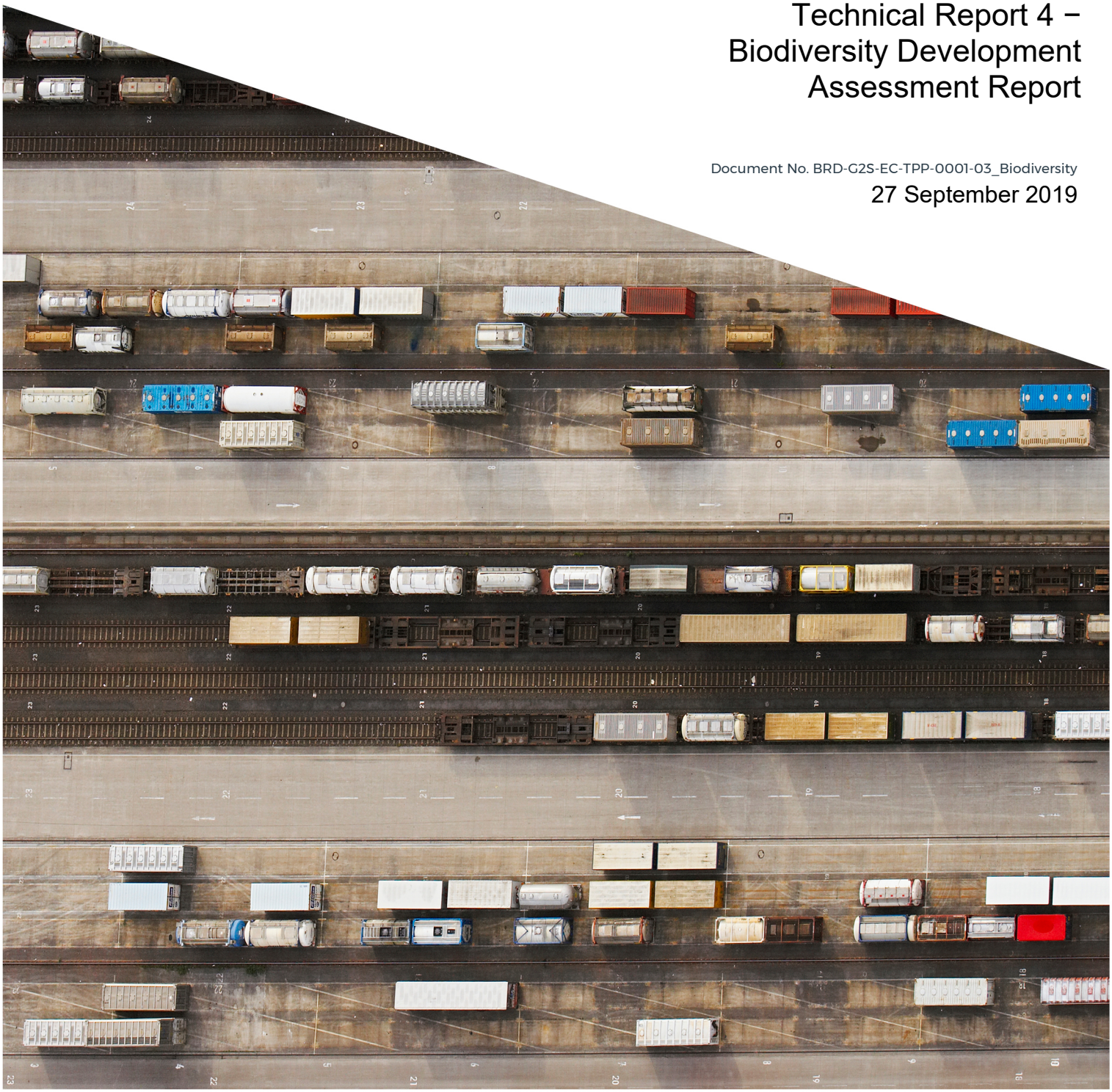
BOTANY RAIL DUPLICATION

TECHNICAL REPORT

Technical Report 4 –
Biodiversity
Development
Assessment Report

Botany Rail Duplication - Environmental Impact Statement



Technical Report 4 – Biodiversity Development Assessment Report

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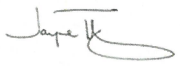
Technical Review by:	J Tipping	Date: 27/09/2019	Signature:	
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Glossary and abbreviations

ARTC	Australian Rail Track Corporation (the proponent)
Ballast	Material such as crushed rock or stone used to provide a foundation for a railway track. Ballast usually provides the bed on which railway sleepers are laid, transmits the load from train movements and restrains the track from movement.
BC Act	Biodiversity Conservation Act 2016
BCF	Biodiversity Conservation Fund
BDAR	Biodiversity Development Assessment Report
Biodiversity Assessment Method (BAM)	The rules for biodiversity assessment established under the BC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values.
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.
BOS	Biodiversity Offset Scheme
Botany Line	A dedicated freight rail line (operated by ARTC) that forms part of the Metropolitan Freight Network. The line extends from near Marrickville Station to Port Botany.
Candidate threatened species	A species credit entity that could potentially be present at a site, based on the PCTs and habitat resources present at that site, and that requires targeted survey in order to confirm or discount its presence at the site in accordance with the BAM.
CEEC	Critically endangered ecological community
CEMP	Construction Environmental Management Plan
construction ancillary facilities	Temporary facilities during construction that include, but are not limited to, construction work areas, sediment basins, temporary water treatment plants, pre-cast yards and material stockpiles, laydown areas, parking, maintenance workshops and offices, and construction compounds.
construction compound	An area used as the base for construction activities, usually for the storage of plant, equipment and materials, and/or construction site offices and worker facilities.

Council, the	Bayside Council
DEE	Department of the Environment and Energy
detailed design	The stage of design where project elements are design in detail, suitable for construction.
DPI	Department of Primary Industries
DPIE	Department of Planning, Industry and Environment
Ecosystem credit	A credit that relates to a vegetation type and the threatened species that are reliably predicted by that vegetation type (as a habitat surrogate).
EEC	Endangered ecological community
EES	Environment, Energy and Science
EIS, the	Botany Rail Duplication environmental impact statement
embankment	A raised area of earth or other materials used to carry a rail line in certain areas.
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
existing rail corridor	The corridor within which the existing rail infrastructure is located. In the study area, the existing rail corridor is the Botany Line.
Exotic species	A species of plant or animal that does not naturally occur in Australia.
FM Act	Fisheries Management Act 1994
High threat exotic species	A species of plant that does not naturally occur in Australia and that has been identified by DPIE as being a particular threat to biodiversity values (also known as high threat weeds).
IBRA	Interim Biogeographic Regionalisation for Australia
Indigenous native species	A species of plant or animal that naturally occurs in the study area (see also ‘native species’).
impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
LEP	Local Environment Plan
LGA	local government area
Locality	The area within a 10 km radius of the project site.
Migratory species	Species listed under international agreements (i.e. Ramsar, JAMBA and CAMBA conventions) to which Australia is a party.
MNES	Matters of National Environmental Significance
Native species	A species of plant or animal that naturally occurs in Australia (see also ‘indigenous native species’).

OEH	Office of Environment and Heritage, now the Environment, Energy and Science (EES) Group in the Department of Planning, Industry and Environment (DPIE)
PCT	Plant community type
PMST	'Protected Matters Search Tool', an online tool used to identity matters protected under the EPBC Act that are known or predicted to occur in a given search area.
possession	A period of time during which a rail line is closed to train operations to permit work to be carried out on or near the line.
Predicted threatened species	A threatened species that is associated with the ecosystem credits at a site, based on the PCTs and habitat resources present at that site.
Prescribed impacts	Impacts on biodiversity values that are not directly related to the removal of native vegetation but which require consideration in accordance with section 9.2 of the BAM. Examples include 'Impacts on habitat of threatened species or ecological communities associated with human made structures' and 'Impacts on habitat associated with areas of non-native vegetation'.
Priority weed	Weeds with a legal obligation to control under the *Biosecurity Act 2015.*
project site, the	The area that would be directly affected by construction. It includes the location of operational project infrastructure, the area that would be directly disturbed by the movement of construction plant and machinery, and the location of the storage areas/compounds etc., that would be used to construct that infrastructure.
project, the	The construction and operation of the Botany Rail Duplication.
SAII	Serious and irreversible impacts
SAII entity	Species and ecological communities that are likely to be the subject of serious and irreversible impacts (SAIIs).
Secretary's environmental assessment requirements (SEARs)	Requirements and specifications for an environmental assessment prepared by the Secretary of the Department of Planning and Environment under section 115Y of the *Environmental Planning and Assessment Act 1979* (NSW).
SEPP	State Environment Planning Policy
Species credit	A credit that relates to an individual threatened species that cannot be reliably predicted based on habitat surrogates. Threatened species that require species credits are identified in the Threatened Biodiversity Data Collection.
Species credit entity	A threatened species or component of threatened species habitat that is identified in the Threatened Biodiversity Data Collection as requiring calculation of species credits.
State significant infrastructure	Major transport and services infrastructure considered to have State significance as a result of size, economic value or potential impacts.

study area, the	The study area is defined as the wider area including and surrounding the project site, with the potential to be directly or indirectly affected by the project (e.g. by noise and vibration, visual or traffic impacts). The actual size and extent of the study area varies according to the nature and requirements of each assessment and the relative potential for impacts but which is sufficient to allow for a complete assessment of the proposed project impacts to be undertaken.
Project site	The area that would be directly impacted by construction and operation of the project.
TEC	Threatened ecological community
Threatened biota	Threatened species, populations or ecological communities listed under the BC Act, FM Act and/or the EPBC Act.
Weed of National Significance (WoNS)	Weeds regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts.

Executive summary

Australian Rail Track Corporation (ARTC) proposes to construct and operate a new second track within the existing Botany Line rail corridor between Mascot and Botany, in the Bayside local government area (LGA). The Botany Rail Duplication ('the project') would increase freight rail capacity to and from Port Botany. The project is State significant infrastructure in accordance with Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This Biodiversity Development Assessment Report (BDAR) has been prepared to assess the impacts of the construction and operation of the project on threatened biota and their habitats in accordance with the biodiversity assessment method (BAM).

Terrestrial flora surveys were conducted and included vegetation mapping, identification of plant community types and vegetation zones in accordance with the BAM and targeted threatened flora surveys. Terrestrial fauna surveys compromise habitat assessments and targeted threatened fauna surveys. Rapid aquatic habitat surveys were also undertaken. A likelihood of occurrence assessment was utilised to produce a candidate species list to inform appropriate targeted surveys for threatened and migratory species. Targeted surveys were conducted for 'species credit' species identified by the BAM calculator. These included the Green and Golden Bell Frog (*Litoria aurea*) and the Southern Myotis (*Myotis macropus*).

Much of the land within the study area has been previously cleared of native vegetation for the railway, roads, residential and industrial areas, and for areas of recreation. The majority of the rail corridor is cleared and vegetated with introduced grasses and herbs interspersed with bare ground, ballast and other artificial substrates. Planted trees also occur in some areas, as do thickets of weeds such as Lantana. The rail line crosses the Botany Wetlands at Mill Stream, and most native vegetation and habitat values present in the project site (the area that would be directly affected by construction) is associated with this area. Native vegetation and habitat within the project site is in medium to poor condition and features impacts from existing rail corridor maintenance, edge effects, weed infestation, and exotic fauna species (i.e. foxes and cats).

Two native vegetation plant community types (PCTs) were recorded in the project site. These are:

- PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion. This PCT is commensurate with Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community listed under the BC Act.
- PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion. This PCT is commensurate with Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions listed as an endangered ecological community (EEC) under the *Biodiversity Conservation Act 2016* (BC Act). No patches in the project site meet the condition criteria for the threatened Swamp Oak ecological community listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In addition, three non-native vegetation types were assigned to a predetermined miscellaneous ecosystem class, being:

- Miscellaneous ecosystem – highly disturbed areas with no or limited native vegetation.
- Miscellaneous ecosystem – urban exotic/native landscape plantings.
- Miscellaneous ecosystem – water bodies.

During field surveys, 178 species of plant were recorded. Of these 41 were native and 137 were introduced species, including 13 priority weed species listed under the *Biosecurity Act 2015.* No threatened flora species listed under the BC Act or EPBC Act occur in the project site or would be impacted by the project.

Fauna habitats are limited along much of the rail corridor given the predominantly cleared and disturbed nature of the site. Planted fig trees and eucalypts and exotic species provide foraging and nesting habitat for a range of common fauna, including more mobile species typical of urban parks and gardens. Botany Wetland contains dense areas of emergent aquatic vegetation, particularly to the north of the project site, and contains habitat for common frog species and waterbirds.

A moderate diversity of fauna species was recorded during field surveys, with better quality habitats at Botany Wetland contributing to the range of species present. A total of 67 species was recorded. Two threatened fauna species were recorded, the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Grey-headed Flying-fox (*Pteropus oliocephalus*). Both species are ecosystem credit species for this project as no breeding habitat is present. No candidate species credit fauna species were recorded during surveys, and none are considered likely to be affected by the project. The Green and Golden Bell Frog is considered to no longer be present at the Botany Wetlands. No evidence of the Southern Myotis was recorded during surveys. There are no recent records of this species along Mill Stream or the Cooks River.

Migratory waders would likely occur at the Botany Wetlands on occasion, however this habitat within the project area is a negligible proportion of the available foraging habitat in this wetland. Given their relatively small size compared to Towra Point Nature Reserve Ramsar site located on the southern side of Botany Bay, and lack of suitable mudflat habitat, the Botany Wetlands would not comprise important habitat for any migratory species.

Mill Stream is mapped as key fish habitat and considered moderate key fish habitat given the presence of clearly defined bed and banks with permanent waters in pools or in connected wetland areas, the presence of freshwater aquatic vegetation, and presence of native fish. No threatened fish listed under the *Fisheries Management Act 1994* (FM Act) or EPBC Act would occur at Botany Wetlands. A small wetland located north of Mill Pond Drive and west of Botany Road is mapped as a Coastal Wetland according to the *Coastal Management State Environmental Planning Policy* (SEPP) 2018. This wetland is located immediately adjacent to the project boundary and the project crosses its proximity area north-west of Southern Cross Drive.

The project would remove about 0.72 hectares of native vegetation from a total impact area of 8.12 hectares. Impacts on native vegetation would be restricted to the removal of 0.62 hectares of Swamp Oak Forest and 0.1 ha of Freshwater Wetlands on Coastal Floodplains from immediately adjacent to the rail bridge at Mill Stream. Some minor material within Mill Stream would be excavated and scour protection would also be constructed along the eastern and western banks of Mill Stream, where required. Impacts on the water body would be minor. Impacts on Commonwealth land comprise the removal of 0.1 hectare of urban exotic/native landscape plantings.

The project has been purposefully designed to avoid or minimise effects on biodiversity values as far as is practicable, including through the location of compound sites in already disturbed areas where possible. Mitigation measures will be implemented to further minimise effects on biodiversity values of the project site.

Biodiversity offset obligations have been determined using the BAM calculator for residual impacts as follows:

- Three ecosystem credits are required for PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands.
- Eight ecosystem credits are required for PCT 1232 Swamp Oak floodplain swamp forest.
- No species credits are required.

Assessments of significance of effects on the Green and Golden Bell Frog and Grey-headed Flying-fox have been prepared based on the consideration of the criteria contained in the EPBC Act assessment of significance guidelines 1.1 (DoE, 2013). An assessment of the likely significance of effects on plants and animals (as a component of the environment of Commonwealth land) pursuant to the Significant impact guidelines 1.2 for actions on Commonwealth land (DSEWPC 2013). The outcome of these assessments is that the project is unlikely to have a significant impact on MNES. Given the minor magnitude of impacts, further assessment or approval under the EPBC Act is highly unlikely to be required. The project would not result in any significant effects on any threatened biota listed under the EPBC Act and so there is no requirement for biodiversity offsets under the EPBC Act and associated policy (DSEWPaC, 2012).

1. Introduction

1.1 Overview

1.1.1 Background

Australian Rail Track Corporation (ARTC) proposes to construct and operate a new second track within the existing Botany Line rail corridor between Mascot and Botany, in the Bayside local government area (LGA). The Botany Rail Duplication ('the project') would increase freight rail capacity to and from Port Botany. The location of the project is shown in Figure 1.1.

The project is State Significant Infrastructure in accordance with Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). As State Significant Infrastructure, the project needs approval from the NSW Minister for Planning and Public Spaces.

This report has been prepared to accompany the environmental impact statement (EIS) to support the application for approval of the project, and address the Secretary of the Department of Planning and Environment's environmental assessment requirements (the SEARs), issued on 21 December 2018.

1.1.2 Overview of the project

The project would involve:

- Track duplication – constructing a new track predominantly within the rail corridor for a distance of about three kilometres.
- Track realignment (slewing) and upgrading – moving some sections of track sideways (slewing) and upgrading some sections of track to improve the alignment of both tracks and minimise impacts to adjoining land uses.
- New crossovers – constructing new rail crossovers to maintain and improve access at two locations (totalling four new crossovers).
- Bridge works – constructing new bridge structures at Mill Stream, Southern Cross Drive, O'Riordan Street and Robey Street (adjacent to the existing bridges), and re-constructing the existing bridge structures at Robey Street and O'Riordan Street.
- Embankment/retaining structures – construction of a new embankment and retaining structures adjacent to Qantas Drive between Robey and O'Riordan streets and a new embankment between the Mill Stream and Botany Road bridges.

Further information on the key elements of the project is provided in the EIS.

Ancillary work would include bi-directional signalling upgrades, drainage work and protecting/relocating utilities.

Subject to approval of the project, construction is planned to start at the end of 2020, and is expected to take about three years for the main construction works to be undertaken. Construction is expected to be completed in late 2023 with commissioning activities undertaken in early 2024.

It is anticipated that some features of the project would be constructed while the existing rail line continues to operate. Other features of the project would need to be constructed during programmed weekend rail possession periods when rail services along the line cease to operate.

The project would operate as part of the existing Botany Line and would continue to be managed by ARTC. ARTC is not responsible for the operation of rolling stock. Train services are currently, and would continue to be, provided by a variety of operators. Following the completion of works, the existing functionality of surrounding infrastructure would be restored.

Key features of the project are shown on Figure 1.2.

Figure 1.1 Botany Rail Duplication location

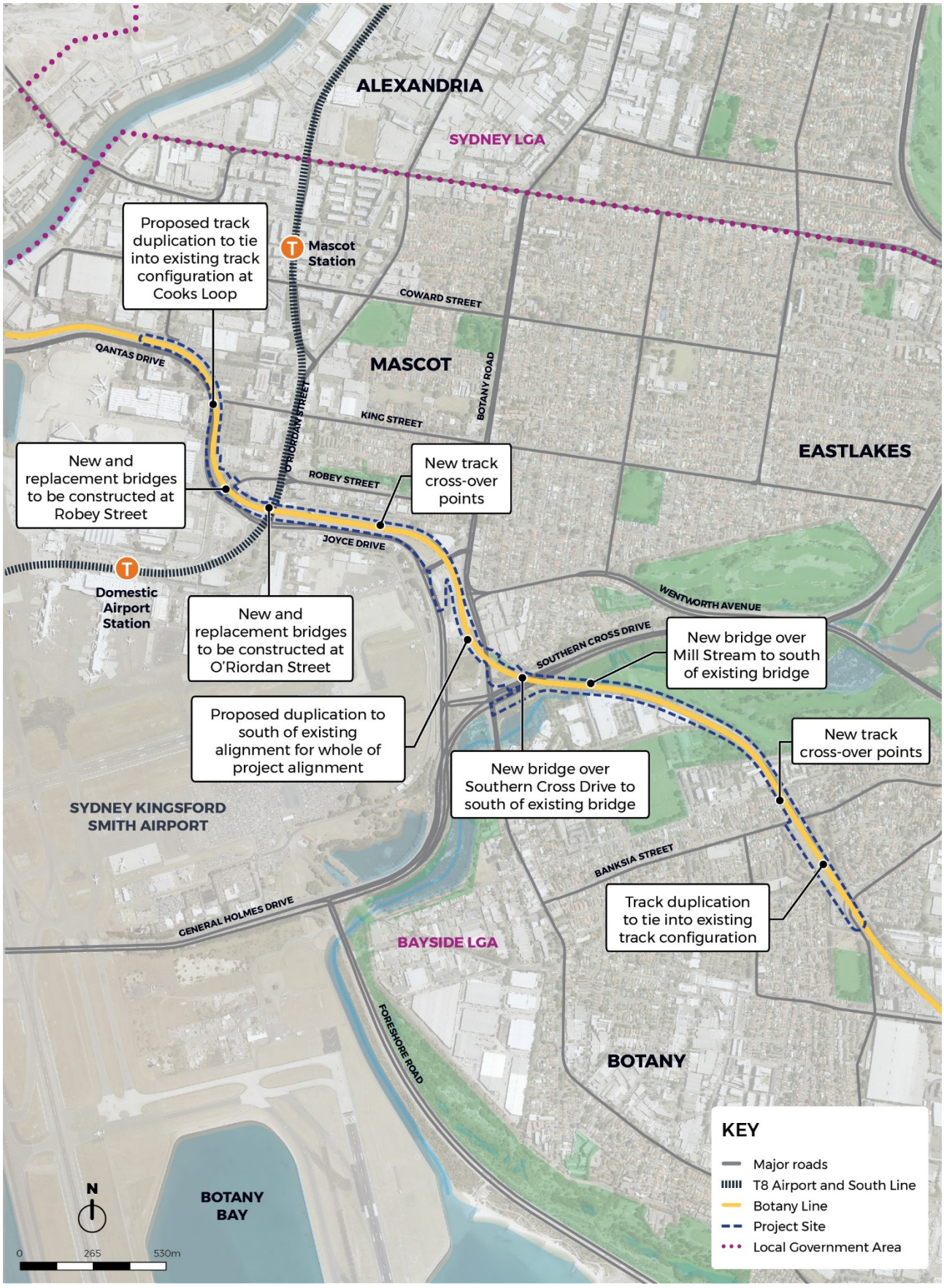


Figure 1.2 Botany Rail Duplication project overview

1.2 Purpose and scope of this report

This Biodiversity Development Assessment Report (BDAR) has been prepared to assess the impacts of the construction and operation of the project on threatened biota and their habitats in accordance with the biodiversity assessment method (BAM) and the requirements of the *Biodiversity Conservation Act 2016* (BC Act) and the *Biodiversity Conservation Regulation 2017*. This report also incorporates an assessment of impacts on biodiversity values covered by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Fisheries Management Act 1994* (FM Act).

The objectives of this BDAR are to:

- outline the methods used in the biodiversity assessment
- describe the landscape features that relate to the assessment, including the physical environment and regional context of the project site
- describe the biophysical environment of the project site, including extent of native vegetation, type and condition of Plant Community Types (PCTs), flora and fauna species and terrestrial and aquatic habitats
- describe the conservation significance of the project site in terms of threatened biota and their habitats that are known or predicted to occur
- provide a description of the project, including potential effects on biodiversity values, including threatened biota listed under the BC Act and FM Act, matters of national environmental significance (MNES) and the environment of Commonwealth land
- identify measures undertaken to avoid and minimise effects on biodiversity values
- present the data used to perform the BAM assessment and credit calculations for the project
- identify the need or otherwise to provide biodiversity offsets for residual impacts of the project under the BC Act and FM Act
- determine if the project is likely to have a significant impact on MNES (including Commonwealth land) and the need or otherwise to provide biodiversity offsets under the EPBC Act
- briefly discuss options to deliver the required quantum of biodiversity offset for the project.

The main components of the methodology for this BDAR include:

- desktop assessment to describe the existing environment and landscape features of the project site and to identify the suite of threatened and migratory biota potentially affected by the project
- field survey in accordance with the BAM to describe the biodiversity values of the project site and surrounding study area and determine the likelihood of threatened biota and their habitats occurring in the study area or being affected by the project
- determination of reasonable actions to avoid and minimise impacts to biodiversity values and assessment of residual biodiversity impacts of the project
- completion of offset calculations using the BAM credit calculator, to determine the ecosystem and species credits that would be required to offset impacts under the BC Act
- assessment of the likely significance of impacts on MNES (including Commonwealth land) and identification of the requirement for offset under the EPBC Act
- assessment of aquatic impacts and the requirement for offset under the FM Act.

The report addresses the relevant SEARs for the EIS, as outlined in Section 2.2.

1.3 Structure of this report

The structure of the report is outlined below.

- Section 1 Introduction – provides an introduction to the report
- Section 2 Legislative and policy context – describes the legislative and policy context for the assessment, and relevant guidelines
- Section 3 Methodology – describes the methodology for the assessment
- Section 4 Existing environment – General – describes the existing environment as relevant to the assessment
- Section 5 Existing environment – Native vegetation – describes vegetation as relevant to the assessment
- Section 6 Existing environment – Threatened species and aquatic habitats – describes threatened biota subject to this assessment
- Section 7 Existing environment – Matters of National Environmental Significance – describes Matters of National Environmental Significance
- Section 8 Impact assessment – describes impacts relevant to the assessment
- Section 9 Management of impacts – lists mitigation measures to minimise impacts
- Section 10 Offset requirements – outlines the offsets requirements and outlines offset strategies for this project
- Section 11 Conclusion – provides a conclusion to the report
- Section 12 References – lists references used in the report.

2. Legislative and policy context

This section summarises the legislation, guidelines and/or policies driving the approach to the assessment.

2.1 Relevant legislation, policies and guidelines

2.1.1 *Environmental Planning and Assessment Act 1979*

State significant infrastructure is regulated under the EPA Act, which requires proponents to apply to the NSW Minister for Planning and Public Spaces for infrastructure approval, supported by an EIS.

The SEARs for the project define the matters to be addressed in the EIS, including biodiversity assessment requirements under the BC Act, FM Act and the EPBC Act.

2.1.2 *Biodiversity Conservation Act 2016* and *Biodiversity Conservation Regulation 2017*

The *Biodiversity Conservation Act 2016* (BC Act), together with the *Biodiversity Conservation Regulations 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 Office of Environment and Heritage (OEH, now the Environment, Energy and Science (EES) Group of the Department of Planning, Industry and Environment (DPIE)) 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 credit calculator) which processes site survey and assessment data. The credit 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 Biodiversity Conservation Fund (BCF) ensures that landowners have the funds needed to carry out the management actions required each year and provides a financial incentive to landowners to carry out those actions. The scheme is administered by the EES Group of the DPIE and ensures accountability and compliance through legislation, regular reporting requirements and financial measures. Under certain circumstances a developer may make a payment directly into the BCF to offset the impacts of a proposed development in lieu of purchasing and retiring biodiversity credits. The Biodiversity Conservation Trust 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.

2.1.3 *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', 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. The NSW DPI (DPI, now part of the Department of Planning and Industry) has a 'no net loss' habitat policy which may require proponents to conduct habitat rehabilitation and/or provide environmental compensation. To assist in the protection of key fish habitats, the *Policy and guidelines for fish habitat conservation and management* (DPI 2013) was produced. 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 (which includes mangroves and seagrass)
- de-snagging.

This report assessed the potential effects on key fish habitat associated with Mill Stream, Alexandra Canal and potential effects on threatened species (Section 8.2.4).

2.1.4 *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 recorded in the study area and their control measures are detailed in Section 5.4.

2.1.5 *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Australian DEE (DEE) and provides a legal framework to protect and manage nationally important flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance' (MNES).

Under the EPBC Act, proposed actions (i.e. activities or projects) with the potential to significantly impact matters protected by the EPBC Act must be referred to the Australian Minister for the Environment to determine whether they are controlled actions, requiring approval from the Minister. The following matters are defined as protected matters by Part 3 of the EPBC Act:

- matters of national environmental significance
- the environment of Commonwealth land
- the environment in general if they are being carried out by an Australian Government agency.

The following MNES are of relevance to this BDAR:

- threatened species and ecological communities
- migratory species
- Ramsar wetlands
- the environment of Commonwealth land.

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 effects on MNES and plants and animals, as a component of the environment of Commonwealth land, including assessments of significance in accordance with the EPBC Act significant impact guidelines (Department of the Environment 2013) where relevant
- identification of suitable impact mitigation and environmental management measures for threatened and migratory biota, where relevant
- identification of the need or otherwise for biodiversity offsets for effects on listed biodiversity matters.

2.1.6 NSW Sustainable design guidelines

NSW Sustainable design guidelines v3.0 (TfNSW 2013) is a TfNSW process. These guidelines identify initiatives and how they can be implemented through monitoring changes in technology and innovation. The initiatives in this guideline have not been included as the project specific mitigation measures provide more tailored measures specific to the site and project to achieve a better ecological outcome.

2.1.7 Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources

Water sharing plans are being progressively developed for rivers and groundwater systems across NSW following the introduction of the *Water Management Act 2000* (WMA 2000). These plans protect the health of our rivers and groundwater. The relevant plan for the study area is for the greater metropolitan region. Communities of potential groundwater dependent ecosystems (GDEs) relating to the study area were identified from the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (NSW Government 2011).

2.2 Secretary's environmental assessment requirements

The SEARs relevant to biodiversity are outlined in Table 2.1, together with a reference to where they are addressed in this report.

Table 2.1 SEARs relevant to this assessment

Requirements	Where addressed in this report
3. Assessment of Key Issues* (2) For each key issue the Proponent must:	
a) describe the biophysical and socio-economic environment, as far as it is relevant to that issue	Section 4 Section 5 Section 6 Section 7
b) describe the legislative and policy context, as far as it is relevant to the issue	Section 2
c) identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts	Section 8
d) demonstrate how options within the project potentially affect the impacts relevant to the issue	n/a
e) demonstrate how potential impacts have been avoided (through design, or construction or operation methodologies)	Section 8.1
f) detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant); and	Section 9
g) detail how any residual impacts will be managed or offset, and the approach and effectiveness of these measures.	Section 10
5. Biodiversity	
1 The Proponent must assess biodiversity impacts in accordance with Section 7.9 of the biodiversity Conservation Act 2016 (BC Act), the Biodiversity Assessment Method (BAM), and documented in a Biodiversity Development Assessment Report (BDAR) or a BDAR waiver sought where applicable.	This report
2 The BDAR must include information in the form detailed in section 6.12 of the BC Act, clause 6.8 of the Biodiversity Conservation Regulation 2017, and the BAM.	Throughout
3 The BDAR must be submitted with all digital spatial data associated with the survey and assessment as per Appendix 10 of the BAM.	Data will be provided to the EES Group of the DPIE (formally OEH) as required on submission of the EIS
4 The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under section 6.10 of the BC Act.	Section 3.8
5 The BDAR must include details of the measures proposed to address offset obligations.	Section 10

Requirements	Where addressed in this report
6 The Proponent must assess any impacts on biodiversity values not covered by the BAM. This includes a threatened aquatic species assessment (Part 7A Fisheries Management Act 1994 – FM Act) to address whether there are likely to be any significant impacts on listed threatened species, populations or ecological communities listed under the FM Act.	Section 6.3 Section 8.2.4
7 The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the BC Act, FM Act and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).	Section 8.5
7. Water – Hydrology	
2 The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	
a) natural processes within rivers, wetlands, estuaries, marine waters, and floodplains, that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge	Section 8.2.4 Section 8.7.4
b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement.	Section 8.7.5

3. Methodology

3.1 Study area

The project is generally located within the rail corridor of the Botany Line, about eight kilometres south of the Sydney central business district, in the suburbs of Mascot, Botany and Pagewood. The north-western extent of the project site is located in the vicinity of Qantas Drive, south of Coward Street in Mascot. The south-eastern extent of the project is located just to the north of the Stephen Road bridge in Botany. The rail corridor is owned by the NSW Government (RailCorp) and leased to ARTC. Some additional areas outside of the rail corridor that would be used as compound sites are also included in the study area.

3.2 Key tasks

Key tasks undertaken for this BDAR have included:

- background research
- terrestrial flora surveys including vegetation mapping, identification of plant community types and vegetation zones in accordance with the BAM and targeted threatened flora surveys
- terrestrial fauna surveys including habitat assessments and targeted threatened fauna surveys
- aquatic habitat surveys
- assessment of potential impacts of the project, including identification of measures to avoid and minimise impacts on biodiversity
- identification of offset requirements, including calculation of credit requirements in accordance with the BAM and discussion of offset requirements under the EPBC Act and FM Act.

3.3 Desktop assessment

A desktop assessment was conducted to identify:

- landscape-scale features of the study area in accordance with Section 4.2 of the BAM (OEH 2017a)
- site context of the study area that includes assessing vegetation cover and patch size as required under Subsections 4.3.2 and 5.3.2 of the BAM (OEH 2017a)
- 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 5 of the BAM (OEH 2017a)
- 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 6 of the BAM (OEH 2017a)
- and evaluate existing environment information to determine whether additional surveys, mapping and reporting is required to support project approval.

The desktop assessment included analysis of the following information sources:

- Aerial photographic imagery (Land and Property Information, 2018a).
- NSW Mitchell Landscapes (Land and Property Information, 2018b).
- Interim Biogeographic Regionalisation of Australia (IBRA version 7.0) (DOEE 2016).
- Atlas of Groundwater Dependent Ecosystems (GDE) (Australian Bureau of Meteorology 2018).
- Directory of Important Wetlands of Australia (DIWA – DOEE 2018a).
- State Environmental Planning Policy (Coastal Management) 2018 – Coastal Wetlands (DPE, 2018).
- Priority weed listings for the Greater Sydney region (DPI 2018).
- The Native Vegetation of the Sydney Metropolitan Area (OEH 2016a).

- *Native vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands* (Tozer *et al*. 2010).
- *Sydney Gateway Green and Golden Bell Frog Surveys 2017/2018.* Report prepared for Roads and Maritime Services (SMEC 2018).
- *Sydney Gateway Program – Preliminary environmental investigation. December 2017*, Report prepared for Roads and Maritime Services (SMEC 2017).
- *WestConnex Enabling Works Airport East Precinct: Biodiversity Assessment.* Report prepared for Roads and Maritime Services (SMEC 2014).

Threatened species database searches outlined in Table 3.1.

Table 3.1 Threatened species database searches

Database	Search date	Area searches	Reference
PlantNET spatial search	June and September 2018	5 km radius centred on the suburb of Mascot	Royal Botanic Gardens and Domain Trust (2018)
BioNet Atlas species sighting search	June and September 2018	10 km x 10 km centred on the study area	OEH (2018b)
EPBC Protected Matters Search Tool	June & September 2018	10 km x 10 km centred on the study area	DOEE (2018d)
Biodiversity Assessment Method (BAM) Calculator (Credit Calculator)	August	BAM calculations based on study area inputs	NA
NSW DPI (Fishing and Aquaculture) spatial data	June 2018	Local waterways	DPI (2018a)

3.4 Terrestrial flora surveys

Threatened flora surveys were undertaken over a three-day period on the 26 June, 19 & 26 September 2018. Surveys focused on the mapping of native and non-native vegetation types and targeting the possible presence of threatened flora species using a combination of vegetation integrity plots, random meanders and parallel field traverses generally in accordance with the NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft) (DEC 2004), NSW Guide to Surveying Threatened Plants (OEH 2016) and the BAM (OEH 2017). A detailed overview of terrestrial flora survey methods is presented below.

3.4.1 Nomenclature

Names of vegetation communities used in this report are based on the Plant Community Type (PCT) used in the NSW BioNet Vegetation Classification Database (OEH 2018a).

PCTs are cross-referenced with those used for threatened ecological communities listed under the BC Act and/or the EPBC Act.

Names of plants used in this document follow PlantNET (RGBT 2018). Scientific names are used in this report for species of plant. Scientific and common names (where available) are provided in the species results provided in Appendix B. The names of introduced species are denoted with an asterisk (*).

For threatened species of plants, the names used in the DPIE (formally OEH) Threatened Species Profile Database (OEH 2018e) are also provided in Appendix A where these differ from the names used in the PlantNET database.

3.4.2 Stratification and verification of existing vegetation mapping

Preliminary mapping of vegetation community boundaries was undertaken through analysis of existing vegetation mapping and aerial photograph interpretation.

Vegetation within the study area and locality has been mapped at the regional scale in:

- Native vegetation of the Southeast NSW: Revised Classification and Map for the Coast and Eastern Tablelands (Tozer *et al*. 2010).
- The Native Vegetation of the Sydney Metropolitan Area (OEH 2016).

Refined vegetation mapping within the study area was also undertaken as part of the *Preliminary Environmental Investigation* (SMEC 2017) for the Sydney Gateway road project.

Analysis of the aerial photographs was used to identify areas of disturbance (e.g. buildings, vehicle tracks, dams and power lines), vegetation structure and likely native versus exotic species composition throughout the site. This provided an initial definition of vegetation communities into simple structural and disturbance classifications for verification during field surveys.

Data on geology, dominant canopy species, native species richness, vegetation structure and condition was collected across the study area during field surveys to validate and refine this existing vegetation classification to determine their associated PCT in accordance with the BioNet Vegetation Classification System (OEH, 2018a).

3.4.3 Mapping of vegetation zones

The vegetation within the study area was firstly assessed to a PCT level and then aligned to a vegetation zone which is defined in the BAM as ‘an area of native vegetation on the subject land that is the same PCT and has a similar broad condition state’ (OEH, 2017a). A broad condition state infers that the vegetation has a similar tree cover, shrub cover, ground cover, weediness or combinations of these attributes which determine vegetation condition.

The vegetation broad condition states which were applied to determine vegetation zones within the study area are summarised in Table 3.2. These factors were defined by using features such as levels of disturbance, weed invasion and resilience.

Table 3.2 Vegetation broad condition states

Condition category	Description
Good	Vegetation still retains the species complement and structural characteristics. The vegetation displays resilience to weed invasion due to intact groundcover, shrub and canopy layers. Native species diversity is relatively high. Weeds may exist in this vegetation type but exhibit <10% foliage cover.
Moderate	Vegetation has retained a native canopy but the understorey and groundcover layers are generally co-dominated by exotic species that exhibit between 10–<40% foliage cover. The mid and low stratums may have been structurally modified because of previous clearing.
Poor	Vegetation has retained a native canopy or the canopy cover is showing signs of regeneration. The understorey and groundcover layers are generally dominated or co-dominated by exotic species that exhibit between >40% foliage cover or exhibit low native species richness (<25% PCT benchmark). Native species diversity is generally relatively low and the mid and low stratums have been structurally modified due to weed incursions or clearing.
Low	Native vegetation generally lacking a native over-storey and where either less than 50% of ground cover vegetation is indigenous species, or greater than 90% of ground cover vegetation is cleared. For native grassland, wetland or herbfield where either less than 50% of ground cover vegetation is indigenous species, or more than 90% of ground cover vegetation is cleared.

3.4.4 Vegetation integrity plots

A total of five vegetation integrity plots were completed as outlined in the BAM and as described below. A schematic diagram illustrating the layout of each vegetation integrity plot is provided in Figure 3.1.

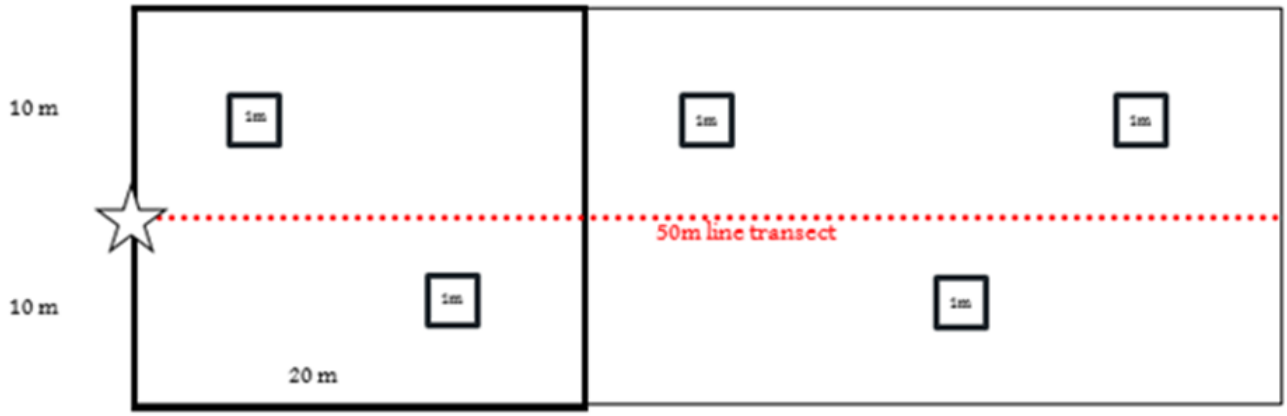


Figure 3.1 Schematic diagram illustrating the layout of the nested 20 m x 20 m and 20 m x 50 m plot used for the assessment of vegetation integrity at each plot location

The following site attributes were recorded at each vegetation integrity plot location:

- Location (easting – northing grid type MGA 94, Zone 56).
- Vegetation structure and dominant species and vegetation condition. Vegetation structure was recorded through estimates of percentage foliage cover, average height and height range for each vegetation layer.
- Native and exotic species richness (within a 400 m^2 quadrat): This consisted of recording all species by systematically walking through each 20 metre x 20 metre quadrat. The cover and abundance (percentage of area of quadrat covered) of each species was estimated. The growth form, stratum/layer and whether each species was native/exotic/high threat weed was also recorded.
- Number of trees with hollows (1,000 m^2 quadrat): This was the frequency of hollows within living and dead trees within each 50 metre x 20 metre quadrat. A hollow was only recorded if (a) the entrance could be seen: (b) the estimated entrance width was at least 5 centimetres across: (c) the hollow appeared to have depth: (d) the hollow was at least 1 metre above the ground and the (e) the centre of the tree was located within the sampled quadrat.
- Number of large trees and stem size diversity (1,000 m^2 quadrat): tree stem size diversity was calculated by measuring the diameter at breast height (DBH) (i.e. 1.3 metres from the ground) of all living trees (greater than 5 centimetre DBH) within each 50 metre x 20 metre quadrat. For multi-stemmed living trees, only the largest stem was included in the count. Number of large trees was determined by comparing living tree stem DBH against the PCTs benchmarks.
- Total length of fallen logs (1,000 m^2 quadrat): This was the cumulative total of logs within each 50 metre x 20 metre quadrat with a diameter of at least 10 centimetre and a length of at least 0.5 metres.
- Litter cover: This comprised estimating the average percentage groundcover of litter (i.e. leaves, seeds, twigs, branchlets and branches with a diameter less than 10 centimetres which is detached from a living plant) from within five 1 metre x 1 metre sub-plots spaced evenly either side of the 50 metre central transect.
- Evaluation of regeneration: This was estimated as the presence/absence of overstorey species present at the site that was regenerating (i.e. saplings with a diameter at breast height less than or equal to 5 centimetres).

Prior to establishing plot survey locations, vegetation stratification was undertaken to provide a representative vegetation zone for sampling. Stratification involved marking waypoints and bearings randomly to provide a representative assessment of the vegetation integrity of the vegetation zone in the study area and establishing the required number of plots at some of these waypoints.

A comparison of the number of BAM survey plots that were completed and the required BAM plots per vegetation zones is provided in Table 3.3.

Vegetation integrity plot locations and orientations are provided in Table 3.4 and illustrated in Figure 5.1.

Table 3.3 Comparison of number of plots required under the BAM and completed per vegetation zone

Vegetation type and zone	Vegetation zone area (ha)	BAM plot required	Number of plots completed
VZ1 – PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion – Moderate condition	0.1	1	2 (Q3, Q4)
VZ2 – PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion – Poor condition	0.46	1	2 (Q2, Q5)
VZ3 – PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion – Low condition	0.16	1	1 (Q1)

Table 3.4 Location and orientation of vegetation integrity plots completed within the study area

Plot ID	Vegetation type and zone	Easting	Northing	Orientation (°)
Q1	VZ3 – PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion – Low condition	333340	6243282	263
Q2	VZ2 – PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion – Poor condition	333311	6243280	250
Q3	VZ1 – PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion – Moderate condition	333516	6243313	295
Q4	VZ1 – PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion – Moderate condition	333487	6243325	10
Q5	VZ2 – PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion – Poor condition	333452	6243356	230

At each vegetation integrity plot a 30-minute targeted threatened flora search was also conducted for each candidate species (refer Section 3.4.8) that were considered to have potential habitat in the sampled vegetation type.

3.4.5 Random meander survey

Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random meander throughout the study area recording dominant and key plant species (e.g. threatened species, priority weeds), boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

Random meander surveys were conducted to locate candidate threatened species and populations within area of suitable habitat.

3.4.6 Parallel field traverses

Parallel field traverses followed methods outlined in the NSW Guide to Surveying Threatened Plants (OEH 2016b). Parallel field traverses involved two people walking a fixed bearing transect at 10 metre intervals over known or high likelihood potential habitat for candidate threatened flora species.

3.4.7 Threatened flora likelihood of occurrence assessment

Threatened flora species and populations subject to likelihood of occurrence assessments were those identified during the background research, BAM calculator candidate and predicted species lists and any additional species considered to have the potential to occur in the professional opinion of contributors to this assessment.

The likelihood of occurrence assessment was utilised to produce a candidate species list to inform appropriate targeted surveys. The assessment was based on the habitat profile for the species and other habitat information in the Threatened Species Profile Database (OEH 2017b) and the Species Profile and Threats Database (DEE 2018b).

The assessment also included consideration of the dates and locations of nearby records and information about species distribution and populations in the locality along with key habitat requirements such as:

- associated native plant community types and taxa
- topographic, soil or geological preferences
- microhabitats (e.g. preference for rocky outcrops, ground soaks or tree canopies)
- disturbances, such as fire history, and the level and type of disturbance (e.g. slashing, canopy removal).

For this study, the likelihood of occurrence of threatened flora species and populations was determined based on the criteria outlined in Table 3.5.

Table 3.5 Likelihood of occurrence criteria for terrestrial threatened flora species and populations

Likelihood	Criteria
Known	The species was observed in the study area either during the current survey or during another survey less than 5 years' prior; assuming no significant change in conditions on site (e.g. vegetation clearing, fire).
High	A species has a high likelihood of occurrence if: ■ the study area contains or forms part of a large area (> 1 ha) of high quality suitable habitat that has not been subject to recent disturbance (e.g. fire), the species is known to form a persistent soil seedbank and the species has been recorded recently (within 10 years) in the locality ■ the species is a cryptic flowering species that has been recorded recently (within 10 years) in the locality and has a large area (> 1 ha) of high quality potential habitat on site that was not seasonally targeted by surveys.
Moderate	A species has a moderate likelihood of occurrence if: The species: ■ has a small area (< 1 ha) of high quality suitable habitat or a large area (> 1 ha) of marginal habitat in the study area that has not been subject to recent disturbance (e.g. fire), and ■ the species is known to form a persistent soil seedbank, and ■ the species has been recorded recently (within 10 years) in the locality. The species is a cryptic flowering species, with a small area of high quality potential habitat (< 1 ha) or a large area of marginal habitat on site (> 1 ha), that was not seasonally targeted by surveys.
Low	A species has a low likelihood of occurrence if: ■ the species' potential habitat is of high quality but is small in area (< 1 ha) and it is not a cryptic species nor a species known to have a persistent soil seedbank or ■ the species' potential habitat is marginal and the species has not been recorded in the locality.
None	Potentially suitable habitat is absent from the study area.

3.4.8 Candidate terrestrial threatened flora species and survey effort

Four threatened flora species were identified as either having a moderate or higher likelihood of occurrence or were identified by the BAM calculator and hence were identified as candidate species that were the focus of detailed targeted surveys (Appendix B and Appendix F). A summary of survey effort for each candidate threatened flora species is outlined in Table 3.6.

Table 3.6 Candidate terrestrial threatened flora species survey effort

Scientific name	Common name	Status[1]	Potential habitat[2]	Seasonal survey requirements	Recommended survey effort / species notes	Survey effort expended
Ancistrachne maidenii	*Ancistrachne maidenii*	V	PCT 1234	Not specified in BAM, summer flowering.	Flowers in summer.	Targeted surveys were completed in PCT 1234 during September 2018.
Cryptostylia hunteriana	Leafless Tongue Orchid	E	PCT 1234	Nov – Feb	Unlikely to locate during a season with low winter rainfall. Southern populations flower Dec & Jan, Northern populations flower Nov & Dec.	Targeted surveys were not conducted for this species based on the lack of suitable ground stratum habitat.
Wilsonia backhousei	Narrow-leafed Wilsonia	V	PCT 1234	All year	Plants cannot be observed unless water level is 'low'.	Targeted surveys were completed in PCT 1234 during September 2018.
Zannichellia palustris	*Zannichellia palustris*	E	PCT 1071	Mar – Nov	Flowers during warmer months.	Targeted surveys were completed in PCT 1071 during September 2018.

(1) V = Vulnerable, E = Endangered as listed under the BC Act
(2) BioNet ecological data (accessed 11/09/2018)

3.5 Terrestrial fauna surveys

Fauna surveys were undertaken on the 26 and 27 June, 26 September, 3, 10, 11 and 18 October 2018 in accordance with the BAM and with reference to DEC (2004) and other species specific survey guidelines. A summary of methods is provided below.

3.5.1 Habitat assessment

Fauna habitat assessments were undertaken throughout the project site, including active searches for 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.

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

- wetlands, ponds and drains that could provide habitat for frogs, particularly the Green and Golden Bell Frog (*Litoria aurea*)
- mudflats suitable for foraging by migratory waders
- trees with bird nests or other potential fauna roosts (with a particular focus on searching for raptor nests or hollows suitable for owls and large cockatoos)
- specific food trees
- rocky outcrop and ground debris.

Evidence of fauna species included searches for:

- 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
- evidence of foraging.

3.5.2 Fauna surveys

Fauna surveys conducted through the study area included:

- General fauna surveys conducted by two ecologists along the length of the rail corridor on 26 June 2018, involving recording opportunistic observations of fauna species and habitat features.
- An early morning bird survey was conducted by two ecologists within wetland habitat proximate to the rail corridor in Eastlake golf course on 26 September.
- Spotlighting for nocturnal fauna was carried out by two ecologists along a section of the rail corridor adjacent to Eastlake golf course on 26 June where habitat values were higher.
- Microbat ultrasonic echolocation call recordings (Anabat surveys) were undertaken at two locations in the rail corridor on the night of June 26. The anabats were left to record overnight and collected the following morning. An Anabat was also placed next to the Botany Wetland and left to record for two hours on both 18 and 30 October 2018 during frog surveys.
- Searches for evidence of roosting bats at the bridge over Mill Stream.
- Dusk observation of the bridge over Mill Stream on 26 June, and 10, 11, and 18 October for emerging microbats that could potentially be using the structure as a roost site.
- Call playback for bitterns at Botany Wetland on 10 and 11 October 2018.
- Targeted Green and Golden Bell Frog surveys at Botany Wetland in and adjacent to the project site, and at Tempe Wetland, on 10, 11, 18 and 30 October (see below).

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

Targeted Green and Golden Bell Frog surveys

Targeted surveys for the Green and Golden Bell Frog were undertaken to build on earlier surveys for this species undertaken in the study area by SMEC (2013, 2018). Surveys are summarised in Table 3.7 and discussed below.

Targeted surveys for the Green and Golden Bell Frog were undertaken by SMEC (2018) in summer 2017 and summer/autumn 2018 in the area. Surveys were undertaken at Mill Pond and a reference site at Barton Park/Eve Street in Arncliffe where the species is known to occur in February 2017. Surveys were also undertaken at Tempe Wetland, Alexandra Canal, and Mill Pond (and the reference site in Barton Park) in late summer and autumn 2018. Due to access constraints in 2018, no additional nocturnal surveys were undertaken at Mill Pond. Rather, SMEC surveyed for tadpoles and basking frogs during the day at this location. Surveys by SMEC were undertaken where possible in accordance with the EPBC Act survey guidelines (DECCW 2010a), however survey conditions were not ideal given the lack of ongoing rainfall. SMEC (2018) concluded that the Green and Golden Bell Frog was unlikely to be present, due to the lack of evidence of the species, presence of Mosquitofish and high levels of disturbance and pollution (SMEC 2018).

Surveys for the Green and Golden Bell Frog were also undertaken by SMEC at a small wetland between the rail corridor, Botany Road, Mill Pond Road and General Holmes Drive for the WestConnex Enabling Works (SMEC 2013). This small wetland has only a tenuous connection to the larger Botany Wetlands. Surveys were undertaken over two nights in December 2013. Little rain had fallen in the week prior, however there had been wet conditions in mid-November 2013. Given the small area of the wetland, the lack of suitable fringing habitat and its relative isolation from proximate habitat, SMEC (2013) considered it reasonably unlikely that the Green and Golden Bell Frog would be present at this location. Given the small size of the pond and its isolation from nearby wetland areas, and lack of any evidence of the Green and Golden Bell Frog at the more extensive Botany Wetland, no additional surveys were considered necessary at this small pond.

Further surveys were conducted in September and October 2018 by GHD ecologists to confirm the absence of the species in the project site and surrounds. These included diurnal and nocturnal surveys at Botany Wetland (Eastlakes Golf Course) and Mill Pond (adjacent to Botany Road). Surveys were also conducted at Tempe Wetland. No surveys of the Marsh Street or Eve Street wetland reference populations were undertaken in spring 2018 due to the low numbers of individuals persisting at these sites (A. Robinson, A. White pes. com.). Rather, calling by Green and Golden Bell Frogs during September and October at Kooragang Island was confirmed with Michael Mahony of the University of Newcastle, although he noted there was little calling on the night of 10 October 2018. Weather had continued to be dry over winter, however heavy rainfalls occurred in early September and early October.

Where possible, surveys have been conducted in accordance with the survey guidelines (DEWHA 2010a), which recommend surveys are conducted:

- between September and March
- within one week of heavy rainfall (greater than 50 mm in seven days)
- on warm and windless nights
- over four nights in ideal conditions.

Given the generally dry conditions experienced in Sydney in the last few years, not all surveys met all the recommended conditions. Most of the recent surveys have, however, occurred after very heavy rainfall events and included surveys on warm and windless nights, and have generally met the DEWHA (2009) survey requirements. Given the large number of separate surveys over many months and years, this survey effort is considered reasonable to ascertain species presence/absence.

Survey timing, locations, effort and weather conditions (from the Sydney Airport weather station, BOM 2018a) during and prior to surveys is detailed in Table 3.7.

Table 3.7 Targeted Green and Golden Bell Frog surveys

Date	Minimum temperature	Maximum temperature	Rainfall (mm)	Rainfall over 7 days prior to survey (mm)	Survey locations	Survey effort expended	Frog species recorded
27 February 2018	17.4	24.8	2.2	58.4	Barton Park (reference site)	~1.5 person hours (spotlighting, call playback)	Striped Marsh Frogs (calling)
					Tempe Wetland Alexandra Canal	~2.5 person hours (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog Striped Marsh Frog Common Eastern Froglet (all calling)
7 March 2018	18.7	25.6	3.4	8.4	Barton Park (reference site)	~1.5 person hours (spotlighting, call playback)	Peron's Tree Frog Striped Marsh Frogs (calling)
					Tempe Wetland Alexandra Canal	~3 person hours (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog Striped Marsh Frog Common Eastern Froglet (all calling)
20 March 2018	20.1	26.3	0	61.8	Barton Park (reference site)	~1.5 person hours (spotlighting, call playback)	Striped Marsh Frog
					Tempe Wetland Alexandra Canal	~3 person hours (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog (calling) Striped Marsh Frog (calling)

Date	Minimum temperature	Maximum temperature	Rainfall (mm)	Rainfall over 7 days prior to survey (mm)	Survey locations	Survey effort expended	Frog species recorded
28 March 2018	16.9	28.4	0	36.2	Barton Park (reference site)	~1.5 person hours (spotlighting, call playback)	No frogs detected
					Tempe Wetland Alexandra Canal	~3 person hours (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog (calling) Striped Marsh Frog (calling)
5 April 2018	18.8	28.8	0	3.6	Mill Pond	2 person hours (dip-netting, diurnal searches)	No frogs detected
8 April 2018	13.1	25.0	0	0.0	Mill Pond	2 person hours (dip-netting, diurnal searches)	No frogs detected
12 September 2018	12.8	26.9	0	36.2	Tempe Wetland	2 person hours (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog Striped Marsh Frog Common Eastern Froglet (all calling)
26 September 2018	12.2	17.1	3.8	8.2	Botany Wetland, Mill Stream	2 person hours (habitat assessment, searches for basking frogs during the day)	No frogs detected
3 October 2018	13.9	27.2	0	6.6	Botany Wetland, Mill Stream	1 person hour (searches for basking frogs during the day)	No frogs detected

Date	Minimum temperature	Maximum temperature	Rainfall (mm)	Rainfall over 7 days prior to survey (mm)	Survey locations	Survey effort expended	Frog species recorded
10 October 2018	15.9	17.4	0	64.4	Botany Wetland, Mill Stream	3 person hours (spotlighting, call playback)	Common Eastern Froglet (calling)
					Tempe Wetland	1 person hour (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog Striped Marsh Frog Common Eastern Froglet (all calling)
11 October 2018	12.1	17.7	8.4	64.4	Botany Wetland, Mill Stream	3 person hours (spotlighting, call playback)	Common Eastern Froglet Dwarf Eastern Tree Frog (all calling)
					Tempe Wetland	1 person hour (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog Striped Marsh Frog Common Eastern Froglet (all calling)
18 October 2018	17.4	25.5	8.6	38.6	Botany Wetland, Mill Stream	3 person hours (spotlighting, call playback)	Common Eastern Froglet (calling) Peron's Tree Frog (calling) Dwarf Eastern Tree Frog (calling/active)

Date	Minimum temperature	Maximum temperature	Rainfall (mm)	Rainfall over 7 days prior to survey (mm)	Survey locations	Survey effort expended	Frog species recorded
					Tempe Wetland	1 person hour (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog Striped Marsh Frog Common Eastern Froglet (all calling/active)
30 October 2018	15.4	26.7	0	2.8	Botany Wetland, Mill Stream	3 person hours (spotlighting, call playback)	Common Eastern Froglet (calling) Peron's Tree Frog (calling) Dwarf Eastern Tree Frog (calling/active)
					Tempe Wetland	1 person hour (spotlighting, call playback)	Peron's Tree Frog Dwarf Eastern Tree Frog Striped Marsh Frog Common Eastern Froglet (all calling/active)

Bat call analysis

Calls 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.

The 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) as summarised in Table 3.8. Due to the absence of reference calls from the study area, 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).

Table 3.8 Confidence ratings applied to bat calls

Identification	Description
D – Definite	Species identification not in doubt.
PR – Probable	Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call type or call lacks sufficient detail to allow definite species identification.
SG – Species Group	Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species e.g. *Chalinolobus gouldii* /*Mormopterus ozimops* sp. *Nyctophilus* sp. The calls of *Nyctophilus geoffroyi* / *gouldi* typically cannot be distinguished during the analysis process and are therefore lumped together. *Nyctophilus sp/Myotis Macropus.* The calls of these species can be easily confused during the analysis process and are therefore often lumped together.

3.5.3 Threatened fauna likelihood of occurrence assessment

Threatened fauna species and populations subject to likelihood of occurrence assessments were those identified during the background research, BAM calculator candidate and predicted species lists and any additional species considered to have the potential to occur in the professional opinion of contributors to this assessment.

The likelihood of occurrence assessment was utilised to produce a candidate species list to inform appropriate targeted surveys. The assessment was based on the habitat profile for the species and other habitat information in the Threatened Species Profile Database (OEH 2017b) and the Species Profile and Threats Database (DEE 2018b).

The assessment also included consideration of the dates and locations of nearby records and information about species distribution and populations in the locality along with key habitat requirements.

For this study, the likelihood of occurrence of threatened flora species and populations was determined based on the criteria outlined in Table 3.9. The likelihood of occurrence assessment is provided in Appendix A.

Table 3.9 Likelihood of occurrence criteria for threatened fauna species and populations

Likelihood	Criteria
Known	The species was observed in the study area either during the current survey or during another survey less than 5 years' prior; assuming no significant change in conditions on site (e.g. vegetation clearing, fire).
High	A species has a high likelihood of occurrence if: ■ the study area contains or forms part of a large area (> 1 ha) of high quality suitable habitat, and ■ and the species has been recorded recently (within 10 years) in the locality.
Moderate	A species has a moderate likelihood of occurrence if: The species: ■ has a small area (< 1 ha) of high quality suitable habitat or a large area (> 1 ha) of marginal habitat in the study area, and ■ the species has been recorded recently (within 10 years) in the locality.
Low	A species has a low likelihood of occurrence if: ■ the species' potential habitat is marginal and the species has not been recorded in the locality.
None	Potentially suitable habitat is absent from the study area.

3.5.4 Candidate terrestrial threatened flora species and survey effort

Two threatened fauna species were identified as either having a moderate or higher likelihood of occurrence or were identified by the BAM calculator. These species were identified as candidate species and were the focus of detailed targeted surveys (Appendix B and Appendix F). A summary of survey effort for each candidate threatened fauna species is outlined in Table 3.10.

Table 3.10 Candidate threatened fauna species

Scientific name	Common name	Status[1]	Potential habitat	Seasonal survey requirements	Recommended survey effort	Survey effort expended
Litoria aurea	Green and Golden Bell Frog	E	Botany Wetland	Nov-March	Surveys over four nights between September and March in ideal conditions (within one week of heavy rainfall (greater than 50 mm in seven days), on warm and windless nights (see Section 3.5.2).	Four nights of survey in generally appropriate weather conditions in September and October. This follows on from previous surveys in the wider area by SMEC (2013, 2018).

Scientific name	Common name	Status[1]	Potential habitat	Seasonal survey requirements	Recommended survey effort	Survey effort expended
Myotic macropus	Southern Myotis	V	Botany Wetland	Oct-March	Roost search – 30 minutes per structure Anabat – four nights	Dusk observation of the bridge over Mill Stream on 26 June, and 10, 11, and 18 October for emerging microbats. Anabat surveys were undertaken at ■ two locations in the rail corridor on the night of June 26 (including Botany Wetland) ■ Tempe Wetland and Alexandra Canal on 12 and 13 September ■ Botany Wetland on 18 and 30 October 2018 (evening only)

3.6 Aquatic habitat surveys

3.6.1 Habitat assessment

An aquatic habitat assessment was conducted on 3 October 2018 at the Botany Wetlands (Eastlakes Golf Club and Botany Road), as well as downstream areas of Mill Stream and Botany Bay near Foreshore Drive with reference to *Aquatic ecology in environmental impact assessment EIA guidelines* (Marcus Lincoln Smith 2003). An assessment of the in-stream physical habitat was conducted based on the NSW AUSRIVAS habitat assessment sheet (Turak et al 2004). This entailed qualitative assessments of the substrata and water channel and an on-site assessment of hydraulic habitat features and suitability for threatened taxa identified from the database and literature searches. The sensitivity of key fish habitat and the functionality of Botany Wetland was classified according to the *Policy and guidelines for fish habitat conservation and management* (DPI 2013) and *Fish passage requirements for waterway crossings* (NSW Fisheries 2003).

3.6.2 Water quality

Water quality sampling was conducted at Botany Wetlands and downstream at Mill Pond. A calibrated YSI 600 QS MSP water quality meter was used to record in-situ parameters, while alkalinity was obtained through the use of field titration kits.

3.6.3 Threatened fauna likelihood of occurrence assessment

Threatened aquatic species subject to likelihood of occurrence assessments were those identified during the background research. The likelihood of occurrence assessment was utilised to produce a candidate species list to inform appropriate targeted surveys. The assessment was based on the habitat profile for the species and other habitat information in the Threatened Species Profile Database (OEH 2017b) and the Species Profile and Threats Database (DEE 2018b).

The assessment also included consideration of the dates and locations of nearby records and information about species distribution and populations in the locality along with key habitat requirements.

For this study, the likelihood of occurrence of threatened flora species and populations was determined based on the criteria outlined in Table 3.9. The likelihood of occurrence assessment is provided in Appendix B.

3.7 Limitations

The majority of the study area is located in the operating rail corridor, which has been subject to previous clearing and disturbance. Similarly, adjacent areas are located in a highly industrial area of Sydney, with only limited biodiversity values. The rail corridor crosses the Botany Wetlands, and these have been the main focus of field surveys due to the higher biodiversity values present.

The desktop assessment provided a list of the threatened biota previously recorded or that could potentially occur in the study area or be affected by the project (including seasonal, transient or cryptic species). The habitat assessment conducted allows for identification of habitat resources for those species known or predicted to occur in the locality, to assist in determining their likelihood of occurrence in the study area.

The initial surveys along the rail corridor were conducted in winter, and it is likely that some species that occur were not detected during the field survey. Given the low value of habitats along most of the rail corridor, surveys in these areas were considered sufficient to inform the preparation of this BDAR.

Surveys have been conducted at Botany Wetlands over various months, and in various weather conditions. In particular, this has included targeted surveys for the Green and Golden Bell Frog, as well as detailed vegetation and habitat assessment surveys of the wetlands. In addition, surveys conducted for the associated motorway project have informed the assessment of threatened species habitat and occurrence in the wider area, in particular for the Green and Golden Bell Frog and the Southern Myotis. The level of survey undertaken, together with the survey timing and weather conditions, is considered sufficient to inform the preparation of this BDAR.

This BDAR has been prepared based on the project description and engineering drawings provided by the proponent and design team. It is assumed that the description and spatial data accurately represent the extent of direct impacts arising from the project and so these data have been used to calculate the extent of removal of vegetation and habitat arising from the project using GIS. These calculations have in turn been relied upon in the BAM calculations and the determination of key thresholds such as whether the project would have a direct impact on a TEC, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated project design and/or spatial data.

3.8 Personnel

This BDAR was prepared by Mark Stables (accredited assessor number BAAS18097) and Kirsten Crosby (accredited assessor number BAAS17011) in accordance with the BAM. A technical review of the credit calculations was undertaken by Alex Cockerill (accredited assessor number BAAS17020). Staff qualifications are presented in Table 3.11.

Table 3.11 Staff and qualifications

Name	Position/Role on project	Qualifications	Relevant experience
Mark Stables	Principal Ecologist (flora) Desktop assessment, site surveys, reporting	BSc (Hons.) Accredited BAM Assessor (number BAAS18097)	17+ years
Kirsten Crosby	Senior Ecologist (fauna) Desktop assessment, site surveys, reporting	BSc (Zoology), PhD Accredited BAM Assessor (number BAAS17011)	13+ years
Julia Wylie	Ecologist Desktop assessment, site surveys	BEnv Accredited BAM Assessor (number BAAS18034)	5 years
Malith Weerakoon	Ecologist Desktop assessment, site surveys, reporting	BSc, MPhil. (Zoology)	5 years
Josh Cox	Aquatic ecologist Desktop assessment, site surveys, reporting	BEnvSc (Hons)	8 years
Alex Cockerill	Principal Ecologist BAM Calculator review	BSc (Hons.) Accredited BAM Assessor (number BAAS17020)	18+ years
Jayne Tipping	Technical Director Biodiversity Technical Review	BSc (Ecology), MEnvLaw	25+ years

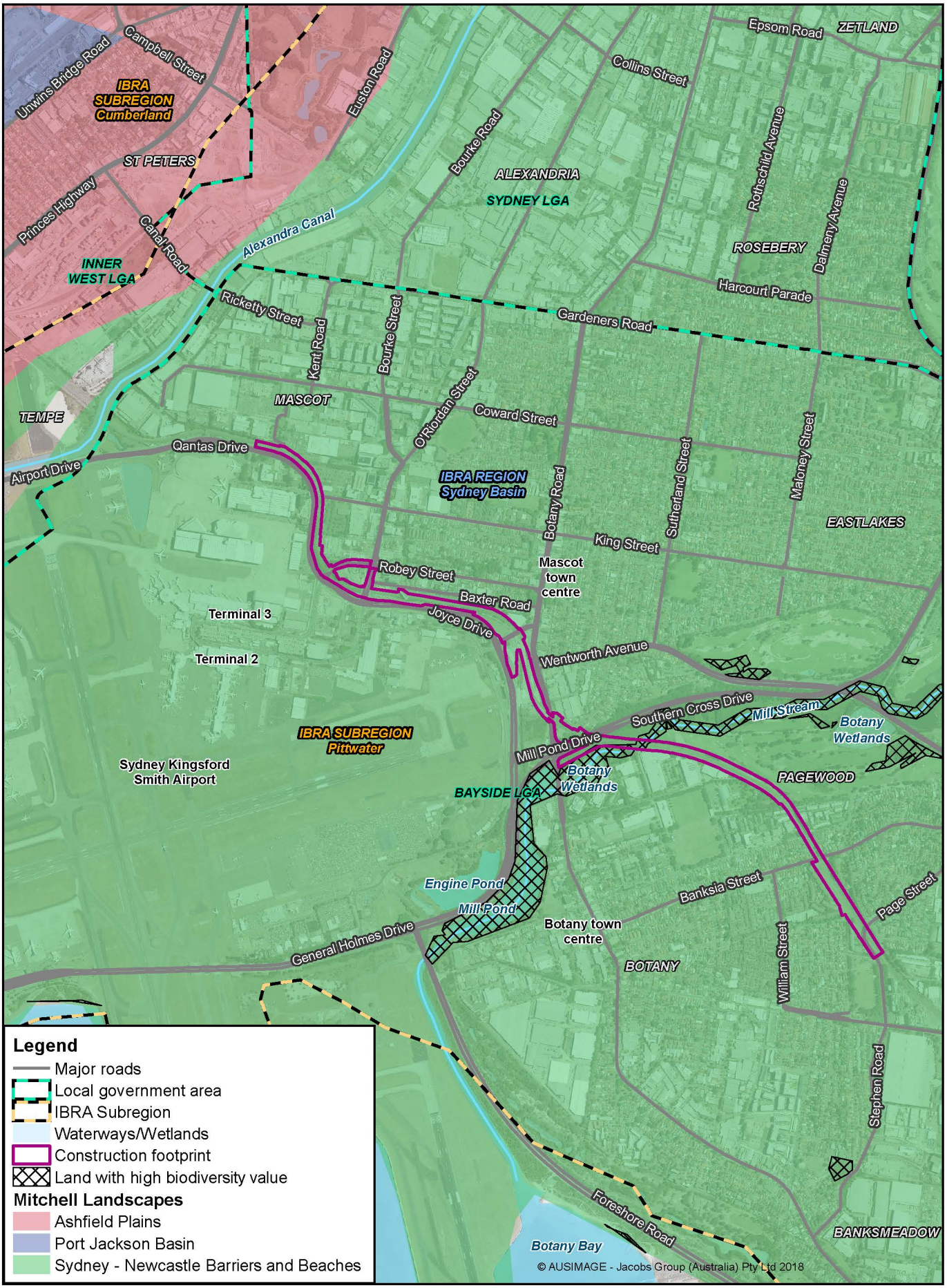
4. Existing environment – General

4.1 Landscape feature

The study area is in the Sydney Basin IBRA bioregion and occurs within the SYB07 Pittwater IBRA sub region (IBRA version 7.0). Landscape features within the study area as prescribed in Section 4 of the BAM are summarised in Table 4.1 and shown in Figure 4.1.

Table 4.1 Landscape features

Landscape feature	Study area
IBRA bioregions and sub regions	Sydney Basin Bioregion / SYB07 Pittwater sub region
NSW landscape regions (Mitchell landscapes)	Sydney – Newcastle Barriers and Beaches
Local Government Area (LGA)	Botany Bay City Council
Rivers and streams	Mill Stream – due to the surrounding modified stormwater and drainage pattern the strahler stream order is unknown.
Important and local wetlands	Important wetland – Towra Point Wetland (~5 km to the south) Local wetland – Botany wetland
Connectivity features	The main habitat corridor is associated with Botany Wetland and Mill Stream.
Areas of geological significance and soil hazard features	There are no mapped areas of geological significance. Soil hazards include areas of high probability Acid Sulphate Soil Risk associated with the Botany Wetlands and low probability areas over the majority of the project site extending from O'Riordan Street intersection in the west to Banksia Street in the east.
Areas of outstanding biodiversity value	No declared areas of outstanding biodiversity value occur in or near the study area.
Landscape features listed in the SEARs	n/a



Author: Geeta Kumar
Date: 13/05/2019
Map no: PS113386_GIS_010_A1

Figure 4.1

Landscape features

4.2 Determining site context

To determine site context as required under Section 4.3 of the BAM, an assessment of native vegetation cover and patch size in accordance with Subsections 4.3.2 and 5.3.2 of the BAM have been undertaken and are outlined below.

4.2.1 Native vegetation cover

Native vegetation cover within the project site and a 500-metre buffer area along each side of the centre line of the project site was determined in accordance with Subsection 4.2.2 of the BAM and is summarised in Table 4.2 and shown in Figure 4.2.

Table 4.2 Native vegetation cover

Assessment area	Total assessment area (ha)	Area of native vegetation cover (ha)	Native vegetation percentage cover
500 m along each side of the centre line of the project site	440.84	15.99	0–10% (3.63%)

4.2.2 Patch size

Patch size is defined under the BAM (OEH, 2017) as an area of native vegetation that:

- occurs on the development site or stewardship site, and
- includes native vegetation that has a gap of less than 100 metres from the next area of moderate to good native vegetation (or less than or equal to 30 metres for non-woody ecosystems).

Patch size may extend onto adjoining land that is not part of a development site or a stewardship site.

Patch size area is assigned to each vegetation zone as a class, being less than 5 hectares, 5–24 hectares, 25–100 hectares or greater than or equal to 100 hectares. Due to the highly disturbed and fragmented landscape, patch size for each native vegetation zone has been determined to be less than 5 hectares.

0 250 500 m

Figure 4.2

Determining site context

Author: Geeta Kumar
Date: 13/05/2019
Map no: PS113386_GIS_011_A1

5. Existing environment – Native vegetation

5.1.1 Overview

Two native vegetation PCTs were recorded in the project site. These are:

- PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion.
- PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion.

In addition, three non-native vegetation types were assigned to a miscellaneous ecosystem class, being:

- Miscellaneous ecosystem – highly disturbed areas with no or limited native vegetation.
- Miscellaneous ecosystem – urban exotic/native landscape plantings.
- Miscellaneous ecosystem – water bodies.

These two native and three non-native vegetation types (listed above) were assigned to six discrete vegetation zones based on broad vegetation condition class criteria as outlined in Section 3.4.3. A summary of PCTs and associated vegetation zones along with non-native vegetation types are presented in Table 5.1. The extent and distribution of each vegetation type and zone is shown in Figure 5.1.

Detailed descriptions and selection justification for each PCT and vegetation zone is provided in Section 5.2 below. A summary and description of non-native vegetation types is presented in Section 5.3.

Table 5.1 Overview of native and non-native vegetation types and zones identified within the project site

Vegetation type	Vegetation zone (VZ)	Threatened ecological community (BC Act)	Vegetation formation	Vegetation class	IBRA region / subregion	PCT % cleared	Patch size (ha)	Vegetation integrity score	Extent in project site (ha)
PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	VZ1 – Moderate	Freshwater wetland on coastal floodplains – Endangered BC Act	KF_CH8 Freshwater Wetlands	Coastal Freshwater Lagoons	Sydney Basin / Sydney Cataract	75	<5	65.2	0.10
PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	VZ2 – Poor	Swamp Oak Floodplain Forest – Endangered BC Act	KF_CH9 Forested Wetlands	Coastal Floodplain Wetlands		90	5-24	25.7	0.46
	VZ3 – Low						<5	22.7	0.16
								Total native vegetation	0.72
Miscellaneous ecosystem – highly disturbed areas with no or limited native vegetation	VZ4	–	–	–	–	–	–	–	5.53
Miscellaneous ecosystem – urban exotic/native landscape plantings	VZ5	–	–	–	–	–	–	–	1.92
Miscellaneous ecosystem – water bodies	VZ6	–	–	–	–	–	–	–	0.10
								Total non-native vegetation	7.55
								Total all vegetation types	8.27

DATA SOURCE: Aerial Imagery © AUSIMAGE - Jacobs Group (Australia) Pty Ltd 2018

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CLIENT ARTC

REV.	DATE	AMENDMENT / REVISION DESCRIPTION
A1	03/05/2019	Vegetation Types and Zones

MWR No. | APPROVAL

SCALES ON A1 SIZE DRAWING: 0 20 40 m, 1:2,500

CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: WSP, GHD

DRG No.

	NAME	DATE
TITLE		
DRAWN	G KUMAR	3/05/2019
DRG CHECK	K CROSBY	3/05/2019

PREPARED FOR

BOTANY RAIL DUPLICATION

A3

Figure 5.1.
Vegetation types and zones

RMS REGISTRATION No. | PART

ISSUE STATUS: FOR INFORMATION | EDMS No. | SHEET No. | ISSUE: A1

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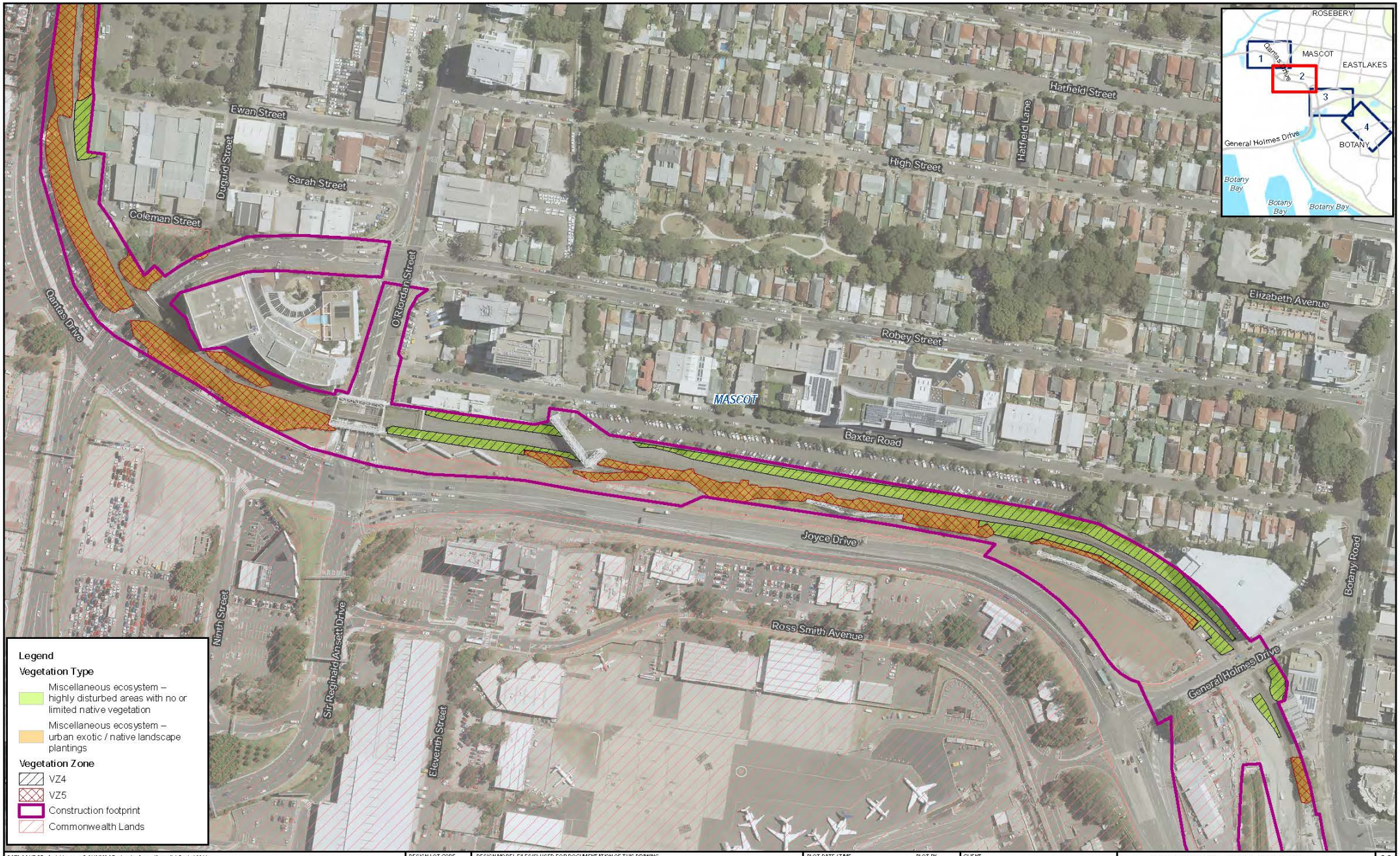

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REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
A1	30/05/2019	Vegetation Types and Zones		

SCALES ON A1 SIZE DRAWING: 0 20 40 m, 1:2,500

CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: WSP GHD

DRG No.

	NAME	DATE
DRAWN	G KUMAR	30/5/2019
DRG CHECK	K CROSBY	30/5/2019

TITLE

PREPARED FOR

CLIENT: ARTC

BOTANY RAIL DUPLICATION

A3

Figure 5.1.
Vegetation types and zones

RMS REGISTRATION No.: | PART

ISSUE STATUS: FOR INFORMATION | EDMS No. | SHEET No. | ISSUE: A1

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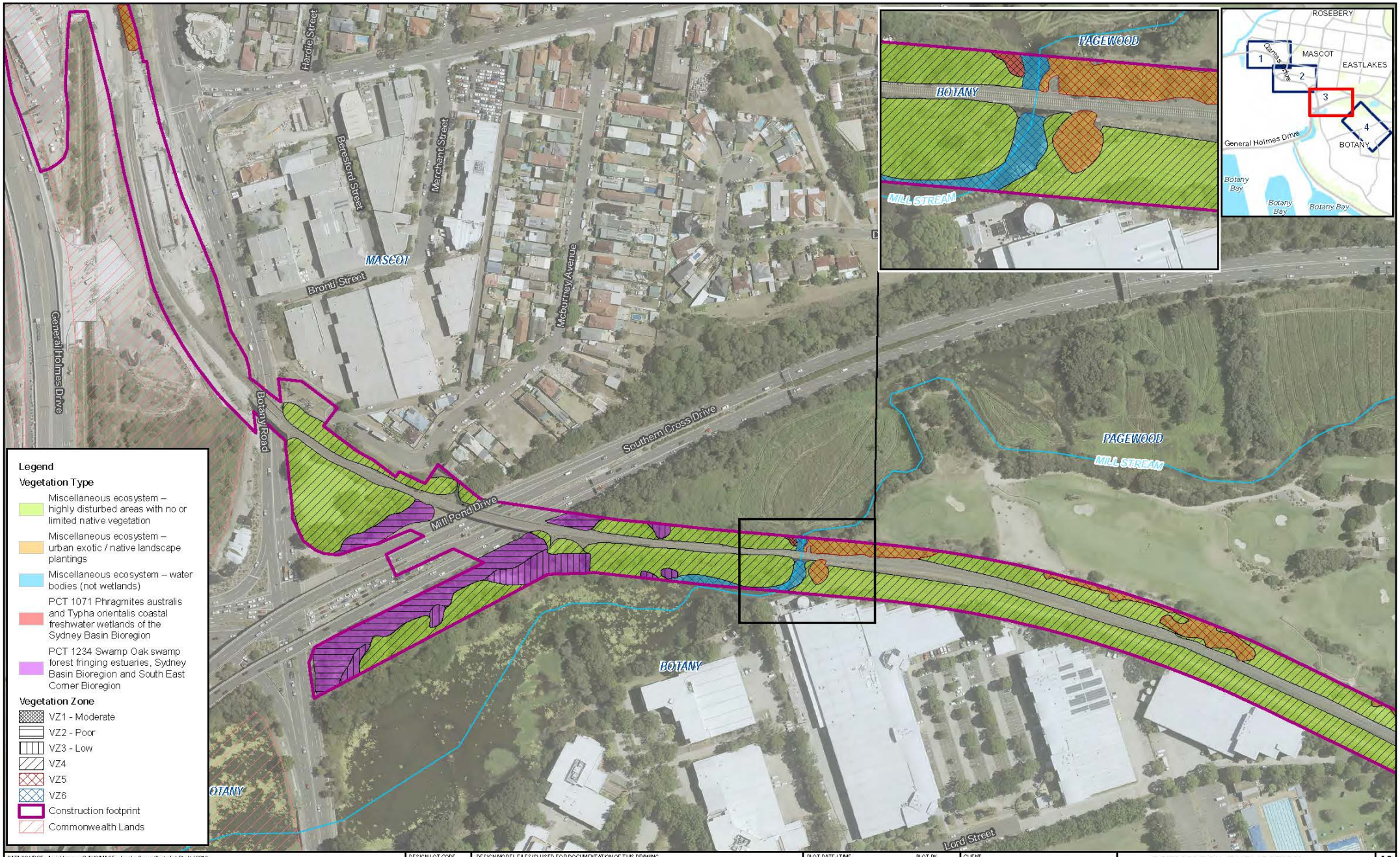

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A1	03/05/2019	Vegetation Types and Zones

WVR No. | APPROVAL

SCALES ON A1 SIZE DRAWING: 0 20 40 m, 1:2,500

CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: wsp GHD

DRG No.

	NAME	DATE
TITLE		
DRAWN	G KUMAR	3/05/2019
DRG CHECK	K CROSBY	3/05/2019

PREPARED FOR

BOTANY RAIL DUPLICATION

A3

Figure 5.1.
Vegetation types and zones

RMS REGISTRATION No. | PART

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CLIENT: ARTC

REV	DATE	AMENDMENT / REVISION DESCRIPTION
A1	03/05/2019	Vegetation Types and Zones

WVR No. | APPROVAL

SCALES ON A1 SIZE DRAWING: 0 20 40 m, 1:2,500

CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: AHD

DRAWINGS / DESIGN PREPARED BY: wsp GHD

DRG No.

TITLE	NAME	DATE
DRAWN	G KUMAR	3/05/2019
DRG CHECK	K CROSBY	3/05/2019

PREPARED FOR

BOTANY RAIL DUPLICATION

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Figure 5.1.
Vegetation types and zones

RMS REGISTRATION No.: | PART

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5.2 PCT descriptions

A description of recorded attributes for each native vegetation PCT are provided below.

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

The occurrence of this vegetation type within the study area is illustrated in Figure 5.1 with photographic representation provided in Photo 5.1. A profile of PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion is provided in Table 5.2 and a comparison of recorded vegetation integrity data against community condition benchmark data is presented in Table 5.3.

Table 5.2 Summary of PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion

PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	
PCT Justification	In assigning this vegetation type, the following candidate PCTs were considered based on floristic similarities and landscape position: ■ PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion ■ PCT 1737 Typha rushland. Whilst both PCTs occur on drainage flats and areas of local ponding and are dominated by Typha, PCT 1737 typically occurs north from Woy Woy to Hexham. PCT 1071 was selected based on the occurrence in the greater Sydney area (SYB07 Pittwater) and is associated with modified former wetlands such a Botany Wetland.
Vegetation formation	KF_CH8 Freshwater Wetlands
Vegetation class	Coastal Freshwater Lagoons
Vegetation zone	VZ1
Conservation status:	BC Act: Freshwater Wetland on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions – Endangered Ecological Community. EPBC Act: Not listed.
Percent cleared	75%
Patch size class	<5 hectares
Impact area	0.1 hectares
Vegetation integrity plots	Q3 & Q4
Current vegetation integrity score	65.2
Landscape position	This native vegetation type was recorded from poorly drained floodplain depression areas near Mill Stream, at the south-western end of the Eastlakes Golf Course and airport land between General Homes Drive and Botany Road.
Species upper stratum	Absent
Species middle stratum	Absent

PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	
Species ground stratum	*Typha orientalis* (Cambungi), *Isachne globosa* (Swamp Millet) and *Persicaria strigosa* (Spotted Knotweed)
Vegetation condition	This vegetation type was recorded in moderate condition with a predominately native cover. A number of High Threat Weeds and Priority Weeds were recorded, including *Ageratina adenophora** (Crofton Weed), *Alternanthera philoxeroides** (Alligator Weed), *Isolepis prolifera** (Budding Club-rush) and *Rubus fruticosus* agg.* (Blackberry).

Photo 5.1 PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion at Mill Stream (north of the rail corridor).

Table 5.3 Comparison of PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion vegetation integrity plot data against PCT condition benchmark data

Plot	Tree richness	Shrub richness	Grass richness	Forb richness	Fern richness	Other richness	Tree cover	Shrub cover	Grass cover	Forb cover	Fern cover	Other cover	Length timber	Leaf litter	Large tree	Vegetation integrity score
BM[1]	**1**	**2**	**5**	**4**	**1**	**1**	**0**	**0**	**122**	**2**	**0**	**0**	**0**	**0**	**0**	**100**
Q3	0	0	4	1	1	0	0	0	95.3	5	0.1	0	0	0	0	65.2
Q4	0	0	5	1	0	0	0	0	100.8	3	0	0	0	0	0	

(1) Benchmark data for equivalent community in NSW Sydney Basin IBRA Bioregion; Vegetation Type - PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion; Keith Formation: KF_CH8 Freshwater Wetlands; Keith Class: Coastal Freshwater Lagoons; source (NSW BioNet Vegetation Classification database accessed September 2018 and cross referenced with Biodiversity Assessment Method Calculator).

5.2.2 PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion

The occurrence of this vegetation type within the study area is illustrated in Figure 5.1, with photographic representation provided in Photo 5.2 and Photo 5.3. A profile of PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion is provided in Table 5.4 and a comparison of recorded vegetation integrity data against community condition benchmark data is presented in Table 5.5.

Table 5.4 Summary of PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion

PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	
PCT Justification	In assigning this vegetation type, the following candidate PCTs were considered based on floristic similarities and landscape position: ■ PCT 1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion ■ PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion ■ PCT 1800 Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley. All candidate PCTs are dominated by *Casuarina glauca* (Swamp Oak) and as such landscape position was used to justify PCT selection. PCT 1800 was dismissed as it generally occurs on river-flats of the Cumberland plain away from the coast. PCT 1232 mostly is associated with floodplain depressions and flats and is generally less associated with coastal estuarine environments. PCT 1234 was selected based on the historic connection with saline influences of Botany Bay. Whilst it is acknowledged that the tidal influences have been modified due to a weir the sediment and landscape position is consistent with PCT 1234.
Vegetation formation	KF_CH9 Forested Wetlands
Vegetation class	Coastal Floodplain Wetlands
Vegetation zone	VZ2 and VZ3
Conservation status:	BC Act: Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions – Endangered Ecological Community. EPBC Act: Does not meet key characteristics or condition thresholds for EPBC Act listing.
Percent cleared	90%
Patch size class	<5 hectares
Impact area	0.62 hectares (0.46 ha Poor / 0.16 ha Low)
Vegetation integrity plots	Q1, Q2 & Q5
Current vegetation integrity score	Poor condition: 25.7 Low condition: 22.7
Landscape position	This native vegetation type was recorded from low-lying areas associated with creeks and tributaries that drain to Botany Bay.
Species upper stratum	*Casuarina glauca* (Swamp Oak)
Species middle stratum	*Lantana camara** (Lantana)

PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	
Species ground stratum	*Ehrharta erecta** (Panic Veldgrass), *Eragrostis curvula** (African Love Grass), *Parietaria judaica** (Asthma Weed), *Panicum maximum* var. *maximum** (Guinea Grass).
Vegetation condition	This vegetation type was recorded in both poor and low condition. Whilst species richness was low in both condition classes, the differentiation was based on canopy age class. It is noted that much of the extent of poor condition class vegetation appears to be planted or the result of regeneration on modified sediments following previous road (Southern Cross Drive and Botany Road) and rail (Port Botany rail) infrastructure projects. Poor condition class was assigned to patches that exhibited a semi-mature to mature canopy but lacked middle and ground stratum (Photo 5.2). Low condition class was assigned to patches that exhibited regrowth juvenile to isolated semi-mature *Casuarina glauca* (Swamp Oak) individuals (Photo 5.3). All vegetation within this condition class is regrowth from previous vegetation clearing associated with the previous construction of a gas pipeline and utility services. Both condition classes exhibited a dominance of High Threat Weeds and Priority Weed species, many of which are considered transformer species that limit native middle and ground stratum development.

Photo 5.2 PCT 1234 – Poor condition vegetation adjacent to Southern Cross Drive

Photo 5.3 PCT 1234 – Low condition vegetation adjacent to Mill Stream

Table 5.5 Comparison of PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion vegetation integrity plot data against PCT condition benchmark data

Plot	Tree richness	Shrub richness	Grass richness	Forb richness	Fern richness	Other richness	Tree cover	Shrub cover	Grass cover	Forb cover	Fern cover	Other cover	Length timber	Leaf litter	Large tree	Vegetation integrity score
BM[1]	**4**	**8**	**8**	**7**	**2**	**3**	**21**	**21**	**73**	**3**	**1**	**1**	**12**	**40**	**1**	**100**
Q1	2	2	2	3	0	0	8	4	2.1	1.9	0	0	8	19	0	22.7
Q2	3	1	0	2	0	0	78	1	0	1.1	0	0	8	89	0	25.7
Q5	3	1	0	0	0	0	46.4	0.4	0	0	0	0	8.5	69	0	Not required

(1) Benchmark data for equivalent community in NSW Sydney Basin IBRA Bioregion; Vegetation Type - PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion; Keith Formation: KF_CH9 Forested Wetlands; Keith Class: Coastal Floodplain Wetlands; source (NSW BioNet Vegetation Classification database accessed September 2018 and cross referenced with Biodiversity Assessment Method Calculator).

5.3 Non-native vegetation

All non-native vegetation types do not meet floristic or structural characteristics of any recognised native PCT. Non-native vegetation was assigned to a miscellaneous ecosystem classification and was identified to exhibit three different vegetation types that are discussed below.

5.3.1 Miscellaneous ecosystem – highly disturbed areas with no or limited native vegetation

This non-native vegetation type occurs over the majority of the study area (about 5.53 hectares) and is the result of previous clearing and ongoing maintenance of rail infrastructure. The distribution of this vegetation type is shown in Figure 5.1 and represented in Photo 5.4. The structure varies from scattered or clumped areas of trees to exotic scrub and grassland. Dominant tree species include; *Acacia saligna** (Golden Wreath Wattle), *Cinnamomum camphora** (Camphor Laurel), *Erythrina crista-galli** (Cockspur Coral Tree), *Erythrina x sykesii** (Coral Tree), *Morus alba** (Mulberry) and *Schinus molle** (Pepper Corn).

Exotic shrub species include; *Acacia saligna** (Golden Wreath Wattle), *Lantana camara** (Lantana), *Ligustrum sinense** (Small-leaved Privet) and *Rubus fruticosus* agg. * (Blackberry).

Exotic grassland species include: *Axonopus fissifolius** (Narrow-leaved Carpet Grass), *Cenchrus echinatus** (Mossman River Grass), *Chloris gayana** (Rhodes Grass), *Cynodon dactylon* (Common Couch), *Ehrharta erecta** (Panic Veldgrass), *Eragrostis curvula** (African Love Grass), *Melinis repens** (Red Natal Grass) and *Panicum maximum* var. *maximum** (Guinea Grass). A large range of annual and perennial exotic forb species also occur.

Photo 5.4 Miscellaneous ecosystem – highly disturbed areas with no or limited native vegetation (east of Mill Stream)

5.3.2 Miscellaneous ecosystem – urban exotic / native landscape plantings

This non-native vegetation type occurs throughout the study area (about 1.92 hectares) and is the result of previous horticultural ornamental landscape plantings. The distribution of this vegetation type is shown in Figure 5.1 and represented in Photo 5.5.

Common plantings include native eucalypt species such as *Corymbia citriodora* (Lemon-scented Gum), *Corymbia maculata* (Spotted Gum), *Eucalyptus botryoides* (Bangalay), *Eucalyptus microcorys* (Tallowwood), *Eucalyptus saligna* (Blue Gum) and others.

Other scattered plantings include; *Acer palmatum** (Japanese Maple), *Callistemon* sp. (Cultivar)* (Bottlebrush), *Ficus* sp. (Fig), *Grevillea robusta* (Silky Oak), *Jacaranda mimosifolia** (Jacaranda) and *Phoenix canariensis** (Canary Island Date Palm).

Photo 5.5 Miscellaneous ecosystem – urban exotic/native landscape plantings located throughout the rail alignment

5.3.3 Miscellaneous ecosystem – water bodies

Mill Stream is crossed by the project. This PCT comprises open areas of water and may include submerged vegetation such as *Valiseria americana* and *Myriophyllum aquaticum.*

Photo 5.6 Submerged *Valiseria Americana** (Ribbon Weed) Mill Stream

Photo 5.7 Submerged *Myriophyllum aquaticum** (Brazilian Water-milfoil) Mill Stream

5.4 Priority weeds

During field surveys, 178 species of plant were recorded. Of these 41 were native and 137 were introduced species (refer to Appendix C).

Of the 137 introduced species recorded within the study area, 13 species were listed under the NSW *Biosecurity Act 2015* as priority weeds for the Greater Sydney region (DPI, 2018) whilst nine are also listed as Weeds of National Significance (AWC, 2015). All priority weeds identified and species listed as Weeds of National Significance (AWC, 2015) are outlined below in Table 5.6.

Table 5.6 Priority weeds and weeds of national significance recorded

Scientific name	Common name	Duty under the Biosecurity Act 2015	Weed of national significance?
Alternanthera philoxeroides	Alligator Weed	Prohibition on dealings: Must not be imported into the State or sold. Biosecurity Zone: The Alligator Weed Biosecurity Zone is established for all land within the state except land in the following regions: Greater Sydney.	Yes
Anredera cordifolia	Madeira Vine	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Arundo donax	Giant Reed	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment.	No
Asparagus aethiopicus	Ground asparagus	Prohibition on dealings: Must not be imported into the State or sold.	Yes

Scientific name	Common name	Duty under the Biosecurity Act 2015	Weed of national significance?
Asparagus plumosus	Climbing Asparagus Fern	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Cestrum parqui	Green Cestrum	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment.	No
Chrysanthemoides monilifera subsp. *rotundata*	Bitou Bush	Prohibition on dealings: Must not be imported into the State or sold. Biosecurity Zone: The Bitou Bush Biosecurity Zone is established for all land within the State except land within 10 kilometres of the mean high water mark of the Pacific Ocean between Cape Byron in the north and Point Perpendicular in the south (includes the study area).	Yes
Cortaderia selloana	Pampas Grass	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. The plant should not be bought, sold, grown, carried or released into the environment. This Regional Recommended Measure applies to *Cortaderia jubata* (pink pampas grass).	No
Lantana camara	Lantana	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Olea europaea subsp. *cuspidata*	African Olive	Regional Recommended Measure: The Greater Sydney region is classified as the core infestation area. Whole region: The plant or parts of the plant are not traded, carried, grown or released into the environment. Core infestation area: Land managers prevent spread from their land where feasible. Land managers reduce impacts from the plant on priority assets.	No
Opuntia sp.	Prickly Pear	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Rubus fruticosus agg.	Blackberry	Prohibition on dealings: Must not be imported into the State or sold.	Yes
Senecio madagascariensis	Fireweed	Prohibition on dealings: Must not be imported into the State or sold.	Yes

5.5 Threatened ecological communities

Two threatened ecological communities listed under the BC Act were recorded within the study area. These are:

- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

The conservation status of each threatened ecological community, associated PCT, condition and extent within the project site is provided in Table 5.7.

Table 5.7 A summary of threatened ecological communities listed under the BC Act recorded within the study area

Threatened ecological community	Status	Vegetation type	Vegetation zone	Extent in project site
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	VZ1 Moderate condition	0.1
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	VZ2 Poor condition	0.46
			VZ3 Low condition	0.16
			Total	**0.72**

Note: E= listed as an endangered species under the BC Act

A description of each threatened ecological community with specific details of how each PCT meets each element of the scientific determination, including characteristic species, details of the soils and geology associated with the listing is provided in Table 5.8 and Table 5.9. The location of each threatened ecological community in relation to the project site is provided in Figure 6.1.

Table 5.8 Comparison of BC Act-listed Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions final determination criteria and associated PCT 1071

TEC & PCT	Bioregion	Landform and altitudinal range	Soil / geology	Structure	Species assemblage	Condition threshold
Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	North Coast, Sydney Basin and South East Corner bioregions	Associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands.	Typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains.	The structure of the community may vary from sedgelands and reedlands to herbfields, and woody species of plants are generally scarce. Typically dominated by herbaceous plants and have very few woody species.	There are 66 characteristic species listed for this community. The total species list of the community is larger with many species present at a small number of sites or in low abundance.	There is no condition threshold described for this community in the determination.
PCT 1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Sydney Basin	Recorded within freshwater tributaries (Mill Stream) and semi-permanent inundated coastal wetland areas.	Recorded in silt soils in moist alluvial depressions within a coastal floodplain associated with Botany Bay.	Both occurrences of this vegetation type were recorded as reedlands dominated by *Typha orientalis*.	Native species richness is relatively low (Q3:6, Q4:6) although native cover is close to benchmark (Table 5.3).	The recorded vegetation has a vegetation integrity score of 65.2 and is considered to meet this threatened ecological community listing.
Comparison	Meets criterion	Meets criterion	Meets criterion	Meets criterion	Meets criterion	Meets criterion

Table 5.9 Comparison of BC Act-listed Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions final determination criteria and associated PCT 1234

TEC & PCT	Bioregion	Landform and altitudinal range	Soil / geology	Structure	Species assemblage	Condition threshold
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Threatened Ecological Community	North Coast, Sydney Basin and South East Corner bioregions	It generally occupies low-lying parts of floodplains, alluvial flats, drainage lines, lake margins and fringes of estuaries; habitats where flooding is periodic and soils show some influence of saline ground water.	Alluvium; silts, clay-loams and sandy loams.	The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees.	Dominated by a tree canopy of either *Casuarina glauca* or, more rarely, *Melaleuca ericifolia* with or without subordinate tree species; the relatively low abundance of Eucalyptus species; and the prominent groundcover of forbs and graminoids. There are 45 characteristic species listed for this community. The total species list of the community is larger with many species present at a small number of sites or in low abundance.	There is no condition threshold described for this community in the determination.
PCT 1234 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Sydney Basin	Much of the extent of this vegetation type occurs on low lying areas associated with the historic Botany Bay floodplain. Areas of fill and landscape plantings have altered most of these patches although each patch is considered to have a groundwater connection to the surrounding floodplain.	Associated with alluvial flats, drainage lines and areas of fill connected with Mill Stream and the broader Botany Bay floodplain.	The structure of poor condition class vegetation was recorded as open forest whilst low condition vegetation was recoded as regenerating with scattered trees.	Tree canopy dominated by *Casuarina glauca.*	All condition class vegetation was considered to meet this threatened ecological community listing.
Comparison	Meets criterion	Meets criterion	Meets criterion	Meets criterion	Meets criterion	Meets criterion

5.6 Groundwater dependent ecosystems

Communities of potential groundwater dependent ecosystems (GDEs) are identified based on a review of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources (NSW Government 2011) and the BOM (2018b) Groundwater Dependent Ecosystems Atlas. Parts of the Botany Wetlands north-east of Wentworth Avenue (over 1 kilometre upstream of the project site) are mapped as an aquatic GDE, while small patches of native vegetation associated with the Botany Wetlands, including some near the project site, are mapped as terrestrial GDEs (BOM 2018b).

The Botany Sand Beds Aquifer is a large subterranean GDE that extends from Botany Bay northwards to Surry Hills and Centennial Park (BOM 2018b). It is relatively shallow (1–2 metres below the surface), and has been an important groundwater source for the area for many decades. Due to the permeability of the sands, shallowness of the aquifer and a long history of industry in many parts of the aquifer's catchment, the Botany Sand Beds Aquifer has been and continues to be, highly vulnerable to contamination (Bayside Council 2019).

It is likely that patches of Swamp Oak forest in the project site are dependent on groundwater to some degree, given the BOM (2018b) mapping of other patches of this vegetation nearby as being groundwater dependent. Mill Stream and its associated riparian vegetation is contaminated from the Botany Sand Beds Aquifer. Groundwater samples collected within the project area as part of the specialist assessment undertaken for this project, found manganese levels exceeded the *ANZECC Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) and arsenic which exceeded the *US EPA RSL – May 2016 – Tapwater criteria*. PFOS concentrations above the *Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Pla*n criteria have been reported in surface water samples collected from Mill Pond (Refer to *Technical Report 8 – Surface Water Impact Assessment* for further details).