park or other areas within Parramatta River estuary.

Mitigation measures are recommended in section 10.2 including rehabilitation of marine vegetation in parts of the project site that are not required for permanent infrastructure (for example the works area adjacent to the new or upgraded bridges), as well as underneath bridges where possible. A habitat restoration and revegetation plan would be prepared to guide rehabilitation of marine vegetation.

11.3 Offsets for impacts on MNES

11.3.1 Offset requirements

The project has been determined a controlled action due to impacts on threatened species and ecological communities listed under the EPBC Act, in particular the Green and Golden Bell Frog.

The NSW Government and Australian Government finalised amendments to the Assessment Bilateral Agreement after changes to NSW legislation, and the Amending Agreement no. 1 was signed on 24 March 2020. The Australian Government formally endorsed the NSW Biodiversity Offsets Scheme (BOS) through the EPBC Act Condition-setting Policy (DAWE 2020).

Under the bilateral agreement, only one decision including conditions on approval is made by NSW, accounting for NSW MNES. The EPBC Act condition setting policy (DAWE 2020) notes that where a project demonstrates compliance with an endorsed state or territory policy, the proponent will not be required to simultaneously comply with the corresponding Australian Government policy. As such, Transport for NSW is not required to calculate offsets separately using the EPBC Act offsets policy (DSEWPaC 2012), unless offsets are required for a matter not covered by the BOS. Assessments of significance have been prepared for threatened and migratory species and the conclusion is that the project would not have a significant impact on any MNES (see Appendix G).

To meet offsets required for Commonwealth listed entities for controlled actions under the NSW BOS, Transport for NSW would:

– retire biodiversity credits based on the like-for-like provisions in the BC Regulation or
– pay into the BCF, noting it is Transport for NSW’s responsibility to notify the Biodiversity Conservation Trust (BCT) that their payment is for a controlled action, as the BCT is required to meet the Commonwealth offset requirement component in a like-for-like manner.

Biodiversity credits would be retired prior to construction of the project commencing.

11.3.2 Offset strategy

This BDAR includes the identification and assessment of potentially affected MNES. The project is likely to have a significant impact on the Green and Golden Bell Frog, which is also listed under the BC Act. No threatened species that are not listed under the BC Act would be significantly impacted by the project. Species credits have been calculated in accordance with BAM for this species and will be delivered in accordance with the BOS and BC Act, pursuant to the agreement bilateral (refer Table 11.7).

Table 11.7 Offset requirements for MNES – species credits under the BAM

Species	Direct impact (hectares)	Shading impacts (hectares)	Species credits required
Litoria aurea / Green and Golden Bell Frog	1.52	0.14	20 + 4

11.4 Offsets for impacts on the Millennium Parklands

Biodiversity offsets would be procured for the project and vegetation rehabilitation would be conducted to replace trees and habitats lost from the Millennium Parklands as a result of the project. In particular, the following would be undertaken:

– offsetting impacts on native biodiversity (native vegetation, threatened species and migratory species) through the NSW Biodiversity Offsets Scheme (see section 11.1). Transport for NSW is investigating the possibility of supporting local offsets in the Sydney Olympic Park area.
– offsetting impacts on marine vegetation in accordance with the DPI Fisheries requirements, which may involve rehabilitation and revegetation of mangroves in parts of the project site, Newington Nature Reserve wetland and other areas of the Parramatta River (see section 11.2). A habitat restoration and revegetation plan would guide rehabilitation planning, implementation, monitoring and maintenance of disturbed areas including local, native plantings in conjunction with other landscape treatments to minimise impacts to local ecosystems (see section 10.2).
– a tree offset strategy would be developed to offset the loss of trees not covered by the BC Act or FM Act offset requirements and achieve a net increase in tree number and canopy. The strategy would be developed, and locations of replacement trees confirmed, in consultation with Sydney Olympic Park Authority, City of Parramatta Council and City of Ryde Council (see section 10.2).

12. Conclusion

12.1 Existing environment

Detailed environmental investigations have been conducted for the project. The field surveys were carried out between February 2019 and January 2022. Detailed survey information also exists for the Millennium Parklands, Newington Nature Reserve and Sydney Olympic Park, and has also been relied on for this assessment.

Five native PCTs were identified in the project site, of which three are listed as threatened ecological communities under the BC Act, one is listed as a threatened ecological community under the EPBC Act, and two are protected marine vegetation under the FM Act. Seven threatened species were recorded in the study area during surveys. Several migratory waders are also known to occur. A number of additional threatened species are also likely to occur on occasion.

Key threatened and migratory species known to occur in the study area include:

– the Parramatta key population of the Green and Golden Bell Frog which occurs in the locality
– a population of *Wilsonia backhousei* present in Newington Nature Reserve
– the breeding pair of the White-bellied Sea-eagle in Newington Nature Reserve
– the Large-footed Myotis, known to breed in in a culvert in the Millennium Parklands
– an important population of Latham's Snipe, known from wetlands in the Sydney Olympic Park area
– mapped important habitat for the Bar-tailed Godwit and Curlew Sandpiper.

Key protected and sensitive lands in the study area include:

– Newington Nature Reserve
– coastal wetlands
– key fish habitat.

12.2 Potential impacts

Construction of the project would result in direct impacts on up to 2.43 hectares of native vegetation and 5.51 hectares of planted vegetation. The removal of mangroves would result in the loss of around 40 hollow-bearing trees, which may provide roosting habitat for microbats.

The project would impact key fish habitat associated with the Parramatta River. Piers in the river would comprise instream structures but would not block fish passage noting that in-stream connectivity would be maintained around piers. The presence of piles, pile caps and piers in the Parramatta River floodplain reduce the efficiency of the floodplain in conveying flood water downstream. This would result in slightly higher flood levels on the upstream side of the bridge structures. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve.

The project has the potential to have indirect and prescribed impacts on adjacent wetland habitats, including Newington Nature Reserve Wetland and Narawang Wetland during construction and operation, through changes to hydrology and water quality. Construction and operation would create noise and vibration that may affect roosting microbats. The project site is outside the buffer area of the White-bellied Sea-eagle nest.

The project would directly impact the following threatened ecological communities:

– 0.03 hectares of Coastal Saltmarsh EEC listed under the BC Act/VEC listed under the EPBC Act
– 0.01 hectares of Freshwater Wetlands on Coastal Floodplains EEC listed under the BC Act
– 0.62 hectares of Swamp Oak Floodplain Forest EEC listed under the BC Act
– 1.05 hectares of Sydney Turpentine Ironbark Forest CEEC listed under the BC Act.

There would be no direct impact on the remnant Sydney Turpentine Ironbark Forest CEEC listed under the BC Act and EPBC Act that occurs in Newington Nature Reserve. An assessment of potentially serious and irreversible impacts (SAII) has been provided for this community. However, the project would result in the removal of 1.05 hectares of planted vegetation, on an artificial landform of unknown provenance. This vegetation has been considered to form part of the CEEC as the final determination for the community does not exclude planted stands nor does it require a natural soil profile, for vegetation to be considered the CEEC (NSW TSSC 2019). The project would remove 1.05 hectares of planted vegetation that broadly corresponds with the description of this community provided in the final determination.

An assessment of potential SAII has been provided for the Curlew Sandpiper. The project would have the following impacts on this migratory species:

– loss of 0.35 hectares of mapped important habitat
– potential indirect impacts on adjacent wetland habitat through sedimentation, erosion and mobilisation of contaminants. These impacts would be mitigated through environmental controls during construction and design features during operation
– potential indirect impacts on Newington Nature Reserve wetland through slightly increased flooding (50 millimetres in the one per cent AEP flood event)
– no impact on wetland habitat or mudflats associated with Homebush Bay, the Waterbird Reserve or Badu Mangroves.

An assessment of potential SAII has also been provided for Sydney Turpentine Ironbark Forest. The project would have the following impacts on this CEEC:

– loss of 1.05 hectares of planted vegetation that broadly corresponds with the description of this community provided in the final determination.

The project is unlikely to result in any other impacts to this potential SAII entity, as the vegetation to be impacted is planted on an artificial soil profile and is unlikely to contribute to the ongoing persistence or genetic diversity of any natural stands of this CEEC.

12.3 Offset requirements

The majority of the project site contains non-native vegetation or other site features that do not comprise habitat for threatened biota and do not require biodiversity offsets under the BAM. The project would result in direct impacts to 50.95 hectares of buildings, infrastructure and hardstand as well as areas of planted vegetation and exotic grassland, that do not require the calculation of offsets.

Offsets are required for residual impacts on 2.43 hectares of native vegetation and threatened species habitat that cannot be avoided or mitigated. Credit requirements for direct impacts resulting from the project were calculated using the BAM calculator and comprise:

– 13 Estuarine mangrove forest (PCT 920) credits
– 1 Estuarine saltmarsh (PCT 1126) credit
– 10 Estuarine swamp oak forest (PCT 1234) credits
– 1 *Phragmites australis* and *Typha orientalis* coastal freshwater wetland (PCT 1071) credit
– 11 Sydney Turpentine Ironbark Forest (PCT 1281) credits
– 1 *Wilsonia backhousei* species credit
– 20 Green and Golden Bell Frog species credits
– 28 Southern Myotis species credits
– 6 Bar-tailed Godwit species credits
– 9 Curlew Sandpiper species credits.

Construction of the two bridges over the Parramatta River would result in shading impact to 0.91 hectares of native vegetation around the bridge structures. Additional credits are recommended for shade impacts to vegetation and known or potential habitat surrounding each proposed bridge structure, as follows:

– 13 Estuarine mangrove forest (PCT 920) credits
– 1 Estuarine saltmarsh (PCT 1126) credit
– 2 Estuarine swamp oak forest (PCT 1234) credits
– 1 *Wilsonia backhousei* species credit
– 4 Green and Golden Bell Frog species credits
– 16 Southern Myotis species credits
– 10 Bar-tailed Godwit species credits
– 15 Curlew Sandpiper species credits.

The Australian Government formally endorsed the NSW Biodiversity Offsets Scheme (BOS) in March 2020. Offset requirements for threatened biota listed under the EPBC Act likely to be significantly impacted (comprising the Green and Golden Bell Frog) have been calculated in accordance with BAM and will be delivered in accordance with the BOS and BC Act, pursuant to the assessment bilateral agreement.

Impacts to key fish habitat are to be offset to ensure no net loss in accordance with the Policy and guidelines for fish habitat conservation and management. Transport for NSW is investigating options for on-ground works to offset biodiversity liabilities under the FM Act. This includes investigating projects in Newington Nature Reserve and the Badu Mangroves in Bicentennial Park or other areas within the Parramatta River estuary.

12.4 Mitigation

The following mitigation measures are recommended:

– minimising clearing vegetation to be investigated during the next stages of design, particularly in the Millennium Parklands
– minimising of overhead wiring adjacent to Newington Nature Reserve and Narawang Wetland, along Holker Busway and the bridges over the Parramatta River to limit impacts on the Grey-headed Flying-fox, White-bellied Sea-eagle and migratory waders
– bridge design to minimise impacts to fish habitat and mangroves
– appropriate design of lighting in compliance with the *National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds* (DotE 2020) and to prevent light spill in the Sydney Olympic Park area, including the prioritisation of lighting fixtures with reduced or filtered blue, violet and ultra-violet wavelengths
– preparation of a Biodiversity Management Plan (BMP) including relevant subplans such as threatened species management plans for the Green and Golden Bell Frog and microbats
– design and implementation of mitigation measures for the protection of sensitive areas outside the project site during construction, particularly with regards to management of contaminated and acid sulfate soils and stormwater runoff
– protocols developed in conjunction with Sydney Olympic Park Authority ecologists for landscaping, hygiene and biosecurity matters during minor works and construction phases within Sydney Olympic Park
– weed and pest management measures, including maintenance periods
– procedures for the management and assessment of unexpected finds
– pre-clearing surveys during minor works and construction phases in the vicinity of areas of known threatened species habitat, including surveys to identify and manage removal of hollow-bearing trees
– management of fauna and habitat features during clearing, with particular attention regarding the protection of Green and Golden Bell Frog and migratory wader habitat outside the project site, developed in consultation with ecologists from Sydney Olympic Park Authority
– timing of construction works to minimise impacts on threatened microbats roosting at Holker Street or other culverts, and installation of nest boxes or inclusion of microbat-friendly roosts in the design of bridge structures to mitigate the loss of hollows as a result of mangrove clearing

- consideration of maintenance of connectivity for Green and Golden Bell Frog habitat, and quality of habitat, with frog-proof fencing and other measures, to be designed based on advice from Sydney Olympic Park Authority ecologists
- monitoring of construction and operation impacts on *Wilsonia backhousei* and threatened fauna species including the Green and Golden Bell Frog, White-bellied Sea-eagle and Southern Myotis
- rehabilitation of disturbed areas not affected by permanent works following construction
- mitigation of edge effects and light spill with native landscaping in sensitive areas such as adjacent to Newington Nature Reserve, along Holker Busway and Hill Road with regard to the *National Light Pollution Guidelines for Wildlife* (Department of the Environment and Energy, 2020)
- planting of feed trees for the Grey-headed Flying-fox would be considered, with a particular focus on locally indigenous winter flowering species, such as Forest Red Gum (*Eucalyptus tereticornis*), Spotted Gum (*Corymbia maculata*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*).

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Appendix A

Consistency with Minimum Information Requirements for Biodiversity Development Assessment Reports

Table A.1 Minimum BDAR requirements

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
Introduction	Chapters 2 and 3	*Information* Introduction to the biodiversity assessment including:	Section 1
		brief description of the proposal	Section 1.2
		identification of subject land boundary, including: – operational footprint – construction footprint indicating clearing associated with temporary construction facilities and infrastructure	Figure 1.2
		general description of the subject land	Section 1.2
		sources of information used in the assessment, including reports and spatial data	Section 3.1, 13
		Maps and Tables (in document)	
		Map of the subject land boundary showing the final proposal footprint, including the construction footprint for any clearing associated with temporary/ancillary construction facilities and infrastructure	Figure 1.1 and Figure 1.2
Landscape context	Sections 3.1 and 3.2, Appendix E	Identification of landscape features at the development site, including:	Section 4
		– general description of subject land topographic and hydrological setting, geology and soils	Sections 4.2 and 4.3
		– per cent native vegetation cover in the assessment area (as described in BAM Section 3.2)	Section 5.1
		– IBRA bioregions and subregions (as described in BAM sub-section 3.1.3(2.))	Section 4.1
		– rivers and streams classified according to stream order (as described in BAM sub-section 3.1.3(3.) and Appendix E)	Section 4.3
		– wetlands within, adjacent to and downstream of the site (as described in BAM sub-section 3.1.3(3.))	Section 4.3 and 5.8
		– connectivity of different areas of habitat (as described in BAM sub-section 3.1.3(5–6.))	Section 4.7
		– karst, caves, crevices, cliffs, rocks and other geological features of significance and for vegetation clearing proposals, soil hazard features (as described in BAM sub-section s 3.1.3(7.) and 3.1.3(12.)	Section 4.2.3
		– areas of outstanding biodiversity value occurring on the subject land and assessment area (as described in BAM sub-section 3.1.3(8–9.))	Section 4.7
		– any additional landscape features identified in any SEARs for the proposal	Section 5.8
		– NSW (Mitchell) landscape on which the subject land occurs	Section 4.5

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
		Maps and Tables (in document)	
		Site Map – Boundary of subject land – Cadastre of subject land – Landscape features identified in BAM sub-section 3.1.3	Figure 4.1
		Location Map – Digital aerial photography at 1:1,000 scale or finer – Boundary of subject land – Assessment area, (ie the subject land and either 1500 metres buffer area or 500 metres buffer for linear development – Landscape features identified in BAM sub-section 3.1.3 – Additional detail (eg local government area boundaries) relevant at this scale	Figure 4.1
		Landscape features identified in BAM sub-section 3.1.3 and to be shown on the Site Map and/or Location map include: – IBRA bioregions and subregions – rivers, streams and estuaries – wetlands and important wetlands – connectivity of different areas of habitat – karst, caves, crevices, cliffs, rocks and other geological features of significance and if required, soil hazard features – areas of outstanding biodiversity value occurring on the subject land and assessment area – any additional landscape features identified in any SEARs for the proposal – NSW (Mitchell) landscape on which the subject land occurs	Figure 4.1 Figure 5.3
		Data (to be supplied)	
		All report maps as separate jpeg files Individual digital shapefiles of: – subject land boundary – assessment area (i.e. subject land and 1500 metres buffer area) boundary – cadastral boundary of subject land – areas of native vegetation cover – landscape features	Provided separately to BCS

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
Native vegetation	Chapter 4, Appendix A and Appendix H	*Information*	
		Identify native vegetation extent within the subject land, including cleared areas and evidence to support differences between mapped vegetation extent and aerial imagery (as described in BAM Section 4.1(1–3.) and sub-section 4.1.1).	Section 5
		Provide justification for all parts of the subject land that do not contain native vegetation (as described in BAM sub-section 4.1.2)	Section 5.2 Section 5.3.3
		Review of existing information on native vegetation including references to previous vegetation maps of the subject land and assessment area (described in BAM Section 4.1(3.) and sub-section 4.1.1)	Section 5.3.1
		Describe the systematic field-based floristic vegetation survey undertaken in accordance with BAM Section 4.2	Section 3.2.2
		Where relevant, describe the use of more appropriate local data, provide reasons that support the use of more appropriate local data and include the written confirmation from the decision-maker that they support the use of more appropriate local data (as described in BAM sub-section 1.4.2 and Appendix A)	Not applicable
		For each PCT within the subject land, describe:	
		– vegetation class	Section 5.3.3
		– extent (ha) within subject land	Section 5.3
		– plant species relied upon for identification of the PCT and relative abundance of each species	Section 5.3.3
		– evidence used to identify a PCT including any analyses undertaken, references/sources, existing vegetation maps (BAM Section 4.2(1–3.))	Section 5.3.3
		– if relevant, TEC status including evidence used to determine vegetation is the TEC (BAM sub-section 4.2.2(1–2.)	Section 5.3.4
		Describe the vegetation integrity assessment of the subject land, including:	
		– identification and mapping of vegetation zones (as described in BAM sub-section 4.3.1)	Section 5.3.3
		– assessment of patch size (as described in BAM sub-section 4.3.2)	Section 4.6.2
		– use of relevant benchmark data from BioNet Vegetation Classification (as described in BAM sub-section 4.3.3(5.))	Section 5.3.3
		– survey effort (ie number of vegetation integrity survey plots) as described in BAM sub-section 4.3.4(1–2.)	Section 5.3.2
		Where use of more appropriate local benchmark data is proposed (as described in BAM sub-section 1.4.2, BAM sub-section 4.3.3(5.) and BAM Appendix A):	
		– identify the PCT or vegetation class for which local benchmark data will be applied	Not applicable
		– identify published sources of local benchmark data (if benchmarks obtained from published sources)	Not applicable
		– describe methods of local benchmark data collection (if reference plots used to determine local benchmark data)	Not applicable

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
		– provide justification for use of local data rather than BioNet Vegetation Classification benchmark values	Not applicable
		– provide written confirmation from the decision-maker that they support the use of local benchmark data	Not applicable
		Maps and Tables (in document)	
		Map of native vegetation extent within the subject land at scale not greater than 1:10,000 including identification of cleared areas (as described in BAM Section 4.1(1–3.)) and all parts of the subject land that do not contain native vegetation (BAM sub-section 4.1.2)	Figure 4.1, Figure 5.1
		Map of PCTs within the subject land (as described in BAM Section 4.2(1.))	Figure 5.1
		Map of vegetation zones within the subject land (as described in BAM sub-section 4.3.1)	Figure 5.1
		Map the location of floristic vegetation survey plots and vegetation integrity survey plots relative to PCTs boundaries	Figure 5.1
		Map of TEC distribution on the subject land and table of TEC listing, status and area (ha)	Figure 5.2, Table 5.4
		Map of patch size locations for each native vegetation zone and table of patch size areas (as described in BAM sub-section 4.3.2)	Figure 4.1, Table 4.5
		Table of current vegetation integrity scores for each vegetation zone within the site and including: – composition condition score – structure condition score – function condition score – presence of hollow bearing trees	Table 5.6 Appendix E
		Data (to be supplied)	
		All report maps as separate jpeg files	Provided separately to BCS
		Plot field data (MS Excel format) Plot field data sheets	Provided separately to BCS Appendix E
		Digital shape files of: – PCT boundaries within subject land – TEC boundaries within subject land – vegetation zone boundaries within subject land – floristic vegetation survey and vegetation integrity plot locations	Provided separately to BCS

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
Threatened species	Chapter 5	*Information* Identify ecosystem credit species likely to occur on the subject land, including:	
		– list of ecosystem credit species derived from the BAM-C (as described in BAM sub-section 5.1.1 and Section 5.2(1.))	Section 6.3.1
		– justification and supporting evidence for exclusion of any ecosystem credit species based on geographic limitations, habitat constraints or vagrancy (as described in BAM sub-sections 5.2.1 and 5.2.2)	Not applicable
		– justification for addition of any ecosystem credit species to the list	Not applicable
		Identify species credit species likely to occur on the subject land, including:	
		– list of species credit species derived from the BAM-C (as described in BAM sub-section 5.1.1)	Section 6.3.2
		– justification and supporting evidence for exclusions based on geographic limitations, habitat constraints or vagrancy (as described in BAM sub-sections 5.2.1 and 5.2.2)	Section 6.3.2
		– justification and supporting evidence for exclusions based on degraded habitat constraints and/or microhabitats on which the species depends (as described in BAM sub-section 5.2.2)	Table 6.4
		– justification for addition of any species credit species to the list	Section 6.3.2
		From the list of candidate species credit species, identify:	
		– species assumed present within the subject land (if relevant) (as described in BAM sub-section 5.2.4(2.a.))	Section 6.3.2
		– species present within the subject land on the basis of being identified on an important habitat map for a species (as described in BAM sub-section 5.2.4(2.d.))	Section 6.3.2
		– species for which targeted surveys are to be completed to determine species presence (sub-section 5.2.4(2.b.))	Section 6.3.2
		– species for which an expert report is to be used to determine species presence (sub-section 5.2.4(2.c.))	Not applicable
		Present the outcomes of species credit species assessments from:	
		– threatened species survey (as described in BAM Section 5.2.4)	Section 6.3.3
		– expert reports (if relevant) including justification for presence of the species and information used to make this determination (as described in BAM Section 5.2.4 and 5.3, Box 3)	Not applicable
		Where survey has been undertaken include detailed information on:	
		– survey method and effort, (as described in BAM Section 5.3) – justification of survey method and effort (e.g. citation of peer-reviewed literature) if approach differs from the Department’s taxa-specific survey guides or where no relevant guideline has been published – timing of survey in relation to requirements in the TBDC or the Department’s taxa-specific survey guides. Where survey was undertaken outside these guides include justification for the timing of surveys – survey personnel and relevant experience	Section 3.2.2 Section 3.2.3 Section 3.4 Section 3.8

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
		– describe any limitations to surveys and how these were addressed/overcome	
		Where an expert report has been used in place of survey (as described in BAM Section 5.3, Box 3), include:	
		– justification of the use of an expert report – identify the expert, provide evidence of their expert credentials and Departmental approval of expert status – all requirements of Box 3 have been addressed in the expert report	Not applicable
		Where use of local data is proposed (BAM sub-section 1.4.2):	
		– identify relevant species – identify data to be amended – identify source of information for local data, e.g. published literature, additional survey data, etc. – justify use of local data in preference to VIS Classification or TBDC data – provide written confirmation from the decision-maker that they support the use of local data	Not applicable
		Species polygon completed for species credit species present within the subject land (assumed present or determined on the basis of survey, expert report or important habitat map) ensuring that:	
		– the unit of measure for each species is documented	Section 6.3.3
		– for species assessed by area: – the polygon includes the extent of suitable habitat for the target species within the subject land (as described in BAM sub-section 5.2.5) – a description of, and evidence-based justification for, the habitat constraints, features or microhabitats used to map the species polygon including reference to information in the TBDC for that species and any buffers applied	Section 6.3.3 Section 11.1.2
		– for species assessed by counts of individuals: – the number of individual plants present on the subject land (as described in BAM sub-section 5.2.5(3.)) – the method used to derive this number (i.e. threatened species survey or expert report) and evidence-based justification for the approach taken – the polygon includes all individuals located on the subject land with a buffer of 30 metres around the individuals or groups of individuals on the subject land	Not applicable
		Identify the biodiversity risk weighting for each species credit species identified as present within the subject land (as described in BAM Section 5.4)	Section 6.3.3
		Maps and Tables (in document)	
		Table showing ecosystem credit species in accordance with BAM Section 5.1.1, and identifying: – the ecosystem credit species removed from the list – the sensitivity to gain class of each species	Table 6.2

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
		Table detailing species credit species in accordance with BAM Section 5.2 and identifying: – the species credit species removed from the list of species because the species is considered vagrant, out of geographic range or the habitat or micro habitat features are not present – the candidate species credit species not recorded on the subject land as determined by targeted survey, expert report or important habitat map	Table 6.3 Table 6.4
		Table detailing species credit species recorded or assumed as present within the subject land, habitat constraints or microhabitats associated with the species, counts of individuals (flora)/extent of suitable habitat (flora and fauna) (as described in BAM sub-section 5.2.6) and biodiversity risk weighting (BAM Section 5.4)	Table 6.5
		Map indicating the GPS coordinates of all individuals of each species recorded within the subject land and the species polygon for each species (as described in BAM sub-section 5.2.5)	Figure 6.2 Figure 6.3 Figure 6.4 Figure 6.5
		Data (to be supplied)	
		Digital shape files of suitable habitat identified for survey for each candidate species credit species Survey locations including GPS coordinates of any plots, transects, grids Digital shape files of each species polygon including GPS coordinates of located individuals Species polygon map in jpeg format Expert reports and any supporting data used to support conclusions of the expert report Field data sheets detailing survey information including prevailing conditions, date, time, equipment used, etc	Provided separately to BCS
Prescribed impacts	Chapter 6	*Information* Identify potential prescribed biodiversity impacts on threatened entities, including: – karst, caves, crevices, cliffs, rocks and other geological features of significance (as described in BAM sub-section 6.1.1) – occurrences of human-made structures and non-native vegetation (as described in BAM sub-section 6.1.2) – corridors or other areas of connectivity linking habitat for threatened entities (as described in BAM sub-section 6.1.3) – water bodies or any hydrological processes that sustain threatened entities (as described in BAM sub-section 6.1.4) – protected animals that may use the proposed wind farm development site as a flyway or migration route (as described in BAM sub-section 6.1.5) – where the proposed development may result in vehicle strike on threatened fauna or on animals that are part of a threatened ecological community (as described in BAM sub-section 6.1.6)	Section 8
		Identify a list of threatened entities that may be dependent upon or may use habitat features associated with any of the prescribed impacts	Section 8
		Describe the importance of habitat features to the species including, where relevant, impacts on life-cycle or movement patterns (e.g. sub-section 6.1.3)	Section 8

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
		Where the proposed development is for a wind farm: – identify a candidate list of protected animals that may use the development site as a flyway or migration route, including: resident threatened aerial species, resident raptor species and nomadic and migratory species that are likely to fly over the proposal area (as described in BAM sub-section 6.1.5) – provide details of targeted survey for candidate species of wind farm developments undertaken in accordance with BAM sub-section 6.1.5(2–3.) – predict the habitual flight paths for nomadic and migratory species likely to fly over the subject land and map the likely habitat for resident threatened aerial and raptor species (BAM sub-section 6.1.5(4.))	Not applicable
		Maps and Table (in document)	
		Map showing location of any prescribed impact features (i.e. karst, caves, crevices, cliffs, rocks, human-made structures, etc.) Maps of habitual flight paths for nomadic and migratory species likely to fly over the site and maps of likely habitat for threatened aerial species resident on the site (for wind farm developments only)	Figure 5.3
		Data (to be supplied)	
		Digital shape files of prescribed impact feature locations Prescribed impact features map in jpeg format	Provided separately to BCS
Avoid and minimise impacts	Chapter 7	*Information* Demonstration of efforts to avoid and minimise impacts on biodiversity values (including prescribed impacts) associated with the proposal location in accordance with Chapter 7, including an analysis of alternative: – modes or technologies that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed mode or technology – routes that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed route – alternative locations that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed location – alternative sites within a property on which the proposal is located that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed site	Section 9.1
		Describe efforts to avoid and minimise impacts (including prescribed impacts) to biodiversity values through proposal design (as described in BAM Sections 7.1 and 7.2)	Section 9.1
		Identification of any other site constraints that the proponent has considered in determining the location and design of the proposal (as described in BAM Section 7.2.1(3.))	Section 9.1
		Maps and Table (in document)	
		Table of measures to be implemented to avoid and minimise the impacts of the proposal, including action, outcome, timing and responsibility	Table 10.1
		Map of alternative footprints considered to avoid or minimise impacts on biodiversity values; and of the final proposal footprint, including construction and operation	Section 9.1, photos 5-8

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
		Maps demonstrating indirect impact zones where applicable	Not applicable
		Data (to be supplied)	
		Digital shape files of: – alternative and final proposal footprint – direct and indirect impact zones – Maps in jpeg format	Not applicable
Assessment of impacts	Chapter 8, Sections 8.1 and 8.2	*Information*	
		Determine the impacts on native vegetation and threatened species habitat, including a description of direct impacts of clearing of native vegetation, threatened ecological communities and threatened species habitat (as described in BAM Section 8.1)	Section 9.3
		Assessment of indirect impacts on vegetation and threatened species and their habitat including (as described in BAM Section 8.2): – description of the nature, extent, frequency, duration and timing of indirect impacts of the proposal – documenting the consequences to vegetation and threatened species and their habitat including evidence-based justifications – reporting any limitations or assumptions, etc. made during the assessment – identification of the threatened entities and their habitat likely to be affected.	Section 9
		Assessment of prescribed biodiversity impacts (as described in BAM Section 8.3) including: assessment of the nature, extent and duration of impacts on the habitat of threatened species or ecological communities associated with: – karst, caves, crevices, cliffs, rocks and other features of geological significance – human-made structures – non-native vegetation – connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range – movement of threatened species that maintains their life cycle – water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities	Section 9.7
		assessment of the impacts of wind turbine strikes on protected animals	Not applicable
		assessment of the impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC	Section 9.7

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
		Maps and Tables (in document)	
		Table showing change in vegetation integrity score for each vegetation zone as a result of identified impacts	Table 11.1
Mitigation and management of impacts	Chapter 8, Section 8.4 and 8.5	Information	
		Identification of measures to mitigate or manage impacts in accordance with the recommendations in BAM Sections 8.4 and 8.5 including: – techniques, timing, frequency and responsibility – identify measures for which there is risk of failure – evaluate the risk and consequence of any residual impacts – document any adaptive management strategy proposed	Table 10.1
		Identification of measures for mitigating impacts related to: – displacement of resident fauna (as described in BAM sub-section 8.4.1(2.)) – indirect impacts on native vegetation and habitat (as described in BAM sub-section 8.4.1(3.)) – mitigating prescribed biodiversity impacts (as described in BAM sub-section 8.4.2)	Table 10.1
		Details of the adaptive management strategy proposed to monitor and respond to impacts on biodiversity values that are uncertain (BAM Section 8.5)	Not applicable
		Maps and Tables (in document) Table of measures to be implemented to mitigate and manage impacts of the proposal, including action, outcome, timing and responsibility	Table 10.1
Impact summary	Chapter 9	*Information*	
		Identification and assessment of impacts on TECs and threatened species that are at risk of a serious and irreversible impacts (SAII, in accordance with BAM Section 9.1) including: – addressing all criteria in sub-section 9.1.1 for each TEC listed as at risk of an SAII present on the subject land – addressing all criteria in sub-section 9.1.2 for each threatened species at risk of an SAII present on the subject land – documenting assumptions made and/or limitations to information – documenting all sources of data, information, references used or consulted – clearly justifying why any criteria could not be addressed	Section 9.6
		Identification of impacts requiring offset in accordance with BAM Section 9.2	Section 11.1.2, Figure 11.1
		Identification of impacts not requiring offset in accordance with BAM sub-section 9.2.1(3.)	Section 11.1.1, Figure 11.2

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
		Identification of areas not requiring assessment in accordance with BAM Section 9.3	Section 11.1.1
		Maps and Tables (in document)	
		Map showing the extent of TECs at risk of an SAII within the subject land Map showing location of threatened species at risk of an SAII within the subject land Map showing location of: – impacts requiring offset – impacts not requiring offset – areas not requiring assessment	Figure 6.5 Figure 9.5
		Data (to be supplied)	
		Digital shape files of: – extent of TECs at risk of an SAII within the subject land – location of threatened species at risk of an SAII within the subject land – boundary of impacts requiring offset – boundary of impacts not requiring offset – boundary of areas not requiring assessment Maps in jpeg format	Provided separately to BCS
Impact summary	Chapter 10	*Information*	
		Ecosystem credits and species credits that measure the impact of the development on biodiversity values, including: – future vegetation integrity score for each vegetation zone within the subject land (Equation 25 and Equation 26 in BAM Appendix H) – change in vegetation integrity score (BAM sub-section 8.1.1) – number of required ecosystem credits for the direct impacts of the proposal on each vegetation zone within the subject land (BAM sub-section 9) – number of required species credits for each candidate threatened species that is directly impacted on by the proposal (BAM sub-section 10.1.3)	Section 11.1.2, Appendix F
		Maps and Tables (in document)	
		Table of PCTs requiring offset and the number of ecosystem credits required	Table 11.1
		Table of threatened species requiring offset and the number of species credits required	Table 11.3
		Data (to be supplied)	
		Submitted proposal in the BAM calculator	Provided separately to BCS

Report Section	BAM ref.	Information and map requirements	Where addressed in this BDAR
Biodiversity credit report	Chapter 10	*Information* Description of credit classes for ecosystem credits and species credits at the development or clearing site or land to be biodiversity certified (BAM Section 10.2)	Section 11.1.2
		Maps and Tables (in document) Table of credit class and matching credit profile	Table 11.1 Table 11.2 Table 11.3
		Data (to be supplied) BAM credit report in pdf format	Appendix F

Appendix B

Threatened species for assessment

Table B.1 Likelihood of occurrence of threatened flora species in the study area

Key: V – vulnerable, E – endangered, CE – critically endangered, EP – endangered population, M – migratory

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Acacia bynoeana Bynoes Wattle	E	V	EPBC PMST; BAM-C	-	Endemic to central eastern NSW, known a limited number of locations, often comprising populations of few plants. Grows mainly in heath/ dry sclerophyll forest on sandy soils, prefers open, sometimes slightly disturbed sites such as trail margins, road edges, and in recently burnt open patches. Flowers September to March, and fruit matures in November.	Low	No records within the locality and no suitable habitat within study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Acacia clunies-rossiae Kanangra Wattle	V	-	BioNet NSW	1	Occurs within the Kowmung and Cox's River areas, entirely within Kanangra-Boyd and Blue Mountains National Parks. Grows on skeletal soils on rocky slopes, or on alluvium along creeks. Flowering occurs in spring.	Low	No suitable habitat within study area.	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Acacia pubescens Downy Wattle	V	V	BioNet NSW, EPBC PMST; BAM-C	4489	Occurs mainly in Bankstown-Fairfield-Rookwood and Pitt Town areas, with outliers at Barden Ridge, Oakdale and Mountain Lagoon. Grows on alluviums, shales and shale/sandstone intergrades. Soils characteristically gravely, often with ironstone. Occurs in open woodland and forest, in communities including Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland. Flowers August to October.	Low	No suitable habitat present within footprint. Species may occur in wider study area in remnant vegetation but is not present in the footprint. Records at Harris Park (2000), Rosehill (2005), Carlingford (2001), Putney (2011), and to the south near Flemington and Rookwood. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Acacia terminalis subsp. *terminalis* Sunshine Wattle	E	E	EPBC PMST	-	Occurs in near-coastal areas from northern shores of Sydney Harbour south to the northern and western shores of Botany Bay. Occurs on sandy soil on creek banks, hillslopes of in shallow soil in rock crevices and sandstone platforms on cliffs. Grows in scrub and open eucalypt woodland or forest (Bremner and Goeth 2010).	Low	Known distribution confined to the eastern suburbs area of Sydney, NSW, between Botany Bay and the northern foreshore of Port Jackson. No suitable habitat within study area.	Species	N	N/A	N/A
Allocasuarina glareicola	E	E	EPBC PMST	-	Primarily restricted to small populations in and around Castlereagh NR (NW Cumberland Plain), but with an outlier population at Voyager Point, Liverpool. Also reported from Holsworthy Military Area. Grows on tertiary alluvial gravels, with yellow clayey subsoil and lateritic soil. Occurs in Castlereagh open woodland.	Low	No suitable habitat present within footprint. No records within the locality, the closest records are a cluster of individuals 25 km to the northwest.	Species	N	N/A	N/A
Asterolasia elegans	E	E	EPBC PMST	-	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs, may also occur in the western part of Gosford LGA. Seven known populations. Occurs on Hawkesbury sandstone, commonly amongst rocky outcrops and boulders in sheltered forests on mid- to lower slopes and valleys.	Low	No records in locality. Closest known specimen record is at Richmond over 30 km away.	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Caladenia tessellata Thick Lip Spider Orchid	E	V	EPBC PMST; BAM-C	-	Occurs from Central Coast NSW to southern Victoria. Mostly coastal but extends inland to Braidwood in southern NSW. In NSW grows in grassy dry sclerophyll woodland on clay loam or sandy soils, and less commonly in heathland on sandy loam soils (Duncan 2010).	Low	No suitable habitat within study area. One record at Denistone East (2011). Outside the known distribution, which is typically further east than this site. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Callistemon linearifolius Netted Bottle Brush	V	-	BioNet NSW	8	Recorded from the Georges to Hawkesbury Rivers in Sydney, and north to Nelson Bay. There is also a recent record from the northern Illawarra. Grows in dry sclerophyll forest on the coast and adjacent ranges.	Low	No suitable habitat within study area.	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Camarophyllopsis kearneyi	E	-	BAM-C	-	Known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in the Sydney metropolitan region. Its occurrence appears to be limited to the Lane Cove Bushland Park. Surveys in potentially suitable habitats elsewhere in the Sydney Basin Bioregion have failed to find the species.	Low	Known only from Lane Cove LGA. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Commersonia prostrata Dwarf Kerrawang	E	E	BAM-C	-	In NSW occurs as individual plants at Penrose State Forest and Tallong with populations at Rowes Lagoon near the Corang and the Thirlmere lakes area, and at the Tomago sand beds near Newcastle. Grows on sandy, sometimes peaty soils in a variety of habitats.	Low	No suitable habitat within study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Cryptostylis hunteriana Leafless Tongue Orchid	V	V	EPBC PMST	-	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with Large Tongue Orchid and the Bonnet Orchid. Soils include moist sands, moist to dry clay loam and occasionally in accumulated eucalypt leaves. Flowers November-February.	Low	No records within the locality. Known records to the north at Ku-ring-gai Chase National Park, and to the south around Jervis Bay national Park.	Species	N	N/A	N/A
Cynanchum elegans White- flowered Wax Plant	E	E	EPBC PMST	-	Occurs from Gerroa (Illawarra) to Brunswick Heads and west to Merriwa in the upper Hunter. Most common near Kempsey. Usually occurs on the edge of dry rainforest or littoral rainforest, but also occurs in Coastal Banksia Scrub, open forest and woodland, and Melaleuca scrub. Soil and geology types are not limiting.	Low	No suitable habitat within study area. The closest records are approximately 17 km away at Western Sydney Parklands.	Species	N	N/A	N/A
Darwinia biflora	V	V	BioNet NSW, EPBC PMST	304	Known from north and north-western Sydney, in the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai LGAs. Grows on the edges of weathered shale-capped ridges, at the intergrade with Hawkesbury Sandstone. Occurs in woodland, open forest and scrub/heath. Associated overstorey species include Scribbly Gum, Red Bloodwood and/or Scaly Bark.	Low	No suitable habitat within study area. No associated geology or canopy species present.	Species	N	N/A	N/A

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Deyeuxia appressa	E	E	EPBC PMST	-	Known only from two pre-1942 records in Sydney, at Saltpan Creek and Killara. May be extinct in the wild. Thought to occur in moist conditions.	Low	No records within the locality. Highly restricted, known only from two pre-1942 records in the Sydney area; Killara and Padstow, unlikely to be in these areas now because of previous disturbance and lack of natural soil profiles.	Species	N	N/A	N/A
Dillwynia tenuifolia Sieber ex D.C. in the Baulkham Hills local government area	EP	-	BioNet NSW	1	Occurs in western Sydney, predominately the Cumberland Plain as well as the Lower Blue Mountains and north to Yengo. Grows in scrubby/dry heath areas of Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays and associated transitional communities including Castlereagh Scribbly Gum Woodland. EP restricted to the Baulkham Hills local government area.	Nil	Study area outside the geographic extent of the endangered population.	Species	N	N/A	N/A
Dillwynia tenuifolia	V	V	BioNet NSW	2	Occurs in western Sydney, predominately the Cumberland Plain as well as the Lower Blue Mountains and north to Yengo. Grows in scrubby/dry heath areas of Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays and associated transitional communities including Castlereagh Scribbly Gum Woodland.	Low	No suitable habitat within study area.	Species	N	N/A	N/A

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Epacris purpurascens var. *purpurascens*	V	-	BioNet NSW; BAM-C	114	Occurs from Gosford in the north, Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South. Grows in a range of sclerophyll forest, scrubs and swamps, most of which have a strong shale soil influence.	Low	No suitable habitat within study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Eucalyptus camfieldii Heart-leaved Stringybark	V	V	EPBC PMST	-	Occurs from Raymond Terrace to Waterfall, with populations known from Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai and the Royal NP. Occurs in exposed situations on sandstone plateaus, ridges and slopes near the coast, often on the boundary of tall coastal heaths or low open woodland. It grows in shallow sandy soils overlying Hawkesbury sandstone.	Low	One record at Putney (2011). Study area outside known distribution more records towards the east at Killara, and Hornsby areas.	Species	N	N/A	N/A
Eucalyptus nicholii Narrow- leaved Black Peppermint	V	V	BioNet NSW	12	Naturally occurs only in New England Tablelands from Nundle to north of Tenterfield. Widely planted as urban street tree. Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite.	Low	Study area outside the species known natural distribution. Previous records within the locality most likely planted specimens.	Species	N	N/A	N/A

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Eucalyptus scoparia Wallangarra White Gum	E	V	BioNet NSW	2	Occurs mostly in Queensland with only three known occurrences in NSW near Tenterfield. In NSW it is found on well-drained granitic hilltops, slopes and outcrops, often as scattered trees in open forest and woodland.	Present. Species recorded in P5 car park within Sydney Olympic Park.	Study area outside the species known natural distribution. Individuals present are planted specimens and are not considered as threatened species in this assessment.	Species	N	N/A	N/A
Eucalyptus sp. Cattai	CE	CE	EPBC PMST	-	Occurs between Colo Heights and Castle Hill, in NW Sydney, though it historically extended through to central areas of Sydney. Grows in scrub, heath and low woodland on sandy soils, generally on flat ridge tops.	Low	No records in the study area since 2000. No suitable habitat on site.	Species	N	N/A	N/A
Genoplesium baueri Bauers Midge Orchid	V	E	EPBC PMST	-	Occurs from Ulladulla to Port Stephens, with only 13 known extant populations. Grows in sparse sclerophyll forest and moss gardens over sandstone.	Low	One record at Denistone East (2011), more commonly occurring to the north of Hornsby and in Ku-ring-gai Chase National Park. Unlikely to occur due to the disturbed nature of the site and lack of preferred habitat.	Species	N	N/A	N/A
Grammitis stenophylla Narrow-leaf Finger Fern	E	-	BioNet NSW	4	Occurs along the coast of NSW and as far west as Narrabri. Grows in small colonies in moist places, usually near streams, on rocks and in trees in rainforest and moist eucalypt forest.	Low	No suitable habitat within study area.	Species	N	N/A	N/A
Grevillea beadleana Beadle's Grevillea	E	E	BioNet NSW	1	Four disjunct populations in north-east NSW: Torrington west of Tenterfield, Oxley Wild Rivers NP, Guy Fawkes River NP and Shannon Creek southwest of Grafton. Grows in open eucalypt forest with shrubby understorey, usually on steep granite slopes at high altitudes.	Low	Study area outside species natural distribution and no suitable habitat on site.	Species	N	N/A	N/A

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Grevillea parviflora subsp. *parviflora* Small-flower Grevillea	V	V	EPBC PMST; BAM-C	-	Occurs between Moss Vale/Bargo and lower Hunter Valley, with most occurrences in Appin, Wedderburn, Picton and Bargo. Broad habitat range including heath, shrubby woodland and open forest on light clay or sandy soils, and often in disturbed areas such as on the fringes of tracks.	Low	Closest record 10 km away at Lane Cove National Park (2009). Outside typical distribution. Known populations at Cessnock and Wedderburn. No suitable habitat within study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

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Grevillea parviflora subsp. supplicans	E	-	BAM-C	-	Has a very restricted range and is confined to north-west Sydney near Arcadia and the Maroota-Marramarra Creek area in the Hornsby and Baulkham Hills LGA's. Occurs in heathy woodland associations on skeletal sandy soils over sandstone. Preference for yellow clays with periodically impeded drainage. Affinity with disturbance margins such as trail/road verges where soils are suitable and there is available light.	Low	Outside known distribution. No suitable habitat within study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Gyrostemon thesioides	E	-	BAM-C	-	Has only been recorded at three sites in NSW; to the west of Sydney, near the Colo, Georges and Nepean Rivers. The most recent sighting was of a single male plant near the Colo River within Wollemi National Park. The species has not been recorded from the Nepean and Georges Rivers for 90 and 30 years respectively, despite searches. Grows on hillsides and riverbanks and may be restricted to fine sandy soils.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

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Haloragis exalata subsp. *exalata* Square Raspwort	V	V	BAM-C	-	Square Raspwort occurs in four widely scattered localities in eastern NSW. It is disjunctly distributed in the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW. Requires protected and shaded damp situations in riparian habitats.	Low	No records within locality and no suitable habitat within study area.	Species	Y	N/A	Y
Haloragodendron lucasii Hal	E	E	EPBC PMST	-	Known from nine sites in a 10 km range in the Gordon-Hornsby area. Occurs on Hawkesbury Sandstone in moist sandy loam soil. Prefers sheltered aspects and gentle slopes below cliff lines near creeks in low open woodland or open forest. Distribution correlated with high soil moisture and phosphorus levels.	Low	No records within locality and no suitable habitat within study area.	Species	N	N/A	N/A
Hibbertia puberula subsp. *glabrescens* Hibbertia sp. Bankstown	CE	CE	EPBC PMST; BAM-C	-	Listed under EPBC Act as *Hibbertia puberula* subsp. *glabrescens*. Known only from Bankstown airport. Habitat is very heavily modified, lacks canopy species and is currently a low grass/shrub association with many pasture grasses and other introduced herbaceous weeds. Soil at the site is a sandy (Tertiary) alluvium with a high silt content.	Low	Study area does not encompass Bankstown Airport and no suitable habitat occurs within the study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

Species name	**BC Act status**	**EPBC Act status**	**Data source**	**Number of records in locality**	**Habitat association**	**Likelihood of occurrence**	**Justification**	**Credit types**	**Predicted by calculator (Y, N or N/A)**	**Confirmed predicted (Y, N or N/A)**	**Confirmed candidate (Y, N or N/A)**
Hibbertia spanantha Julian's Hibbertia	CE	CE	BioNet NSW, EPBC PMST	6	Grows in forest with canopy species including *Eucalyptus pilularis, E. resinifera, Corymbia gummifera* and *Angophora costata.* The understorey is open with species of Poaceae, Orchidaceae, Fabaceae and Liliaceae.	Low	No suitable habitat within study area.	Species	N	N/A	N/A
Hibbertia superans	E	-	BioNet NSW; BAM-C	43	Occurs from Castle Hill to South Maroota, and an isolated population near Kempsey. Grows on sandstone ridgetops often near the shale/sandstone boundary, in open woodland and heathland. Prefers open /disturbed areas, such as tracksides.	Low	No records within locality and no suitable habitat within study area. Known population is further north of study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

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Hygrocybe anomala var. ianthinomarginata	V	-	BAM-C	-	Known from the type locality, Lane Cove Bushland Park, Lane Cove and from other locations in the Sydney regional including Royal National Park, Chatswood, Castle Hill and the Blue Mountains (Springwood). Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Hygrocybe aurantipes	V	-	BAM-C	-	Known from the type locality, Lane Cove Bushland Park, Lane Cove and from other locations in the Sydney regional including Royal National Park, Chatswood, Castle Hill and the Blue Mountains (Springwood). Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

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Hygrocybe austropratensis	E	-	BAM-C	-	Known from the type locality, Lane Cove Bushland Park, Lane Cove and from other locations in the Sydney regional including Royal National Park, Chatswood, Castle Hill and the Blue Mountains (Springwood). Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Hygrocybe collucera	E	-	BAM-C	-	Known from the type locality, Lane Cove Bushland Park, Lane Cove and from other locations in the Sydney regional including Royal National Park, Chatswood, Castle Hill and the Blue Mountains (Springwood). Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

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Hygrocybe griseoramosa	E	-	BAM-C	-	Known from the type locality, Lane Cove Bushland Park, Lane Cove and from other locations in the Sydney regional including Royal National Park, Chatswood, Castle Hill and the Blue Mountains (Springwood). Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Hygrocybe lanecovensis	E	-	BAM-C	-	Known from the type locality, Lane Cove Bushland Park, Lane Cove and from other locations in the Sydney regional including Royal National Park and Chatswood. Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

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Hygrocybe reesiae	V	-	BAM-C	-	Known from type locality, Lane Cove Bushland Park, Lane Cove and other locations in the Sydney region including Royal National Park, Chatswood, Castle Hill, Northbridge, Marsfield, East Linfield and the Blue Mountains (Mount Wilson, Hazelbrook) Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Hygrocybe rubronivea	V	-	BAM-C	-	Known in a few locations including in Lane Cove Bushland Park and the Blue Mountains in NSW and in areas of south-east Queensland. However little information exists for populations outside Lane Cove Bushland Park. Occurs in gallery warm temperate forests dominated by Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Cheese Tree (*Glochidion ferdinandi*) and Sweet Pittosporum (*Pittosporum undulatum*). Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss.	Low	Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

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Lasiopetalum joyceae	V	V	BioNet NSW	1	Has a restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the Hawkesbury River. Grows on heath on sandstone.	Low	Species previously recorded within the locality, but no suitable habitat recorded within the study area.	Species	N	N/A	N/A
Leptospermum deanei	V	V	EPBC PMST	-	Occurs in NW Sydney, in the Hornsby, Warringah, Ku-ring-gai and Ryde LGAs. Grows in woodland on lower hill slopes or near creeks, in sandy alluvial soil or sand over sandstone. Occurs in riparian scrub, woodland and open forest.	Low	No suitable habitat within study area.	Species	N	N/A	N/A
Macadamia integrifolia Macadamia Nut		V	BioNet NSW	13	The Macadamia Nut is found in remnant rainforest in northern NSW and south-east Queensland, preferring partially open areas such as rainforest edges. While specimens have been collected from the North Coast of NSW, this species is not known to occur naturally in NSW.	Low	Outside species known distribution and no suitable habitat within study area. Records in the locality would be of planted individuals.	Species	N	N/A	N/A
Marsdenia viridiflora subsp. *viridiflora* *Marsdenia viridiflora* R. Br. subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government	EP		BioNet NSW	459	Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range. A climber that grows in vine thickets and open shale woodland.	Low	Species unlikely to occur as no preferred habitat present within the study area.	Species	N	N/A	N/A

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Maundia triglochinoides	V	-	BAM-C	-	Restricted to coastal NSW current southern limit at Wyong. Grows on heavy clay, low nutrient soil in swamps, lagoons, dams, channels, creeks or shallow freshwater 30-60 cm depth.	Low	Broadly suitable habitat at the study area, but no records within locality. Known population is further north of study area.	Species	Y	N/A	Y
Melaleuca biconvexa Biconvex Paperbark	V	V	EPBC PMST BAM-C	-	Scattered, disjunct populations in coastal areas from Jervis Bay to Port Macquarie, with most populations in the Gosford-Wyong areas. Grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	Low	No records within the locality. No preferred habitat present.	Species	Y	N/A	Y
Melaleuca deanei Deanes Paperbark	V	V	BioNet NSW, EPBC PMST	10	Occurs from Nowra- St Albans and west to the Blue Mountains, with most records in Ku-ring-gai / Berowra and Holsworthy/Wedderburn areas. Mostly grows on broad flat ridgetops, dry ridges and slopes and strongly associated with low nutrient sandy loam soils, sometimes with ironstone. Grows in heath- open forest, often in sandstone ridgetop woodland communities.	Low	No suitable habitat within study area.	Species	N	N/A	N/A
Pelargonium sp. *striatellum* Omeo Stork's-bill	E	E	EPBC PMST	-	Is a tufted perennial forb known from only three locations in NSW, with two on lakebeds on the basalt plains of the Monaro and one at Lake Bathurst. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	Low	Species unlikely to occur within study area. No records in locality. Known distribution considerably south, near the ACT and Victoria (Lake Omeo).	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Persicaria elatior Knotweed	V	V	EPBC PMST BAM-C	-	Tall Knotweed has been recorded in south-eastern NSW from Ulladulla to the Victorian border. In northern NSW it is known from Raymond Terrace and the Grafton area. This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. Knotweed grows on sandy, alluvial soil in swampy areas and riparian herblands along watercourses and lake edges. Associated plant species include *Melaleuca linearifolia, M. quinquenervia, seudognaphalium luteoalbum, Persicaria hydropiper, Floydia praealta* and *Cyperus semifertilis.*	Low	No suitable habitat within study area.	Species	Y	N/A	Y
Persoonia hirsuta Hairy Geebung	E	E	EPBC PMST; BAM-C	-	Occurs within the Blue Mountains, Southern Highlands and Sydney coastal regions from Hilltop to Glen Davis and Royal NP to Gosford. Population within the Hills Shire particularly important due to high density of plants. Grows on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone up to 600m above sea level.	Low	No suitable habitat within study area. The subject site is also outside the core local distribution of the species. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Persoonia mollis subsp. *maxima*	E	E	EPBC PMST	-	Occurs in an approx. 5.75 x 7.5 km area in the Hornsby Heights- Mt Colah area. Grows in sheltered aspects of deep gullies or on the steep upper hillsides of narrow gullies on Hawkesbury Sandstone. These habitats support relatively moist, tall forest vegetation communities, often with mesic influences.	Low	No records within the locality, no suitable habitat and outside of its known distribution.	Species	N	N/A	N/A
Persoonia nutans Nodding Geebung	E	E	EPBC PMST	-	Occurs from Richmond to Macquarie Fields on the Cumberland Plain. Grows only on aeolian and alluvial sediments in sclerophyll forest and woodland vegetation communities. Largest populations occur in Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.	Low	No suitable habitat within study area. One record at Westmead (2008) and Villawood (1996), unlikely to occur in study area due to the disturbed nature of the site.	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Pilularia novae-hollandiae Austral Pillwort	E	-	BAM-C	-	The Austral Pillwort is a small semi-aquatic fern that resembles fine grass. In NSW, the Austral Pillwort has been recorded from suburban Sydney, Khancoban, the Riverina between Albury and Urana (including Henty, Walbundrie, Balldale and Howlong). Only known extant populations in NSW are at Lake Cowal and Oolambeyan NP, but the species is obscure and may be overlooked elsewhere. Grows in shallow swamps and waterways, often among grasses and sedges. Previous records in Albury-Urana were from table drains beside roads, whereas the only record in the ACT was from a subalpine grassy plain. It is most often recorded in drying mud as this is when it is most conspicuous.	Low	Broadly suitable habitat at the study area, but no contemporary records within locality. No known population in the region of the study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Pimelea curviflora var. *curviflora*	V	V	BioNet NSW, EPBC PMST; BAM-C	8	Confined to area between north Sydney in the south and Maroota in the north-west. Former range extended to Parramatta River including Five Dock, Bellevue Hill and Manly. Grows on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. Often grows amongst dense grasses and sedges. Flowers October to May.	Low	No suitable habitat within study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Pimelea spicata Spiked Rice-flower	E	E	BioNet NSW, EPBC PMST	304	Disjunct populations within the Cumberland Plain (from Mount Annan and Narellan Vale to Freemans Reach and Penrith to Georges Hall) and Illawarra (from Mt Warrigal to Gerroa) (DEC 2005). In the Cumberland Plain region, restricted to areas which support or historically supported Cumberland Plain Woodland. Grows on well-structured clay soils derived from Wianamatta Shale. In the Illawarra, grows on variable soils in close proximity to the coast on hills or coastal headlands. Inhabits coastal woodland or grassland with emergent shrubs (DEC 2005).	Low	No suitable habitat within study area.	Species	N	N/A	N/A
Pomaderris brunnea Brown Pomaderris	E	V	BioNet NSW	5	Found in a very limited area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area and near Camden. Brown Pomaderris grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	Low	Broadly suitable habitat at the study area, but no known population in the region of the study area. Easily identifiable genus, and there were no Pomaderris species identified within the proposal footprint, despite targeted searches by experienced botanists.	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Pomaderris prunifolia - endangered population *P. prunifolia* in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas	EP	-	BioNet NSW; BAM-C	17	Known from only three sites within population range: at Rydalmere, within Rookwood Cemetery and at The Crest of Bankstown. At Rydalmere occurs along a road reserve near a creek, among grass species on sandstone. At Rookwood Cemetery occurs in small gully of degraded Cooks River / Castlereagh Ironbark Forest on shale soils.	Low	No suitable habitat within study area. Records at Parramatta (2008), Dundas (1997), Ermington (1998), Flemington (1898), Lidcombe (1898), Rookwood (2008). Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species. Records from sandstone geology in road reserves in Rydalmere occur on different landforms and soil landscapes to other urban parks in the study area. Easily identifiable genus, and there were no Pomaderris species identified within the proposal footprint, despite targeted searches by experienced botanists.	Species	Y	N/A	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Pterostylis gibbosa Illawarra Greenhood	E	E	EPBC PMST	-	Known from a small number of populations in the Illawarra, Nowra and Hunter regions. First collected in western Sydney. Only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. Grows in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum, Woollybutt and *Melaleuca decora* . Near Nowra, the species grows in an open forest of Spotted Gum, Forest Red Gum and Grey Ironbark. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine.	Low	No records within the locality. Outside the known distribution. Closest records at Georges River National Park. Preferred habitat unlikely to occur but further survey will confirm.	Species	N	N/A	N/A
Pterostylis saxicola Sydney Plains Greenhood	E	E	BioNet NSW, EPBC PMST	2	Occurs in western Sydney between Picton and Freemans Reach. Grows in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. Associated vegetation above these rock shelves is sclerophyll forest or woodland on shale or shale/sandstone transition soils.	Low	One record at Denistone East (2011), Prospect (1804). Potential marginal habitat, although unlikely to occur due to the disturbance in these areas	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Pultenaea pedunculata Matted Bush-pea	E	-	BioNet NSW	3	Represented by just three disjunct populations in NSW: in the Cumberland Plains in Sydney, the coast between Tathra and Bermagui and the Windellama area south of Goulburn (where it is locally abundant). In the Cumberland Plain, now found at Villawood and Prestons, and north-west of Appin between the Nepean River and Devines Tunnel number 2 (Upper Sydney Water Supply Canal). Occurs in woodland vegetation in clay or sandy-clay soils (Blacktown Soil Landscape) on Wianamatta Shale-derived soils, usually close to patches of Tertiary Alluvium (Liverpool area) or at or near the Shale-Sandstone interface (Appin). All sites have a lateritic influence with ironstone gravel (nodules) present.	Low	Potential marginal habitat. Records at Villawood (2001, 2007). Although potential marginal habitat is present in the study area, this is not a cryptic species and was not recorded during targeted surveys.	Species	N	N/A	N/A
Rhizanthella slateri Eastern Australian Underground Orchid	V	E	BioNet NSW	1	Currently known only from 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available. Flowers September and November.	Low	Could potentially occur in remnant Eucalyptus forest in the study area. Would not occur in estuarine or freshwater wetland communities, and unlikely to occur in planted forest and modified soil profiles in the project site.	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Rhodamnia rubescens Scrub Turpentine	CE		BioNet NSW; BAM-C	6	Occurs in coastal districts north from Batemans Bay in New South Wales to areas inland of Bundaberg in Queensland. Populations typically occur in coastal regions and occasionally extend inland onto escarpments up to 600 metres a.s.l. in areas with rainfall of 1,000 -1,600 mm. Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	Low	Species previously recorded within the locality but no suitable habitat recorded within the study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Rhodomyrtus psidioides Native Guava	CE	CE	EPBC PMST	-	Native Guava occurs from Broken Bay, approximately 90 kilometres north of Sydney, New South Wales, to Maryborough in Queensland. Populations are typically restricted to coastal and sub-coastal areas of low elevation however the species does occur up to c. 120 km inland in the Hunter and Clarence River catchments and along the Border Ranges in NSW. It is a pioneer species found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines.	Low	No records within the locality and no suitable habitat within study area.	Species	N	N/A	N/A

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Syzygium paniculatum Magenta Lilly Pilly	E	V	BioNet NSW, EPBC PMST; BAM-C	40	Occurs in narrow coastal strip from Bulahdelah to Conjola State Forest. Grows in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas, often in remnant littoral or gallery rainforests.	Low	No suitable habitat present within the study area. If recorded on site specimens are likely to be planted individuals. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Tetratheca glandulosa Glandular Pink-bell	V	V	BioNet NSW; BAM-C	43	Restricted to The Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong LGAs. Associated with shale-sandstone transition habitat (shale-cappings over sandstone). Occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils generally shallow, yellow, clayey/sandy loam, commonly with lateritic fragments. Vegetation varies from heath to open forest and is broadly equivalent to Sydney Sandstone Ridgetop Woodland community.	Low	No suitable habitat within study area. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Thesium austral Austral Toadflax	V	V	EPBC PMST	-	Found in small, scattered populations along the east coast, northern and southern tablelands. Occurs in grassland or grassy woodland and is often found in association with Kangaroo Grass.	Low	No records within the locality. Closets records at Lithgow. Unlikely to occur within the locality due to disturbance of habitats from development.	Species	N	N/A	N/A
Wahlenbergia multicaulis - endangered population Tadgell's Bluebell in the local government areas of Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield	EP	-	BioNet NSW; BAM-C	117	Found in disturbed sites and grows in a variety of habitats including forest, woodland, scrub, grassland and the edges of watercourses and wetlands. Typically occurs in damp, disturbed sites (with natural or human disturbance of various forms), typically amongst other herbs rather than in the open. There are 13 known sites, two of which are in northern Sydney (Thornleigh and Mt Ku-Ring-Gai) with the remainder in western Sydney (Rookwood, Chullora, Bass Hill, Bankstown, Georges Hall, Campsie, South Granville and Greenacre).	Low	No suitable habitat present within the highly modified vegetation within the project footprint. Associated with PCT 1281 only, which is present as a planted stand of vegetation on an artificial landform, with no natural soil seed bank or seed source for self-recruitment for this species. Habitat degraded button ticked in BAM-C as no suitable habitat present within the footprint for this species.	Species	Y	N/A	N
Wilsonia backhousei Narrow-leafed Wilsonia	V		BioNet NSW; BAM-C	123	In NSW, found on the coast between Mimosa Rocks National Park and Wamberal north of Sydney (Nelson's Lake, Potato Point, Sussex Inlet, Wowly Gully, Parramatta River at Ermington, Clovelly, Voyager Point, Wollongong and Royal National Park). This is a species of the margins of salt marshes and lakes.	Present	Known population at the northern end of Newington Nature Reserve.	Species	Y	N/A	Y

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit types	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Zannichellia palustris	E		BioNet NSW; BAM-C	5	In NSW, known from the lower Hunter and in Sydney Olympic Park. Grows in fresh or slightly saline stationary or slowly flowing water. Flowers during warmer months. NSW populations behave as annuals, dying back completely every summer.	Moderate	Species is known from Sydney Olympic Park, but in areas outside of the study area.	Species	Y	N/A	Y
Zieria involucrata	E	V	EPBC PMST	-	Found within The Hills, Hawkesbury, Hornsby and Blue Mountains local government areas. It occurs primarily on Hawkesbury sandstone but has also been found on Narrabeen Group sandstone and Quaternary alluvium. It has been recorded in sheltered forests on mid-lower slopes and valleys.	Low	No records within the locality and no suitable habitat within study area.	Species	N	N/A	N/A

Key: *V – vulnerable,* E – endangered, CE – critically endangered, EP – endangered population

Table B.2 Likelihood of occurrence of threatened fauna species in the study area

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Giant Burrowing Frog *Heleioporus australiacus*	V	V	BioNet NSW, EPBC PMST	2	Since 1990 there have been approximately 50 recorded locations of Green and Golden Bell Frog in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands. The Giant Burrowing Frog is distributed in south eastern NSW and Victoria, and appears to exist as two distinct populations: a northern population largely confined to the sandstone geology of the Sydney Basin and extending as far south as Ulladulla, and a southern population occurring from north of Narooma through to Walhalla, Victoria. It is found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based.	Nil	No sandstone habitat present within study area. No records within the locality	Species	Y	NA	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Green and Golden Bell Frog *Litoria aurea*	E	V	BioNet NSW, EPBC PMST	11,621	The species inhabits marshes, dams, and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimal habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites the species has been recorded in, occur in highly disturbed areas.	High	Potential habitat and recent records within the locality. There are known populations at the Newington Nature Reserve with a number of records within 200 metres of the project alignment.	Species	Y	NA	Y
Red-crowned Toadlet *Pseudophryne australis*	V	-	BioNet NSW	30	Restricted distribution, confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter.	Nil	No sandstone habitat not present within study area. No recent records within the vicinity of the study area.	Species	N	NA	N
Stuttering Frog *Mixophyes balbus*	E	V	EPBC PMST	-	Occurs along the east coast of Australia from southern Queensland to north-eastern Victoria. Stronghold in the Dorrigo region, in north-east NSW. Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Breeds in streams during summer after heavy rain.	Nil	No rainforest steams within study area. No records within the locality	Species	N	NA	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Australasian Bittern *Botaurus poiciloptilus*	E	E	BioNet NSW, EPBC PMST	9	Australasian Bitterns are widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. The Species favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.), it hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. The species may construct feeding platforms over deeper water from reeds trampled by the bird; platforms are often littered with prey remains.	Moderate	Potential habitat present within study area.	Ecosystem	Y	Y	NA
Barking Owl *Ninox connivens*	V	-	BioNet NSW	9	Found throughout continental Australia except for the central arid regions. Occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains and in some northeast coastal and escarpment forests. Sometimes extends home range into urban areas. Inhabit woodland and open forest, including fragmented remnants and partly cleared farmland. Flexible in its habitat use, hunting can extend in to closed forest and more open areas. Typically roosts in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as *Acacia* and *Casuarina* species.	Low	Preferred forested habitat not present within study area. No suitable hollow-bearing trees present. May forage on occasion if within a territory. No records within the locality.	Species/Ecosystem	Y	Y	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Black Bittern *Ixobrychus flavicollis*	V	-	BioNet NSW	9	Scattered records along the east coast of NSW, with individuals rarely being recorded south of Sydney or inland. Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. May occur in flooded grassland, forest, woodland, rainforest and mangroves, where permanent water is present.	Moderate	Potential habitat occurs within study area.	Ecosystem	Y	Y	NA
Black-chinned Honeyeater (eastern subspecies) *Melithreptus gularis gularis*	V	-	BAM-C	-	Extends south from central Queensland, through NSW, Victoria into south eastern South Australia, though it is very rare in the last state. In NSW it is widespread, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions, though it is very rare in the latter. Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*).	Low	No suitable forested habitat in the study area. Lack of connectivity to large tracts of woodland.	Ecosystem	Y	Y	NA

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Black-necked Stork *Ephippiorhynchus asiaticus*	E	-	BAM_C, BioNet NSW	1	Widespread in coastal and subcoastal northern and eastern Australia, as far south as central NSW (although vagrants may occur further south or inland away from breeding areas). Species becomes increasingly uncommon south of the Clarence Valley, and rarely occurs south of Sydney. Floodplain wetlands (swamps, billabongs, watercourses and dams) of the major coastal rivers are the key habitat in NSW for the species. Secondary habitat includes minor floodplains, coastal sandplain wetlands and estuaries.	Low	Outside the typical distribution of the species. Suitable habitat present in wetlands in the study area.	Ecosystem	Y	Y	NA
Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*	V	-	BAM-C	-	Occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is less commonly found on coastal plains and ranges. Mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. Sedentary, considered to be resident in many locations throughout its range; present in all seasons or year-round at many sites; territorial year-round. Hollows in standing dead or live trees and tree stumps are essential for nesting. Breeds in pairs or co-operatively in territories which range in size from 1.1 to 10.7 hectares (mean = 4.4 hectares).	Low	No suitable forested habitat in the study area. Lack of connectivity to large tracts of woodland.	Ecosystem	Y	Y	NA

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Bush Stone-curlew *Burhinus grallarius*	E	-	BioNet NSW	3	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east, it is either rare or extinct throughout its former range. It inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber, its diet consists of insects and small vertebrates, such as frogs, lizards and snakes. It is largely nocturnal, being especially active on moonlit nights and nests on the ground in a scrape or small bare patch.	Low	Incidental records in the locality, no existing populations in the study area. Not recorded during targeted surveys.	Species	Y	NA	N
Comb-crested Jacana *Irediparra gallinacea*	V	-	BAM-C	-	The Comb-crested Jacana inhabit permanent freshwater wetlands, either still or slow-flowing, with a good surface cover of floating vegetation, especially waterlilies, or fringing and aquatic vegetation. In New South Wales the Comb-crested Jacana is known to occur in Hunter region, with stragglers recorded in south-eastern NSW (possibly in response to unfavourable conditions further north).	Low	Outside the typical distribution of the species. Suitable habitat present in wetlands in the study area.	Ecosystem	Y	Y	NA

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Dusky Woodswallow *Artamus cyanopterus cyanopterus*	V	-	BioNet NSW	12	The Dusky Woodswallow is widespread from the coast to inland, including the western slopes of the Great Dividing Range and farther west. It is often recorded in woodlands and dry open sclerophyll forests, and has also been recorded in shrublands, heathlands regenerating forests and very occasionally in moist forests or rainforests. The understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, often with coarse woody debris. It is also recorded in farmland, usually at the edges of forest or woodland or in roadside remnants or wind breaks with dead timber. The nest is an open shallow untidy cup frequently built in an open hollow, crevice or stump. Although Dusky Woodswallows have large home ranges, individuals may spend most of their time in about a two hectares range and defend an area about 50 metres around the nest. Dusky Woodswallows prefer larger remnants over smaller remnants. Competitive exclusion by Noisy Miners (*Manorina melanocephala*) is a significant threat to this species.	Moderate	Suitable foraging habitat present within study area. May occur occasionally in wooded areas of the study area including mangroves.	Ecosystem	Y	Y	NA
Eastern Grass Owl *Tyto longimembris*	V	-	BioNet NSW	1	In NSW they are more likely to be resident in the north-east. Numbers can fluctuate greatly, increasing especially during rodent plagues. Found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. Always breeds on the ground. Nests are found in trodden grass, and often accessed by tunnels through vegetation.	Low	Outside the typical distribution of the species. Suitable habitat present in wetlands in the study area.	Ecosystem	N	N	NA

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Fairy Tern *Sternula nereis nereis*	-	V	EPBC PMST	-	Found on isolated sandy inlets and along the coast from Dampier Archipelago, Western Australia, southward to Tasmania and Victoria, and is only vagrant to the east coast. It is most common in Western Australia and rare in New South Wales. Found on coastal beaches, inshore and offshore islands, sheltered inlets, sewage farms, harbours, estuaries and lagoons. It favours both fresh and saline wetlands and near-coastal terrestrial wetlands, including lakes and salt-ponds.	Low	Study area outside usual range. Generally restricted to near-coastal areas.	Species	NA	NA	NA
Flame Robin *Petroica phoenicea*	V	-	BAM-C, BioNet NSW	1	Breeds in upland areas in NSW and moves to the inland slopes and plains in winter. Likely two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands. Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys.	Low	A single record from the locality of the study area, a rare species locally.	Ecosystem	Y	Y	NA

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Freckled Duck *Stictonetta naevosa*	V	-	BAM-C	-	The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. It breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina. The duck is forced to disperse during extensive inland droughts when wetlands in the Murray River basin provide important habitat. The species may also occur as far as coastal NSW and Victoria during such times. Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.	Low	Study area outside usual range. Generally occurs in inland areas.	Ecosystem	Y	Y	NA

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Gang-gang Cockatoo *Callocephalon fimbriatum*	V	-	BAM-C, BioNet NSW	29	In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. In spring and summer, the species is generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas.	Low	Outside the typical range of the local population. No suitable hollow-bearing trees in the study area.	Species/Ecosystem	Y	Y	N
Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas *Callocephalon fimbriatum*	EP	-	BioNet NSW	26	In spring and summer the species is generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. EP restricted to the Hornsby and Ku-ring-gai Local Government Areas.	Low	Outside the typical range of the local population. No suitable hollow-bearing trees in the study area.	Species	N	NA	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Glossy Black-Cockatoo *Calyptorhynchus lathami*	V	-	BioNet NSW	1	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. It inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (*Allocasuarina littoralis*) and Forest Sheoak (*A. torulosa*) are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, *Allocasuaraina diminuta*, and *A. gymnathera*. Belah is also utilised and may be a critical food source for some populations. The species is dependent on large hollow-bearing eucalypts for nest sites.	Low	Outside the typical range of the local population. No suitable hollow-bearing trees in the study area. Limited preferred foraging habitat in the study area. Habitat constraints (of *Allocasuarina* and *casuarina* species) not present within associated vegetation zone (PCT 1281).	Species/ Ecosystem	Y	N	N
Grey Falcon *Falco hypoleucos*	E	V	EPBC PMST	-	The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. The species is usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. It also occurs near wetlands where surface water attracts prey.	Low	Study area outside usual range. Generally, occurs in inland areas.	Ecosystem	N	N	NA

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Hooded Robin (south-eastern form) *Melanodryas cucullata cucullata*	V	-	BAM-C	-	The Hooded Robin is widespread, found across Australia, except for the driest deserts and the wetter coastal areas – northern and eastern coastal Queensland and Tasmania. However, it is common in few places, and rarely found on the coast. It is considered a sedentary species, but local seasonal movements are possible. The south-eastern form (subspecies *cucullata*) is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west, where it is replaced by subspecies *picata*. The species prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. It also requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	Low	Study area outside usual range. Generally occurs in inland areas.	Ecosystem	Y	Y	NA
Little Eagle *Hieraaetus morphnoides*	V	-	BioNet NSW	9	Found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. Occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. Also found in Sheoak or *Acacia* woodlands and riparian woodlands of inland NSW. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.	Moderate	Local records occur with the study area, it is likely the study area represents part of the home range of local individuals. No breeding habitat present.	Species/Ecosystem	Y	Y	N

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Little Lorikeet *Glossopsitta pusilla*	V	-	BioNet NSW	19	Distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year. Forages primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in *Angophora*, *Melaleuca* and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity.	Moderate	Records within locality and suitable habitat present within study area.	Ecosystem	Y	Y	NA
Masked Owl *Tyto novaehollandiae*	V		BioNet NSW	3	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90 per cent of NSW, excluding the most arid north-western corner. Lives in dry eucalypt forests and woodlands from sea level to 1100 metres and often hunts along the edges of forests, including roadsides. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	Low	Preferred forested habitat not present within study area. No suitable hollow-bearing trees present. May forage on occasion if within a territory. No records within the locality.	Species/Ecosystem	Y	Y	N

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Orange-bellied Parrot *Neophema chrysogaster*	CE	CE	EPBC PMST	-	Breeds in the south-west of Tasmania and migrates in autumn to spend the winter on the mainland coast of south-eastern South Australia and southern Victoria. Occasional reports from NSW, with the most recent records from Shellharbour and Maroubra in May 2003. Typical winter habitat is saltmarsh and strandline/foredune vegetation communities either on coastlines or coastal lagoons. Spits and islands are favoured but can occur anywhere within these coastal regions. Can be found foraging in weedy areas associated with these coastal habitats or even in totally modified landscapes such as pastures, seed crops and golf courses.	Low	Study area not located on coast. No records within the locality.	Species	N	N	N
Painted Honeyeater *Grantiella picta*	V	V	BAM-C, EPBC PMST	-	Nomadic species occurring at low densities throughout its range. Most commonly found on the inland slopes of the Great Dividing Range in NSW, where almost all breeding occurs. More likely to be found in the north of its distribution in winter. Inhabits Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests. Specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus *Amyema*.	Low	No suitable habitat present within study area. No records within the locality. Habitat constraint (mistletoes present at a density of >5/ha) absent from associated vegetation zone. No mistletoes present within planted PCT 1281.	Ecosystem	Y	N	NA

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Powerful Owl *Ninox strenua*	V	-	BioNet NSW	1093	Widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains. Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. Requires large tracts of forest or woodland habitat but can also occur in fragmented landscapes. Breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. Roosts by day in dense vegetation comprising species such as Turpentine, Black She-oak, Blackwood, Rough-barked Apple, Cherry Ballart and a number of eucalypt species.	Present	Suitable foraging habitat present within study area. Records within the locality. No suitable hollow-bearing nest trees present.	Species/Ecosystem	Y	Y	N

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Regent Honeyeater *Anthochaera phrygia*	CE	CE	BAM-C, BioNet NSW, EPBC PMST	2	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes.	Low	Important habitat not present. May occur on rare occasions.	Species/Ecosystem	Y	Y	N

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Scarlet Robin *Petroica boodang*	V	-	BAM-C, BioNet NSW	5	Occurs from the coast to the inland slopes in NSW. Disperses to the lower valleys and plains of the tablelands and slopes after breeding. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. Found in dry eucalypt forests and woodlands with usually open and grassy understorey with few scattered shrubs. Lives in both mature and regrowth vegetation and occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Abundant logs and fallen timber are important components of its habitat.	Moderate	Marginal habitat present within study area. May occur occasionally in forested areas of the subject site.	Ecosystem	Y	Y	NA
Sooty Owl *Tyto tenebricosa*	V	-	BioNet NSW	1	Occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. Found in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roost by day in the hollow of a tall forest tree or in heavy vegetation and nest in very large tree hollows.	Low	Preferred habitat not present within study area.	Species/Ecosystem	Y	Y	N

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Speckled Warbler *Chthonicola sagittata*	V	-	BAM-C	-	The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	Low	Preferred habitat not present within study area.	Ecosystem	Y	Y	N
Spotted Harrier *Circus assimilis*	V	-	BioNet NSW	4	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. The species occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	Moderate	Recent records from within the study area.	Ecosystem	Y	Y	NA

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Square-tailed Kite *Lophoictinia isura*	V	-	BioNet NSW	5	Ranges along coastal and subcoastal areas from south-western to northern Australia. Scattered records throughout NSW indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. Summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. Found in a variety of timbered habitats including dry woodlands and open forests and shows a particular preference for timbered watercourses. Observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland in arid north-western NSW.	Moderate	Local records occur with the study area, it is likely the study area represents part of the home range of local individuals. No breeding habitat present.	Species/Ecosystem	Y	Y	N
Superb Fruit-Dove *Ptilinopus superbus*	V	-	BioNet NSW	1	Occurs principally from north-eastern in Queensland to north-eastern NSW. It is much less common further south, where it is largely confined to pockets of suitable habitat as far south as Moruya. Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees. Part of the population is migratory or nomadic. At least some of the population, particularly young birds, moves south through Sydney, especially in autumn.	Low	Species previously recorded within the locality but no suitable rainforest habitat recorded in the study area.	Ecosystem	Y	Y	NA

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Swift Parrot *Lathamus discolor*	E	CE	BioNet NSW, EPBC PMST	22	Migrates from Tasmania to south-eastern Australia in the autumn and winter months. Mostly occurs on the coast and south west slopes in NSW. Occurs on the mainland in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Forest Red Gum *E. tereticornis*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*.	Moderate	Important habitat not present. May occur on rare occasions.	Species/Ecosystem	Y	Y	N
Turquoise Parrot *Neophema pulchella*	V	-	BioNet NSW	5	Extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Typically lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	Low	Preferred habitat not present. Tends not to occur in urban Sydney	Ecosystem	Y	Y	NA
Varied Sittella *Daphoenositta chrysoptera*	V	-	BioNet NSW	3	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The species inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	Moderate	May occur occasionally in wooded areas of the study area.	Ecosystem	Y	Y	NA

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White-bellied Sea-eagle *Haliaeetus leucogaster*	V	-	BioNet NSW	317	Widespread along the NSW coast, and along all major inland rivers and waterways. Habitats characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Occurs at sites near the sea or seashore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat.	High	Breeds in nearby Newington Nature Reserve. Forages within the Parramatta River and Haslams Creek. Nest tree buffer outside the proposal footprint.	Species/Ecosystem	Y	Y	N
White-fronted Chat *Epthianura albifrons*	V	-	BioNet NSW	208	Found mostly in temperate to arid climates and very rarely sub-tropical areas. Occurs mostly in the southern half of NSW, in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Typically found foraging on bare or grassy ground in wetland areas, singly or in pairs.	Low	Potential habitat in the estuarine habitats within the study area, however local population is likely to be extinct.	Ecosystem	Y	Y	NA

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White-fronted Chat population in the Sydney Metropolitan Catchment Management Area *Epthianura albifrons*	EP	-	BioNet NSW	208	Occurs in damp open habitats along the coast. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Typically found foraging on bare or grassy ground in wetland areas, singly or in pairs. EP restricted to the Sydney Metropolitan CMA.	Low	Potential habitat in the estuarine habitats within the study area, however local population is likely to be extinct.	Species	Y	NA	N
Australian Grayling *Prototroctes maraena*	-	E	EPBC PMST	-	Occurs in streams and rivers on the eastern and southern flanks of the Great Dividing Range, from Sydney, southwards to the Otway Ranges of Victoria and in Tasmania. Found in fresh and brackish waters of coastal lagoons, from Shoalhaven River in NSW to Ewan Ponds in South Australia. Adults inhabit cool, clear, freshwater streams with gravel substrate and areas alternating between pools and riffle zones.	Nil	Outside the known distribution of the species	NA	N		
Black Rockcod *Epinephelus daemelii*	-	V	EPBC PMST	-	Found in warm temperate/sub-tropical parts of south-western Pacific. Naturally occur along NSW Coast, including Lord Howe Island. Adults generally found on rocky reefs. Juveniles found in coastal rock pools and around rocky shores in estuaries.	Low	No suitable rocky reef habitat present.	NA			

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Macquarie Perch *Macquaria australasica*	-	E	EPBC PMST	-	Known only from scattered localities in the cool upper reaches of the Murray-Darling system of NSW, including the Hawkesbury-Nepean and Shoalhaven catchments, Victoria and the Australian Capital Territory. Also found in man-made lakes on the NSW coast and in lakes and reservoirs, where adults aggregate in small shoals during the spawning season. Inhabits cool, clear freshwaters of rivers with deep holes and shallow riffles. They are also found	Nil	No suitable freshwater stream habitat present.	NA			
Cumberland Plain Land Snail *Meridolum corneovirens*	E	-	BioNet NSW	13	Lives in small areas on the Cumberland Plain west of Sydney, from Richmond and Windsor south to Picton and from Liverpool west to the Hawkesbury and Nepean Rivers at the base of the Blue Mountains. The species primarily inhabits Cumberland Plain Woodland (a critically endangered ecological community). This community is a grassy, open woodland with occasional dense patches of shrubs. It is also known from Shale Gravel Transition Forests, Castlereagh Swamp Woodlands and the margins of River-flat Eucalypt Forest, which are also listed communities. It lives under litter of bark, leaves and logs, or shelters in loose soil around grass clumps. Occasionally shelters under rubbish.	Low	No suitable woodland habitat within the study area, majority of vegetation is planted. The closest records (6 km) to the alignment are at Auburn Golf Course (2012). Targeted surveys found limited available habitat in subject site.	Species	Y	NA	N

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Dural Woodland Snail *Pommerhelix duralensis*	E	E	EPBC PMST, BioNet NSW	36	Shale-influenced-habitat specialist, which occurs in low densities along the western and northwest fringes of the Cumberland IBRA subregion on shale-sandstone transitional landscapes. Found within the Local Government Areas of The Hills Shire, Hawkesbury Shire and Hornsby Shire. Records from the Blue Mountains City, Penrith City and Parramatta City may represent this species. Favours forested habitats with good native cover and woody debris. Shelters under rocks or inside curled-up bark, it does not burrow nor climb.	Low	Low potential to occur in the subject site. Marginal habitat within the study area given history of disturbance. Collected in the Parramatta region in 1944 and 1955	Species	Y	NA	N
Brush-tailed Rock-wallaby *Petrogale penicillata*	E	V	EPBC PMST	-	Occurs from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit. Occupies rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. It typically shelters or basks during the day in rock crevices, caves and overhangs and are most active at night when foraging. Browse on vegetation in and adjacent to rocky areas.	Nil	No escarpment habitat present within study area. No records within the locality.	Species	N	NA	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Eastern Chestnut Mouse *Pseudomys gracilicaudatus*	V	-	BioNet NSW	1	Mainly occurs north from the Hawkesbury River area as scattered records along to coast and eastern fall of the Great Dividing Range extending north into Queensland. Isolated records in the Jervis Bay area. Found in heathland in low numbers and most common in dense, wet heath and swamps. Optimal habitat appears to be in vigorously regenerating heathland burnt from 18 months to four years previously.	Low	Preferred habitat not present within study area. Study area subject to high levels of historical disturbance	Ecosystem	N	N	NA
Eastern Coastal Free-tailed Bat *Micronomus norfolkensis*	V	-	BioNet NSW	30	Found along the east coast from south Queensland to southern NSW. Occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in man-made structures.	Moderate	May forage and breed in the study area.	Ecosystem	Y	Y	NA
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	V	-	BioNet NSW	22	Found on the south-east coast and ranges of Australia, from southern Queensland to Victoria. Prefers moist habitats, with trees taller than 20 metres. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	Moderate	Limited suitable tall forest habitat present. Study area subject to high levels of historical disturbance	Ecosystem	Y	Y	NA

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Eastern Pygmy-possum *Cercartetus nanus*	V			1	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. The species is found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. It feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes and is an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable.	Low	No heathy woodland habitat present. Study area subject to high levels of historical disturbance. Lack of connectivity to suitable habitat.	Species	Y	N	N
Greater Broad-nosed Bat *Scoteanax rueppellii*	V	-	BioNet NSW	28	Found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. Widespread on the New England Tablelands in NSW, however, does not occur at altitudes above 500 metres. Found in a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, most commonly found in tall wet forest. Usually roosts in tree hollows but also found in buildings.	Moderate	May forage and breed in the study area.	Ecosystem	Y	Y	NA

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Greater Glider *Petauroides volans*	-	V	BioNet NSW, EPBC PMST	3	Restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevational range from sea level to 1200 metres above sea level. Prefers taller montane, moist eucalypt forest with relatively old trees and abundant hollows.	Low	Limited suitable tall forest habitat present. Study area subject to high levels of historical disturbance. Lack of connectivity to suitable habitat. No populations remain in the inner Sydney area. No suitable habitat within the study area. 'Habitat degraded' button selected in the BAM-C to indicate the lack of suitable habitat for this species.	Species	Y	N/A	N
Grey-headed Flying-fox *Pteropus poliocephalus*	V	V	BioNet NSW, EPBC PMST	2173	Generally found within 200 kilometres of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. May be found in unusual locations in times of natural resource shortage. Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 kilometres of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	High	Suitable foraging habitat within the study area. No roost camps in the study area.	Species/Ecosystem	Y	Y	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Koala *Phascolarctos cinereus*	V	V	BioNet NSW, EPBC PMST	12	Found on the central and north coasts, southern highlands, southern and northern tablelands, Blue Mountains, southern coastal forests of NSW, with some smaller populations on the plains west of the Great Dividing Range. Inhabits eucalypt woodlands and forests, and feeds on the foliage of more than 70 eucalypt species and 30 non-eucalypt species but will select preferred browse species in any one area.	Low	Limited suitable forest habitat present. Study area subject to high levels of historical disturbance. Lack of connectivity to suitable habitat. 'Habitat degraded' button selected in BAM-C to indicate that no suitable habitat is present within the study area, given lack of intact, connected native vegetation that would provide habitat for this species.	Species/Ecosystem	Y	N	N
Large Bentwing-bat *Miniopterus orianae oceanensis*	V	-	BioNet NSW	288	Occurs along the east and north-west coasts of Australia. Uses caves as the primary roosting habitat, but also uses derelict mines, storm-water tunnels, buildings and other man-made structures. Hunts in forested areas, catching moths and other flying insects above the tree tops.	High	Suitable foraging habitat within the study area. May roost in culverts. No breeding habitat. Records near Newington Nature Reserve and Sydney Olympic Park	Species/Ecosystem	Y	Y	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Large-eared Pied Bat *Chalinolobus dwyeri*	V	V	BioNet NSW, EPBC PMST	5	The Large-eared Pied Bat is found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes. The species roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. It is found in well-timbered areas containing gullies.	Low	Low quality to marginal foraging habitat within the study area. Not located near sandstone escarpments.	Species	N	NA	NA
Little Bentwing-bat *Miniopterus australis*	V	-	BioNet NSW	51	Occurs along the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Prefers moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Roosts in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day. Forages for small insects beneath the canopy of densely vegetated habitats.	Moderate	Suitable foraging habitat within the study area. May roost in culverts. No breeding habitat. Records near Newington Nature Reserve and Sydney Olympic Park	Species/Ecosystem	Y	Y	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Long-nosed Bandicoot population in inner western Sydney *Perameles nasuta*	EP	-	BioNet NSW	26	The exact area occupied by the Long-nosed Bandicoot population in inner western Sydney is not clearly defined and includes the local government areas (LGA) of Marrickville and Canada Bay, with the likelihood that it also includes Canterbury, Ashfield and Leichhardt LGAs. The species shelter mostly under older houses and buildings and forage in parkland and back-yards.	Low	No suitable habitat within the study area. Outside the distribution of the local population	Species	N	NA	N
New Holland Mouse *Pseudomys novaehollandiae*	-	V	EPBC PMST	-	Largely restricted to the coast of central and northern NSW, with one inland occurrence near Parkes. Known from Royal National Park (NP), the Kangaroo Valley, Kuring-Gai Chase NP, and Port Stephens to Evans Head near the Queensland border. Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes. Soil type may be an important indicator of suitability of habitat, with deeper top soils and softer substrates being preferred for digging burrows.	Low	No suitable heathy habitat in the study area. No records within the locality.	Ecosystem	Y	Y	N
Southern Brown Bandicoot *Isoodon obesulus obesulus*	E	E	EPBC PMST	-	Patchy distribution, found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River. Generally only found in heath or open forest with a heathy understorey on sandy or friable soils. Nest during the day in a shallow depression in the ground covered by leaf litter, grass or other plant material.	Low	No suitable heathy habitat in the study area. No records within the locality.	Species	N	NA	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Southern Myotis *Myotis macropus*	V	-	BioNet NSW	76	Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in flat/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage, typically in close proximity to water.	High	Suitable foraging and breeding habitat within the study area. Known roost present. Records at Newington Nature Reserve, Sydney Olympic Park, and North Parramatta.	Species	Y	NA	Y
Spotted-Tailed Quoll *Dasyurus maculatus*	V	E	BioNet NSW, EPBC PMST	3	Found in eastern NSW, the species has been recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Uses hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites. Females occupy home ranges of 200 to 500 hectares, while males occupy very large home ranges from 500 to over 4000 hectares. Known to traverse their home ranges along densely vegetated creeklines.	Low	Low quality habitat within the study area. No connectivity to large tracts of habitat	Ecosystem	Y	Y	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Squirrel Glider *Petaurus norfolcensis*	V	-	BioNet NSW	1	Widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Require abundant tree hollows for refuge and nest sites.	Low	Low quality habitat within the study area. No connectivity to large tracts of habitat. No local populations remain in the inner Sydney area. No suitable habitat within the study area. 'Habitat degraded' button selected in the BAM-C to indicate the lack of suitable habitat for this species.	Species	Y	NA	N
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*	V	-	BioNet NSW	36	Wide-ranging species found across northern and eastern Australia. Rare visitor of south-western NSW in late summer and autumn. Scattered records of this species across the New England Tablelands and North West Slopes. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. It forages in most habitats across its very wide range, with and without trees.	High	Suitable foraging and breeding habitat within study area.	Ecosystem	Y	Y	NA
Broad-headed Snake *Hoplocephalus bungaroides*	E	V	EPBC PMST BAM-C	-	Largely confined to Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and Shoalhaven groups, within the coast and ranges in an area within approximately 250 kilometres of Sydney. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring.	Nil	No sandstone habitat present. Geographic limitation (the south west margins of the subregion) applies – the site is not at the south west margin of the IBRA subregion.	Species/ Ecosystem	Y	N	N

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type	Predicted by calculator (Y, N or N/A)	Confirmed predicted (Y, N or N/A)	Confirmed candidate (Y, N or N/A)
Loggerhead Turtle *Caretta caretta*	E	E	BioNet NSW	1	Loggerhead Turtles are found in tropical and temperate waters off the Australian coast. In NSW they are seen as far south as Jervis Bay and have been recorded nesting on the NSW north coast and feeding around Sydney.	Low	Species previously recorded within the locality but no suitable habitat recorded in the study area. Unlikely to occur in the Parramatta River.	NA	NA	NA	NA
Rosenberg's Goanna *Varanus rosenbergi*	V	-	BAM-C	-	Rosenberg's Goanna occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. There are records from the South West Slopes near Khancoban and Tooma River. Also occurs in South Australia and Western Australia. Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component.	Nil	No sandstone woodland habitat present.	Ecosystem	Y	Y	NA

Key: V – vulnerable, E – endangered, CE – critically endangered, EP – endangered population, M – migratory

Table B.3 Likelihood of occurrence of migratory species in the study area

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Antipodean Albatross *Diomedea antipodensis*	V	V,M	EPBC PMST	-	The Antipodean Albatross is endemic to New Zealand, however forages widely in open water in the south-west Pacific Ocean, Southern Ocean and the Tasman Sea, notably off the coast of NSW. The Antipodean Albatross is marine, pelagic and aerial. It rarely enters the belt of icebergs region of Antarctica, but in late summer, it may approach the edge of pack-ice. It sleeps and rests on ocean waters when not breeding.	Low	Oceanic species with no records within the locality	
Australian Painted Snipe *Rostratula australis*	E	V, M	BioNet NSW, EPBC PMST	3	In NSW many records are from the Murray-Darling Basin including the Paroo wetlands, Lake Cowal, Macquarie Marshes, Fivebough Swamp and more recently, swamps near Balldale and Wanganella. Other important locations with recent records include wetlands on the Hawkesbury River, the Clarence and lower Hunter Valleys. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Forages nocturnally on mudflats and in shallow water.	Moderate	Occurs locally on an intermittent basis and suitable habitat is associated with the study area.	Ecosystem
Bar-tailed Godwit *Limosa lapponica*	-	M	EPBC PMST, BioNet NSW	781	Recorded in the coastal areas of all Australian states. Widespread along the east and south-east coasts of NSW, including the offshore islands. Few inland records from NSW. Inhabit estuarine mudflats, beaches and mangroves. Common in coastal areas around Australia. Social birds, often seen in large flocks and in the company of other waders.	High	Regularly observed in habitats associated with the study area.	Species/ Ecosystem
Black-browed Albatross *Thalassarche melanophris*	V	V, M	EPBC PMST	-	Circumpolar range over the southern oceans and are seen off the southern Australian coast mainly during winter. Migrates to waters off the continental shelf from approximately May to November and is regularly recorded off the NSW coast during this period. Previously recorded in Botany Bay National Park. Inhabits Antarctic, subantarctic, subtropical marine and coastal waters over upwellings and boundaries of currents.	Low	Oceanic species with no records within the locality	
Black-faced Monarch *Monarcha melanopsis*	-	M	EPBC PMST	-	Found along the coast of eastern Australia, becoming less common further south. Occurs around the eastern slopes and tablelands of the Great Divide, inland to Coutts Crossing, Armidale, Widden Valley, Wollemi National Park, Wombeyan Caves and Canberra. Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	Moderate	Marginal habitat present within study area. May occur occasionally in forested areas of the subject site during migratory movements or post-breeding dispersal.	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Black-tailed Godwit *Limosa limosa*	V	M	BioNet NSW, EPBC PMST	1	Most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the coast, and inland in NSW. May occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. Also recorded within the Murray-Darling Basin, on the western slopes of the Northern Tablelands and in the far north-western corner of the state. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps.	Low	No recent records locally, although rare occurrences cannot be entirely discounted.	Species/ Ecosystem
Broad-billed Sandpiper *Limicola falcinellus*	V	M	BioNet NSW	1	Mainly occurs in the Hunter River estuary in NSW, with birds occasionally reaching the Shoalhaven estuary. Few records for inland NSW. Favours sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons. Roosts on banks on sheltered sand, shell or shingle beaches.	Moderate	A rare species locally, but records occur in habitats associated with the study area and occasion occurrences cannot be entirely discounted.	Species/ Ecosystem
Buller's Albatross *Thalassarche bullei*	-	V, M	EPBC PMST	-	The Northern Buller's Albatross is a marine, pelagic species. It occurs in subtropical and subantarctic waters of the South Pacific Ocean. Habitat preferences are poorly known. In Australia, the species occurs over inshore, offshore and pelagic waters and off the coast of south-east Tasmania. The Pacific Albatross prefers waters of the East Australia Current where sea surface-temperatures are greater than 16.5 °C. The birds fly in low or medium airspace using updraft off sea swell for lift. The species takes food from the surface with shallow dives up to 1 metre deep observed. The birds breed on subtropical and subantarctic islands and rock stacks in the New Zealand region, on sparsely vegetated slopes, cliff tops and ledges on rocky islands or stacks.	Low	Oceanic species with no records within the locality	
Campbell Albatross *Thalassarche impavida*	-	V, M	EPBC PMST	-	Non-breeding visitor to Australian waters. Commonly seen foraging over the oceanic continental slopes off Tasmania, Victoria and New South Wales. Inhabits sub-Antarctic and subtropical waters from pelagic to shelf-break water habitats. Nests only at Campbell Island and the adjacent Isle de Jeanette Marie south of New Zealand	Low	Oceanic species with no records within the locality	
Caspian Tern *Hydroprogne caspia*	-	M	BioNet NSW	31	Found in coastal and inland areas. In NSW, widespread east of the divide, mainly in coastal regions as well as the Riverina and Western regions, with occasional records elsewhere. Breeding has been recorded in the Menindee Lakes. Mostly found in sheltered coastal embayments, preferring areas with sandy or muddy margins. Usually forages in open wetlands, including lakes and rivers.	Moderate	Local records occur with the study area, it is likely the study area represents part of the home range of local individuals.	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Chatham Albatross *Thalassarche eremita*	-	E, M	EPBC PMST	-	Breeding restricted to Pyramid Rock, Chatham Islands, off the coast of New Zealand. Commonly seen foraging range in coastal waters off eastern and southern New Zealand, and Tasmania. Found in shelf-waters around breeding islands, over continental shelves during the non-breeding season, and occurs inshore and offshore. Enters harbours and bays and is scarce in pelagic waters.	Low	Oceanic species with no records within the locality	
Common Greenshank *Tringa nebularia*	-	M	EPBC PMST,, BioNet NSW	93	Common throughout Australia in the summer. In NSW, the species has been recorded in most coastal regions. It is widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions. Found both on the coast and inland, in estuaries and mudflats, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms and flooded crops.	Moderate	Suitable habitat associated with the study area. Locally rare, but occasional occurrences cannot be discounted.	
Common Noddy *Anous stolidus*	-	M	EPBC PMST	-	the Common Noddy is widespread throughout the tropical regions of the Indian, Pacific and Atlantic Oceans, usually occurs out to sea during the non-breeding season, but when breeding it usually stays near islands. The Common Noddy is found in tropical and sub-tropical seas off the west, north and east coasts of Australia, from the Abrolhos Islands in WA to the islands of the Great Barrier Reef in Qld, as well as Norfolk and Lord Howe Islands. Some are seen almost annually in NSW as far south as Sydney. It also ranges across tropical parts of the Pacific, Indian and Atlantic Oceans. The Common Noddy is found on offshore tropical islands, often in large colonies of more than 100,000 nests.	Low	Preferred habitat not present.	
Common Sandpiper *Actitis hypoleucos*	-	M	BioNet NSW, EPBC PMST,	70	Does not breed in Australia. When in Australia it is found on all coastlines and in inland areas but is concentrated in the north and west with important areas in WA, the NT and Qld. Utilises a wide range of coastal and inland wetlands with varying salinity levels.	Moderate	Potential habitat is available within study area.	
Common Tern *Sterna hirundo*	-	M	BioNet NSW	2	Regular non-breeding visitor, mainly found along the eastern coast, where they are widespread and common from south-eastern Queensland to eastern Victoria, though less often recorded south of Port Hacking in NSW. Mainly coastal when not breeding and found in offshore waters, ocean beaches, estuaries and large lakes. Occasionally seen in freshwater swamps, floodwaters, sewage farms and brackish and saline lakes.	Low	Preferred habitat not present within study area.	
Crested Tern *Thalasseus bergii*		M	BioNet NSW	21	Distributed around the Australian coast, it occurs on ocean beaches, estuaries and coastal lagoons and occasionally on salt lakes. The species is known to rest on sand spits, low points and reefs along coastal beaches and inlets. It rarely flies far from shore out to sea or inland on bodies of fresh water.	Low	No preferred habitat within study area.	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Curlew Sandpiper *Calidris ferruginea*	E	M	BioNet NSW, EPBC PMST	241	The Curlew Sandpiper is distributed around most of the Australian coastline (including Tasmania). It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. Inland records are probably mainly of birds pausing for a few days during migration. The Curlew Sandpiper breeds in Siberia and migrates to Australia (as well as Africa and Asia) for the non-breeding period, arriving in Australia between August and November, and departing between March and mid-April. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland. It forages in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach-cast seagrass or seaweed.	Moderate	Suitable habitat associated with the study area.	Species/Eco system
Double-banded Plover *Charadrius bicinctus*	-	M	EPBC PMST	-	In Australia, the Double-banded Plover is found mainly on the east coast and Tasmania and is a regular visitor to Norfolk and Lord Howe Islands. It has been recorded occasionally in Western Australia. It is widespread throughout New Zealand. The Double-banded Plover is found on coastal beaches, mudflats, sewage farms, riverbanks, fields, dunes, upland tussock grasses and shingle.	Moderate	Suitable habitat associated with the study area.	
Eastern Curlew *Numenius madagascariensis*	-	CE, M	BioNet NSW, EPBC PMST,	10	Occurs across the entire coast but is mainly found in estuaries such as the Hunter River, Port Stephens, Clarence River, Richmond River and the south coast. Generally occupies coastal lakes, inlets, bays and estuarine habitats, and is mainly found in intertidal mudflats and sometimes saltmarsh of sheltered coasts in NSW. Rarely seen inland.	Moderate	Records from habitat associated with the study area. Rare or incidental occurrences cannot be discounted	Species/Eco system
Eastern Osprey *Pandion cristatus*	V	M	BioNet NSW, EPBC PMST	10	Found right around the Australian coast line, except for Victoria and Tasmania. Common around the northern coast, especially on rocky shorelines, islands and reefs. Uncommon to rare or absent from closely settled parts of south-eastern Australia. Rare records from inland areas. Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. Breeds in NSW from July to September. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	Moderate	Recent local records and the study area likely occurs in the home range of local individuals.	Species/Eco system
Fairy Prion *Pachyptila turtur*	-	V	EPBC PMST	-	Breeds on Macquarie Island and a number of other subantarctic islands outside of Australia. The subspecies digs burrows among rocks or low vegetation in which to nest. Burrows may be dug below mat forming herbs. Fairy Prion feed by plucking food from the ocean surface. Some individuals may migrate towards New Zealand and southern Australia in winter.	Low	Oceanic species with no records within the locality	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Fork-tailed Swift *Apus pacificus*	-	M	BioNet NSW, EPBC PMST	5	The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 metre to at least 300 metres above ground and probably much higher. In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. The sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines.	Low	Preferred habitat not present. May occur seasonally over the site but there is no suitable terrestrial habitat locally.	
Gibson's Albatross *Diomedea gibsoni*	V	V, M	EPBC PMST	-	Essentially endemic to the Auckland Islands of New Zealand. The non-breeding range is poorly known however the species probably disperses across the southern Pacific. The species is regularly encountered on trans-Tasman shipping routes and at seas off Sydney, and regularly occurs off the NSW coast usually between Green Cape and Newcastle.	Low	Oceanic species with no records within the locality	
Great Knot *Calidris tenuirostris*	V	CE, M	EPBC PMST, BioNet NSW	1	In NSW, the species has been recorded at scattered sites along the coast down to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith. It occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons and is often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms.	Low	No preferred habitat present within study area.	Species/Ecosystem
Grey Plover *Pluvialis squatarola*	-	M	EPBC PMST, BioNet NSW	1	Breeds around the Arctic regions and migrates to the southern hemisphere, being a regular summer migrant to Australia, mostly to the west and south coasts. Almost entirely coastal, being found mainly on marine shores, inlets, estuaries and lagoons with large tidal mudflats or sandflats for feeding, sandy beaches for roosting, and also on rocky coasts.	Low	A relatively rare species to NSW greater Sydney estuaries. Suitable habitat is associated with the study area but there are no recent records for this species.	
Grey-tailed Tattler *Tringa brevipes*	-	M	EPBC PMST, BioNet NSW	1	Non-breeding visitor to Australia. In NSW occurs along the coast from the Queensland border south to Tilba Lake and has been recorded as far south as Gippsland. In NSW it is recorded more frequently north of Sydney. Found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. Inland records are rare. Forages in shallow water in intertidal areas. Usually roosts in the branches of mangroves or rocks which may be partly submerged. Also rarely recorded in dense shrubs, on driftwood or sand dunes.	Low	No preferred habitat within study area.	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Latham's Snipe *Gallinago hardwickii*	-	M	EPBC PMST, BioNet NSW	720	Non-breeding migrant to the south east of Australia. Breeds in Japan and on the east Asian mainland. Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. Found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration. Also uses crops and pasture.	High	Potential habitat and recent records within the locality. There are known populations at the Newington Nature Reserve and in habitats associated with the study area. A number of records occur within 200 metres of the project alignment.	
Lesser Sand Plover *Charadrius mongolus*	V	E, M	EPBC PMST	-	The Lesser Sand-plover breeds in central and north eastern Asia, migrating further south for winter. In Australia the species is found around the entire coast but is most common in the Gulf of Carpentaria, and along the east coast of Queensland and northern NSW. Individuals are rarely recorded south of the Shoalhaven estuary, and there are few inland records. The species is almost entirely coastal in NSW, favouring the beaches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats; occasionally occurs on sandy beaches, coral reefs and rock platforms.	Low	No records within the locality. Preferred near-coastal habitat not present within study area.	Species/Ecosystem
Little Curlew *Numenius minutus*	-	M	EPBC PMST	-	Widespread in the north of Australia and scattered elsewhere. Recorded in Australia between September and April with few winter records. Most often found feeding in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated.	Low	No records within the locality.	
Little Tern *Sternula albifrons*	-	M	BioNet NSW	3	Migrates to NSW from September to November, occurring mainly north of Sydney. Breeds in spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months. Almost exclusively coastal, preferring sheltered environments; however, may occur several kilometres from the sea in harbours, inlets and rivers. Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands.	Low	Preferred near-coastal habitat not present within study area.	Species/Ecosystem

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Marsh Sandpiper *Tringa stagnatilis*	-	M	EPBC PMST, BioNet NSW	22	Found on coastal and inland wetlands throughout Australia. It is recorded in all regions of NSW but especially the central and south coasts and (inland) on the western slopes of Great Divide and western plains. The Hunter River Estuary and the Macquarie Marshes are internationally important sites for this species. The species lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. It is a summer migrant to Australia, from about August to April.	Moderate	Suitable habitat associated with the study area and occurs locally on an intermittent basis.	
Northern Buller's Albatross *Thalassarche bulleri platei*	-	V, M	EPBC PMST	-	Occurs in subtropical and subantarctic waters of the South Pacific Ocean. Habitat preferences are poorly known. Occurs over inshore, offshore and pelagic waters and off the coast of south-east Tasmania. Prefers waters of the East Australia Current where sea surface-temperatures are greater than 16.5 °C. Breeds on subtropical and subantarctic islands and rock stacks in the New Zealand region, on sparsely vegetated slopes, cliff tops and ledges on rocky islands or stacks.	Low	Oceanic species with no records within the locality	
Northern Giant-Petrel *Macronectes halli*	V	V, M	EPBC PMST	-	Circumpolar pelagic distribution, usually between 40-64ºS in open oceans. Their range extends into subtropical waters (to 28ºS) in winter and early spring. Common visitor in NSW waters, predominantly along the south-east coast during winter and autumn. Breeding in Australian territory is limited to Macquarie Island and occurs during spring and summer.	Low	Oceanic species with no records within the locality	
Northern Royal Albatross *Diomedea sanfordi*	-	E, M	EPBC PMST	-	The Northern Royal Albatross breeds in New Zealand waters. The main population (estimated at 6,500 to 7,000 pairs) nests on islands off the Chatham Islands, and up to 50 pairs nest at Taiaroa Head on the South Island. Most the population spends the non-breeding period off both coasts of southern South America, especially off Chile and Argentina. It is a rare visitor to NSW waters, predominantly visiting southern waters in the winter and early spring period. The Northern Royal Albatross primarily forages in inshore and offshore waters over the continental shelf to the shelf edge.	Low	Oceanic species with no records within the locality	
Oriental Cuckoo, Himalayan Cuckoo *Cuculus opatus*	-	M	EPBC PMST	-	This species migrates to northern and eastern Australia in the warmer months. Occurs south to the Shoalhaven area. Occurs in a range of habitats, including monsoon forest, rainforest edges, leafy trees in paddocks, river flats, roadsides and mangroves.	Moderate	Vagrant to the locality, but occurrence within the study area cannot be discounted. Does not breed in Australia.	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Pacific Golden Plover *Pluvialis fulva*	-	M	BioNet NSW, EPBC PMST	282	Breeds on the Arctic tundra in western Alaska. It winters in South America and islands of the Pacific Ocean to India, Indonesia and Australia. Widespread along the coastline in Australia. Found on muddy, rocky and sandy wetlands, shores, paddocks, saltmarsh, coastal golf courses, estuaries and lagoons.	Moderate	Occurs locally on an intermittent basis and suitable habitat is associated with the study area.	
Pectoral Sandpiper *Calidris melanotos*	-	M	EPBC PMST, BioNet NSW	31	Widespread but scattered records across NSW, east of the divide and in the Riverina and Lower Western regions. Breeds in the northern hemisphere. In Australasia, prefers shallow fresh to saline wetlands and is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. Usually in coastal or near-coastal habitats, and prefers wetlands with open mudflats and low emergent or fringing vegetation such as grass or samphire.	Moderate	Suitable habitat associated with the study area.	
Pintail Snipe *Gallinago stenura*	-	M	EPBC PMST	-	A single banded bird was reported near West Wyalong in NSW. Occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation during non-breeding period. Also found in drier, more open wetlands such as claypans in more arid parts of species' range. Commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands.	Low	A northern Australian species that does not occur locally. No records within the locality	
Rainbow Bee-eater *Merops ornatus*	-	M	EPBC PMST	-	Distributed across much of mainland Australia, except in desert areas, and breeds throughout most of its range. Often found in open forests, woodlands and shrublands, and cleared areas, usually near water. Occurs on farmland with remnant vegetation and in orchards and vineyards. Uses disturbed sites such as quarries, cuttings and mines to build its nesting tunnels.	Low	No sandy banks within the study area as suitable nesting habitat.	
Red Knot *Calidris canutus*	-	E, M	EPBC PMST, BioNet NSW	13	Breeds in northern hemisphere. Occurs in coastal areas around Australia, with important sites in VIC, SA, WA, NT and Qld. Mainly inhabits intertidal mudflats, sandflats and sandy beaches. Occasionally seen in terrestrial saline wetlands but rarely in freshwater wetlands. Forage in soft substrates in intertidal areas.	Low	Preferred habitat not present within study area.	Species/Eco system
Red-necked Stint *Calidris ruficollis*	-	M	EPBC PMST, BioNet NSW	25	The Red-necked Stint breeds in north-eastern Siberia and northern and western Alaska. It follows the East Asian-Australasian Flyway to spend the southern summer months in Australia. It is found widely in Australia, except in the arid inland. Red-necked Stints are found on the coast, in sheltered inlets, bays, lagoons, estuaries, intertidal mudflats and protected sandy or coralline shores. They may also be seen in saltworks, sewage farms, saltmarsh, shallow wetlands including lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats, flooded paddocks or damp grasslands. They are often in dense flocks, feeding or roosting.	Moderate	Suitable habitat associated with the study area.	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Ruddy Turnstone *Arenaria interpres*	-	M	EPBC PMST, BioNet NSW	1	In Australia, Ruddy Turnstones are widespread around the coast of the mainland and offshore islands. They breed on the northern coasts of Europe, Asia and North America. They are found on coastlines around the world, when not breeding or on passage. The Ruddy Turnstone is found singly or in small groups along the coastline and only occasionally inland. They are mainly found on exposed rocks or reefs, often with shallow pools, and on beaches. In the north, they are found in a wider range of habitats, including mudflats.	Low	Preferred habitat not present.	
Ruff *Philomachus pugnax*	-	M	EPBC PMST	-	Recorded at Kurnell, Tomki, Casino, Ballina, Kooragang Island, Broadwater Lagoon and Little Cattai Creek. Also found around the Riverina, including Windouran Swamp, Wanganella, Fivebough Swamp and the Tullakool Saltworks. Most NSW records come from the Sydney region. Found on generally fresh, brackish of saline wetlands with exposed mudflats at the edges. Found in terrestrial wetlands including lakes, swamps, pools, lagoons, tidal rivers, swampy fields and floodlands. Occasionally seen on sheltered coasts, in harbours, estuaries, seashores and are known to visit sewage farms and saltworks. They are sometimes found on wetlands surrounded by dense vegetation including grass, sedges, saltmarsh and reeds.	Low	Suitable habitat is associated with the study area, but this species is only a rare visitor to NSW estuarine habitats.	
Rufous Fantail *Rhipidura rufifrons*	-	M	EPBC PMST	-	Found along NSW coast and ranges. Inhabits rainforest, dense wet forests, swamp woodlands and mangroves. During migration, it may be found in more open habitats or urban areas.	Moderate	No suitable habitat for establishing breeding territories but may occur in study area habitats as a bird of passage or during post-breeding dispersals.	
Salvin's Albatross *Thalassarche salvini*	-	V, M	EPBC PMST	-	Non-breeding visitor to Australian waters. Ranges widely through the south Pacific. During the non-breeding season, the species occurs over continental shelves around continents. Occurs both inshore and offshore and enters harbours and bays.	Low	Oceanic species with no records within the locality	
Satin Flycatcher *Myiagra cyanoleuca*	-	M	EPBC PMST	-	Found along the east coast of Australia from far northern Queensland to Tasmania. Uncommonly seen species, especially in the far south of its range, where it is a summer breeding migrant. Inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	Moderate	Recorded locally in habitat associated with the study area.	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Sharp-tailed Sandpiper *Calidris acuminata*	-	M	EPBC PMST, BioNet NSW	564	Spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage. In Australasia, prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. Breeds in northern Siberia.	High	Suitable habitat associated with the study area.	
Short-tailed Shearwater *Ardenna tenuirostris*		M	BioNet NSW		The Short-tailed Shearwater breeds on Tasmania and off the coast of south Australia, with the bulk of the population in the south-east. Breeding occurs mainly on coastal islands, typically in areas of grassland or other vegetation, but sometimes cliffs or bare ground.	Low	Preferred habitat not present.	
Shy Albatross *Thalassarche cauta cauta*	V	V, M	EPBC PMST	-	Most adult Shy Albatrosses remain in the waters off southeast Australia all year round, and seldom venture more than 600 kilometres from the breeding colony. Breeding occurs on Albatross Island, Bass Strait, and Mewstone and Pedra Branca, off southern Tasmania.	Low	Oceanic species with no records within the locality	
Sooty Shearwater *Ardenna grisea*		M	BioNet NSW	1	In summer months, the Short-tailed Shearwater is the most common shearwater along the south and south-east coasts of Australia. Enormous flocks of birds head south to breeding grounds off these coasts as they return from wintering grounds in the North Pacific. Some counts have recorded numbers as great as 60 000 individuals passing every hour, with over 18 million birds making the trek. At this time a number of birds are washed up on beaches and die as a result of exhaustion, sickness and bad weather. Most are birds hatched during the previous breeding season. Considering the incredible numbers of birds that make this annual migration, the number of fatalities is fairly small.	Low	Preferred habitat not present.	
Southern Giant-Petrel *Macronectes giganteus*	E	E, M	EPBC PMST	-	Circumpolar pelagic range from Antarctica to approximately 20° S and common visitor off the coast of NSW.	Low	Oceanic species with no records within the locality	
Southern Royal Albatross *Diomedea epomophora*	-	V, M	EPBC PMST	-	Over 99 per cent of the Southern Royal Albatross population breeds on Campbell Island, and a small proportion on the Auckland Islands. Southern royal albatrosses are generally solitary at sea. Young birds gather to display in gams on the breeding grounds. Non-breeding birds and juveniles cross the Southern Ocean to feed in South American waters before returning to the breeding areas by circumnavigating the globe.	Low	Oceanic species with no records within the locality	
Spectacled Monarch *Monarcha trivirgatus*	-	M	EPBC PMST	-	The Spectacled Monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. Prefers thick understorey in rainforest, wet gullies and waterside vegetation as well as mangroves.	Low	Marginal preferred habitat present within study area. No records within the locality	

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Swinhoe's Snipe *Gallinago megala*	-	M	EPBC PMST	-	Few definite records in Australia. Mostly recorded in north Australia, particularly the Kimberley region, from October–April. Non-breeding migrant to Australia and occurs at the edges of wetlands, such as wet paddy fields, swamps and freshwater streams. Also known to occur in grasslands, drier cultivated areas (including crops of rapeseed and wheat) and market gardens.	Low	A northern Australian species that does not occur locally. No records within the locality	
Terek Sandpiper *Xenus cinereus*	-	M	BioNet NSW	1	Found in two main sites, the Richmond River estuary and the Hunter River estuary. Recorded on coastal mudflats, lagoons, creeks and estuaries, and favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 kilometres inland around brackish pools.	Moderate	Suitable habitat associated with the study area. Locally rare but has occurred within the last ten years.	Species/Eco system
Wandering Albatross *Diomedea exulans*	E	V, M	EPBC PMST	-	The Wandering Albatross visits Australian waters extending from Fremantle, Western Australia, across the southern water to the Whitsunday Islands in Queensland between June and September. It has been recorded along the length of the NSW coast. At other times birds roam the southern oceans and commonly follow fishing vessels for several days. The species spend the majority of its time in flight, soaring over the southern oceans.	Low	Oceanic species with no records within the locality	
Wedge-tailed Shearwater *Ardenna pacifica*		M	BioNet NSW	2	The Wedge-tailed Shearwater breeds on the east and west coasts of Australia and on off-shore islands. The species is common in the Indian Ocean, the Coral Sea and the Tasman Sea. In Australia, Wedge-tailed Shearwaters have been observed feeding along the junction between inshore and offshore water masses.	Low	Preferred habitat not present.	
Whimbrel *Numenius phaeopus*	-	M	EPBC PMST	-	Regular migrant to Australia and New Zealand, with a primarily coastal distribution. Found in all states but is more common in the north. Found mainly on the coast, on tidal and estuarine mudflats, especially near mangroves. Sometimes found on beaches and rocky shores. Scattered inland records of in all regions.	Low	No recent records within the locality, but suitable habitat is associated with the study area.	
White-capped Albatross *Thalassarche steadi*	-	V, M	EPBC PMST	-	The White-capped Albatross is probably common off the coast of south-east Australia throughout the year. This species is similar to the Shy Albatross and can be difficult to identify, especially at sea and as a juvenile. Whilst there has been no specific study, the species has been caught on longline hooks off Tasmania. It has been observed that juveniles are rare in New Zealand waters, being more common off south-east Australia and South Africa. Breeding colonies occur on islands south of New Zealand.	Low	Oceanic species with no records within the locality	
White-throated Needletail *Hirundapus caudacutus*	-	M	BioNet NSW, EPBC PMST	32	Migrates to eastern Australia from October to April. Almost exclusively aerial and most often seen before storms, low pressure troughs and approaching cold fronts and occasionally bushfire. Occurs over most types of habitat, but mostly recorded above wooded areas, including open forest and rainforest. May also fly between trees or in clearings, below the canopy. Recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows.	Low	Preferred habitat not present. May occur seasonally over the site but there is no suitable terrestrial habitat locally.	Ecosystem

Species name	BC Act status	EPBC Act status	Data source	Number of records in locality	Habitat association	Likelihood of occurrence	Justification	Credit type
Yellow Wagtail *Motacilla flava*	-	M	EPBC PMST	-	Occurs within Australia in open country habitat with disturbed ground and some water. Recorded in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lawns. Breeds in temperate Europe and Asia.	Moderate	Recorded once locally in the last five years, likely a rare seasonal visitor to habitats associated with the study area.	

Key: V – vulnerable, E – endangered, CE – critically endangered, EP – endangered population, M – migratory

Appendix C

Flora survey results

Table C.1 Flora species recorded within the study area

Family	Scientific Name	Common Name	Exotic	PCT or vegetation zone					
				920	1071	1126	1234	1281	Planted vegetation
				Percentage cover recorded in VI plots					
Acanthaceae	*Avicennia marina* subsp. *australasica*	Grey Mangrove		60, 60, 50, 50		5, 0.1, 2			
Aizoaceae	*Tetragonia tetragonioides*	New Zealand Spinach				5, 10, 15	5		
Alliaceae	*Nothoscordum borbonicum*	Onion Weed	*						0.1
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed				0.1			
Anacardiaceae	*Toxicodendron succedaneum*	Rhus Tree	*						0.5
Apiaceae	*Centella asiatica*	Indian Pennywort					0.5		1
	Cyclospermum leptophyllum	Slender Celery	*			0.1, 0.1			0.1
Apocynaceae	*Araujia sericifera*	Moth Vine	*						0.1, 0.1, 0.1, 0.1
Arecaceae	*Phoenix canariensis*	Canary Island Date Palm	*						0.2
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	*				0.1		
	Asparagus asparagoides	Bridal Creeper	*			0.1			
	Asparagus plumosus	Climbing Asparagus Fern	*						0.1
Asphodelaceae	*Asphodelus fistulosus*	Onion Weed	*						0.4
Asteraceae	*Ageratina adenophora*	Crofton Weed	*				0.5		
	Bidens pilosa	Cobbler's Pegs	*		2	0.1	0.1, 0.1	1	0.2, 0.4, 1, 2
	Cirsium vulgare	Spear Thistle	*				0.1	0.1	0.1
	Conyza bonariensis	Flaxleaf Fleabane	*			0.1	0.1, 0.1		0.2
	Conyza canadensis var. *canadensis*	Canadian Fleabane	*						0.2
	Conyza sumatrensis	Tall fleabane	*		0.2		0.2	0.1, 0.2	
	Euchiton spp.	A Cudweed							0.1
	Hypochaeris radicata	Catsear	*		0.2			0.1	
	Ozothamnus diosmifolius	White Dogwood							0.1

Family	Scientific Name	Common Name	Exotic	PCT or vegetation zone					
				920	1071	1126	1234	1281	Planted vegetation
				Percentage cover recorded in VI plots					
	Senecio diaschides						0.1		
	Senecio hispidulus	Hill Fireweed					0.1		
	Senecio madagascariensis	Fireweed	*						0.1
	Silybum marianum	Variegated Thistle	*				0.2		
	Sonchus oleraceus	Common Sowthistle	*			0.1, 0.1			0.5
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine							0.1
Caryophyllaceae	*Spergularia marina*	Lesser Sea-spurrey				0.1			
Casuarinaceae	*Casuarina cunninghamiana* subsp. *cunninghamiana*	River Oak							2
	Casuarina glauca	Swamp Oak				0.1, 0.1	25, 30, 25, 12		5, 6, 2, 20
Chenopodiaceae	*Atriplex australasica*					0.1, 0.2, 0.2			
	Einadia hastata	Berry Saltbush							0.5
	Sarcocornia quinqueflora subsp. *quinqueflora*					2, 5, 20			
	Suaeda australis					30, 50, 50	2		
Commelinaceae	*Commelina cyanea*	Native Wandering Jew				0.1, 0.1	0.1	0.2	0.1
	Tradescantia fluminensis	Wandering Jew	*						0.1, 10
Convolvulaceae	*Dichondra repens*	Kidney Weed					1	1	2
	Ipomoea purpurea	Common Morning Glory	*				0.5		
Cyperaceae	*Baumea articulata*	Jointed Twig-rush			4, 5				
	Baumea rubiginosa				6				
	Bolboschoenus caldwellii						0.2, 0.5		
	Bolboschoenus fluviatilis	Marsh Club-rush			2, 2				

Family	Scientific Name	Common Name	Exotic	PCT or vegetation zone					
				920	1071	1126	1234	1281	Planted vegetation
				Percentage cover recorded in VI plots					
	Carex appressa	Tall Sedge			2				5
	Carex fascicularis	Tassel Sedge			8				
	Cyperus eragrostis	Umbrella Sedge	*						0.1
	Cyperus exaltatus				1, 2				
	Ficinia nodosa	Knobby Club-rush							1
	Gahnia clarkei	Tall Saw-sedge							5
	Lepironia articulata								2
	Schoenoplectus mucronatus				5, 6				
Euphorbiaceae	*Chamaesyce prostrata*	Red Caustic Weed	*						0.1
	Euphorbia peplus	Petty Spurge	*			0.1			0.1
	Homalanthus populifolius								0.2
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*							1	
	Hardenbergia violacea	False Sarsaparilla							0.1
	Melilotus indicus	Hexham Scent	*						0.1
	Trifolium campestre	Hop Clover	*			1			
	Trifolium dubium	Yellow Suckling Clover	*					0.2	
	Trifolium spp.	A Clover	*			0.2			
	Trifolium subterraneum	Subterranean Clover	*		0.2				
	Vicia sativa	Common vetch	*					0.1	
Fabaceae (Mimosoideae)	*Acacia decurrens*	Black Wattle						5, 10	2, 5, 12
	Acacia floribunda	White Sally							5
	Acacia implexa	Hickory Wattle							2, 15
	Acacia longifolia subsp. *longifolia*	Sydney Golden Wattle			5		0.2	2, 2	0.2, 0.5

Family	Scientific Name	Common Name	Exotic	PCT or vegetation zone					
				920	1071	1126	1234	1281	Planted vegetation
				Percentage cover recorded in VI plots					
	Acacia parramattensis	Parramatta Wattle							2
	Acacia saligna	Golden Wreath Wattle	*		0.1				
Fumariaceae	*Fumaria muralis* subsp. *muralis*	Wall Fumitory	*						1
Iridaceae	*Dietes* spp.								0.1
Juncaceae	*Juncus australis*	Rush							0.5
	Juncus bufonius	Toad Rush	*		1		0.1		
	Juncus kraussii subsp. *australiensis*	Sea Rush				1, 5			
	Juncus pallidus				2, 2				
	Juncus usitatus				0.5, 1		4		
Lamiaceae	*Plectranthus parviflorus*					0.1			0.5
	Stachys arvensis	Stagger Weed	*			0.1			
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			2, 0.5	2	1, 5		2, 5, 4, 1, 8, 1, 10
	Lomandra spp.	Mat-rush					10		
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry							0.1, 0.1
	Geitonoplesium cymosum	Scrambling Lily							0.1
Malvaceae	*Brachychiton populneus subsp. populneus*								1, 1, 2
	Malva parviflora	Small-flowered Mallow	*						0.2
	Modiola caroliniana	Red-flowered Mallow	*			0.1, 0.1			
	Sida rhombifolia	Paddy's Lucerne	*						0.5, 1
Myoporaceae	*Myoporum acuminatum*	Boobialla			0.5				1
	Myoporum boninense subsp. *australe*				0.4		0.2		
Myrsinaceae	*Lysimachia arvensis*	Scarlet Pimpernel	*			0.1			

Family	Scientific Name	Common Name	Exotic	PCT or vegetation zone					
				920	1071	1126	1234	1281	Planted vegetation
				Percentage cover recorded in VI plots					
Myrtaceae	*Angophora floribunda*	Rough-barked Apple							2, 8
	Callistemon rigidus	Stiff Bottlebrush			5				
	Corymbia maculata	Spotted Gum							2, 5
	Eucalyptus baueriana	Blue Box							4, 2, 4, 5, 2
	Eucalyptus fibrosa	Red Ironbark							10
	Eucalyptus moluccana	Grey Box							3
	Eucalyptus paniculata	Grey Ironbark					2, 3		4, 20
	Eucalyptus punctata	Grey Gum							14
	Eucalyptus robusta	Swamp Mahogany							2, 15
	Eucalyptus saligna	Sydney Blue Gum							2
	Eucalyptus tereticornis	Forest Red Gum							10, 12, 14, 12
	Kunzea ambigua	Tick Bush						2, 2	0.1, 2, 6
	Leptospermum polygalifolium	Tantoon							0.5
	Melaleuca decora								2, 5
	Melaleuca ericifolia	Swamp Paperbark			5		0.5		
	Melaleuca linariifolia	Flax-leaved Paperbark					1		
	Melaleuca nodosa						1		1
	Melaleuca quinquenervia	Broad-leaved Paperbark					1		
	Melaleuca styphelioides	Prickly-leaved Tea Tree			2		5		5
	Syncarpia glomulifera subsp. *glomulifera*							14, 15	2, 2, 2
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	*						0.1
Oleaceae	*Ligustrum lucidum*	Large-leaved Privet	*				15		
	Notelaea longifolia f. *longifolia*				1				1
	Olea europaea subsp. *cuspidata*	African Olive	*				15		
Oxalidaceae	*Oxalis perennans*							0.1, 0.2	

Family	Scientific Name	Common Name	Exotic	PCT or vegetation zone					
				920	1071	1126	1234	1281	Planted vegetation
				Percentage cover recorded in VI plots					
Passifloraceae	*Passiflora edulis*	Common Passionfruit	*						0.1
	Passiflora suberosa	Cork Passionfruit	*						0.1
Phormiaceae	*Dianella caerulea*	Blue Flax-lily			0.2	0.2	0.5	2	1, 2, 0.5, 2, 5
Pittosporaceae	*Bursaria spinosa* subsp. *spinosa*	Native Blackthorn						4	2, 2, 20
	Pittosporum undulatum	Sweet Pittosporum				5	1	2, 5	0.5, 10, 1, 0.5
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	*			0.1	0.1, 0.1	0.1	0.4, 0.4,
Poaceae	*Austrostipa* spp.	A Speargrass							0.1
	Austrostipa verticillata	Slender Bamboo Grass			1				
	Avena fatua	Wild Oats	*		0.1				
	Briza minor	Shivery Grass	*			0.1			
	Bromus catharticus	Prairie Grass	*					1	1
	Cenchrus clandestinus	Kikuyu Grass	*		8	0.1			
	Chloris gayana	Rhodes Grass	*						2
	Cynodon dactylon	Common Couch					30, 5	5	20, 3, 10
	Echinopogon ovatus	Forest Hedgehog Grass					0.5		
	Ehrharta erecta	Panic Veldtgrass	*	0.1		1	0.1, 4, 2	5, 4	0.5, 2, 6, 4, 6, 30
	Entolasia marginata	Bordered Panic							0.2, 0.5
	Entolasia stricta	Wiry Panic						2	5
	Eragrostis brownii	Brown's Lovegrass						2	
	Eragrostis curvula	African Lovegrass	*				1, 2	2	1
	Imperata cylindrica	Blady Grass							1, 4
	Melinis repens	Red Natal Grass	*				0.1		
	Microlaena stipoides var. *stipoides*	Weeping Grass					3, 4	2, 5	20, 6, 5, 5
	Paspalum dilatatum	Paspalum	*		2		1, 0.5		

Family	Scientific Name	Common Name	Exotic	PCT or vegetation zone					
				920	1071	1126	1234	1281	Planted vegetation
				Percentage cover recorded in VI plots					
	Paspalum distichum	Water Couch			0.5				
	Poa labillardierei var. *labillardierei*	Tussock							0.2
	Sporobolus virginicus					25, 5, 20			
	Stenotaphrum secundatum	Buffalo Grass	*				2		
	Themeda triandra				1				
	Vulpia muralis	Wall Fescue	*					2	
	Zoysia macrantha	Prickly Couch					0.1		
Polygonaceae	*Acetosa sagittata*	Rambling Dock	*			0.2			0.1
Primulaceae	*Samolus repens*	Creeping Brookweed				0.1	1		
Proteaceae	*Grevillea robusta*	Silky Oak							0.1, 0.2
	Hakea salicifolia	Willow-leaved Hakea							2
	Hakea sericea	Needlebush							0.1
Ranunculaceae	*Clematis glycinoides*	Headache Vine							0.2
Rosaceae	*Rubus fruticosus* sp. *agg.*	Blackberry complex	*						2
Rubiaceae	*Galium propinquum*	Maori Bedstraw							0.2
Sapindaceae	*Cardiospermum grandiflorum*	Balloon Vine	*				0.2		
	Cupaniopsis anacardioides	Tuckeroo							0.2, 0.2, 0.4, 0.5
	Dodonaea triquetra	Large-leaf Hop-bush							0.1
Scrophulariaceae	*Bacopa monnieri*	Bacopa					0.1		
Solanaceae	*Solanum americanum*	Glossy Nightshade							0.2
	Solanum aviculare	Kangaroo Apple							0.1
	Solanum nigrum	Black-berry Nightshade	*		0.2			0.1	0.2
Ulmaceae	*Celtis sinensis*	Japanese Hackberry	*						0.1
Urticaceae	*Parietaria judaica*	Pellitory	*	2					

Family	Scientific Name	Common Name	Exotic	PCT or vegetation zone					
				920	1071	1126	1234	1281	Planted vegetation
				Percentage cover recorded in VI plots					
Verbenaceae	*Lantana camara*	Lantana	*				30		0.5
	Verbena bonariensis	Purpletop	*						
	Verbena officinalis	Common Verbena	*				0.1		0.2
	Verbena rigida var. *rigida*	Veined Verbena	*				0.1		
Vitaceae	*Cayratia clematidea*	Native Grape			0.1			0.1, 0.2	

Appendix D

Fauna survey results

Table D.1 Fauna species recorded within the study area during surveys for the project

Common Name	Scientific Name	BC Status	EPBC Status	Exotic	Camellia[1]	Ermington to Melrose Park[1]	Wentworth Point & Sydney Olympic Park[1]
Birds							
Australasian Darter	*Anhinga novaehollandia*				O		
Australasian Figbird	*Sphecotheres vieilloti*					O	
Australian King-parrot	*Alisterus scapularis*					O	
Australian Magpie	*Cracticus tibicen*				O	W	O
Australian Pelican	*Pelecanus conspicillatus*						O
Australian Raven	*Corvus coronoides*				O	O	O
Australian White Ibis	*Threskiornis molucca*				O	O	O
Australian Wood Duck	*Chenonetta jubata*				O		
Black Swan	*Cygnus atratus*						O
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*					W	O
Black-fronted Dotterel	*Elseyornis melanops*						O
Black-winged Stilt	*Himantopus himantopus*						O
Brown Goshawk	*Accipiter fasciatus*					O	
Channel-billed Cuckoo	*Scythrops novaehollandiae*						OW
Common Myna	*Sturnus tristis*			*	O	O	O
Common Starling	*Sturnus vulgaris*			*	O	O	
Crested Pigeon	*Ocyphaps lophotes*				O	O	O
Dusky Moorhen	*Gallinula tenebrosa*						O
Eastern Great Egret	*Ardea modesta*						O
Eastern Rosella	*Platycercus eximius*					O	

[1] Observation key: O – Observed, W – Heard, D - Definite (anabat), Pr – Probable (anabat), SG – Species Group (Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species)

Common Name	Scientific Name	BC Status	EPBC Status	Exotic	Camellia[1]	Ermington to Melrose Park[1]	Wentworth Point & Sydney Olympic Park[1]
Eastern Spinebill	*Acanthorhynchus tenuirostris*				O		
Eurasian Coot	*Fulica atra*						O
Fairy Martin	*Petrochelidon ariel*						O
Galah	*Eolophus roseicapillus*					O	
Grey Butcherbird	*Cracticus torquatus*					W	
Grey Fantail	*Rhipidura albiscapa*					O	
Grey Teal	*Anas gracilis*						O
Hardhead	*Aythya australis*						O
Laughing Kookaburra	*Dacelo novaeguineae*					O	O
Little Black Cormorant	*Phalacrocorax sulcirostris*						O
Little Corella	*Cacatua sanguinea*					O	
Little Egret	*Egretta garzetta*					O	
Little Pied Cormorant	*Microcarbo melanoleucos*						O
Magpie-lark	*Grallina cyanoleuca*				O	O	
Masked Lapwing	*Vanellus miles*						O
Noisy Miner	*Manorina melanocephala*				O	O	O
Olive-backed Oriole	*Oriolus sagittatus*						O
Pacific Black Duck	*Anas superciliosa*						O
Pied Cormorant	*Phalacrocorax varius*				O	W	O
Pied Currawong	*Strepera graculina*				O	O	O
Powerful Owl	*Ninox strenua*					W	
Purple Swamphen	*Porphyrio porphyrio*						O
Rainbow Lorikeet	*Trichoglossus haematodus*					O	O
Red Wattlebird	*Anthochaera carunculata*					O	O
Red-browed Finch	*Neochmia temporalis*					O	O

Common Name	Scientific Name	BC Status	EPBC Status	Exotic	Camellia[1]	Ermington to Melrose Park[1]	Wentworth Point & Sydney Olympic Park[1]
Red-necked Avocet	*Recurvirostra novaehollandiae*						O
Red-whiskered Bulbul	*Pycnonotus jocosus*			*		O	O
Rock Dove	*Columba livia*			*	O		
Royal Spoonbill	*Platalea regia*					O	
Sacred Kingfisher	*Todiramphus sanctus*					O	
Sharp-tailed Sandpiper	*Calidris acuminata*		C,J,K				O
Silver Gull	*Chroicocephalus novaehollandiae*				O	O	O
Silvereye	*Zosterops lateralis*					O	
Spotted Pardalote	*Pardalotus punctatus*						O
Spotted Turtle-Dove	*Streptopelia chinensis*			*	O	O	
Striated Heron	*Butorides striatus*				O		
Sulphur-crested Cockatoo	*Cacatua galerita*					O	
Superb Fairy-wren	*Malurus cyaneus*				O	O	O
Welcome Swallow	*Hirundo neoxena*						O
White-bellied Sea-eagle	*Haliaeetus leucogaster*	V	C			O	
White-browed Scrubwren	*Sericornis frontalis*						O
White-faced Heron	*Egretta novaehollandiae*						O
Willie Wagtail	*Rhipidura leucophrys*				O		O
Yellow Thornbill	*Acanthiza nana*					O	
Mammals							
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V		O		
Black Rat	*Rattus rattus*			*	O		
Cat	*Felis catus*			*	O		
Common Ringtail Possum	*Pseudocheirus peregrinus*					O	
Eastern Free-tailed Bat	*Ozimops ridei*					Pr	Pr

Common Name	Scientific Name	BC Status	EPBC Status	Exotic	Camellia[1]	Ermington to Melrose Park[1]	Wentworth Point & Sydney Olympic Park[1]
Gould's Wattled Bat	*Chalinolobus gouldii*				D	O	D
Large Bent-winged Bat	*Miniopterus orianae oceanensis*						PR (1 call only)
White-striped Freetail Bat	*Austronomus australis*					D	
	C. gouldii/S. rueppellii					SG	SG
	C. *gouldii/O. ridei/M. norfolkensis*					SG	SG
	M. macropus/Nyctophilus sp.						SG
	M. o. oceanensis/Vespadelus sp.				SG		SG
	S. orion/ F. tasmaniensis					SG	
Frogs							
Brown-striped Frog	*Limnodynastes peronii*				W	W	W
Peron's Tree Frog	*Litoria peronii*						W
Green and Golden Bell Frog	*Litoria aurea*	E	V				K
Eastern Dwarf Tree Frog	*Litoria fallax*						W
Common Eastern Froglet	*Crinia signifera*				W	W	W
Reptiles							
Eastern Blue-tongue	*Tiliqua scinoides*						O
Eastern Water-skink	*Eulamprus quoyii*				O	O	

Status key: Migratory – C, J, K; Vulnerable – V; Endangered – E; Critically endangered – CE
Observation key: O – Observed, W – Heard, D – Definite (anabat), Pr – Probable (anabat), SG – Species Group (Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species), K – known population
Status: BC Act = Biodiversity Conservation Act 2016; EPBC Act = Environment Protection and Biodiversity Conservation Act 1999
Note: 1. Ermington to Melrose Park (Melrose Park and Ken Newman) – Wentworth Point and Sydney Olympic Park (SOPA Bird, SOP, Narawang, Haslams, Brick Pit)

Table D.2 Fauna species recorded at Sydney Olympic Park and Newington Nature Reserve by Sydney Olympic Park Authority (data collated from a number of reports provided by Sydney Olympic Park Authority)

Common Name	Scientific Name	BC Status	EPBC Status
Common Eastern Froglet	*Crinia signifera*	-	-
Eastern Dwarf Tree Frog	*Litoria fallax*	-	-
Green and Golden Bell Frog	*Litoria aurea*	E	V
Green Tree Frog	*Litoria caerulea*	-	-
Peron's Tree Frog	*Litoria peronii*	-	-
Spotted Grass Frog	*Limnodynastes tasmaniensis*	-	-
Striped Marsh Frog	*Limnodynastes peronii*	-	-
Australasian Darter	*Anhinga novaehollandiae*	-	-
Australasian Figbird	*Sphecotheres vieilloti*	-	-
Australasian Grebe	*Tachybaptus novaehollandiae*	-	-
Australasian Shoveler	*Anas rhynchotis*	-	-
Australian Brush-turkey	*Alectura lathami*	-	-
Australian Hobby	*Falco longipennis*	-	-
Australian King-Parrot	*Alisterus scapularis*	-	-
Australian Little Bittern	*Ixobrychus dubius*	-	-
Australian Magpie	*Cracticus tibicen*	-	-
Australian Pelican	*Pelecanus conspicillatus*	-	-
Australian Pipit	*Anthus novaeseelandiae*	-	-
Australian Raven	*Corvus coronoides*	-	-
Australian Reed-Warbler	*Acrocephalus australis*	-	-
Australian Shelduck	*Tadorna tadornoides*	-	-
Australian Spotted Crake	*Porzana fluminea*	-	-
Australian White Ibis	*Threskiornis molucca*	-	-
Australian Wood Duck	*Chenonetta jubata*	-	-
Azure Kingfisher	*Ceyx azureus*	-	-
Barn Owl	*Tyto alba*		
Bar-tailed Godwit	*Limosa lapponica*	-	C,J,K, Bonn
Black Swan	*Cygnus atratus*	-	-
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	-	-
Black-faced Monarch	*Monarcha melanopsis*	-	Bonn
Black-fronted Dotterel	*Elseyornis melanops*	-	-
Black-necked Stork	*Ephippiorhynchus asiaticus*	E	-
Black-shouldered Kite	*Elanus axillaris*	-	-
Black-winged Stilt	*Himantopus himantopus*	-	-
Brown Gerygone	*Gerygone mouki*	-	-
Brown Goshawk	*Accipiter fasciatus*	-	-
Brown Honeyeater	*Lichmera indistincta*	-	-
Brown Quail	*Coturnix ypsilophora*	-	-
Brown Songlark	*Cincloramphus cruralis*	-	-
Brown Thornbill	*Acanthiza pusilla*	-	-

Common Name	Scientific Name	BC Status	EPBC Status
Brush Cuckoo	*Cacomantis variolosus*	-	-
Budgerigar	*Melopsittacus undulatus*	-	-
Buff-banded Rail	*Gallirallus philippensis*	-	-
Caspian Tern	*Hydroprogne caspia*	-	J
Cattle Egret	*Ardea ibis*	-	C,J
Channel-billed Cuckoo	*Scythrops novaehollandiae*	-	-
Chestnut Teal	*Anas castanea*	-	-
Cockatiel	*Nymphicus hollandicus*	-	-
Common Blackbird	*Turdus merula*	-	-
Common Bronzewing	*Phaps chalcoptera*	-	-
Common Myna	*Sturnus tristis*	-	-
Common Starling	*Sturnus vulgaris*	-	-
Common Tern	*Sterna hirundo*	-	C,J,K
Crested Pigeon	*Ocyphaps lophotes*	-	-
Crested Tern	*Thalasseus bergii*	-	J
Dollarbird	*Eurystomus orientalis*	-	-
Domestic Duck		-	-
Dusky Moorhen	*Gallinula tenebrosa*	-	-
Eastern Curlew	*Numenius madagascariensis*	-	CE,C,J,K, Bonn
Eastern Koel	*Eudynamys orientalis*	-	-
Eastern Rosella	*Platycercus eximius*	-	-
Eastern Spinebill	*Acanthorhynchus tenuirostris*	-	-
Eastern Yellow Robin	*Eopsaltria australis*	-	-
Eurasian Coot	*Fulica atra*	-	-
Fairy Martin	*Petrochelidon ariel*	-	-
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	-	-
Fuscous Honeyeater	*Ptilotula fuscus*	-	-
Galah	*Eolophus roseicapillus*	-	-
Golden Whistler	*Pachycephala pectoralis*	-	-
Golden-headed Cisticola	*Cisticola exilis*	-	-
Great Cormorant	*Phalacrocorax carbo*	-	-
Great Egret	*Ardea alba*		
Grey Butcherbird	*Cracticus torquatus*	-	-
Grey Fantail	*Rhipidura albiscapa*	-	-
Grey Goshawk	*Accipiter novaehollandiae*	-	-
Grey Teal	*Anas gracilis*	-	-
Hardhead	*Aythya australis*	-	-
Hoary-headed Grebe	*Poliocephalus poliocephalus*	-	-
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	-	-
Intermediate Egret	*Ardea intermedia*	-	-
Latham's Snipe	*Gallinago hardwickii*	-	J,K, Bonn
Laughing Kookaburra	*Dacelo novaeguineae*	-	-

Common Name	Scientific Name	BC Status	EPBC Status
Leaden Flycatcher	*Myiagra rubecula*	-	-
Little Black Cormorant	*Phalacrocorax sulcirostris*	-	-
Little Corella	*Cacatua sanguinea*	-	-
Little Egret	*Cattle Egret*	-	-
Little Grassbird	*Megalurus gramineus*	-	-
Little Pied Cormorant	*Microcarbo melanoleucos*	-	-
Little Wattlebird	*Anthochaera chrysoptera*	-	-
Long-billed Corella	*Cacatua tenuirostris*	-	-
Magpie-lark	*Grallina cyanoleuca*	-	-
Mangrove Gerygone	*Gerygone levigaster*	-	-
Marsh Sandpiper	*Tringa stagnatilis*	-	C,J,K, Bonn
Masked Lapwing	*Vanellus miles*	-	-
Masked Lapwing	*Vanellus miles*	-	-
Musk Lorikeet	*Glossopsitta concinna*	-	-
Nankeen Kestrel	*Falco cenchroides*	-	-
Nankeen Night-Heron	*Nycticorax caledonicus*	-	-
New Holland Honeyeater	*Phylidonyris novaehollandiae*	-	-
Noisy Miner	*Manorina melanocephala*	-	-
Olive-backed Oriole	*Oriolus sagittatus*	-	-
Osprey	*Pandion haliaetus*	-	Bonn
Pacific Baza	*Aviceda subcristata*	-	-
Pacific Black Duck	*Anas superciliosa*	-	-
Pacific Golden Plover	*Pluvialis fulva*	-	C,J,K, Bonn
Peregrine Falcon	*Falco peregrinus*	-	-
Pheasant Coucal	*Centropus phasianinus*	-	-
Pied Cormorant	*Phalacrocorax varius*	-	-
Pied Currawong	*Strepera graculina*	-	-
Pink-eared Duck	*Malacorhynchus membranaceus*	-	-
Purple Swamphen	*Porphyrio porphyrio*	-	-
Rainbow Lorikeet	*Trichoglossus haematodus*	-	-
Red Wattlebird	*Anthochaera carunculata*	-	-
Red-browed Finch	*Neochmia temporalis*	-	-
Red-capped Plover	*Charadrius ruficapillus*	-	-
Red-kneed Dotterel	*Erythrogonys cinctus*	-	-
Red-necked Avocet	*Recurvirostra novaehollandiae*	-	-
Red-necked Stint	*Calidris ruficollis*	-	C,J,K, Bonn
Red-rumped Parrot	*Psephotus haematonotus*	-	-
Red-whiskered Bulbul	*Pycnonotus jocosus*	-	-
Restless Flycatcher	*Myiagra inquieta*	-	-
Rock Dove	*Columba livia*	-	-
Rose Robin	*Petroica rosea*	-	-
Royal Spoonbill	*Platalea regia*	-	-

Common Name	Scientific Name	BC Status	EPBC Status
Rufous Fantail	*Rhipidura rufifrons*	-	Bonn
Rufous Whistler	*Pachycephala rufiventris*	-	-
Sacred Kingfisher	*Todiramphus sanctus*	-	-
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	-	-
Scarlet Honeyeater	*Myzomela sanguinolenta*	-	-
Sharp-tailed Sandpiper	*Calidris acuminata*	-	C,J,K, Bonn
Shining Bronze-Cuckoo	*Chalcites lucidus*	-	-
Silver Gull	*Chroicocephalus novaehollandiae*	-	-
Silvereye	*Zosterops lateralis*	-	-
Southern Boobook	*Ninox novaeseelandiae*	-	-
Spangled Drongo	*Dicrurus bracteatus*	-	-
Spotless Crake	*Porzana tabuensis*	-	-
Spotted Pardalote	*Pardalotus punctatus*	-	-
Spotted Turtle-dove	*Streptopelia chinensis*	-	-
Striated Heron	*Butorides striatus*	-	-
Sulphur-crested Cockatoo	*Cacatua galerita*	-	-
Superb Fairy-wren	*Malurus cyaneus*	-	-
Swamp Harrier	*Circus approximans*	-	-
Swift Parrot	*Lathamus discolor*	E	CE
Tawny Frogmouth	*Podargus strigoides*	-	-
Topknot Pigeon	*Lopholaimus antarcticus*	-	-
Tree Martin	*Petrochelidon nigricans*	-	-
Welcome Swallow	*Hirundo neoxena*	-	-
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V	C
White-browed Scrubwren	*Sericornis frontalis*	-	-
White-faced Heron	*Egretta novaehollandiae*	-	-
White-headed Pigeon	*Columba leucomela*	-	-
White-naped Honeyeater	*Melithreptus lunatus*	-	-
White-necked Heron	*Ardea pacifica*	-	-
White-plumed Honeyeater	*Ptilotula penicillatus*	-	-
White-throated Gerygone	*Gerygone olivacea*	-	-
White-winged Triller	*Lalage sueurii*	-	-
Willie Wagtail	*Rhipidura leucophrys*	-	-
Yellow Thornbill	*Acanthiza nana*	-	-
Yellow-faced Honeyeater	*Caligavis chrysops*	-	-
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	-	-
Black Flying-fox	*Pteropus alecto*	-	-
Black Rat	*Rattus rattus*	-	-
Brown Hare	*Lepus capensis*	-	-
Cat	*Felis catus*	-	-
Chocolate Wattled Bat	*Chalinolobus morio*	-	-
Common Brushtail Possum	*Trichosurus vulpecula*	-	-

Common Name	Scientific Name	BC Status	EPBC Status
Common Ringtail Possum	*Pseudocheirus peregrinus*	-	-
Eastern Coastal Free-tailed Bat	*Mormopterus ridei*	V	-
Fox	*Vulpes vulpes*	-	-
Gould's Wattled Bat	*Chalinolobus gouldii*	-	-
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	V	-
Large Forest Bat	*Vespadelus darlingtoni*	-	-
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	-	-
Short-beaked Echidna	*Tachyglossus aculeatus*	-	-
Southern Myotis	*Myotis macropus*	V	-
White-striped Freetail-bat	*Tadarida australis*	-	-
Barred-sided Skink	*Eulamprus tenuis*	-	-
Blackish Blind Snake	*Anilios nigrescens*	-	-
Cream-striped Shinning-skink	*Cryptoblepharus virgatus*	-	-
Dark-flecked Garden Sunskink	*Lampropholis delicata*	-	-
Eastern Blue-tongue	*Tiliqua scincoides*	-	-
Eastern Snake-necked Turtle	*Chelodina longicollis*	-	-
Eastern Water Dragon	*Intellagama lesueurii*	-	-
Lace Monitor	*Varanus varius*	-	-
Macquarie River Turtle	*Emydura macquarii macquarii*	-	-
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*	-	-
Red-bellied Black Snake	*Pseudechis porphyriacus*	-	-
Red-eared Slider	*Trachemys scripta elegans*	-	-
Robust Ctenotus	*Ctenotus robustus*	-	-
Weasel Skink	*Saproscincus mustelinus*	-	-

Status key: V – Vulnerable; E – Endangered; CE – Critically endangered; C – China-Australia Migratory Bird Agreement, J – Japan-Australia Migratory Bird Agreement, K – Republic of Korea--Australia Migratory Bird Agreement, Bonn – Bonn Convention on the Conservation of Migratory Species of Wild Animals

Appendix E

BAM input data and plot datasheets

Table E.3Vegetation integrity plot data

			Composition (species richness)							Structure (% cover)						Function														
PCT	**Condition**	**Plot**	**TG**	**SG**	**GG**	**FG**	**EG**	**OG**	**Total**	**TG**	**SG**	**GG**	**FG**	**EG**	**OG**	**Large trees**	**Hollow trees**	**Litter cover (%)**	**Fallen logs (metres)**	**Tree DBH 5-10 (cm)**	**Tree DBH 10-20 (cm)**	**Tree DBH 20-30 (cm)**	**Tree DBH 30-50 (cm)**	**Tree DBH 50-80 (cm)**	**Tree regen**	**HTE cover (total)**	**Zone**	**Easting**	**Northing**	**Bearing**
		Benchmark	**2**	**2**	**2**	**2**	**0**	**1**	**9**	**62**	**4**	**0**	**0**	**0**	**0**	**0**		**20**	**0**											
920	Good	4	1	0	0	0	0	0	1	60	0	0	0	0	0	2	0	13.4	9.0	1	1	1	1	1	1	0.1	56	318596	6256270	85
		9	1	0	0	0	0	0	1	60	0	0	0	0	0	5	6	7.8	7.0	1	1	1	1	0	1	0	56	321728	6256290	80
		10	1	0	0	0	0	0	1	50	0	0	0	0	0	5	11	18.0	14.0	1	1	1	1	1	1	0	56	321613	6256395	310
		11	1	0	0	0	0	0	1	50	0	0	0	0	0	3	7	18.0	10.0	1	1	1	1	0	1	0	56	321479	6256478	257
		Benchmark	**1**	**3**	**3**	**2**	**0**	**0**	**9**	**0**	**6**	**23**	**1**	**0**	**0**	**0**		**20**	**0**											
1126	Moderate	7	1	2	1	2	0	0	6	5	35	25.0	5.1	0	0	0	0	11.4	11.0	1	0	0	0	0	1	0	56	321641	6256350	320
		8	2	2	3	5	0	0	12	0.2	70	10.1	10.5	0	0	0	0	52.0	16.0	0	0	0	0	0	0	0.1	56	321829	6256320	255
		12	2	3	3	6	0	0	14	2.1	57	23	15.7	0	0	0	0	28.0	4.0	1	0	0	0	0	1	1.3	56	321533	6256450	115
		Benchmark	**4**	**8**	**8**	**8**	**2**	**4**	**34**	**22**	**22**	**70**	**3**	**1**	**1**	**1**		**40**	**12**											
1234	Poor	5	1	1	1	0	0	0	3	25	1	1	0	0	0	0	0	90.8	13.0	1	1	1	1	0	1	64.3	56	318386	6256129	210
		Benchmark	**4**	**8**	**8**	**8**	**2**	**4**	**34**	**22**	**22**	**70**	**3**	**1**	**1**	**1**		**40**	**12**											
1234	Moderate	13a	1	1	3	3	0	0	8	30	2	34.1	6.1	0	0	1	0	2.0	0	1	1	1	0	1	1	6.1	56	321723	6256030	345
		Benchmark	**4**	**8**	**8**	**8**	**2**	**4**	**34**	**22**	**22**	**70**	**3**	**1**	**1**	**1**		**40**	**12**											
1234	Planted	16	4	4	4	2	0	0	14	31	1.9	14	0.6	0	0	0	0	90.0	10.0	1	1	1	0	0	1	3.5	56	321617	6255120	8
		20	2	2	4	4	0	0	12	15	6	14.2	1.7	0	0	0	0	91.0	23.0	1	1	1	0	0	1	0	56	321933	6255570	196
		Benchmark	**7**	**13**	**9**	**12**	**3**	**9**	**53**	**63**	**30**	**39**	**8**	**2**	**9**	**1**		**61**	**80**											
1281	Planted	18	2	4	4	3	0	1	14	20	10	11	2.2	0	0.2	0	0	8.0	5.0	1	1	1	1	0	0	7.0	56	321844	6255765	120
		19	2	3	1	3	0	1	10	24	9	5	2.3	0	0.1	0	0	28.0	0	1	1	1	0	0	0	4.0	56	321904	6255679	305
		Benchmark	**1**	**2**	**5**	**5**	**1**	**0**	**14**	**0**	**0**	**102**	**2**	**0**	**0**	**2**		**25**	**60**											
1071	Moderate	25	1	5	11	1	0	1	19	1.0	12.9	28.5	0.2	0	0.1	0	0	8.0	0	0	0	0	0	0	0	0	56	321367	6254776	224
		14	0	1	11	0	0	0	12	0	5	28	0	0	0	0	0	10.0	0	0	0	0	0	0	0	10.0	56	321250	6254053	60
		Benchmark																												
N/A	Planted vegetation	6	4	8	3	6	0	1	21	25.6	5.6	15.5	8.8	0	0.1	0	0	36.0	2.0	1	1	1	1	0	1	42.4	56	320216	6256282	315
		13	6	9	6	3	0	4	24	31	34.3	8.8	1.2	0	0.4	0	0	87.8	7.0	1.0	1.0	1.0	0.0	0.0	1.0	0.6	56	321623	6256412	330
		17	1	4	2	3	0	2	12	12	18.5	40	1.2	0	0.7	0	0	22.0	16.0	0	0	0	0	0	0	8.6	56	321749	6255939	156
		21	8	0	2	0	0	0	10	27.3	0	10	0	0	0	0	0	48.0	8.0	1	1	1	0	0	1	5.1	56	321827	6255423	200
		22	5	2	4	0	0	0	11	18.2	21	9.2	0	0	0	0	0	72.0	0.0	1	1	1	1	0	0	6.0	56	321786	6255363	200
		23	8	0	2	1	0	0	11	47.5	0	13	2	0	0	0	0	91.0	0.0	1	1	1	1	0	1	0.0	56	321731	6255240	200
		24	6	3	5	0	0	0	14	35	4	21	0.1	0	0	0	0	58.0	6.0	1	1	1	1	0	1	0.2	56	321430	6254836	215
		15	4	1	1	1	0	0	7	22	0.5	5	2	0	0	0	0	70.0	20.0	1	1	1	0	0	0	2.1	56	321159	6254231	40

Notes: *TG=Tree; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other; HTE=High Threat Exotic

Appendix F

Credit reports

BAM Credit Summary Report

Proposal Details

Assessment Id

00030218/BAAS17031/21/00030219

Proposal Name

Parramatta Light Rail Stage 2

BAM data last updated *

22/06/2023

Assessor Name

Kathryn Chesnut

Report Created

22/09/2023

BAM Data version *

61

Assessor Number

BAAS17031

BAM Case Status

Finalised

Date Finalised

22/09/2023

Assessment Revision

6

Assessment Type

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	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Estuarine mangrove forest												
1	920_good	Not a TEC	34.8	34.8	0.72	PCT Cleared - 86%	High Sensitivity to Gain			2.00		13
											Subtotal	**13**

Estuarine saltmarsh												
2	1126_moderate	Subtropical and Temperate Coastal Saltmarsh	96.5	96.5	0.03	Environment Protection and Conservation Act listing status	High Sensitivity to Gain	Not Listed	Vulnerable	1.75		1
											Subtotal	**1**
Estuarine Swamp Oak forest												
3	1234_poor	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	15.2	15.2	0.33	Biodiversity Conservation Act listing status	High Sensitivity to Gain	Endangered Ecological Community	Not Listed	2.00		3

4	1234_moderate	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	40.6	40.6	0.01	Biodiversity Conservation Act listing status	High Sensitivity to Gain	Endangered Ecological Community	Not Listed	2.00		1
5	1234_planted	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	40.8	40.8	0.28	Biodiversity Conservation Act listing status	High Sensitivity to Gain	Endangered Ecological Community	Not Listed	2.00		6
											Subtotal	**10**

Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion												
6	1071_moderate	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	31.4	31.4	0.01	PCT Cleared - 75%	High Sensitivity to Gain	Endangered Ecological Community	Not Listed	2.00		1
											Subtotal	**1**
Sydney Turpentine - Ironbark forest												
7	1281_planted	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion	16.7	16.7	1	Population size	High Sensitivity to Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	True	11
											Subtotal	**11**
											Total	**36**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits

Calidris ferruginea / Curlew Sandpiper (Fauna)									
920_good	34.8	34.8	0.36			Endangered	Critically Endangered	True	9
								Subtotal	**9**
Limosa lapponica baueri / Bar-tailed Godwit (baueri) (Fauna)									
920_good	34.8	34.8	0.36			Not Listed	Vulnerable	False	6
								Subtotal	**6**
Litoria aurea / Green and Golden Bell Frog (Fauna)									
920_good	34.8	34.8	0.39			Endangered	Vulnerable	False	7
1234_poor	15.2	15.2	0.01			Endangered	Vulnerable	False	1
1071_moderate	31.4	31.4	0.01			Endangered	Vulnerable	False	1
1281_planted	16.7	16.7	0.98			Endangered	Vulnerable	False	8
1234_moderate	40.6	40.6	0.01			Endangered	Vulnerable	False	1
1234_planted	40.8	40.8	0.12			Endangered	Vulnerable	False	2
								Subtotal	**20**
Myotis macropus / Southern Myotis (Fauna)									
920_good	34.8	34.8	0.72			Vulnerable	Not Listed	False	13
1126_moderate	96.5	96.5	0.03			Vulnerable	Not Listed	False	1
1234_poor	15.2	15.2	0.33			Vulnerable	Not Listed	False	3
1281_planted	16.7	16.7	0.98			Vulnerable	Not Listed	False	8
1234_moderate	40.6	40.6	0.01			Vulnerable	Not Listed	False	1
1234_planted	40.8	40.8	0.12			Vulnerable	Not Listed	False	2
								Subtotal	**28**

Wilsonia backhousei / Narrow-leafed Wilsonia (Flora)									
1126_moderate	96.5	96.5	0.01			Vulnerable	Not Listed	False	1
								Subtotal	**1**

BAM Predicted Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00030218/BAAS17031/21/00030219	Parramatta Light Rail Stage 2	22/06/2023
Assessor Name	Report Created	BAM Data version *
Kathryn Chesnut	22/09/2023	61
Assessor Number	Assessment Type	BAM Case Status
BAAS17031	Major Projects	Finalised
Assessment Revision		Date Finalised
6		22/09/2023

* 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.

Threatened species reliably predicted to utilise the site. No surveys are required for these species. Ecosystem credits apply to these species.

Common Name	Scientific Name	Vegetation Types(s)
Australasian Bittern	Botaurus poiciloptilus	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Australian Painted Snipe	Rostratula australis	1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Barking Owl	Ninox connivens	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Black Bittern	Ixobrychus flavicollis	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Black-chinned Honeyeater (eastern subspecies)	Melithreptus gularis gularis	1281-Sydney Turpentine - Ironbark forest

Black-necked Stork	Ephippiorhynchus asiaticus	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Black-tailed Godwit	Limosa limosa	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Broad-billed Sandpiper	Limicola falcinellus	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Broad-headed Snake	Hoplocephalus bungaroides	1281-Sydney Turpentine - Ironbark forest
Brown Treecreeper (eastern subspecies)	Climacteris picumnus victoriae	1234-Estuarine Swamp Oak forest
Comb-crested Jacana	Irediparra gallinacea	1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Curlew Sandpiper	Calidris ferruginea	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Dusky Woodswallow	Artamus cyanopterus cyanopterus	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
		1281-Sydney Turpentine - Ironbark forest
Eastern Coastal Free-tailed Bat	Micronomus norfolkensis	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
		1281-Sydney Turpentine - Ironbark forest
Eastern False Pipistrelle	Falsistrellus tasmaniensis	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest

Eastern Osprey	Pandion cristatus	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Flame Robin	Petroica phoenicea	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Freckled Duck	Stictonetta naevosa	1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Gang-gang Cockatoo	Callocephalon fimbriatum	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Glossy Black-Cockatoo	Calyptorhynchus lathami	1281-Sydney Turpentine - Ironbark forest
Greater Broad-nosed Bat	Scoteanax rueppellii	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
		1281-Sydney Turpentine - Ironbark forest
Grey-headed Flying-fox	Pteropus poliocephalus	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Hooded Robin (south-eastern form)	Melanodryas cucullata cucullata	1281-Sydney Turpentine - Ironbark forest
Large Bent-winged Bat	Miniopterus orianae oceanensis	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
		1281-Sydney Turpentine - Ironbark forest
Little Bent-winged Bat	Miniopterus australis	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
		1281-Sydney Turpentine - Ironbark forest

Little Eagle	Hieraaetus morphnoides	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
		1281-Sydney Turpentine - Ironbark forest
Little Lorikeet	Glossopsitta pusilla	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Masked Owl	Tyto novaehollandiae	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
New Holland Mouse	Pseudomys novaehollandiae	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Painted Honeyeater	Grantiella picta	1281-Sydney Turpentine - Ironbark forest
Powerful Owl	Ninox strenua	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Regent Honeyeater	Anthochaera phrygia	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Rosenberg's Goanna	Varanus rosenbergi	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Scarlet Robin	Petroica boodang	1281-Sydney Turpentine - Ironbark forest
Sooty Owl	Tyto tenebricosa	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Speckled Warbler	Chthonicola sagittata	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Spotted Harrier	Circus assimilis	1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
Spotted-tailed Quoll	Dasyurus maculatus	920-Estuarine mangrove forest
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
		1281-Sydney Turpentine - Ironbark forest
Square-tailed Kite	Lophoictinia isura	1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion

Square-tailed Kite	Lophoictinia isura	1281-Sydney Turpentine - Ironbark forest
Superb Fruit-Dove	Ptilinopus superbus	1234-Estuarine Swamp Oak forest
Swift Parrot	Lathamus discolor	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Turquoise Parrot	Neophema pulchella	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
Varied Sittella	Daphoenositta chrysoptera	1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest
White-bellied Sea-Eagle	Haliaeetus leucogaster	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
White-fronted Chat	Epthianura albifrons	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
White-throated Needletail	Hirundapus caudacutus	920-Estuarine mangrove forest
		1126-Estuarine saltmarsh
		1234-Estuarine Swamp Oak forest
		1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion
		1281-Sydney Turpentine - Ironbark forest
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	920-Estuarine mangrove forest
		1234-Estuarine Swamp Oak forest
		1281-Sydney Turpentine - Ironbark forest

Threatened species Manually Added

None added

Threatened species assessed as not within the vegetation zone(s) for the PCT(s)

Refer to BAR for detailed justification

Common Name	Scientific Name	Justification in the BAM-C

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00030218/BAAS17031/21/00030219	Parramatta Light Rail Stage 2	22/06/2023
Assessor Name	Assessor Number	BAM Data version *
Kathryn Chesnut	BAAS17031	61
Proponent Names	Report Created	BAM Case Status
Megan Haberley	22/09/2023	Finalised
Assessment Revision	Assessment Type	Date Finalised
6	Major Projects	22/09/2023

* 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

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion	Critically Endangered Ecological Community	1281-Sydney Turpentine - Ironbark forest

Species
Calidris ferruginea / Curlew Sandpiper

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
No Changes

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

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
920-Estuarine mangrove forest	Not a TEC	0.7	0	13	13
1126-Estuarine saltmarsh	Subtropical and Temperate Coastal Saltmarsh	0.0	0	1	1
1234-Estuarine Swamp Oak forest	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.6	0	10	10
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	0.0	0	1	1
1281-Sydney Turpentine - Ironbark forest	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion	1.1	0	11	11

920-Estuarine mangrove forest	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Mangrove Swamps This includes PCT's: 915, 916, 917, 918, 919, 920	Mangrove Swamps >=70% and <90%	920_good	No	13	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.

<table>
<tr><td>920-Estuarine mangrove forest</td><td></td></tr>
<tr><td>1071-Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion</td><td>
Like-for-like credit retirement options
<table>
<tr><th>Name of offset trading group</th><th>Trading group</th><th>Zone</th><th>HBT</th><th>Credits</th><th>IBRA region</th></tr>
<tr><td>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, 3958, 3962, 3964, 3965, 3967, 3971, 3973, 3975, 3976</td><td>-</td><td>1071_moderate</td><td>No</td><td>1</td><td>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.</td></tr>
</table>
</td></tr>
<tr><td>1126-Estuarine saltmarsh</td><td>
Like-for-like credit retirement options
<table>
<tr><th>Name of offset trading group</th><th>Trading group</th><th>Zone</th><th>HBT</th><th>Credits</th><th>IBRA region</th></tr>
</table>
</td></tr>
</table>

	Subtropical and Temperate Coastal Saltmarsh This includes PCT's: 4040, 4094, 4095, 4096, 4097, 4101, 4102, 4103	-	1126_moderate	No	1	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.
1234-Estuarine Swamp Oak forest	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	-	1234_poor	No	3	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.

	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	-	1234_moderate	No	1	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.

	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region
	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	-	1234_planted	No	6	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.

1281-Sydney Turpentine - Ironbark forest

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion This includes PCT's: 1183, 1281, 1284, 3262	-	1281_planted	No	11	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.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Calidris ferruginea / Curlew Sandpiper	**920_good**	0.4	9.00
Limosa lapponica baueri / Bar-tailed Godwit (baueri)	**920_good**	0.4	6.00
Litoria aurea / Green and Golden Bell Frog	**920_good, 1234_poor, 1071_moderate, 1281_planted, 1234_moderate, 1234_planted**	1.5	20.00
Myotis macropus / Southern Myotis	**920_good, 1126_moderate, 1234_poor, 1281_planted, 1234_moderate, 1234_planted**	2.2	28.00
Wilsonia backhousei / Narrow-leafed Wilsonia	**1126_moderate**	0.0	1.00

Credit Retirement Options

Like-for-like credit retirement options

Calidris ferruginea / Curlew Sandpiper	Spp	IBRA subregion
	Calidris ferruginea / Curlew Sandpiper	Any in NSW
Limosa lapponica baueri / Bar-tailed Godwit (baueri)	Spp	IBRA subregion
	Limosa lapponica baueri / Bar-tailed Godwit (baueri)	Any in NSW
Litoria aurea / Green and Golden Bell Frog	Spp	IBRA subregion
	Litoria aurea / Green and Golden Bell Frog	Any in NSW
Myotis macropus / Southern Myotis	Spp	IBRA subregion
	Myotis macropus / Southern Myotis	Any in NSW
Wilsonia backhousei / Narrow-leafed Wilsonia	Spp	IBRA subregion
	Wilsonia backhousei / Narrow-leafed Wilsonia	Any in NSW

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00030218/BAAS17031/21/00030219	Parramatta Light Rail Stage 2	22/06/2023
Assessor Name	Assessor Number	BAM Data version *
Kathryn Chesnut	BAAS17031	61
Proponent Name(s)	Report Created	BAM Case Status
Megan Haberley	22/09/2023	Finalised
Assessment Revision	Assessment Type	Date Finalised
6	Major Projects	22/09/2023

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Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion	Critically Endangered Ecological Community	1281-Sydney Turpentine - Ironbark forest

Species
Calidris ferruginea / Curlew Sandpiper

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
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	HBT Cr	No HBT Cr	Total credits to be retired
920-Estuarine mangrove forest	Not a TEC	0.7	0	13	13.00
1126-Estuarine saltmarsh	Subtropical and Temperate Coastal Saltmarsh	0.0	0	1	1.00
1234-Estuarine Swamp Oak forest	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.6	0	10	10.00
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	0.0	0	1	1.00
1281-Sydney Turpentine - Ironbark forest	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion	1.1	0	11	11.00

920-Estuarine mangrove forest	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

	Mangrove Swamps This includes PCT's: 915, 916, 917, 918, 919, 920	Mangrove Swamps >=70% and <90%	920_good	No	13	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	Zone	HBT	Credits	IBRA region
	Saline Wetlands	Tier 2 or higher threat status	920_good	No	13	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**					
	Class	Trading group	Zone	HBT	Credits	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, 3958, 3962, 3964, 3965, 3967, 3971, 3973, 3975, 3976	-	1071_moderate	No	1	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	Zone	HBT	Credits	IBRA region
	Freshwater Wetlands	Tier 3 or higher threat status	1071_moderate	No	1	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1126-Estuarine saltmarsh	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Subtropical and Temperate Coastal Saltmarsh This includes PCT's: 4040, 4094, 4095, 4096, 4097, 4101, 4102, 4103	-	1126_moderate	No	1	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	Zone	HBT	Credits	IBRA region
	Saline Wetlands	Tier 3 or higher threat status	1126_moderate	No	1	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1234-Estuarine Swamp Oak forest	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	-	1234_poor	No	3	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.
	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	-	1234_moderate	No	1	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.

	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808, 3962, 3963, 3985, 3987, 3993, 4016, 4023, 4026, 4027, 4028, 4030, 4035, 4038, 4040, 4048, 4049, 4050, 4056	-	1234_planted	No	6	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	Zone	HBT	Credits	IBRA region
	Forested Wetlands	Tier 1	1234_poor	No	3	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Forested Wetlands	Tier 1	1234_moderate	No	1	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Forested Wetlands	Tier 1	1234_planted	No	6	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1281-Sydney Turpentine - Ironbark forest	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Sydney Turpentine-Ironbark Forest in the Sydney Basin Bioregion This includes PCT's: 1183, 1281, 1284, 3262	-	1281_planted	No	11	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.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Calidris ferruginea / Curlew Sandpiper	**920_good**	0.4	9.00
Limosa lapponica baueri / Bar-tailed Godwit (baueri)	**920_good**	0.4	6.00
Litoria aurea / Green and Golden Bell Frog	**920_good, 1234_poor, 1071_moderate, 1281_planted, 1234_moderate, 1234_planted**	1.5	20.00
Myotis macropus / Southern Myotis	**920_good, 1126_moderate, 1234_poor, 1281_planted, 1234_moderate, 1234_planted**	2.2	28.00
Wilsonia backhousei / Narrow-leafed Wilsonia	**1126_moderate**	0.0	1.00

Credit Retirement Options

Like-for-like options

<table>
<tr><td rowspan="6">Calidris ferruginea/
Curlew Sandpiper</td><td colspan="2">Spp</td><td>IBRA region</td></tr>
<tr><td colspan="2">Calidris ferruginea/Curlew Sandpiper</td><td>Any in NSW</td></tr>
<tr><td colspan="3">Variation options</td></tr>
<tr><td>Kingdom</td><td>Any species with same or higher category of listing under Part 4 of the BC Act shown below</td><td>IBRA region</td></tr>
<tr><td>Fauna</td><td>Endangered</td><td>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.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="5">Limosa lapponica baueri/
Bar-tailed Godwit (baueri)</td><td colspan="2">Spp</td><td>IBRA region</td></tr>
<tr><td colspan="2">Limosa lapponica baueri/Bar-tailed Godwit (baueri)</td><td>Any in NSW</td></tr>
<tr><td colspan="3">Variation options</td></tr>
<tr><td>Kingdom</td><td>Any species with same or higher category of listing under Part 4 of the BC Act shown below</td><td>IBRA region</td></tr>
<tr><td>Fauna</td><td></td><td>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.</td></tr>
</table>

<table>
<tr><td rowspan="6">Litoria aurea/
Green and Golden Bell Frog</td><td colspan="2">Spp</td><td colspan="2">IBRA region</td></tr>
<tr><td colspan="2">Litoria aurea/Green and Golden Bell Frog</td><td colspan="2">Any in NSW</td></tr>
<tr><td colspan="4">Variation options</td></tr>
<tr><td>Kingdom</td><td colspan="2">Any species with same or higher category of listing under Part 4 of the BC Act shown below</td><td>IBRA region</td></tr>
<tr><td>Fauna</td><td colspan="2">Endangered</td><td>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.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="5">Myotis macropus/
Southern Myotis</td><td colspan="2">Spp</td><td colspan="2">IBRA region</td></tr>
<tr><td colspan="2">Myotis macropus/Southern Myotis</td><td colspan="2">Any in NSW</td></tr>
<tr><td colspan="4">Variation options</td></tr>
<tr><td>Kingdom</td><td colspan="2">Any species with same or higher category of listing under Part 4 of the BC Act shown below</td><td>IBRA region</td></tr>
<tr><td>Fauna</td><td colspan="2">Vulnerable</td><td>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.</td></tr>
</table>

<table>
<tr><td rowspan="6">Wilsonia backhousei/
Narrow-leafed Wilsonia</td><td colspan="2">Spp</td><td>IBRA region</td></tr>
<tr><td colspan="2">Wilsonia backhousei/Narrow-leafed Wilsonia</td><td>Any in NSW</td></tr>
<tr><td colspan="3">Variation options</td></tr>
<tr><td>Kingdom</td><td>Any species with same or higher category of listing under Part 4 of the BC Act shown below</td><td>IBRA region</td></tr>
<tr><td>Flora</td><td>Vulnerable</td><td>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.</td></tr>
</table>

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00030218/BAAS17031/21/00030219	Parramatta Light Rail Stage 2_shading impacts	22/06/2023
Assessor Name	Report Created	BAM Data version *
Kathryn Chesnut	22/09/2023	61
Assessor Number	BAM Case Status	Date Finalised
BAAS17031	Locked	To be finalised
Assessment Revision	Assessment Type	
7	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	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits

Estuarine mangrove forest											
1	920_good	Not a TEC	34.8	34.8	0.73	PCT Cleared - 86%	High Sensitivity to Gain			2.00		13
											Subtotal	**13**
Estuarine saltmarsh											
2	1126_moderate	Subtropical and Temperate Coastal Saltmarsh	96.5	96.5	0.03	Environment Protection and Conservation Act listing status	High Sensitivity to Gain	Not Listed	Vulnerable	1.75		1
											Subtotal	**1**
Estuarine Swamp Oak forest											
3	1234_poor	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	15.2	15.2	0.08	Biodiversity Conservation Act listing status	High Sensitivity to Gain	Endangered Ecological Community	Not Listed	2.00		1

4	1234_moderate	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	40.6	40.6	0.07	Biodiversity Conservation Act listing status	High Sensitivity to Gain	Endangered Ecological Community	Not Listed	2.00		1
											Subtotal	**2**
											Total	**16**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits
Calidris ferruginea / Curlew Sandpiper (Fauna)									
920_good	34.8	34.8	0.56			Endangered	Critically Endangered	True	15
								Subtotal	**15**
Limosa lapponica baueri / Bar-tailed Godwit (baueri) (Fauna)									
920_good	34.8	34.8	0.56			Not Listed	Vulnerable	False	10
								Subtotal	**10**
Litoria aurea / Green and Golden Bell Frog (Fauna)									
920_good	34.8	34.8	0.01			Endangered	Vulnerable	False	1

1126_moderate	96.5	96.5	0.03			Endangered	Vulnerable	False	1
1234_poor	15.2	15.2	0.03			Endangered	Vulnerable	False	1
1234_moderate	40.6	40.6	0.07			Endangered	Vulnerable	False	1
								Subtotal	**4**
Myotis macropus / Southern Myotis (Fauna)									
920_good	34.8	34.8	0.73			Vulnerable	Not Listed	False	13
1126_moderate	96.5	96.5	0.03			Vulnerable	Not Listed	False	1
1234_poor	15.2	15.2	0.08			Vulnerable	Not Listed	False	1
1234_moderate	40.6	40.6	0.07			Vulnerable	Not Listed	False	1
								Subtotal	**16**
Wilsonia backhousei / Narrow-leafed Wilsonia (Flora)									
1126_moderate	96.5	96.5	0.01			Vulnerable	Not Listed	False	1
								Subtotal	**1**

Appendix G

EPBC Act assessments of significance

The desktop assessment, field surveys and impact assessment have been used to identify MNES that are known or may occur at the project site and that have the potential to suffer a significant impact. An assessment of significance has been prepared using the Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999 (DotE 2013) for the following MNES:

- Threatened species:
  - Green and Golden Bell Frog (*Litoria aurea*)
  - Grey-headed Flying-fox (*Pteropus poliocephalus*)
  - Wetland birds (Australian Painted Snipe and Australasian Bittern)
  - Threatened waders (Bar-tailed Godwit, Curlew Sandpiper, Eastern Curlew and Great Knot)
- Migratory species:
  - Latham's Snipe
  - Other migratory species.

Threatened species

G-1-1 Green and Golden Bell Frog (*Litoria aurea*) – vulnerable species

Distribution

The Green and Golden Bell Frog is distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extended into east Gippsland. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (DPIE 2021b).

Habitat requirements

The Green and Golden Bell Frog occupies marshes, dams and stream sides with emergent aquatic vegetation such as Bullrushes and spike rushes. It prefers unshaded waterbodies that a free of predatory fish such as Mosquitofish, with diurnal sheltering sites (DPIE 2021b).

This species is known to tolerate a wide range of turbidity levels, pH range, salinity levels, oxygen levels and temperatures (Pyke and White 1996). Pyke and White (1996) showed that tadpoles can tolerate salinity levels of up to six parts per thousand (ppt) without any apparent effects on their development, while salinity of eight ppt or higher will decrease growth and increase mortality. Mass tadpole death has been observed in breeding ponds on Broughton Island off Port Stephens when salinity has increased above 7.8 ppt through intrusion of seawater into the breeding habitat during storms (Pyke et al 2002). Raised salinity may afford an improved survivorship for developing tadpoles exposed to the frog chytrid pathogen (Clulow et al 2017), assuming salinity levels are not too high.

Habitat in the study area

The Green and Golden Bell Frog population at Parramatta is listed as a key population under the draft National Recovery plan for the species (DEC 2005). It is considered as being comprised of three sub-populations, the most secure being centred on the Brickpit, but also occurs in constructed and other habitat across almost 200 hectares of the Sydney Olympic Park site, and the Clyde Wetland near Camellia (DEC 2005).

In the study area, the Green and Golden Bell Frog is known to occur in Swamp Oak Forest, mangroves, wetlands and creeks at Newington Nature Reserve, the Millennium Parklands and Sydney Olympic Park. While the Green and Golden Bell Frog has the potential to occur in the project site at Camellia, no evidence of the species was recorded during targeted surveys. The key area of habitat in this area is the Clyde Wetland, which is not located in the project site. Mangroves and Swamp Oak Forest in Camellia may be used on rare occasions by individuals from the Clyde Wetland for movement and foraging, but do not link to any other areas of suitable habitat. The project alignment has changed at this location and is now located well away from the Clyde Wetland, and would have limited impacts on potential movement habitat for the species.

Table G.1 Assessment of significance for the Green and Golden Bell Frog

Criteria	Discussion
According to the DotE (2013) ‘significant impact criteria’, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	An ‘important population’ is a population that is necessary for a species’ long-term survival and recovery. The project is located in the vicinity of two key populations of the Green and Golden Bell Frog: the Clyde/Rosehill key population (taking in the Camellia peninsula at the western end of the project study area) and the Homebush Bay key population (associated with Sydney Olympic Park at the south-eastern end of the project study area) (DEC 2005).
Lead to a long-term decrease in the size of an important population of a species	The most secure habitat for the Green and Golden Bell Frog in the locality occurs in the Brickpit, Narawang Wetland and various other constructed ponds in the Millennium Parklands, as well as the Clyde Wetland near Camellia. There would be no removal of breeding ponds as a result of the project.

Criteria	Discussion
	The project would result in the removal of 1.52 hectares of potential habitat comprising mangroves, saltmarsh and freshwater wetland vegetation, from a number of locations at Wentworth Point and Sydney Olympic Park. The proposal would also remove foraging and movement habitat including areas of planted vegetation and exotic grassland occurring in highly modified urban environment. Additional impacts resulting from loss of vegetation due to increased shade are also possible, with up to 0.14 hectares of potential habitat at Wentworth Point likely to be impacted. Impacts at Narawang Wetland predominantly comprise the removal of narrow bands of vegetation immediately adjacent to Hill Road, that would already be subject to edge effects and disturbance from vehicles and pedestrians. The entire stand of buffer vegetation would not be removed. The project has been amended to further minimise direct impacts on Narawang Wetland. The project would remove small areas of saltmarsh and Swamp Oak Forest at Sanctuary Point, as well as larger patches of mangroves and planted vegetation. There would be no removal of vegetation in the adjacent Newington Nature Reserve, however shading by the new bridge may result in changes to vegetation in close proximity to the bridge. Small areas of mangroves to be removed along the Parramatta River and Swamp Oak Forest along the foreshore at Camellia are unlikely to provide breeding habitat for the species. No evidence of the species was recorded in the project site during targeted surveys. The project has been amended to avoid fragmenting mangrove habitat that is connected to the Clyde Wetland. Patches to be impacted along the foreshore have no connectivity to other areas of potential habitat. Construction would temporarily impact some Green and Golden Bell Frog ‘underpasses’, specifically the frog underpass between Kronos Hill and Wentworth Common at Holker Busway, and the flood control weir/culvert between Narawang Wetland and Nuwi Wetland. Works may impact movement of frogs during construction due to noise, vibration and lighting; however, no underpasses would be removed and no physical blockage of underpasses would occur. Permanent impacts on the population are unlikely as these underpasses would be retained for operation. It is noted that Sydney Olympic Park Authority does not map Nuwi Wetland as habitat for the species, however noise and vibration during works at Hill Road may affect movement in the wider Narawang Wetland area. Currently, it is understood there is no evidence that the Green and Golden Bell Frog uses either underpass for movement. Connectivity will continue to exist adjacent to the project site throughout the Narawang Wetland and Newington Nature Reserve, and between Kronos Hill, Wentworth Common and the Brickpit areas, although these areas may also be affected to some degree by noise and lighting during construction. Noise, vibration and lighting also have the potential to impact calling of the Green and Golden Bell Frog, which may then affect breeding success. Construction of the Hill Road bridge may take about 18 months, which could affect one or two breeding periods, if works occur during the calling period. There is evidence that noise can induce a physiological stress response in frogs and impair mate attraction in the natural environment (Tennessen et al 2014), and that anthropogenic noise may negatively affect calling males by shifting the timing of sexual signalling, while artificial noise and light at night may increase calling intensity (Cronin et al 2022). The Green and Golden Bell Frog may live over 10 years in captivity, however its life span in the wild is not certain. Noise and light during construction has the potential to impact some individual’s entire adulthood, while for others it may affect part of the lifecycle. Ongoing noise and light during operation may further exacerbate these impacts. Construction in these areas have the potential to result in sedimentation, erosion and mobilisation of contaminants. Changes in runoff volumes are anticipated to be minor, due to the small footprint of disturbed land required for construction, and like-for-like replacement of road pavement with provision for the light rail, resulting in the existing flow regimes being largely maintained. Mitigation measures would minimize the risk of indirect impacts including sedimentation, erosion and mobilization that may affect habitats adjacent to the construction site. Design measures including treatment of stormwater would minimise the risk of impacts on water quality in adjacent wetlands during operation of the project. The presence of piles, pile caps and piers in the Parramatta River floodplain reduce the efficiency of the floodplain in conveying flood water downstream. This results in higher flood levels on the upstream side of the bridge structures. Construction and operation of the project would increase the extent of flooding in the one per cent AEP flood event in a number of locations, including upstream of the bridge between Melrose Park and Wentworth Point and within the Narawang Wetland. Entry of water into Narawang Wetland and Newington Nature Reserve Wetlands are controlled by a variety of weirs, bunds and

Criteria	Discussion
	gates. Green and Golden Bell Frogs are known to tolerate saline water to some extent, but highly saline water can result in deaths of tadpoles. Localised increases in flood levels upstream of the proposed widened Hill Road bridge south of Bennelong Parkway extend outside the project boundary into Narawang Wetland. Detailed flow transition structures including scour management at the inlet and beneath the proposed widened bridge during next stages of design can mitigate the flow transition into the hydraulic structure beneath the existing Hill Road pavement. Residual flood impacts are anticipated in the immediate vicinity of the inlet structure; however mitigation is anticipated such that any potential flood effects on any sensitive communities and habitat for the Green and Golden Bell Frog upstream of the new bridge structure will be minimized. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. This increase in flood level is minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places), and the increase being between 10 to 50 millimetres. Further design refinement (at each design phase) of the pile caps for new bridges would be undertaken to identify opportunities for reduced impact to the conveyance capacity of the bridges, and to minimise impacts on Newington Nature Reserve wetland. The project has the potential to spread the noxious fish *Gambusia holbrooki* into currently fish-free breeding ponds as a result of changes to flooding regimes. This could impact breeding within these ponds, as this fish species feeds on frog eggs and tadpoles, reducing suitability of some ponds for breeding. The flood management strategy would identify design responses and management measures to ensure that the potential for movement of *Gambusia holbrooki* into Sydney Olympic Park's Green and Golden Bell Frog breeding ponds is minimised. Given that no breeding ponds would be removed in the Millennium Parklands, Newington Nature Reserve or Camellia, clearing of potential habitat is limited in extent and predominantly comprises disturbed habitats along existing edges, and indirect impacts would be minimised, the project is unlikely to result in a long-term decrease in the size of an important population of a species.
Reduce the area of occupancy of an important population	The proposal would remove 1.52 hectares of potential breeding habitat, from various locations along the proposed alignment. No breeding ponds would be removed, however the project has the potential to spread the noxious fish *Gambusia holbrooki* into currently fish-free breeding ponds as a result of changes to flooding regimes. This could impact breeding within these ponds, as this fish species feeds on frog eggs and tadpoles, reducing suitability of some ponds for breeding. The flood management strategy would identify design responses and management measures to ensure that the potential for movement of this noxious fish is minimised. Additional impacts resulting from loss of vegetation due to increased shade are also possible, with up to 0.14 hectares of potential habitat at Wentworth Point likely to be impacted.
Fragment an existing important population into two or more populations	Much of the project is located along existing roads, and there would be limited impacts on connectivity. The project is unlikely to fragment the existing population at Sydney Olympic Park into multiple populations. Clearing of vegetation in the Millennium Parklands area generally occurs along edges of roads. Connectivity would continue to exist adjacent to the project site throughout the Narawang Wetland and Newington Nature Reserve, and between Kronos Hill, Wentworth Common and the Brickpit areas, although these areas may also be affected to some degree by noise and lighting during construction. Construction will temporarily impact some Green and Golden Bell Frog 'underpasses', specifically the underpass between Kronos Hill and Wentworth Common at Holker Busway, and the flood control weir/culvert between Narawang Wetland and Nuwi Wetland. Works may impact movement of frogs during construction due to noise, vibration and lighting; however, no underpasses would be removed and no physical blockage of underpasses would occur. Permanent impacts on the population are unlikely as these underpasses would be retained for operation, however movement of frogs may be affected for 1-2 breeding or dispersal seasons, given the length of time proposed for these works. Currently, it is understood there is no evidence that the Green and Golden Bell Frog uses either underpass for movement, and Sydney Olympic Park Authority does not map Nuwi Wetland as habitat for the species.

Criteria	Discussion
	Small areas of mangroves to be removed along the Parramatta River and Swamp Oak Forest along the foreshore at Camellia are unlikely to provide important habitat for the species. The project has been amended to avoid fragmenting mangrove habitat that is connected to the Clyde Wetland. Patches to be impacted along the foreshore at this location have no connectivity to other areas of potential habitat.
Adversely affect habitat critical to the survival of a species	The Green and Golden Bell Frog inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (eg *Eleocharis* spp.). Optimum breeding habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available (DPIE 2021b). Habitat critical to the survival of the key population would include breeding sites such as Brickpit, Kronos Hill / Wentworth Common, Narawang Wetland and Newington Nature Reserve Wetland in the Homebush area, and Clyde Wetland near Camellia. There would be no removal of breeding as a result of the project. The potential for the spread the noxious fish *Gambusia holbrooki* into currently fish-free breeding ponds as a result of changes to flooding regimes could impact breeding within these ponds. Mitigation measures are proposed to minimise flooding in these areas. Construction works would impact areas of mangroves, exotic vegetation and planted vegetation that may be used on occasion by the Green and Golden Bell Frog when moving between areas of better-quality habitat, however these habitats are unlikely to be critical to the survival of the species. Construction noise and vibration may indirectly impact the frog underpass between Kronos Hill and Wentworth Common at Holker Busway, and the flood control weir/culvert between Narawang Wetland and Nuwi Wetland. Construction may impact movement of frogs during this period, however there would be no permanent fragmentation or isolation of habitat as a result of the project. Currently, it is understood there is no evidence that the Green and Golden Bell Frog uses either underpass for movement, and Sydney Olympic Park Authority does not map Nuwi Wetland as habitat for the species. Based on these points, the project is likely to adversely affect habitat critical to the survival of the species through potential impacts on breeding habitat.
Disrupt the breeding cycle of an important population	Given the avoidance of impacts on better quality wetland areas, permanent impacts on breeding habitat are highly unlikely to occur. There would be no removal of breeding ponds and the small areas of mangroves along the Parramatta River to be removed are unlikely to provide breeding habitat for the species. The roadside drains and artificial ponds are highly unlikely to be used for breeding given their small size and highly modified nature. These areas may however be used as temporary refuges by small numbers of individuals. It is possible that given the likely transient usage of these areas by the species that no individuals would be present at the time of construction. Construction may impact movement of frogs as a result of noise, lighting and vibration. Noise and vibration has the potential to impact calling of the Green and Golden Bell Frog, which may then affect breeding success (Tennessen et al 2014;Cronin et al 2022). Construction work hours would generally be between 7am-7pm, although there is potential for night work. Noise and vibration may affect movement of frogs during their migration and dispersal periods, particularly during the construction period. Construction works would temporarily impact areas of mown lawns, exotic vegetation and planted vegetation that may be used on occasion by the Green and Golden Bell Frog when moving between areas of better quality habitat. Following construction, the ground would be rehabilitated, and these areas could continue to be used by the species as a movement corridor.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There would be no removal of breeding ponds and no impact on any good quality habitat of the key population. The project would remove areas of mangroves along the Parramatta River which may provide marginal habitat for the species. Planted shrub and groundlayer may also provide some foraging or shelter habitat for the Green and Golden Bell Frog. Habitat to be impacted tends to occur on the edge of existing roads and is subject to noise and disturbance from vehicles and pedestrians. Large areas of similar foraging habitat is present throughout Newington Nature Reserve and the Millennium Parklands, as well as planted trees and garden plants in surrounding suburbs. This vegetation is not likely to be important to these species. The loss of a relatively small area of planted vegetation from a 10 kilometre linear alignment is unlikely to substantially impact the habitat of these species.

Criteria	Discussion
	Exotic grassland may provide some foraging habitat for the Green and Golden Bell Frog. Individuals may only occur in these areas on occasion when moving between ponds. Given the exposed nature of this habitat type, and location adjacent to existing roads, it is not likely to be important to the survival of the local population. Construction noise and vibration may impact some Green and Golden Bell Frog underpasses, specifically the underpass between Kronos Hill and Wentworth Common at Holker Busway, and the flood control weir/culvert between Narawang Wetland and Nuwi Wetland. Construction may impact movement of frogs for 1-2 breeding or dispersal seasons, however no permanent impacts are likely, as underpasses would not be removed. It is noted that Sydney Olympic Park Authority does not map Nuwi Wetland as habitat for the species, however noise and vibration during works at Hill Road may affect movement in the wider Narawang Wetland area. Construction of the project has the potential result in sedimentation, erosion, mobilisation of contaminated sediments and chemical spills within aquatic habitats adjoining the construction sites. The implementation of standard mitigation measures including progressive erosion and sediment controls would minimise the risk of indirect impacts on the species during construction.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The project site is located in a highly modified industrial and urban area. Large numbers of exotic species already occur. Introduction of new invasive species that may impact habitat for the Green and Golden Bell Frog is unlikely. The potential for the spread the noxious fish *Gambusia holbrooki* into currently fish-free breeding ponds as a result of changes to flooding regimes could impact breeding within these ponds. Mitigation measures are proposed to minimise flooding in these areas.
Introduce disease that may cause the species to decline	Chytrid fungus may harm frog populations once introduced into an area and is a key concern for the Green and Golden Bell Frog population known to occur at Homebush. Diseases and pathogens can be introduced or spread to site via dirt or organic material attached to machinery, vehicles, equipment and employees. The potential for significant or new impacts associated with these pathogens is relatively low, given the existing development presence and extent of human visitation across the development area and surrounding study area. The project has the potential to spread Chytrid fungus in the project site through contaminated vehicles or equipment. This fungus is generally accepted to have spread throughout coastal NSW and so it is highly unlikely that the project would result in a novel introduction of the fungus. The persistence of the Key Population in the local area is probably attributable to salinity levels or another abiotic factor limiting the spread or virulence of the pathogen. The project is highly unlikely to affect these abiotic factors in any areas of important, occupied habitat (if at all).
Interfere substantially with the recovery of the species	The objectives of the recovery plan are initially to stabilise and prevent further decline of the species, and secondly to return the species to its former distribution, abundance and role in the ecosystem where-ever possible. The second part is highly dependent on the success of the initial objective (DEC 2005). Specific actions include: – preventing the further loss of GGBF habitat at key populations across the species range and where possible secure opportunities for increasing protection of habitat areas – ensure extant GGBF populations are managed to eliminate or attenuate the operation of factors that are known or discovered to be detrimentally affecting the species – implement habitat management initiatives. The project will result in the loss of poorer quality habitat associated with mangroves, planted vegetation, exotic grassland and the temporary disturbance of a potential movement corridor. These activities are unlikely to interfere in the recovery of the key population. Management measures are proposed to minimise the risk of indirect impacts as a result of the project. As such, the project would not interfere substantially with the recovery of the species.
Conclusion	The project is likely to have a significant impact on the Green and Golden Bell Frog as the project intersects or is located immediately adjacent to a key population of the species. While the project has been designed and refined to avoid impacts on important breeding habitat within Sydney Olympic Park, the project will have the following impacts: – Direct impacts are limited to the removal of 1.52 hectares of habitat including saltmarsh, mangroves, Swamp Oak Forest and planted vegetation. – The project has the potential to spread the noxious fish *Gambusia holbrooki* into currently fish-free breeding ponds as a result of changes to flooding regimes.

Criteria	Discussion
	– Indirect impacts from noise, vibration and lighting during construction and operation, which have the potential to affect movement and breeding. – Indirect impacts on aquatic habitat such as sedimentation, erosion and contamination, which would be minimised through the implementation of standard mitigation measures. A flood management strategy would be prepared to build on the flood assessment in Technical Paper 10 (Hydrology, Flooding and Water Quality) and inform design development by minimising flooding impacts to flood sensitive areas and infrastructure within Sydney Olympic Park, including the Narawang Wetland, the Brick Pit and the existing leachate management system This would help to limit the potential for movement of *Gambusia holbrooki* into breeding ponds where it does not currently occur.

G-1-2 Grey-headed Flying Fox (*Pteropus poliocephalus*) – vulnerable species

Distribution

The Grey-headed Flying-fox is predominantly distributed within the coastal lowlands, tablelands and slopes of Eastern Australia, from Bundaberg to Geelong and below 200m asl. More recently, the species has been recorded in South Australia, the Australian Capital Territory, Victoria and inland NSW (DAWE 2021c).

Habitat requirements

The occurrence of Grey-headed Flying -fox is driven by seasonal and temporal resources, associated with the flowering and fruiting of feed trees which support annual migration cycles at regional scales (Eby and Lunney 2002).

Major food plants for the Grey-headed Flying-fox include flirting and flowering rainforest and myrtaceous species including *Ficus* spp., *Syzygium* spp., *Eucalyptus* spp., *Corymbia* spp. and *Angophora* spp. Foraging habitat can be supplemented by a host of introduced plants such as Camphor Laurel, Privet spp. and Cocos Palm as well as commercial fruit crops.

Roost camps occur in rainforest, swamp forest and in gullies including near waterways and act as communal camps for resting, socializing, breeding and refuge.

Critical habitat for the species include vegetation communities that contains the winter and spring flowering species *Eucalyptus tereticornis*, *E. albens, E. crebra, E. fibrosa, E. melliodora, E. paniculata, E. pilularis, E. robusta, E. seeana, E. sideroxylon, E. siderophloia, Banksia integrifolia, Castanospermum australe, Corymbia citriodora citriodora, C. eximia, C. maculata, Grevillea robusta, Melaleuca quinquenervia or Syncarpia glomulifera* (Eby and Law 2008; Eby 2016; Eby et al., 2019).

Habitat in the study area

There are two Grey-headed Flying-fox camps near the project site, the Clyde Camp recorded about two kilometres south of the project site on the Duck River and a nationally important camp located approximately 3.5 kilometres to the west at Parramatta Park (DAWE 2021d). Foraging habitat for the species is present throughout the project footprint, including native and planted eucalypts in highly modified urban areas and areas of mangroves. The project would result in the proposed clearing of foraging habitat for the Grey-headed Flying-fox, comprising 0.67 hectares of mangroves, 1.05 hectares of planted Sydney Turpentine Ironbark forest and up to 5.51 hectares of other planted vegetation. Much of the planted vegetation comprises Swamp Oak, which is not a feed tree of the species. It is also likely that not all planted vegetation at Ken Newman Park would be removed. As such, the total area of planted vegetation that is foraging habitat that would be removed is likely to be less than three hectares. Key feed trees present include *Eucalyptus tereticornis*, *E. fibrosa, E. paniculata, E. robusta, Corymbia maculata, Melaleuca quinquenervia* and *Syncarpia glomulifera.*

Table G.2 Assessment of significance for the Grey-headed Flying-fox

Criteria	Discussion
According to the DotE (2013) ‘significant impact criteria’, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	An ‘important population’ is a population that is necessary for a species’ long-term survival and recovery. The Grey-headed Flying-fox is considered to be a single, mobile population with individuals distributed across Queensland, New South Wales, Victoria, South Australia, Tasmania and the ACT (DAWE 2021c). As such the population of Grey-headed Flying -fox in the study area must be considered an important population for the purpose of this assessment.
Lead to a long-term decrease in the size of an important population of a species	The project would not directly affect any known roost camps in the locality. The project site is located within 50 kilometres of multiple camps located within metropolitan Sydney with the Clyde Camp located about two kilometres south of the project on the Duck River and a nationally important camp located approximately 3.5 kilometres to the west at Parramatta Park. The project would not fragment or isolate patches of foraging habitat, given it is known to forage up to 50 kilometres in a night and has been shown to make migratory movements of almost 1000 kilometres within a year (Churchill 2008, Webb and Tidemann 1996). The project would result in the proposed clearing of foraging habitat for the Grey-headed Flying-fox, comprising 0.72 hectares of mangroves, 1.05 hectares of planted Sydney Turpentine Ironbark forest and less than three hectares of planted trees. Of the canopy species recorded six are identified as key food plants (Eby and Law 2008). Foraging habitat in the project site would be a negligible proportion of available foraging habitat used by individuals from these camps and thus would not be habitat critical to the survival of the species. Given that there would be no impact on breeding camps, the loss of habitat is likely to comprise the removal of less than three hectares of planted eucalypts, 1.05 hectares of planted Sydney Turpentine Ironbark forest and 0.67 hectares of mangroves from small patches along the 10 kilometre alignment, and the high mobility of this species and the proximity of conservation areas, the project is unlikely lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	The project would result in the proposed clearing of foraging habitat for the Grey-headed Flying-fox, comprising 0.72 hectares of mangroves, 1.05 hectares of planted Sydney Turpentine Ironbark forest and less than three hectares of planted trees. Existing connectivity would not be severed for this highly mobile species given the narrow and linear nature of the project. The Grey-headed Flying-fox occurs along the east coast of NSW, as well as in inland areas. The project is unlikely to reduce the area of occupancy of an important population of Grey-headed Flying-foxes.
Fragment an existing important population into two or more populations	Habitat in the site is already fragmented and isolated from surrounding areas of habitat by roads, open spaces, and urban and industrial development. The project would further fragment existing habitat for this highly mobile, wide-ranging species but would not provide a barrier to the movement of Grey-headed Flying-fox between camp sites and foraging grounds.
Adversely affect habitat critical to the survival of a species	The National Recovery Plan (DAWE 2021c) defines critical habitat as vegetation communities that contain important winter and spring-flowering eucalypts, melaleucas and banksias. Critical habitat also includes vegetation communities not containing the above species but which: – contain native species that are known to be productive as foraging habitat during the final weeks of gestation, and during the weeks of birth, lactation and conception (August to May) – contain native species used for foraging and occur within 20 kilometres of a nationally important camps – contain native and or exotic species used for roosting at the site of a nationally important Grey-Headed Flying-Fox camp. Critical habitat within the project site includes less than three hectares of planted eucalypts and 1.05 hectares of planted Sydney Turpentine Ironbark forest which includes six of the key flowering species. The project site also contains 0.67 hectares of mangroves which also provide foraging habitat. No roosting habitat is present at the project site. Given the small area of foraging habitat to be removed, and the location as small fragments along a 10 kilometre linear alignment, and lack of impact of any breeding camps, the proposal is unlikely to adversely affect habitat critical to the survival of the species.

Criteria	Discussion
Disrupt the breeding cycle of an important population	Grey-headed Flying-fox camps provide day roosts, social interactions and breeding for local populations. The Clyde Creek camp has been recorded for the last 9 consecutive years between 2012-2020. It is not known if the roost camp is currently occupied. The proposed action will not directly impact on any known roost camps in the locality. The project is unlikely to disrupt the breeding cycle of an important population as the proposed action will not directly impact on any known roost camps in the locality. The removal of less than four hectares of foraging habitat throughout the project site would reduce the amount of foraging habitat in the locality, however it is unlikely that it will disrupt the breeding cycle of the species.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The project would result in the proposed clearing of foraging habitat for the Grey-headed Flying-fox, comprising 0.72 hectares of mangroves, 1.05 hectares of planted Sydney Turpentine Ironbark forest and less than three hectares of planted eucalypts along a 10 kilometre linear alignment. Given the high mobility of this species and the presence of these alternative habitats, the removal of foraging habitat is unlikely to have a significant effect on the long-term survival of a local population of the Grey-headed Flying-fox.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The project site is located in a highly modified industrial and urban area. Large numbers of exotic species already occur. The project may result in an increase in weeds such as Lantana, which is already present in moderate densities in some locations, as a result of disturbance. An increase in Lantana would lead to a reduction midstorey species which may comprise foraging habitat for the species. Mitigation measures are proposed to prevent weeds being introduced in the project site, or an increase in the severity of weed infestations as a result of construction works. No invasive fauna species that may cause the Grey-headed Flying-fox to decline are likely to become established in the site as a result of the project.
Introduce disease that may cause the species to decline	No diseases that may cause the Grey-headed Flying-fox to decline are likely to become established in the site as a result of the project. The disruption of home-ranging patterns as a result of habitat loss can lead to long-range dispersal trends and stress, leading to poor health and an increase in risk of zoonotic diseases such as Lyssavirus. The loss of up to three hectares of planted eucalypts, 1.05 hectares of planted Sydney Turpentine Ironbark forest and 0.72 hectares of mangroves (foraging habitat) is unlikely cause stress such that there would be an increase in disease in the population. Mitigation measures are proposed to prevent *Phytophthora* being introduced in the project site as a result of construction works.
Interfere substantially with the recovery of the species	The loss of foraging habitat critical to the survival of the species and loss of roost camps are the key threats to the Grey-headed Flying-fox throughout their range. The project will remove up to three hectares of planted eucalypts, 1.05 hectares of planted Sydney Turpentine Ironbark forest and 0.72 hectares of mangroves that is foraging habitat for the Grey-headed Flying-fox. The construction and operation of the proposed light rail will fragment habitat but would not create a barrier to movement. Given the limited extend of foraging habitat that would be removed, and the fact that the proposed action will not directly impact on any known roost camps in the locality, the project is unlikely interfere with the recovery of the Grey-headed Flying-fox.
Conclusion	The project is unlikely to have a significant impact on the Grey-headed Flying-fox as: – There would be no impact on any roost camps. – Impacts are limited to the loss of up to scattered patches of foraging habitat along a 10 kilometre linear alignment, comprising up to three hectares of planted eucalypts, 1.05 hectares of planted Sydney Turpentine Ironbark forest and 0.72 hectares of mangroves. – The project would not create a barrier to the movement of the species.

Wetland birds

G-1-3 Australian Painted Snipe (*Rostratula australis*) – endangered species

Distribution

The Australian Painted Snipe has been recorded at wetlands in all states of Australia and is most common in eastern Australia.

Habitat Requirements

The Australian Painted Snipe is a wading bird inhabiting shallow, terrestrial, freshwater (occasionally brackish) wetlands in all states of Australia. These wetlands include temporary and permanent lakes, swamps, clay pans, inundated/waterlogged grasslands or saltmarsh, dams, rice crops, sewage dams and bore drains (DAWE 2020b).

This species is migratory, breeding in southern Australia from August to February (DAWE 2020b). Australian Painted Snipe breeding habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. Nest records are all, or nearly all, from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover (Rogers et al. 2005).

Habitat in the study area

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). Occasional observations of individuals of this species in the area are associated with wetland areas within Bicentennial Park, the Brickpit and Wentworth Common.

G-1-4 Australasian Bittern (*Botaurus poiciloptilus*) – endangered species

Distribution

The Australasian Bittern occurs from south-east Queensland to south-east South Australia. There is one record of the species within 20 kilometres of the 300 kilometres alignment.

Habitat requirements

The Australasian Bittern is a relatively large wetland bird (66 to 76 centimetres long) occurring in Australia in south east Queensland, south east Australia, Tasmania and south west Western Australia (DAWE 2020b). This species favours terrestrial wetlands (and rarely estuarine habitats) vegetated with tall, dense vegetation dominated by sedges, rushes and/or reeds (flora species from the genera *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus* and *Gahnia*) on muddy/peaty substrates. The Australasian Bittern forages in still water of 30 centimetres maximum depth at the edges of pools or waterways, or platforms/mats of vegetation over deep water (DAWE 2020b).

Knowledge of the breeding habitats is poor, however data indicates that the species breeds in relatively deep, densely vegetated freshwater swamps and pools. The species builds nests in deep cover over shallow water (DAWE 2020b). Large numbers of bitterns may breed in rice crops of the New South Wales' Riverina each year (Bitterns in Rice Project 2018).

Habitat in the study area

Dense wetland habitat is present at Narawang Wetland, as well as constructed ponds at Sydney Olympic Park. Records of the species are known from Narawang Wetland, Haslams Creek and the Brickpit.

Table G.3 Assessment of significance for wetland birds

<table>
<tr><th>Criteria</th><th>Australian Painted Snipe</th><th>Australasian Bittern</th></tr>
<tr><td colspan="3">According to the DotE (2013) ‘significant impact criteria’, an action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:</td></tr>
<tr><td rowspan="2">Lead to a long-term decrease in the size of a population of a species</td><td>The Australian Painted Snipe has been recorded at wetlands in all states of Australia and is most common in eastern Australia. There are low numbers of records of this species in the area. Records of this species are associated with the Brickpit, Wentworth Common and Bicentennial Park.</td><td>In Australia, the Australasian Bittern occurs from south-east Queensland to south-east South Australia as far as the Adelaide Region, southern Eyre Peninsula, Tasmania and in the southwest of Western Australia (Garnett et al. 2011). There are low numbers of records of this species in the area. This species is known from Narawang Wetland, Haslams Creek and the Brickpit.</td></tr>
<tr><td colspan="2">The project will remove up to 1.38 hectares of native vegetation that is potential habitat for these species including estuarine mangrove forest, saltmarsh and Swamp Oak forest and freshwater wetlands. Much of this habitat is considered marginal at best, given its location adjacent to existing roads. Of this area just 0.01 hectares is the species’ preferred freshwater wetland foraging habitat with the remainder comprising potential shelter or roost sites. The impacts on native vegetation are predominantly along a narrow strip of disturbed vegetation adjacent to Hill Road and Holker Street at Sydney Olympic Park, and areas of mangroves along the Parramatta River. Extensive areas of good quality breeding habitat are present throughout Narawang Wetland, Haslams Creek, Newington Nature Reserve Wetland and the Brickpit, as well as other wetlands in the area, such as the Bird Refuge. There would be no direct impact on good quality breeding habitat for these species.

Changes to water quality has the potential to impact growth of wetland vegetation. Contaminants such as heavy metals and dioxins would accumulate in these species and may affect breeding. Changes in runoff volumes are anticipated to be minor, due to the small footprint of disturbed land required for construction, and like-for-like replacement of road pavement with provision for the light rail, resulting in the existing flow regimes being largely maintained. These species are already subject to potential accumulation of contaminants. Mitigation measures and design features are included in the project to minimise the risk of these impacts.

Localised increases in flood levels upstream of the proposed widened Hill Road bridge south of Bennelong Parkway extend outside the project boundary into Narawang Wetland. Detailed flow transition structures including scour management at the inlet and beneath the proposed widened bridge during the next stages of design can mitigate the flow transition into the hydraulic structure beneath the existing Hill Road pavement. Residual flood impacts are anticipated in the immediate vicinity of the inlet structure; however mitigation is anticipated such that any potential flood effects on any sensitive communities and habitat for wetland birds upstream of the new bridge structure will be minimized.

The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. This increase in flood level is minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places), and the increase being between 10 to 50 millimetres. Further design refinement (at each design phase) of the pile caps for new bridges would be undertaken to identify opportunities for reduced impact to the conveyance capacity of the bridges, and to minimise impacts on Newington nature Reserve wetland.

The loss of a very small area of potential habitat that occurs as scattered patches along a linear alignment is unlikely to lead to a long-term decrease in the species’ population.</td></tr>
</table>

<table>
<tr><th>Criteria</th><th>Australian Painted Snipe</th><th>Australasian Bittern</th></tr>
<tr><td rowspan="2">Reduce the area of occupancy of a population</td><td>The area of occupancy has undoubtedly declined as approximately 50 per cent of wetlands in Australia have been removed since European settlement (DAWE 2020b).</td><td>The area of occupancy of the Australasian Bittern in Australia is thought to have declined by 70 per cent between 1977 and 2008. These declines are considered to have led to a comparable decline in the size of the adult population. The declines are primarily linked to the clearing or modification of wetlands for urban and agricultural development, as well as the extraction of water from wetlands for irrigation (TSSC 2011).
Records for the Australasian Bittern are associated with Narawang Wetland, Haslams Creek and the Brickpit.</td></tr>
<tr><td colspan="2">The project will impact up to 1.38 hectares of native vegetation that is potential habitat for these species, of which 0.01 is freshwater wetland habitat. The loss of this small area of vegetation is unlikely to reduce the area of occupancy of these species.</td></tr>
<tr><td>Fragment an existing population into two or more populations</td><td>Movement patterns are poorly known for this species, and it is possibly dispersive or migratory (DAWE 2020b). The removal or disturbance of small patches of emergent reeds adjacent to busy roads is not likely to fragment the population of this mobile species.</td><td>The Australasian Bittern was previously thought to be largely sedentary, however recent tracking studies have shown extensive movements (over hundreds of kilometres) between wetlands in southeast Australia (Bitterns in Rice Project 2016). Occasional movements to inland areas have also been recorded during extensive flooding events (Marchant and Higgins 1990).
The removal or disturbance of small patches of emergent reeds adjacent to busy roads is not likely to fragment the population of this mobile species.</td></tr>
<tr><td rowspan="2">Adversely affect habitat critical to the survival of a species</td><td>Australian Painted Snipe breeding habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. Nest records are all, or nearly all, from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover (Rogers et al. 2005).</td><td>Given that the Australasian Bittern is presumed to have undergone a severe reduction in numbers, based on historic habitat loss and degradation across the core part of its range, all natural habitat (including constructed wetlands with suitable habitat) in which the Australasian Bittern is known or likely to occur should be considered critical to the survival of the species.</td></tr>
<tr><td colspan="2">The loss of 1.38 hectares of potential habitat that occurs as scattered patches along a linear alignment is unlikely to adversely affect the survival of these species. Better quality habitat within the Narawang Wetland would not be directly affected. There would be no impacts on the Waterbird Refuge or Badu Mangroves.
Changes to water quality has the potential to impact growth of wetland vegetation. Contaminants such as heavy metals and dioxins would accumulate in these species and may affect breeding. These species are already subject to potential accumulation of contaminants. Mitigation measures and design features are included in the project to minimise the risk of these impacts.
Given the small area of impact and management of indirect impacts, the project is unlikely to adversely affect the survival of these species.</td></tr>
</table>

Criteria	Australian Painted Snipe	Australasian Bittern
Disrupt the breeding cycle of a population	The Australian Painted Snipe is considered to occur in a single, contiguous breeding population (DAWE 2020b). The species may breed in response to wetland conditions rather than during a particular season. The nest is usually placed in a scrape in the ground, normally concealed in thick marshy vegetation (DAWE 2020b).	The Australasian Bittern generally breeds in solitary pairs, although sometimes several nests may be placed in close proximity to each other (Marchant and Higgins 1990). The species nests adjacent to relatively deep, densely vegetated freshwater swamps and pools, building its nests under dense cover over shallow water (Marchant and Higgins 1990). Annual surveys conducted by the Bitterns in Rice project since 2012 suggest that approximately 500-1000 Bitterns may breed in rice crops of the New South Wales Riverina each year (Bitterns in Rice project 2018). The proposal would not impact this key breeding habitat.
	The proposal would remove 1.38 hectares of potential habitat from along a linear alignment. Better quality breeding habitat comprising dense reeds within Narawang Wetland would not be removed. Changes to water quality has the potential to impact growth of wetland vegetation. Contaminants such as heavy metals and dioxins may be mobilised that could accumulate in these species and may affect breeding. These species are already subject to potential accumulation of contaminants. Mitigation measures and design features are included in the project to minimise the risk of these impacts. Given the small area of impact, lack of direct impacts on good quality breeding habitat, and mitigation of indirect impacts, the project is unlikely to disrupt the breeding cycle of the population.	
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposal would remove very small areas of potential habitat from adjacent to busy roads and industrial areas. This habitat is subject to high levels of disturbance by vehicles (noise and vibration) and pedestrians. Better quality habitat within the Narawang Wetland and other wetlands in the Millennium Parklands would not be directly affected. Construction of the project has the potential result in sedimentation, erosion, mobilisation of contaminated sediments and chemical spills within aquatic habitats adjoining the construction sites. The implementation of standard mitigation measures including progressive erosion and sediment controls would minimise the risk of indirect impacts on the species during construction. Given the small area of impact, lack of direct impacts on good quality breeding habitat, and mitigation of indirect impacts, the project is unlikely to modify habitat to the extent that the species are likely to decline.	
Result in invasive species that are harmful to a critically endangered species becoming established in the endangered species' habitat	Changes in abundance of certain plant species has the potential to reduce wetland productivity which can affect breeding. Foxes and cats are known to prey upon wetland birds. The project would have measures in place to limit the spread of weeds. The project is unlikely to lead to an increase in feral animal populations or the risk of predation.	
Introduce disease that may cause the species to decline	No diseases that may cause the Australian Painted Snipe or Australasian Bittern to decline are likely to become established in the site as a result of the project. Mitigation measures are proposed to prevent Phytophthora being introduced in the site as a result of construction works.	
Interfere substantially with the recovery of the species	The Australian Painted Snipe has primarily been impacted by the loss of wetland habitat (DAWE 2020b).	The Australasian Bittern has primarily been affected by the loss and degradation of its preferred habitat causing substantial decline of the species (DAWE).
	The loss of a very small area of potential habitat that occurs as scattered patches along a linear alignment is unlikely to lead to a long-term decrease in the species' population. Mitigation measures would be implemented to avoid indirect impacts such as sedimentation, erosion or contamination on these species' habitat.	

Criteria	Australian Painted Snipe	Australasian Bittern
Conclusion	The project is unlikely to have a significant impact on the Australian painted Snipe and Australasian Bittern as: – There would be no removal of high quality breeding habitat for the population of these species. – Direct impacts are limited to the removal of small areas (1.38 hectares) of potential habitat from adjacent to busy roads and industrial areas. – Indirect impacts on aquatic habitat such as sedimentation, erosion and contamination would be minimised through the implementation of standard mitigation measures. – There would be no permanent fragmentation or isolation of habitat as a result of the project.	

Threatened waders

G-1-5 Curlew Sandpiper (*Calidiris ferruginea*) – critically endangered species

Distribution

The Curlew Sandpiper occurs around the coasts and are also quite widespread inland, though in smaller numbers. Records occur in all states during the non-breeding period, and also during the breeding season when many non-breeding one year old birds remain in Australia rather than migrating north (DAWE 2021b).

Habitat requirements

Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. Occasionally they are recorded around floodwaters (DAWE 2021b)

Habitat in the study area

The Parramatta River between Rydalmere and Abbotsford, Haslams Creek and Narawang Wetland are mapped as important habitat for the Curlew Sandpiper under the BAM. Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point, in the Georges River catchment.

Records for this species in the area are associated with saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide foraging and roosting habitat for this species.

G-1-6 Eastern Curlew (*Numenius madagascariensis*) – critically endangered species

Distribution

The Eastern Curlew has a primarily coastal distribution. The species is found in all states, particularly the north, east, and south-east regions including Tasmania. Eastern Curlews are rarely recorded inland (DotE 2015c).

Habitat requirements

During the non-breeding season in Australia, the Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (Zosteraceae). Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, and sometimes within the mangroves (DotE 2015c).

Habitat in the study area

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

A small area of suitable foraging habitat for Eastern Curlew is present to the east of the proposed northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present.

Occasional observations of individuals or small groups of this species in the area are associated with saltmarsh areas within Newington Wetland and the Waterbird Refuge. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide foraging and roosting habitat for this species.

G-1-7 Great Knot (*Calidris tenuirostris*) – critically endangered species

Distribution

The Great Knot has been recorded around the entirety of the Australian coast, with a few scattered records inland. It is no longer regular at some sites along the south coast of Australia which used to support small numbers. The greatest numbers are found in northern Western Australia and the Northern Territory (DAWE 2021b).

Habitat requirements

The Great Knot prefers sheltered coastal habitats with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons. They are occasionally found on exposed reefs or rock platforms, shorelines with mangrove vegetation, ponds in saltworks, at swamps near the coast, salt lakes and non-tidal lagoons. The species rarely occurs on inland lakes and swamps (DAWE 2021b).

Habitat in the study area

There is one record of the species along the Parramatta River near Bennelong Parkway at Sydney Olympic Park from 2006 (DPIE 2021a). The species has not been recorded recently.

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

The tidal saltmarsh wetlands at Mason Park and the Waterbird Refuge may provide potential foraging habitat for this species. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) may also provide potential foraging and roosting habitat for this species.

A small area of suitable foraging habitat for the Great Knot is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

Table G.4 Assessment of significance for critically endangered waders

Criteria	Discussion
According to the DotE (2013) ‘significant impact criteria’, an action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population of a species	Records for the Curlew Sandpiper, the Eastern Curlew and Great Knot in the area are associated with wetlands, swamps and saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park. These locations within Sydney Olympic Park represent the most secure habitat for these species in the study area. The project will result in the removal of seasonal foraging habitat through the loss of 0.67 hectares of mangroves, 0.05 hectares of saltmarsh and 0.01 of freshwater wetland. The value of this small area of potential habitat to be removed is relatively low, particularly given that the availability of high-quality habitat presents in the Homebush Bay and Sydney Olympic Park area. The project would not involve the removal of large mudflats and there would be no direct impact on any high-quality habitat that these species are known to occupy, such as the Waterbird Refuge or Badu Wetlands. The inadvertent increase in the mud-flats around the bridge structures following construction may result in more mud-flat being exposed for a greater amount of time, and thus increased the foraging opportunities for shorebirds (Bonnington and Smith 2018). Changes to water quality has the potential to impact growth of wetland vegetation. Contaminants such as heavy metals and dioxins would accumulate in these species and may affect breeding. Changes in runoff volumes are anticipated to be minor, due to the small footprint of disturbed land required for construction, and like-for-like replacement of road pavement with provision for the light rail, resulting in the existing flow regimes being largely maintained. These species are already subject to potential accumulation of contaminants. Mitigation measures and design features are included in the project to minimise the risk of these impacts. Construction and operation of the project would increase the extent of flooding in the one per cent AEP flood event in a number of locations, including within Newington Nature Reserve Wetland and the Narawang Wetland. Entry of water into both wetlands are controlled by a variety of weirs, bunds and gates. The change in flooding regimes is unlikely to substantially affect foraging habitat for these species in these locations. Localised increases in flood levels upstream of the proposed widened Hill Road bridge south of Bennelong Parkway extend outside the project boundary into Narawang Wetland. Detailed flow transition structures including scour management at the inlet and beneath the proposed widened bridge during the next stages of design can mitigate the flow transition into the hydraulic structure beneath the existing Hill Road pavement. Residual flood impacts are anticipated in the immediate vicinity of the inlet structure; however mitigation is anticipated such that any potential flood effects on any sensitive communities and habitat for wetland birds upstream of the new bridge structure will be minimized. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. This increase in flood level is minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places), and the increase being between 10 to 50 millimetres. Further design refinement (at each design phase) of the pile caps for new bridges would be undertaken to identify opportunities for reduced impact to the conveyance capacity of the bridges, and to minimise impacts on Newington nature Reserve wetland. Internationally important migratory shorebird habitat at Towra Point Nature Reserve would not be directly impacted. The project is highly unlikely to indirectly impact this Ramsar site through generation of sediment or pollutants given the design and mitigation measures proposed and the distance from the project. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent to Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact.

Criteria	Discussion
	During long distance migration flights in familiar territory, most birds fly at altitudes well above the height of power lines. Collisions mostly occur when birds cross power lines in their local, daily movements. In contrast to flying in familiar territory, during long distance migration into unfamiliar terrain, birds tend to form large aggregations, fly at lower altitudes near stopover areas and therefore can increase their probability of collision with power lines (Bernadino et al 2018). Open areas like bogs or pastures allow birds to fly closer to the ground than forested habitats, and consequently can pose higher collision risk when crossed by power lines (Bernadino et al 2018). The use of overhead wiring near Narawang Wetland and Newington Nature Reserve Wetland would increase the risk of collision and mortality of migratory waders that utilise these areas. It is recommended that overhead wiring is minimised near wetland habitat. Given the above points, the project is unlikely to result in a long-term decrease in the size of an important population of a species.
Reduce the area of occupancy of a population	The project would not involve the removal of large mudflats and there would be no direct impact on any high-quality habitat within Sydney Olympic Park for these species. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for foraging or roosting given the presence of dense mangroves. A small area of potential foraging habitat for these species is located to the east of the proposed northern landing site for the bridge between Melrose Park and Wentworth Point (ie Melrose Park) where an open intertidal area of sandy and muddy substrates is present. The project would result in the loss of a negligible area (0.98 hectares) of potential foraging habitat associated with the Parramatta River.
Fragment an existing population into two or more populations	The local population of Curlew Sandpiper, Eastern Curlew and Great Knot are unlikely to be fragmented as they are a highly mobile, migratory species. The proposal would result in the erection of permanent structures, and the periodic movement of light rail vehicles however given the extent of existing infrastructure and traffic in the study area this would not tangibly increase the risk or energy cost of movement of these species. The small area (0.98 hectares) of potential foraging habitat to be removed is unlikely to fragment the existing populations of Curlew Sandpiper, Eastern Curlew and Great Knot in the area.
Adversely affect habitat critical to the survival of a species	Critical habitat for the survival of these species includes high quality foraging habitat, safe roosting habitat, and breeding habitat. The project will result in the removal of seasonal foraging habitat through the loss of 0.67 hectares of mangroves, 0.05 hectares of saltmarsh and 0.01 of freshwater wetland. This is a negligible proportion of available over-wintering habitat. The project would not impact high quality habitat in Homebush Bay, the Waterbird Refuge or Badu Mangroves. The project would not affect northern hemisphere breeding grounds. Construction of the project may result in indirect impacts on water quality within Newington Wetland and Narawang Wetland. Construction of the project has the potential to result in sedimentation, erosion, mobilisation of contaminated sediments and chemical spills within aquatic habitats adjoining the construction sites. However, this is unlikely to have a significant adverse impact critical to the survival of the species as the implementation of standard mitigation measures including progressive erosion and sediment controls would minimise the risk of indirect impacts during construction. The change in flooding regimes within Newington Wetland and Narawang Wetland is unlikely to substantially affect foraging habitat for these species in these locations.
Disrupt the breeding cycle of a population	The Curlew Sandpiper, Eastern Curlew and Great Knot breed in the northern hemisphere. The influence of the breeding cycle in Australia is confined to the ability of the birds to put on enough condition to get to the next stage on their return migration to their breeding grounds. Noting the small area (0.73 hectares) of potential foraging habitat impacted by construction works, the absence of direct impact on these species main foraging and breeding habitat, and the negligible and temporary indirect impacts that may occur during construction, the project is unlikely to disrupt the breeding of a population of this species.

Criteria	Discussion
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The project will result in the removal of seasonal foraging habitat through the loss of 0.67 hectares of mangroves, 0.05 hectares of saltmarsh and 0.01 of freshwater wetland. The project would not involve the removal of large mudflats and there would be no direct impact on any high-quality habitat that these species are known to occupy, such as the Waterbird Refuge or Badu Wetlands. Construction and operation of the project would increase the extent of flooding in the one per cent AEP flood event within Newington Nature Reserve Wetland and the Narawang Wetland. The change in flooding regimes is unlikely to substantially affect foraging habitat for these species in these locations. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent to Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. Given these points, the project is unlikely to significantly modify, remove or decrease the availability or quality of habitat to the extent that these species are likely to decline.
Result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species' habitat	Invasive species relevant to migratory shorebirds include: – introduced plant species such as Water Hyacinth – introduced animals such as feral Pigs, Cane Toads, and Carp – new introductions of exotic species from aquaria and gardens – new introductions of exotic marine species from ballast water and hull transport (DotE 2015). The construction of the project is unlikely to contribute to the establishment of any known or potential invasive species in the habitat of these species.
Introduce disease that may cause the species to decline	No diseases that may cause the Curlew Sandpiper, Eastern Curlew and Great Knot to decline are likely to become established in the site as a result of the project. Mitigation measures are proposed to prevent Phytophthora being introduced in the site as a result of construction works.
Interfere substantially with the recovery of the species	There are no adopted or made Recovery Plan for these species. There are a number of threats that affect all migratory waders, including the Curlew Sandpiper, Eastern Curlew Great Knot, that occur in the East Asian-Australasian Flyway. These threats include loss of feeding and roosting habitat, fragmentation, human disturbance and pollution. As mentioned above, the project would remove a small area of potential foraging habitat and has the potential to increase human disturbance and pollution in the area through the construction project. However, it is unlikely to significantly accentuate these threats and to interfere with the recovery of these species, particularly given that high quality foraging and breeding habitat would not be directly impacted by the project and mitigation measures would be implemented to avoid indirect impacts.
Conclusion	The project is unlikely to have a significant impact on the Curlew Sandpiper, Eastern Curlew and Great Knot as: – There would be no removal of large mudflats and no direct impact on high-quality foraging and breeding habitat within Sydney Olympic Park. – Direct impacts are limited to the removal of small area (0.73 hectares) of potential foraging habitat, of which 0.35 hectares is mapped important habitat, a negligible proportion of available habitat in the area. – Indirect impacts on wetland habitat at Newington Wetlands and Narawang Wetland such as sedimentation, erosion and contamination would be minimised through the implementation of standard mitigation measures. – There would be no permanent fragmentation or isolation of habitat as a result of the project. – The change in flooding regimes is unlikely to substantially affect foraging habitat for these species in Newington Wetlands and Narawang Wetland.

G-1-8 Bar-tailed Godwit (*Limosa lapponica baueri*) – vulnerable species

Distribution

The Bar-tailed Godwit has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria, including the offshore islands. There are a few inland records from NSW and Victoria. The Bar-tailed Godwit is most abundant in south-east Tasmania between Orford and Southport Lagoon (DAWE 2021b).

Habitat requirements

The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh. It has been sighted in coastal sewage farms and saltworks, salt lakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats. It is rarely found on inland wetlands or in areas of short grass, such as farmland, paddocks and airstrips (DAWE 2021b).

The Bar-tailed Godwit is gregarious, occurring in small to large groups, numbering up to 1000 at favourable roosting sites (DotE 2005).

Habitat in the study area

The Parramatta River between Rydalmere and Abbotsford, Haslams Creek and Narawang Wetland are mapped as important habitat for the Bar-tailed Godwit under the BAM. Bicentennial Park and Newington Wetland are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

Groups of this species are regularly recorded within saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park, as well as the mudflats of the Parramatta River. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide foraging and roosting habitat for this species.

A small area of suitable foraging habitat for Bar-tailed Godwit is located to the east of the proposed northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present. The project would result in the loss of a negligible area of foraging habitat on the Parramatta River and associated saltmarshes.

Table G.5 Assessment of significance for critically endangered waders

Criteria	Discussion
According to the DotE (2013) ‘significant impact criteria’, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	The population of the Bar-tailed Godwit in the Parramatta River is considered an important population, as important habitat has been mapped in this area. Important areas are those that support bird numbers exceeding the international and national significance thresholds as defined DotE (2015) and the Wildlife Conservation Plan for Migratory Shorebirds

Criteria	Discussion
Lead to a long-term decrease in the size of an important population of a species	Records for the Bar-tailed Godwit in the area are associated with wetlands, swamps and saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park. These locations within Sydney Olympic Park represent the most secure habitat for this species in the study area. The project will result in the removal of seasonal foraging habitat through the loss of 0.67 hectares of mangroves, 0.05 hectares of saltmarsh and 0.01 of freshwater wetland. The value of this small area of potential habitat to be removed is relatively low, particularly given that the availability of high-quality habitat presents in the Homebush Bay and Sydney Olympic Park area. The project would not involve the removal of large mudflats and there would be no direct impact on any high-quality habitat that this species are known to occupy, such as the Waterbird Refuge or Badu Wetlands. The inadvertent increase in the mud-flats around the bridge structures following construction may result in more mud-flat being exposed for a greater amount of time, and thus increased the foraging opportunities for shorebirds (Bonnington and Smith 2018). Changes to water quality has the potential to impact growth of wetland vegetation. Contaminants such as heavy metals and dioxins would accumulate in these species and may affect breeding. Changes in runoff volumes are anticipated to be minor, due to the small footprint of disturbed land required for construction, and like-for-like replacement of road pavement with provision for the light rail, resulting in the existing flow regimes being largely maintained. These species are already subject to potential accumulation of contaminants. Mitigation measures and design features are included in the project to minimise the risk of these impacts. Construction and operation of the project would increase the extent of flooding in the one per cent AEP flood event in a number of locations, including within Newington Nature Reserve Wetland and the Narawang Wetland. Entry of water into both wetlands are controlled by a variety of weirs, bunds and gates. The change in flooding regimes is unlikely to substantially affect foraging habitat for these species in these locations. Localised increases in flood levels upstream of the proposed widened Hill Road bridge south of Bennelong Parkway extend outside the project boundary into Narawang Wetland. Detailed flow transition structures including scour management at the inlet and beneath the proposed widened bridge during the next stages of design can mitigate the flow transition into the hydraulic structure beneath the existing Hill Road pavement. Residual flood impacts are anticipated in the immediate vicinity of the inlet structure; however mitigation is anticipated such that any potential flood effects on any sensitive communities and habitat for wetland birds upstream of the new bridge structure will be minimized. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. This increase in flood level is minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places), and the increase being between 10 to 50 millimetres. Further design refinement (at each design phase) of the pile caps for new bridges would be undertaken to identify opportunities for reduced impact to the conveyance capacity of the bridges, and to minimise impacts on Newington nature Reserve wetland. Internationally important migratory shorebird habitat at Towra Point Nature Reserve would not be directly impacted. The project is highly unlikely to indirectly impact this Ramsar site through generation of sediment or pollutants given the design and mitigation measures proposed and the distance from the project. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent to Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. During long distance migration flights in familiar territory, most birds fly at altitudes well above the height of power lines. Collisions mostly occur when birds cross power lines in their local, daily movements. In contrast to flying in familiar territory, during long distance migration into unfamiliar terrain, birds tend to form large aggregations, fly at lower altitudes near stopover areas and therefore can increase their probability of collision with power lines (Bernadino et al 2018). Open areas like bogs or pastures allow birds to fly closer to the ground than forested habitats, and consequently can pose higher collision risk when crossed by power lines (Bernadino et al 2018). The use of overhead wiring near Narawang Wetland and Newington Nature Reserve Wetland would increase the risk of collision and mortality of migratory waders that utilise these areas. It is recommended that overhead wiring is minimised near wetland habitat. Given the above points, the project is unlikely to result in a long-term decrease in the size of an important population of this species.

Criteria	Discussion
Reduce the area of occupancy of an important population	The project would not involve the removal of large mudflats and there would be no direct impact on any high-quality habitat within Sydney Olympic Park for these species. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for foraging or roosting given the presence of dense mangroves. A small area of potential foraging habitat for these species is located to the east of the proposed northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present. The project would result in the loss of a negligible area (0.73 hectares) of potential foraging habitat associated with the Parramatta River.
Fragment an existing important population into two or more populations	The local population of the Bar-tailed Godwit is unlikely to be fragmented as it is a highly mobile, migratory species. The proposal would result in the erection of permanent structures, and the periodic movement of light rail vehicles however given the extent of existing infrastructure and traffic in the study area this would not tangibly increase the risk or energy cost of movement of these species. The small area (0.73 hectares) of potential foraging habitat to be removed is unlikely to fragment the existing important population of this species in the area.
Adversely affect habitat critical to the survival of a species	Critical habitat for the survival of this species includes high quality foraging habitat, safe roosting habitat, and breeding habitat. The project will result in the removal of seasonal foraging habitat through the loss of 0.67 hectares of mangroves, 0.05 hectares of saltmarsh and 0.01 of freshwater wetland. This is a negligible proportion of available over-wintering habitat. The project would not impact high quality habitat in Homebush Bay, the Waterbird Refuge or Badu Mangroves. The project would not affect northern hemisphere breeding grounds. Construction of the project may result in indirect impacts on water quality within Newington Wetland and Narawang Wetland. Construction of the project has the potential to result in sedimentation, erosion, mobilisation of contaminated sediments and chemical spills within aquatic habitats adjoining the construction sites. However, this is unlikely to have a significant adverse impact critical to the survival of the species as the implementation of standard mitigation measures including progressive erosion and sediment controls would minimise the risk of indirect impacts during construction. The change in flooding regimes within Newington Wetland and Narawang Wetland is unlikely to substantially affect foraging habitat for this species in these locations.
Disrupt the breeding cycle of an important population	The Bar-tailed Godwit breeds in the northern hemisphere. The influence of the breeding cycle in Australia is confined to the ability of the birds to put on enough condition to get to the next stage on their return migration to their breeding grounds. Noting the small area (0.73 hectares) of potential foraging habitat impacted by construction works, the absence of direct impact on these species main foraging and breeding habitat, and the negligible and temporary indirect impacts that may occur during construction, the project is unlikely to disrupt the breeding of an important population of this species.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The project will result in the removal of seasonal foraging habitat through the loss of 0.67 hectares of mangroves, 0.05 hectares of saltmarsh and 0.01 hectares of freshwater wetland. The project would not involve the removal of large mudflats and there would be no direct impact on any high-quality habitat that these species are known to occupy, such as the Waterbird Refuge or Badu Wetlands. Construction and operation of the project would increase the extent of flooding in the one per cent AEP flood event within Newington Nature Reserve Wetland and the Narawang Wetland. The change in flooding regimes is unlikely to substantially affect foraging habitat for these species in these locations. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent to Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. Given these points, the project is unlikely to significantly modify, remove or decrease the availability or quality of habitat to the extent that this species is likely to decline.

Criteria	Discussion
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Invasive species relevant to migratory shorebirds include: – introduced plant species such as Water Hyacinth – introduced animals such as feral Pigs, Cane Toads, and Carp – new introductions of exotic species from aquaria and gardens – new introductions of exotic marine species from ballast water and hull transport (DotE 2015). The construction of the project is unlikely to contribute to the establishment of any known or potential invasive species in the habitat of these species.
Introduce disease that may cause the species to decline	No diseases that may cause the Bar-tailed Godwit to decline are likely to become established in the site as a result of the project. Mitigation measures are proposed to prevent Phytophthora being introduced in the site as a result of construction works.
Interfere substantially with the recovery of the species	There are no adopted or made Recovery Plan for this species. There are a number of threats that affect all migratory waders that occur in the East Asian-Australasian Flyway, including the Bar-tailed Godwit. These threats include loss of feeding and roosting habitat, fragmentation, human disturbance and pollution. As mentioned above, the project would remove a small area of potential foraging habitat and has the potential to increase human disturbance and pollution in the area through the construction project. However, it is unlikely to significantly accentuate these threats and to interfere with the recovery of these species, particularly given that high quality foraging and breeding habitat would not be directly impacted by the project and mitigation measures would be implemented to avoid indirect impacts.
Conclusion	The project is unlikely to have a significant impact on the Bar-tailed Godwit as: – There would be no removal of large mudflats and no direct impact on high-quality foraging and breeding habitat within Sydney Olympic Park. – Direct impacts are limited to the removal of small area (0.73 hectares) of potential foraging habitat, of which 0.35 hectares is mapped important habitat, a negligible proportion of available habitat in the area. – Indirect impacts on wetland habitat at Newington Wetlands and Narawang Wetland such as sedimentation, erosion and contamination would be minimised through the implementation of standard mitigation measures. – There would be no permanent fragmentation or isolation of habitat as a result of the project. – The change in flooding regimes is unlikely to substantially affect foraging habitat for these species in Newington Wetlands and Narawang Wetland.

Important migratory population

G-1-9 Latham's Snipe (*Gallinago hardwickii*)

Distribution

The Latham's Snipe is a non-breeding visitor to south-eastern Australia and is a passage migrant through northern Australia. The species has been recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia (including the Adelaide plains and Mount Lofty Ranges, and the Eyre Peninsula). The range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales. The species is widespread in Tasmania and is found in all regions of Victoria except for the north-west. Most birds spend the non-breeding period at sites located south of the Richmond River in New South Wales (DAWE 2021b).

Habitat requirements

The Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 metres above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity (DAWE 2021b).

Habitat in the study area

Latham's Snipe is known to occur within Sydney Olympic Park in permanent and ephemeral freshwater wetlands. Annual monitoring of the species is conducted by the Sydney Olympic Park Authority. During 2020-2021 monitoring surveys over three non-consecutive days, up to 22 Latham's Snipe were recorded within the Brickpit, Narawang Wetland, Northern Water Feature and Newington Nature Reserve wetland within Sydney Olympic Park. Up to 31 Latham's Snipe were recorded during the Spring Bird census at Sydney Olympic Park in the 2019-2020 period. The majority of Latham's Snipe recorded at Sydney Olympic Park occur within Narawang Wetland with other wetlands supporting small numbers of the species. The Narawang Wetland, with its dense cover of sedges and grasses, is the primary stronghold supporting a Commonwealth-significant population and provides a foraging and sheltering habitat for the species. Incidental sightings of the species have also occurred from pond 2 within Blaxland Riverside Park and also Armory Creek in Newington Armory (Sydney Olympic Park Authority 2021). Latham's Snipe have been irregularly recorded from Haslam Creek Flats, Wentworth Common, Badu Mangroves and Bicentennial Park. The population of Latham's Snipe within Sydney Olympic Park exceeds the threshold as a Nationally Important Site for this species.

Table G.6 Assessment of significance for Latham's Snipe

Criteria	Discussion
According to the DotE (2013) 'significant impact criteria', an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	An area of important habitat for a migratory species is defined as: – habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or – habitat that is of critical importance to the species at particular life stages, and/or – habitat utilised by a migratory species which is at the limit of the species' range, and/or – habitat within an area where the species is declining. An 'ecologically significant proportion' of the population of a migratory species varies, as listed migratory species cover a broad range of species with different lifecycles and population cycles. Factors to be considered include the species' population status, genetic distinctiveness and species-specific behavioural patterns (e.g. site fidelity and dispersal rates) A 'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of migratory animals.

Criteria	Discussion
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	The study area is important habitat for the Latham's Snipe. The migratory species is known to occur within Sydney Olympic Park and the majority of Latham's Snipe recorded occur within Narawang Wetland with other wetlands supporting small numbers of the species. The project would remove 0.01 hectares of freshwater wetland habitat and 0.03 hectares of saltmarsh. There would be no direct impact on high quality habitat for the species within Sydney Olympic Park or the Newington Wetlands. There would be no removal of large mudflats. Construction of the project may result in indirect impacts on water quality within Parramatta River, Haslams Creek, Newington Wetland and Narawang Wetland. Erosion and sediment control would focus on areas of surface disturbance, particularly near waterways including Sydney Olympic Park precinct construction site and bridge and water crossing construction sites. These impacts would be adequately managed through the implementation of standard mitigation measures including progressive erosion and sediment controls, and on-site management protocols within the Transport for NSW Water Discharge and Reuse Guideline. These controls would be used to manage and minimise risks of impacts to water quality. Changes to water quality has the potential to impact growth of wetland vegetation. Contaminants such as heavy metals and dioxins would accumulate in these species and may affect breeding. Changes in runoff volumes are anticipated to be minor, due to the small footprint of disturbed land required for construction, and like-for-like replacement of road pavement with provision for the light rail, resulting in the existing flow regimes being largely maintained. These species are already subject to potential accumulation of contaminants. Mitigation measures and design features are included in the project to minimise the risk of these impacts. Construction and operation of the project would increase the extent of flooding in the one per cent AEP flood event in a number of locations, including within Newington Nature Reserve Wetland and the Narawang Wetland. Entry of water into both wetlands are controlled by a variety of weirs, bunds and gates. The change in flooding regimes is unlikely to substantially affect foraging habitat for this species in these locations. Localised increases in flood levels upstream of the proposed widened Hill Road bridge south of Bennelong Parkway extend outside the project boundary into Narawang Wetland. Detailed flow transition structures including scour management at the inlet and beneath the proposed widened bridge during the next stages of design can mitigate the flow transition into the hydraulic structure beneath the existing Hill Road pavement. Residual flood impacts are anticipated in the immediate vicinity of the inlet structure; however mitigation is anticipated such that any potential flood effects on any sensitive communities and habitat for wetland birds upstream of the new bridge structure will be minimized. The increase in flood levels is limited to 50 millimetres in the one per cent AEP flood event and extends into the Newington Nature Reserve. This increase in flood level is minimal, with current flood depths being upwards of 0.5 metres (up to 1-2 metres in places), and the increase being between 10 to 50 millimetres. Further design refinement (at each design phase) of the pile caps for new bridges would be undertaken to identify opportunities for reduced impact to the conveyance capacity of the bridges, and to minimise impacts on Newington nature Reserve wetland. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent to Narawang Wetland and the new bridges across the Parramatta River, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. During long distance migration flights in familiar territory, most birds fly at altitudes well above the height of power lines. Collisions mostly occur when birds cross power lines in their local, daily movements. In contrast to flying in familiar territory, during long distance migration into unfamiliar terrain, birds tend to form large aggregations, fly at lower altitudes near stopover areas and therefore can increase their probability of collision with power lines (Bernadino et al 2018). Open areas like bogs or pastures allow birds to fly closer to the ground than forested habitats, and consequently can pose higher collision risk when crossed by power lines (Bernadino et al 2018). The use of overhead wiring near Narawang Wetland and Newington Nature Reserve Wetland would increase the risk of collision and mortality of migratory waders that utilise these areas. It is recommended that overhead wiring is minimised near wetland habitat.

Criteria	Discussion
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory specie	Invasive species relevant to migratory shorebirds include: – introduced plant species such as Water Hyacinth – introduced animals such as feral Pigs, Cane Toads, and Carp – new introductions of exotic species from aquaria and gardens – new introductions of exotic marine species from ballast water and hull transport (DotE 2015). No invasive species that are harmful to the Latham's Snipe are likely to become established in the study area as a result of the project.
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	The Latham's Snipe is known to occur in the study area and is considered to be an ecologically significant proportion of the population of the species. The Latham's Snipe does not breed in Australia. The project is not likely to seriously disrupt the lifecycle of the population of Latham's Snipe as there would be no direct impact on high quality foraging habitat for the species within Sydney Olympic Park and mitigation measures would be implemented to avoid indirect impacts such as sedimentation, erosion and contamination on water quality.
Conclusion	The project is unlikely to have a significant impact on the Latham's Snipe as: – There would be no direct impacts on high quality habitat for the species. – Indirect impacts on aquatic habitat such as sedimentation, erosion and contamination would be minimised through the implementation of standard mitigation measures. – There would be no permanent fragmentation or isolation of habitat.

Migratory bird species

G-1-10 Curlew Sandpiper (*Calidiris ferruginea*) – critically endangered, migratory species

The ‘threatened waders’ assessment completed above provides information on this species distribution, habitat requirements and habitat in the study area.

G-1-11 Eastern Curlew (*Numenius madagascariensis*) – critically endangered, migratory species

The ‘threatened waders’ assessment completed above provides information on this species distribution, habitat requirements and habitat in the study area.

G-1-12 Great Knot (*Calidris tenuirostris*) – critically endangered, migratory species

The ‘threatened waders’ assessment completed above provides information on this species distribution, habitat requirements and habitat in the study area.

G-1-13 Bar-tailed Godwit (*Limosa lapponica baueri*) – vulnerable species, migratory species

The ‘threatened waders’ assessment completed above provides information on this species distribution, habitat requirements and habitat in the study area.

G-1-14 Black-tailed Godwit (*Limosa limosa*) – migratory species

Distribution

The Black-tailed Godwit is found in all states and territories of Australia; however, it prefers coastal regions and the largest populations are found on the north coast between Darwin and Weipa. It is generally found in small numbers elsewhere and there are scattered inland records (DAWE 2021b).

Habitat requirements

In Australia the Black-tailed Godwit has a primarily coastal habitat environment. The species is commonly found in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats, or spits and banks of mud, sand or shell-grit; occasionally recorded on rocky coasts or coral islets. The use of habitat often depends on the stage of the tide. It is also found in shallow and sparsely vegetated, near-coastal, wetlands, such as saltmarsh, salt flats, river pools, swamps, lagoons and floodplains (DAWE 2021b).

The Black-tailed Godwit is gregarious, occurring in small to large groups, numbering up in the hundreds at favourable roosting sites (DotE 2005).

Habitat in the study area

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

A small area of suitable foraging habitat for Black-tailed Godwit is located to the east of the proposed northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present. The species would also forage in saltmarsh areas within Newington Wetland, Homebush Bay, the Waterbird Refuge, Bicentennial Park and Mason Park. The project would result in the loss of a negligible area of foraging habitat on the Parramatta River and associated saltmarshes.

G-1-15 Sharp-tailed Sandpiper (*Calidris acuminata*) – migratory species

Distribution

The Sharp-tailed Sandpiper spends the non-breeding season in Australia and occurs mostly to the south-east. The species is widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage (DAWE 2021b).

Habitat requirements

The Sharp-tailed Sandpiper occupies muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. They tend to occupy coastal mudflats mainly after ephemeral terrestrial wetlands have dried out, moving back during the wet season (DAWE 2021b).

Habitat in the study area

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The estuarine and wetland habitats within the Corridor and associated with Parramatta River comprise nationally important' habitat for this species defined under the EPBC Act ((Weller et al 2020).

The Sharp-tailed Sandpiper was not recorded during field surveys for the project. Three individuals were recorded in November 2020 at Newington Nature Reserve during targeted Latham's Snipe monitoring surveys (Sydney Olympic Park Authority 2021).

Within the project site, a small area of suitable foraging habitat for the Sharp-tailed Sandpiper is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

The tidal saltmarsh wetlands Mason Park and Waterbird Refuge provides known foraging habitat for this species. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) provide potential foraging and roosting habitat for this species.

The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

G-1-16 Crested Tern (*Thalasseus bergii*) – migratory species

Distribution

The Crested Tern is found all along the Australian coastline and breeds in colonies on small offshore islands.

Habitat requirements

The species inhabits tropical and subtropical coastlines, foraging in the shallow waters of lagoons coral reefs, estuaries, bays, harbours and inlets, along sandy, rocky, coral or muddy shores, on rocky outcrops in open sea, in mangrove swamps and also far out to sea on open water.

Habitat in the study area

The Crested Tern has been known to occur throughout the Parramatta River estuary between the Duck River and the Sydney Heads with 21 records in the locality in the last 20 years. In close proximity of the project, Ermington Bay on either side of Archer Park, Kendell Bay, Hen and Chicken Bay, Yaralla Bay and Wentworth Bay all provide foraging habitat for this species. Crested Tern have also been recorded within Sydney Olympic Park at Badu Mangroves, Haslam Creek Flats, Narawang Wetland and Newington Armory Precinct (OEH 2021a).

G-1-17 Broad-billed Sandpiper (*Limicola falcinellus*) – migratory species

Distribution

The Broad-billed Sandpiper is most common on the north and north-west coasts and occur regularly at scattered localities in southern Australia, where they are usually seen singly (DAWE 2021b).

Habitat requirements

The Broad-billed Sandpiper occurs in sheltered parts of the coast, favouring estuarine mudflats but also occasionally occur on saltmarshes, shallow freshwater lagoons, saltworks and sewage farms, and in areas with large soft intertidal mudflats, which may have shell or sandbanks nearby. Occasionally they occur on reefs or rocky platforms. They have also been recorded in creeks, swamps and lakes near the coast, particularly those with bare mudflats or sand exposed by receding water (DAWE 2021b).

Habitat in the study area

Two historic records of the species occur along the Parramatta River, with both records along Bennelong Parkway at Sydney Olympic Park (DPIE 2021a) but the species has not been recorded recently.

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

The tidal saltmarsh wetlands Mason Park and Waterbird Refuge may provide potential foraging habitat for this species. Approximately 4km to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) may also provide potential foraging and roosting habitat for this species.

A small area of suitable foraging habitat for the Broad-billed Sandpiper is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

G-1-18 Caspian Tern (*Hydroprogne caspia*) – migratory species

Distribution

The Caspian Tern has a widespread occurrence and can be found in both Australian coastal and inland habitat. In New South Wales, the species is widespread east of the Great Divide, mainly in coastal regions, and also in the Riverina and Lower and Upper Western Regions, with occasional records elsewhere (DAWE 2021b).

Habitat requirements

The Caspian Tern is mostly found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and saltworks.

The Caspian Tern usually forages in open wetlands, including lakes and rivers. They often prefer sheltered shallow water near the margins but can also be found in open coastal waters. In coastal inlets they may prefer to forage in tidal channels, or over submerged mudbanks (DAWE 2021b).

Habitat in the study area

The Caspian Tern has been known to occur within the Parramatta River estuary with records clustered around Haslams Flat and Wentworth Bay (DPIE 2021a).

A cluster of records is present for this species at the Waterbird Refuge at Homebush Bay. Approximately 4km to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) also provide potential foraging and roosting habitat for this species. The Caspian Tern would forage along the Parramatta River. The species does not breed in coastal NSW.

G-1-19 Common Greenshank (*Tringa nebularia*) – migratory species

Distribution

The Common Greenshank does not breed in Australia; however, the species occurs in all types of wetlands and has the widest distribution of any shorebird in Australia. In New South Wales, the species has been recorded in most coastal regions. It is widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions (DAWE 2021b).

Habitat requirements

The Common Greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and salt flats. It will also use artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. The edges of the wetlands used are generally of mud or clay, occasionally of sand, and may be bare or with emergent or fringing vegetation, including short sedges and saltmarsh, mangroves, thickets of rushes, and dead or live trees.

The species is known to forage at edges of wetlands, in soft mud on mudflats, in channels, or in shallows around the edges of water often among pneumatophores of mangroves or other sparse, emergent or fringing vegetation, such as sedges or saltmarsh (DAWE 2021b).

Habitat in the study area

The Common Greenshank has been known to occur within the Parramatta River estuary with records clustered around Haslams Flat, Newington Nature Reserve and Wentworth Bay (DPIE 2021a).

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

A small area of suitable foraging habitat for the Common Greenshank is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves. Approximately four kilometres to the east of the project, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) may also provide potential foraging and roosting habitat for this species.

G-1-20 Pacific Golden Plover (*Pluvialis fulva*) – migratory species

Distribution

Within Australia, the Pacific Golden Plover is widespread in coastal regions, though there are also a number of inland records (in all states), sometimes far inland and usually along major river systems, especially the Murray and Darling Rivers and their tributaries (DAWE 2021b).

Habitat requirements

This species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. Pacific Golden Plovers usually occur on beaches, mudflats and sandflats (sometimes in vegetation such as mangroves, low saltmarsh such as *Sarcocornia*, or beds of seagrass) in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in saltworks. They are less often recorded in terrestrial habitats, usually wetlands such as fresh, brackish or saline lakes, billabongs, pools, swamps and wet claypans, especially those with muddy margins and often with submerged vegetation or short emergent grass.

This species usually forages on sandy or muddy shores (including mudflats and sandflats) or margins of sheltered areas such as estuaries and lagoons, though it also feeds on rocky shores, islands or reefs. In addition, Pacific Golden Plovers occasionally forage among vegetation, such as saltmarsh, mangroves or in pasture or crops (DAWE 2021b).

Habitat in the study area

The Pacific Golden Plover has been known to occur throughout the Parramatta River estuary between Silverwater and Rozelle with 282 records in the locality in the last 20 years.

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

The tidal saltmarsh wetlands Waterbird Refuge in Wentworth Bay provide foraging habitat for this species. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) may also provide potential foraging and roosting habitat for this species. Newington Nature Reserve, Badu Mangroves also provide known foraging habitat for this species (DPIE 2021a).

A small area of suitable foraging habitat for the Pacific Golden Plover is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

G-1-21 Red-necked Stint (*Calidris ruficollis*) – migratory species

Distribution

The species is distributed along most of the Australian coastline with large densities on the Victorian and Tasmanian coasts. The Red-necked Stint has been recorded in all coastal regions and found inland in all states when conditions are suitable (DAWE 2021b).

Habitat requirements

The Red-necked Stint is mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. They also occur in saltworks and sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats. They sometimes use flooded paddocks or damp grasslands.

The Red-necked Stint mostly forages on bare wet mud on intertidal mudflats or sandflats, or in very shallow water, mostly in areas with a film of surface water and mostly close to edge of water. Red-necked Stints may also forage in samphire, generally avoid beds of seagrass, but may feed along edges (DAWE 2021b).

Habitat in the study area

The Red-necked Stint has been known to occur within the Parramatta River estuary with records clustered around Newington Nature Reserve and Wentworth Bay (DPIE 2021a).

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

A cluster of records is also present for this species at the Waterbird Refuge at Homebush Bay. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) is known to provide habitat for this species (DPIE 2021a).

A small area of suitable foraging habitat for the Red-necked Stint is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

G-1-22 Pectoral Sandpiper (*Calidris melanotos*) – migratory species

Distribution

In New South Wales, the Pectoral Sandpiper is widespread, but scattered. Records exist east of the Great Divide, from Casino and Ballina, south to Ulladulla. West of the Great Divide, the species is widespread in the Riverina and Lower Western regions (DAWE 2021b).

Habitat requirements

The Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands (DAWE 202b1).

Habitat in the study area

The Pectoral Sandpiper has been known to occur within the Parramatta River estuary with records clustered around Wentworth Bay (DPIE 2021a).

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

A cluster of records is also present for this species at the Waterbird Refuge at Homebush Bay. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) is known to provide habitat for this species (DPIE 2021a).

A small area of suitable foraging habitat for the Pectoral Sandpiper is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

G-1-23 Double-banded Plover (*Charadrius bicinctus*) – migratory species

Distribution

The Double-banded Plover can be found in both coastal and inland areas. During the non-breeding season, it is common in eastern and southern Australia, mainly between the Tropic of Capricorn and western Eyre Peninsula (DAWE 2021b).

Habitat requirements

The Double-banded Plover is found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers. The species is sometimes associated with coastal lagoons, inland saltlakes and saltworks. It is also found on seagrass beds, especially Zostera, which, when exposed at low tide, remain heavily saturated or have numerous water-filled depressions (DAWE 2021b).

Habitat in the study area

The Double-banded Plover has not been previously recorded in the study area (DPIE 2021a).

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

A small area of suitable foraging habitat for the Double-banded Plover is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

G-1-24 Marsh Sandpiper (*Tringa stagnatilis*) – migratory species

Distribution

The Marsh Sandpiper is found on coastal and inland wetlands throughout Australia. It is recorded in all regions of NSW but especially the central and south coasts and (inland) on the western slopes of Great Divide and western plains (DAWE 2021b).

Habitat requirements

The Marsh Sandpiper lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. In south-east Australia they prefer inland saline lakes and coastal saltworks. They are found infrequently around mangroves (DAWE 2021b).

Habitat in the study area

The Marsh Sandpiper is known to occur within the Parramatta River estuary with records clustered around Newington Nature Reserve and Wentworth Bay (DPIE 2021a).

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

A cluster of records is also present for this species at the Waterbird Refuge at Homebush Bay. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) is known to provide habitat for this species (DPIE 2021a).

A small area of suitable foraging habitat for the Marsh Sandpiper is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

G-1-25 Common Sandpiper (*Actitis hypoleucos*) – migratory species

Distribution

The Common Sandpiper is widespread in small numbers and is found along all coastlines of Australia and in many areas inland. The population is concentrated in northern and western Australia.

Habitat requirements

The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. The Common Sandpiper has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags. Generally the species forages in shallow water and on bare soft mud at the edges of wetlands; often where obstacles project from substrate, e.g. rocks or mangrove roots. Birds sometimes venture into grassy areas adjoining wetlands.

Habitat in the study area

The Common Sandpiper is known to occur within the Parramatta River estuary with records clustered around Newington Nature Reserve, Haslams Creeks and Wentworth Bay (DPIE 2021a).

Bicentennial Park and Newington Wetlands are listed as important wetlands within the Parramatta River shorebird area (Weller et al 2020). The nearest internationally important migratory shorebird habitat is located at Towra Point Nature Reserve, which is approximately 20 kilometres south-east of Wentworth Point.

A cluster of records is also present for this species at the Waterbird Refuge at Homebush Bay. Approximately four kilometres to the east, the intertidal flats, small beaches, rocky outcrops and jetties at Hen and Chicken Bay (Canada Bay) is known to provide habitat for this species (DPIE 2021a).

A small area of suitable foraging habitat for the Common Sandpiper is present on a seasonal basis to the east of the northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present within the project corridor. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for roosting given the presence of mangroves.

Table G.7 Assessment of significance for migratory waders

Criteria	Discussion
According to the DotE (2013) 'significant impact criteria', an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	An area of important habitat for a migratory species is defined as: – habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or – habitat that is of critical importance to the species at particular life stages, and/or – habitat utilised by a migratory species which is at the limit of the species' range, and/or – habitat within an area where the species is declining. An 'ecologically significant proportion' of the population of a migratory species varies, as listed migratory species cover a broad range of species with different lifecycles and population cycles. Factors to be considered include the species' population status, genetic distinctiveness and species-specific behavioural patterns (e.g. site fidelity and dispersal rates). A 'Population', in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of migratory animals.
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	All the migratory wader species listed above are known to occur or have previously been recorded within Sydney Olympic Park or Millennium Parklands, with the exception of the Double-banded Plover. These species have scattered records in Newington Nature Reserve, Wentworth Bay, Narawang Wetland, Haslams Creek, and along the Parramatta River in Melrose Park. The majority of the intertidal zone along Parramatta River would not provide suitable open habitats for foraging given the presence of dense mangroves. A small area of suitable foraging habitat is present to the east of the proposed northern landing site for the bridge between Melrose Park and Wentworth Point (i.e. Melrose Park) where an open intertidal area of sandy and muddy substrates is present. The project would result in the loss of a negligible area of foraging habitat on the Parramatta River. The inadvertent increase in the mud-flats around the bridge structures following construction may result in more mud-flat being exposed for a greater amount of time, and thus increased the foraging opportunities for shorebirds (Bonnington and Smith, 2017). Construction of the bridges across the Parramatta River would create gaps in riparian connectivity through the removal of mangroves along riverbanks. It is unlikely that this would impact the potential movement of any of the migratory waders listed above given the limited extent of potential habitat present in this area, preference for open mudflats, and the highly mobile nature of these species. The proposal would result in the erection of permanent structures, and the periodic movement of light rail vehicles however given the extent of existing infrastructure and traffic in the study area this would not tangibly increase the risk or energy cost of movement of these species. There would be no direct impact on high quality habitat for these species within Sydney Olympic Park including Newington Wetlands. There would be no removal of large mudflats. Construction of the project may result in indirect impacts on water quality within Parramatta River, Haslams Creek, Newington Wetland and Narawang Wetland. Erosion and sediment control would focus on areas of surface disturbance, particularly near waterways including Sydney Olympic Park precinct construction site and bridge and water crossing construction sites. These impacts would be adequately managed through the implementation of standard mitigation measures including progressive erosion and sediment controls, and on-site management protocols within the Transport for NSW Water Discharge and Reuse Guideline. These controls would be used to manage and minimise risks of impacts to water quality. Construction and operation of the project would increase the extent of flooding in the one per cent AEP flood event in a number of locations, including within Newington Nature Reserve Wetland and the Narawang Wetland. Entry of water into both wetlands are controlled by a variety of weirs, bunds and gates. The change in flooding regimes is unlikely to substantially affect foraging habitat for these species in these locations.

Criteria	Discussion
	Internationally important migratory shorebird habitat at Towra Point Nature Reserve would not be directly impacted. The project is highly unlikely to indirectly impact this Ramsar site through generation of sediment or pollutants given the design and mitigation measures proposed and the distance from the project site. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent too Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. Operation of the light rail would increase vehicle strike risk, particularly along Hill Road adjacent too Narawang Wetland, however the light rail is located within an area already subject to vehicle movements, and this would not be a novel impact. During long distance migration flights in familiar territory, most birds fly at altitudes well above the height of power lines. Collisions mostly occur when birds cross power lines in their local, daily movements. In contrast to flying in familiar territory, during long distance migration into unfamiliar terrain, birds tend to form large aggregations, fly at lower altitudes near stopover areas and therefore can increase their probability of collision with power lines (Bernadino et al 2018). Open areas like bogs or pastures allow birds to fly closer to the ground than forested habitats, and consequently can pose higher collision risk when crossed by power lines (Bernadino et al 2018). The use of overhead wiring near Narawang Wetland and Newington Nature Reserve Wetland would increase the risk of collision and mortality of migratory waders that utilise these areas. It is recommended that overhead wiring is minimised near wetland habitat and bridges across the Parramatta River. Given the above points, the project is unlikely to substantially modify, remove or isolate an area of important habitat for these migratory species.
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory specie	Invasive species relevant to migratory shorebirds include: – introduced plant species such as Water Hyacinth – introduced animals such as feral Pigs, Cane Toads, and Carp – new introductions of exotic species from aquaria and gardens – new introductions of exotic marine species from ballast water and hull transport (DotE 2015). No invasive species that are harmful to these migratory waders are likely to become established in the study area as a result of the project.
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	These migratory species have been recorded within or near the study area, with the exception of the Double-banded Plover. All these migratory bird species breed outside of Australia. The project is not likely to seriously disrupt the lifecycle of the populations of the migratory birds listed above, given that there would be limited clearing of saltmarsh habitat (0.03 hectares), and mitigation measures would be implemented to avoid indirect impacts such as sedimentation, erosion and contamination on water quality.
Conclusion	The project is unlikely to have a significant impact on these migratory waders as: – The project would remove a very small area of native vegetation that comprises potential habitat for these spaces (0.03 hectares of saltmarsh and 0.72 hectares of mangroves). – There would be no impact on high quality habitat for these species within the Sydney Olympic Park area (eg Homebush Bay, the Waterbird Refuge and Badu Mangroves). – There would be a negligible loss of foraging habitat along the Parramatta River. – Indirect impacts on aquatic habitat such as sedimentation, erosion and contamination would be minimised through the implementation of standard mitigation measures. – The change in flooding regimes is unlikely to substantially affect foraging habitat for these species in Newington Nature Reserve Wetland and the Narawang Wetland. – There would be no permanent fragmentation or isolation of habitat.

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