Moorebank Intermodal Terminal Project Environmental Impact Statement

Volume 4

October 2014

Technical Paper 3
Ecological Impact Assessment (with associated Biodiversity Offset Strategy)

Technical Paper 3 – Ecological Impact Assessment (with associated Biodiversity Offset Strategy)

Contents of the EIS

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Moorebank Intermodal Terminal – Ecological Impact Assessment

September 2014

Moorebank Intermodal Company

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Approved by: Paul Greenhalgh

Signed:

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Glossary

Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ genetic diversity – the variety of genes (or units of heredity) in any population ▪ species diversity – the variety of species ▪ ecosystem diversity – the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. For this study this is the Sydney Basin bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
Biosecurity	'Biosecurity' is protecting the economy, environment and people's health from pests and diseases. It includes trying to prevent new pests and diseases from arriving, and helping to control outbreaks when they do occur (Commonwealth Department of Agriculture Fisheries and Forestry 2012).
Construction footprint	The extent of direct impacts and any additional areas that could potentially be affected by the Project either directly or indirectly.
Critical Habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered Ecological Community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under either the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999* and both the state (Office of Environment and Heritage) and Commonwealth (Department of Sustainability, Environment, Water, Population and Communities) maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant state and Commonwealth legislation.
(Commonwealth) Department of Environment (DoE)	The Department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the *Environment Protection and Biodiversity Conservation Act 1999*. The Commonwealth Department of Environment was previously known as: ▪ Department of Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) ▪ Department of the Environment, Water, Heritage and the Arts (DEWHA) ▪ Department of Environment and Heritage (DEH) ▪ Department of the Environment and Water Resources (DEWR).
(NSW) Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS)	This Department aims to attract investment to NSW and support innovative, sustainable and globally competitive industries through technical knowledge. The department includes forestry and fisheries and administers the Fisheries Management Act 1994. Formerly known as: ▪ Department of Industry and Investment ▪ Department of Primary Industries.
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*(Commonwealth)
Exotic	Introduced from outside the area (Royal Botanic Gardens 2011). Used in the context of this report to refer to species introduced from overseas.
Fauna furniture	Items such as logs suspended off the ground to encourage arboreal wildlife to use underpasses and provide animals a degree of protection from ground-dwelling predators such as foxes.
FM Act	*Fisheries Management Act 1994*(NSW)

GPS	Global Positioning System - a navigational tool which uses radio receivers to pick up signals from four or more special satellites to provide precise determination of location.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.
Indigenous	Native to the area; not introduced (Royal Botanic Gardens 2011).
Introduced	Not native to the area; not indigenous (Royal Botanic Gardens 2011). Refers to both exotic and non-indigenous Australian native species of plants and animals.
Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key threatening processes are listed under the *Environment Protection and Biodiversity Conservation Act 1999,* the *Threatened Species Conservation Act 1995*, and the *Fisheries Management Act 1994*. Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004).
Local population	The population that occurs within the site, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated as defined by Department of Environment and Climate Change (2007c).
Locality	The area comprising the site and surrounding lands within approximately 5 km.
Long term	Taken to be a period exceeding 20 years; a period likely to encompass five or more generations of threatened species affected by the proposal and to equal or greater than or to the natural frequency of major disturbance events such as and/or floods. Long-term impacts have the greatest potential to significantly affect the viability of occurrences of threatened biodiversity.
Medium term	Taken to be a period of 10–20 years; a period likely to encompass three to five generations of threatened species affected by the proposal and to approximate the natural frequency of major disturbance events such as fires and/or floods. Medium-term impacts have greater potential to significantly affect the viability of occurrences of threatened biodiversity than short-term impacts.
Migratory species	Species listed as Migratory under the EPBC Act relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the EPBC Act.
Noxious weed	An introduced species listed under the *Noxious Weeds Act 1993*. Under the Act, noxious weeds have specific control measure and reporting requirements.
(NSW) Office of Environment and Heritage (OEH)	Following the 2011 NSW elections, the Department of Environment, Climate Change and Water was abolished as a Division of the Government Service and was added to the NSW Department of Premier and Cabinet, as the Office of Environment and Heritage. Broadly, the Office of Environment and Heritage works towards a healthy environment cared for and enjoyed by the whole NSW community: manages the state's natural resources, including biodiversity, soils and natural vegetation: manages natural and cultural heritage across the state's land: acts to minimise the impacts of climate change: promotes sustainable consumption, resource use and waste management: regulates activities to protect the environment: and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making. Previously known as: ▪ Department of Environment, Climate Change and Water (DECCW) ▪ Department of Environment and Climate Change (DECC)

	▪ Department of Environment and Conservation (DEC).
Priorities Action Statements (PAS)	Priorities Action Statements outline the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of threatened species, population and ecological communities and manage key threatening processes (Department of Environment and Climate Change 2007a).
IMT site	Encompasses the construction footprint and adjoining areas within the locality that could potentially be indirectly affected by the proposal.
Propagule	A structure with the capacity to give rise to a new plant, e.g. (1) a seed, (2) part of the vegetative body capable of independent growth if detached from the plant (Royal Botanic Gardens 2011).
Project site	Defined as the entire area occupied by the IMT and rail access at the full build stage and lands to be utilised for construction purposes. Includes the IMT site and rail access options as defined below. The entire area directly impacted by the Project.
Protected species	Those species defined as protected under the NSW *National Parks and Wildlife Act 1974*. Includes all native animals, as well as all native plants listed on Schedule 13 of the *National Parks and Wildlife Act 1974*.
Recovery plan	A plan prepared under the *Environment Protection and Biodiversity Conservation Act 1999,* the *Threatened Species Conservation Act 1995*, and the *Fisheries Management Act 1994* to assist the recovery of a threatened species, population or ecological community.
Short term	Taken to be a period of 0–10 years; a period likely to be no more than twice the average generation time of threatened species affected by the proposal and less than the natural frequency of major disturbance events such as fires and/or floods. Short-term impacts are less likely to significantly affect the viability of occurrences of threatened biodiversity.
Significant	Important, weighty or more than ordinary as defined by Department of Environment, Climate Change and Water (2007c). A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of the Environment Water Heritage and the Arts 2009).
Threatened biodiversity	Threatened species, populations or ecological communities as listed under the *Environment Protection and Biodiversity Conservation Act 1999,* the *Threatened Species Conservation Act 1995*, and the *Fisheries Management Act 1994*.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as threatened) under the *Environment Protection and Biodiversity Conservation Act 1999,* the *Threatened Species Conservation Act 1995*, and the *Fisheries Management Act 1994*. Capitalisation of the terms 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation.
TSC Act	*Threatened Species Conservation Act 1995*(NSW).
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change 2007c).
Weed	A plant growing out of place or where it is not wanted; often characterized by high seed production and their ability to colonise disturbed ground quickly (Royal Botanic Gardens 2011). Weeds include both exotic and Australian native species of plant naturalised outside of their natural range.

1. Project overview

The Moorebank Intermodal Terminal (IMT) Project (the Project) involves the development of approximately 220 hectares (ha) of land at the IMT site(refer to Figure 1.1) for the construction and operation of an IMT and associated infrastructure, facilities and warehousing. The Project includes a rail link connecting the IMT site to the Southern Sydney Freight Line (SSFL) and road entry and exit points from Moorebank Avenue.

For the purposes of this assessment, the following definitions apply:

- *Project site* - defined as the entire area occupied by the IMT and rail access at the full build stage and lands to be utilised for construction purposes. Includes the IMT site and rail access options as defined below.
- *IMT site* – defined as all lands within the Project site to the east of the Georges River excluding the rail access crossings of the river and associated riparian lands.
- *Rail access options* – defined as the land occupied by the rail connection options between the SSFL and the IMT site and associated lands to be utilised for construction purposes.

The primary function of the IMT is to be a transfer point in the logistics chain for shipping containers and to handle both international IMEX cargo, and domestic interstate and intrastate (regional) cargo. The key aims of the Project are to increase Sydney's rail freight mode share including: promoting the movement of container freight by rail between Port Botany and western and south-western Sydney; and reducing road freight on Sydney's congested road network.

The Project proponent is Moorebank Intermodal Company (MIC), a Government Business Enterprise set up to facilitate the development of the Project.

The IMT site is currently largely occupied by the Department of Defence's (Defence) School of Military Engineering (SME). Under the approved Moorebank Units Relocation (MUR) Project, the SME is planned to be relocated to Holsworthy Barracks by mid-2015, which would enable the construction of the Project to commence.

The key features/components of the Project comprise:

- *an IMEX freight terminal* – designed to handle up to 1.05 million TEU per annum (525,000 TEU inbound and 525,000 TEU outbound) of IMEX containerised freight to service 'port shuttle' train services between Port Botany and the Project;
- *an Interstate freight terminal* – designed to handle up to 500,000 TEU per annum (250,000 TEU inbound and 250,000 TEU outbound) of interstate containerised freight to service freight trains travelling to and from regional and interstate destinations; and
- *warehousing facilities* – with capacity for up to 300,000 square metres (m^2) of warehousing to provide an interface between the IMT and commercial users of the facilities such as freight forwarders, logistics facilities and retail distribution centres.

The proposal concept described in the EIS (refer Chapters 7 and 8) provides an indicative layout and operational concept for the Project, while retaining flexibility for future developers and operators of the Project. The proposal concept is indicative only and subject to further refinement during detailed design.

1.1 Rail access options and layouts

The Project is intended to connect to the SSFL, which was commissioned in January 2013 within the Main South Railway Line corridor. The SSFL connects Port Botany to west and south-western Sydney, and would provide a direct route for freight trains from Port Botany to the IMT site.

Three separate rail access options are included as part of the proposal concept as detailed in the main body of the EIS and shown in Figure 1.1. These options comprise:

- *northern rail access option* — with rail access from the north-western corner of the IMT site, passing through the former Casula Powerhouse Golf Course (which is currently owned by Liverpool City Council (LCC)) and crossing the Georges River and floodplain;
- *central rail access option* — with rail access from the centre of the western boundary of the IMT site, passing through Commonwealth land on the western bank of the Georges River (referred to as the ‘hourglass land’); and
- *southern rail access option* — rail access from the south-western corner of the IMT site, passing through the Glenfield Landfill site (owned by Glenfield Waste Services) and crossing the Georges River and floodplain.

In order to maintain flexibility for future developers and operators of the Project, the proposal concept, as presented in the main body of the EIS, provides three indicative IMT internal layouts; one for each of three proposed rail access options. Once the selected developer/operator has been appointed, the Project would progress to the detailed design phase and one of the three rail access options identified above would be selected.

1.2 Indicative Project development phasing

The Project is proposed to be phased (staged) in its development, as summarised in Figure 1.2. The proposed indicative phasing includes both construction and operational phases, which are likely to overlap at certain times. For the purposes of assessment of the Project, five project development phases have been identified and detailed in the main body of the EIS. These are indicative only, but illustrate the type of construction and operation activities that would occur over time at the Project site.

The Project would likely commence in 2015 with the Early Works development phase and would progress with concurrent construction and operation through to the Project Full Build Phase (operation of full IMEX terminal, warehousing and interstate terminal) by approximately 2030.

The development phasing is proposed in line with the forecast market demand for processing of containers through the Project parts (refer Figure 1.2).

1.3 Road access to the site

Freight trucks would access the IMT site from Moorebank Avenue, via the M5 Motorway. Trucks would then access the M7 Motorway and Hume Highway by the M5 Motorway. An upgrade to Moorebank Avenue would be included as part of the first phase of Project development (Project Phase A) to enable safe and efficient access to the IMT site.

1.4 Conservation area

The Project would maintain and enhance riparian vegetation between the Georges River, at least to the 100 year flood level, as a dedicated conservation area to be established during the Early Works stage. With the exception of the rail link to SSFL, associated Georges River bridge and the establishment of stormwater drainage channels, no further development is proposed in this area. The exact size and configuration of the conservation area will be dependent on which rail access option is chosen; however, it will extend along the Georges River between the East Hills Rail Line in the south and the ABB medium voltage production facility in the north and will be approximately 2.5 kilometres in length. It will be in excess of 25 metres in width throughout its length and may be up to 270 metres wide in parts (refer Figure 1.3, Figure 1.4 and Figure 1.5).

The conservation area would comprise vegetation that is to be retained and areas which are currently weed infested, which require rehabilitation. In addition, it would involve extensive replanting of areas within the riparian zone that have been previously cleared.
The preservation of the riparian vegetation as a conservation area would maintain the capacity of riparian lands to provide connectivity between wildlife habitats thereby functioning as a wildlife corridor and would contribute to the biodiversity offset package for the Project. Further, the conservation area would, over time, potentially provide visual screening to the Project operations to alleviate impact on neighbouring residences in the Casula area.

The Project would utilise the opportunity to commence early rehabilitation and supplementary planting of local species in the conservation area.

1.5 Planning and environmental approvals

The Project is subject to both Commonwealth and NSW State Government approvals, and this Environmental Impact Statement (EIS) has been prepared to support applications for both approvals (EPBC number 2011/6086 and SSD-5066). The Project is a ‘controlled action’ under the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Therefore, MIC is seeking approval for the construction and operation of the Project from the (Commonwealth) Department of the Environment (DoE) under Part 9 of the EPBC Act.

Under the (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act), MIC is seeking a staged development approval for the Project as State significant development (SSD). At this stage, MIC is seeking Stage 1 SSD approval for the proposal concept (as described in the EIS) from NSW Department of Planning and Environment (NSW DP&E) under Part 4, Division 4.1 of the EP&A Act (hereafter referred to as the Stage 1 SSD approval). The Stage 1 SSD development approval application also includes a package of 'Early Works' that comprises remediation, clean-up and demolition or relocation of existing buildings, and establishment of a conservation area. This EIS is seeking approval for these Early Works without the need for any further approvals. Subject to Stage 1 SSD approval being received, the Project (with the exclusion of the Early Works) will be subject to further development applications and environmental assessment under the EP&A Act (hereafter referred to as the Stage 2 SSD approvals).

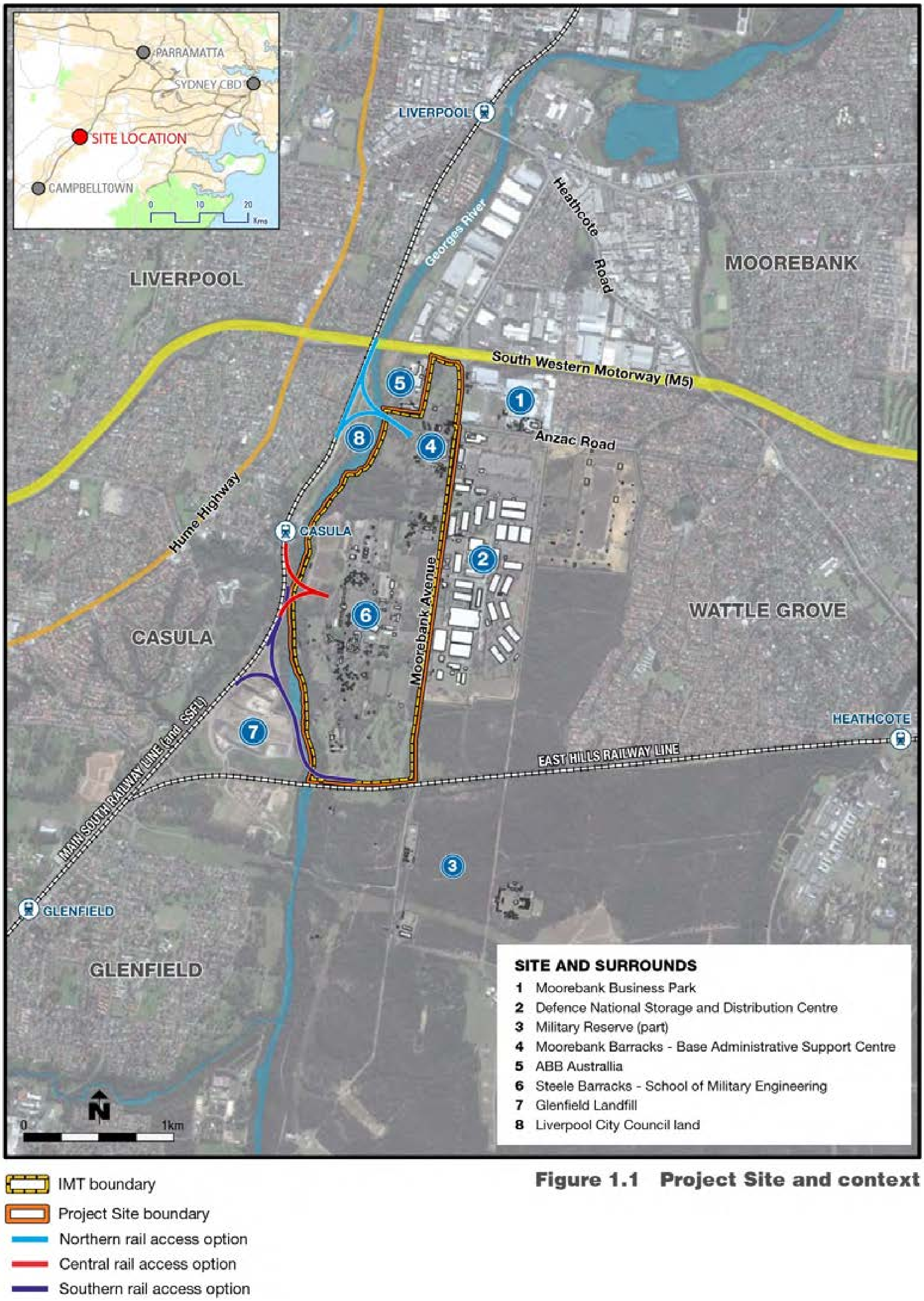

Figure 1.1 Project Site and context

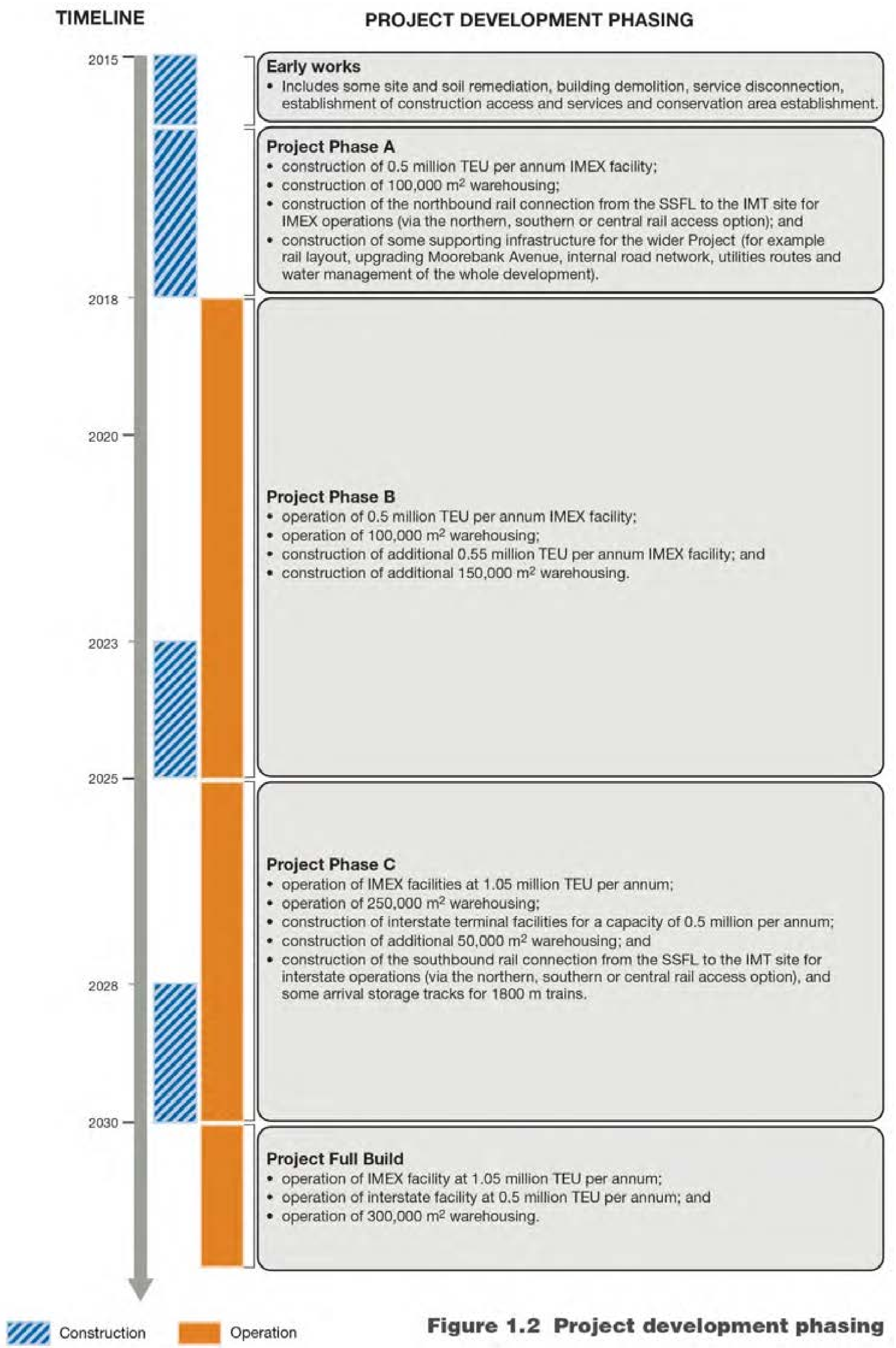

Figure 1.2 Project development phasing

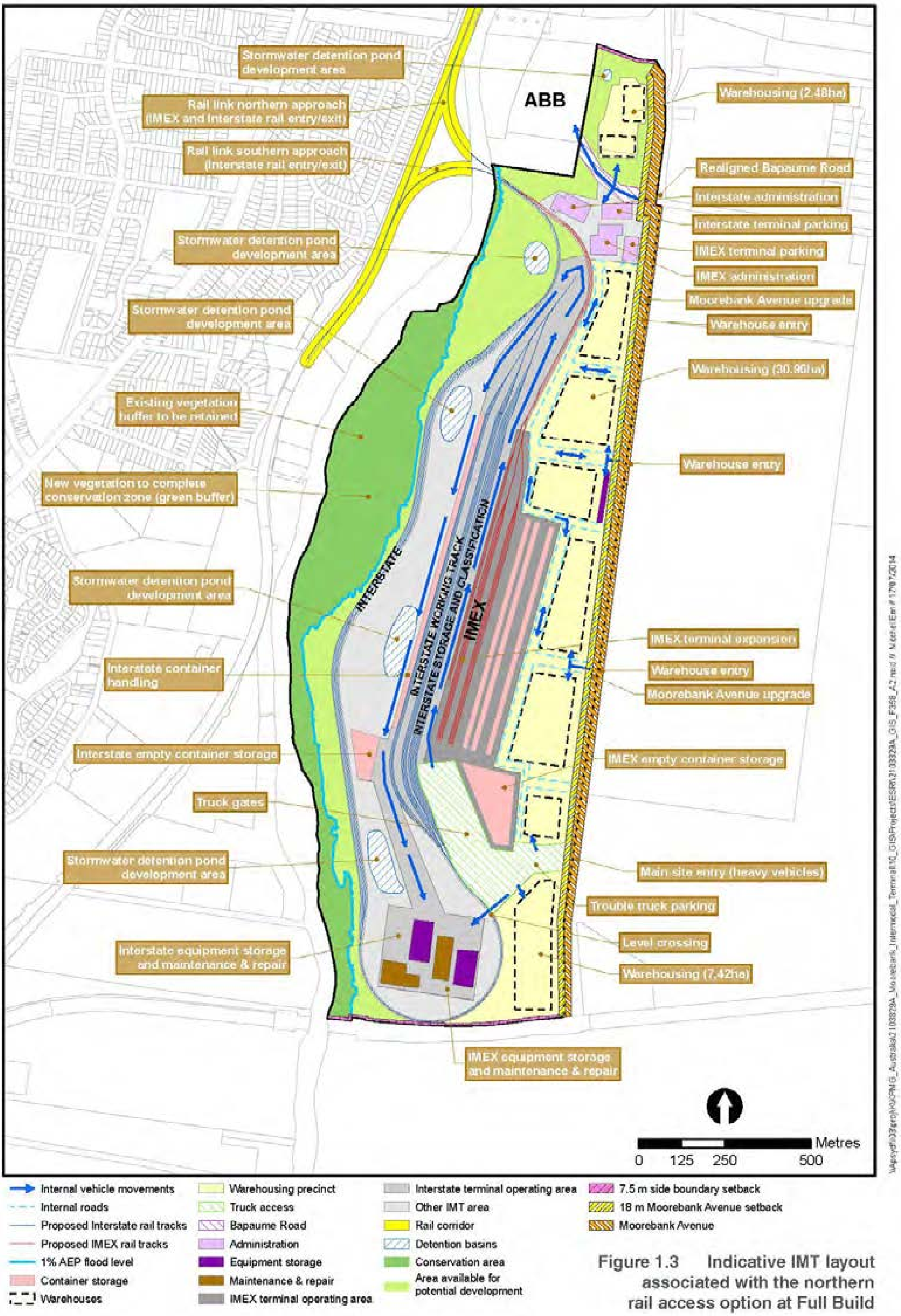

Figure 1.3 Indicative IMT layout associated with the northern rail access option at Full Build

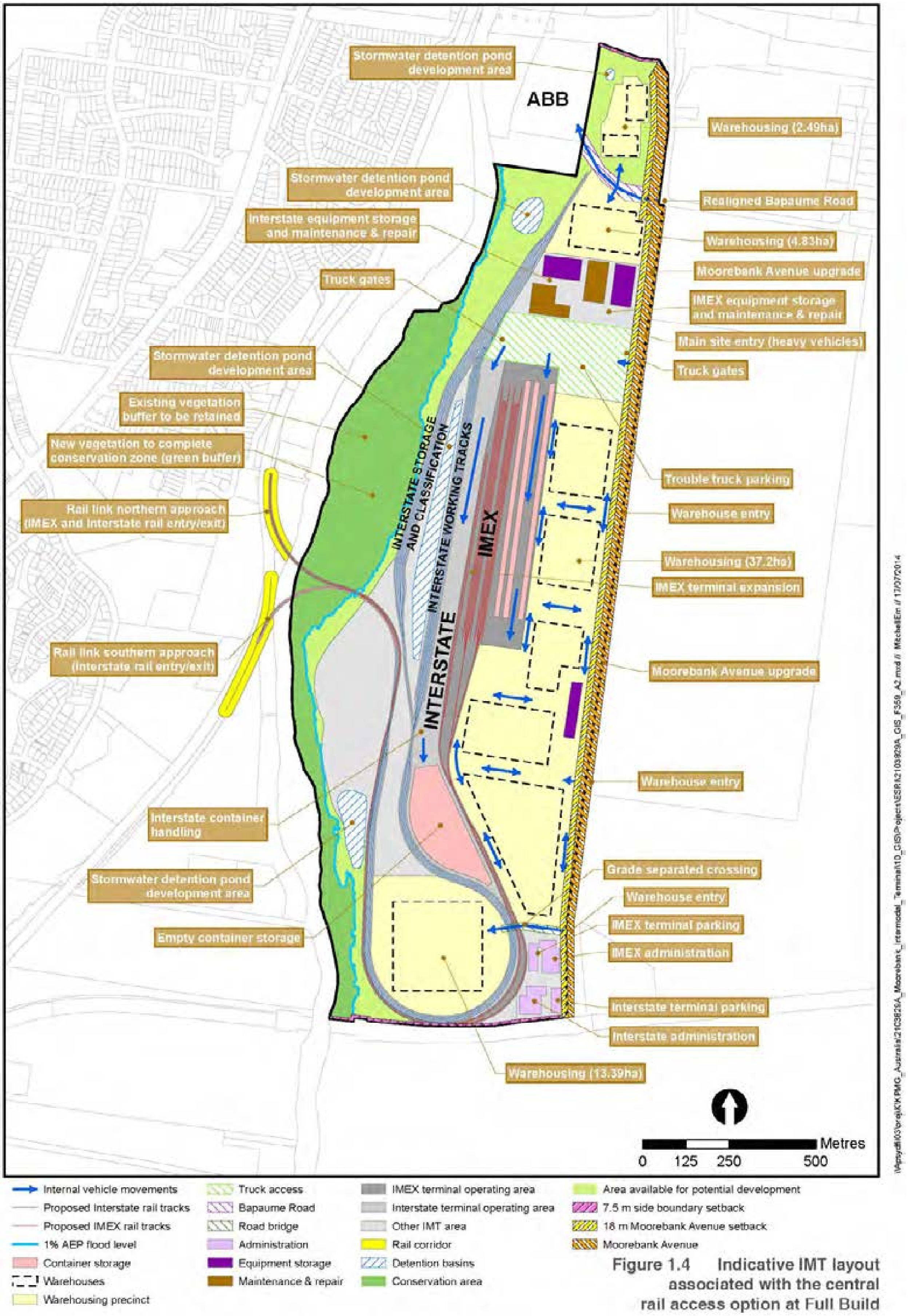

Figure 1.4 Indicative IMT layout associated with the central rail access option at Full Build

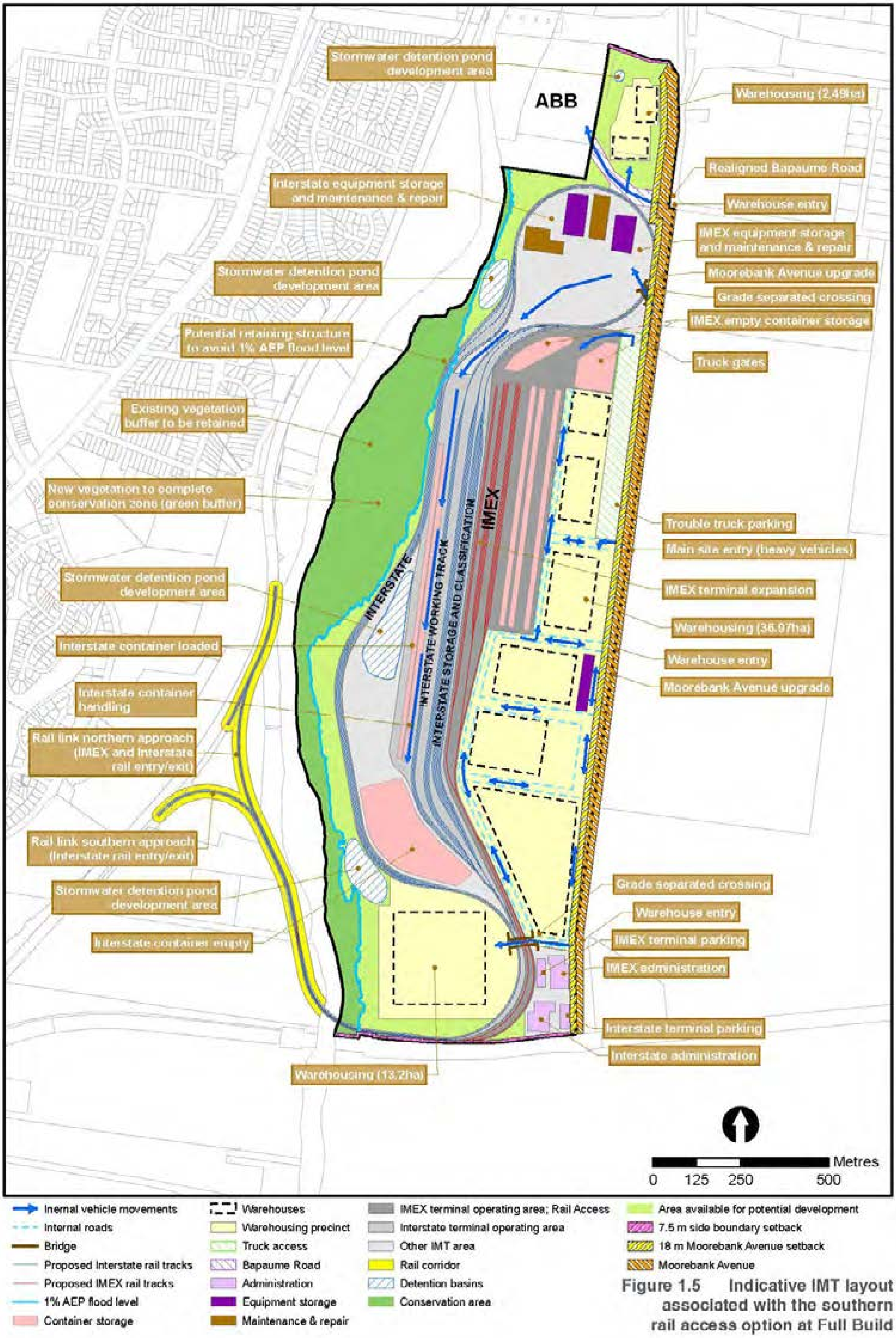

Figure 1.5 Indicative IMT layout associated with the southern rail access option at Full Build

2. Scope and methodology

2.1 Environmental impact assessment requirements

This Technical Paper addresses biodiversity impact assessment requirements of both the Commonwealth Government under the EPBC Act (the 'Final EIS Guidelines'); and the NSW Government under the EP&A Act ('the Secretary's Environmental Assessment Requirements (SEARs)'.

Specifically this technical paper addresses the requirements outlined in the Table 2.1.

Table 2.1 EIS requirements addressed within this technical paper

Requirement	Where addressed in the technical paper
EPBC Act – Final EIS Guidelines	
Information on the abundance, distribution, ecology and habitat preferences of the species or communities.	Section 3
Discussion of the known threats to the species or communities, with reference to threats posed by the proposed action.	Section 4
Details of surveys for these species and communities and their habitat in the proposed action area or surrounding areas.	Section 2
An assessment of the quality and importance of potential habitat for these species and communities in the proposed action area and surrounding areas.	Section 3
The presence of formal or informal conservation reserves for these species or communities within the proposed action area or surrounding areas.	Section 3.1 Section 6.4
For all species and communities that are considered unlikely to be impacted by the proposed action, but for which apparently suitable habitat is present and could be impacted by the proposed action, detailed information to demonstrate that impacts on the species are unlikely to occur.	Section 3, Section4 Appendix B
Discussion of the potential impacts on the above species and communities of pest species, disease and fire outbreaks generated by the proposed action.	Section 4
Consideration of each species or community must have regard to any recovery plan prepared by the Commonwealth, NSW or other state government, in relation to the species, and any publicly available policy statement or conservation advice approved by the minister in relation to the species or community.	Appendix C Appendix D
Provide a local and regional scale analysis of the likely impacts of the action to biodiversity.	Section 4

Requirement	Where addressed in the technical paper
Provide a description of proposed environmental offset measures, including a proposed strategy to offset any impacts of the proposed action on matters of national environmental significance. The proposed strategy must: ▪ demonstrate how it will achieve long-term conservation outcomes; and ▪ have regard to the scale and intensity of impact from the development on the site.	Section 3.4 Appendix F
NSW EP&A Act – SEARs	
▪ Assessment of the biodiversity values of the site and adjoining areas, (particularly the Georges River and its riparian areas), including terrestrial and aquatic flora, fauna, habitat and corridors;	Section 3
▪ An impact assessment of threatened terrestrial and aquatic (including groundwater dependent) species, populations and endangered ecological communities and/or critical habitat under both State and Commonwealth legislation, including the Cumberland Plain Woodland;	Section 3 Section 4 Section 5 Appendix C Appendix D
▪ Ecological surveys in accordance with the relevant State and Commonwealth survey guidelines commensurate with the biology/ecology of species and extent of habitat within and adjacent to the development site;	Section 2
▪ Vegetation clearing (resultant foraging, nesting, roosting and habitat loss and fragmentation, weed and edge effects) and operational impacts;	Section 4
▪ Identification of riparian corridors to be established on the site and details of the riparian area to be rehabilitated along the Georges River and Anzac Creek;	Section 1.3.1 Section 6 Appendix E Appendix F
▪ A strategy to offset unavoidable, residual ecological impacts and native vegetation clearance, consistent with the 'improve and maintain' principle of the NSW Bio-banking policy, and including an offset strategy for any impacts of the development on matters of environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999* and the EPBC Environmental Offsets Policy (October 2012) and on threatened species and endangered ecological communities and/or critical habitat under the *Threatened Species Conservation Act 1995*. The proposed strategy must demonstrate how it meets each of the overarching principles of State and Commonwealth offset policy to achieve long term conservation outcomes; and	Section 6.4 Appendix E Appendix F
▪ Taking into account the *Threatened Species Assessment Guidelines* (DECC 2007), *Fish Passage Requirements for Waterway Crossing Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI), *Threatened Biodiversity Survey* and *Assessment, Guidelines for Developments and Activities* (DEC), *Principles for the Use of Biodiversity Offsets in NSW* (DECCW), Commonwealth EIS guidelines (EPBC 2011/6086, as revised), Significant Impact Guidelines, information on listed ecological communities and listed species, survey guidelines for nationally threatened species and *Environmental Offsets Policy* (SEWPaC 2012).	Section 2 Section 3.8 Section 6.3.6

2.2 Biodiversity impact assessment

This Technical Paper describes the flora, fauna and biodiversity values of the Project site and locality, including species, habitats and vegetation communities. The integrity of the ecological values is described along with any listing under Commonwealth or State threatened species legislation. The report presents baseline biodiversity values for the site, as recorded at the time of writing. It is based on a desktop assessment of current vegetation mapping and biodiversity databases relevant to the Project and surrounds, as well as field surveys to confirm the desktop results.

The report examines flora and fauna assemblages and their habitats and identifies impacts on biodiversity associated with the construction and operation of the Project.

It summarises the proposed mitigation and offset measures and provides assessments of significance required under the Commonwealth EPBC Act and the NSW EP&A Act.

A summary of the survey and assessments completed for the Technical Paper are provided below in Table 2.2

Table 2.2 Summary of survey and assessments

Date	site	Purpose
October 2010, August 2012 and May 2014	Project site	Desktop studies
November 2010	IMT site	A detailed field investigation
February 2013	Central and northern rail access options	A detailed field investigation
May 2014	IMT site, central and northern rail access options	A detailed field investigation to quantify offset requirements in accordance with BBAM
September 2014	IMT site and Wattle Grove offset area	Targeted threatened species survey

Due to access restrictions to the western bank of the Georges River in the Glenfield Waste Services land the assessment of the impacts of the southern rail access option was based on desktop assessment and a review of the results of the ecological assessment for the proposed SIMTA intermodal terminal by Hyder Consulting (2012).

2.3 Nomenclature

Names of vegetation communities used in this report are based on the dominant species and structure of the relevant communities. The names used for vegetation communities in this report follow those used in a study by Tozer (2003). These names are cross-referenced with those of the Office of Environment and Heritage's (OEH's) vegetation types database (Department of Environment Climate Change and Water 2008) used in BioMetric 2.0 (Gibbons *et al.* 2008) and, where applicable, names of Threatened ecological communities listed under the *Threatened Species Conservation Act 1995*('TSC Act') and/or the EPBC Act.

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with reference to PlantNet (Royal Botanic Gardens 2012) for recent taxonomic changes. Scientific names are used in this report for species of plant. Scientific and common names (where available) are provided in the plant species inventory in Appendix A. The names of introduced species are denoted with an asterisk(*).

Names of vertebrate fauna follow the Census of Australian Vertebrates (CAVS) database maintained by the Department of Sustainability Environment Water Population and Communities(2012a). Common names are used in the report for species of animal. Scientific names are included in the animal species inventory.

For Threatened species, the names used on the OEH's Threatened species website (Office of Environment and Heritage 2012b)and/or the Species Profile and Threats Database (Department of Sustainability Environment Water Population and Communities 2012c)are also provided in species inventories where these differ from the names used by Harden, the PlantNet database and the CAVS database.

2.4 Study team

The contributors to the preparation of this paper, their qualifications and roles are listed in Table 2.3.

Table 2.3 Study team

Name	Qualification	Role
Dr. Martin Predavec	BSc (Hons), PhD	Technical Executive –report review
Alex Cockerill	BSc, Hons	Principal Ecologist – report review
Lukas Clews	BSc, GradCertAppSci	Botanist/Ecologist – field surveys, report preparation
Paul Rossington	BSc, GradDipWldMgt	Botanist/Ecologist – field surveys, report preparation
Tanya Bangel	BSc, Hons	Botanist/Ecologist – field surveys, report preparation
Deborah Landenberger	BSc, Hons	Botanist/Ecologist – Biobanking field surveys
Mark Stables	BSc, Hons	Senior Ecologist – field surveys, report preparation

2.5 Desktop study

Records of species, including Threatened species, known or predicted to occur within the Project locality were obtained from a range of standard ecological databases as detailed inTable 2.4. The database searches for the Project were completed in 2010 and repeated in 2012 and 2014. Available literature was reviewed, including regional assessments and ecological surveys of the Project site and locality, including:

- topographic maps and aerial photographs of the Moorebank area
- broad-scale vegetation mapping projects that cover the Project site(Tozer 2003; Tozer *et al.* 2006); and

- previous ecology surveys covering the Project site (e.g. URS 2004, Hyder Consulting (2012)).

Table 2.4 Database searches

Database	Search dates	Area searched[1]	Source
EPBC Act Protected Matters Search Tool	7 October 2010 20 August 2012 5 June 2014	[1]Locality	Department of Sustainability Environment Water Population and Communities(2010b, 2012b; Department of the Environment 2014)
Threatened species, populations and communities database	7 October 2010 20 August 2012 5 June 2014	Sydney Metropolitan Catchment Management Area, Sydney Cataract subregion	Department of Environment Climate Change and Water (DECCW) (2010e)[2] OEH (2012b, 2014b)
BioNet Atlas of NSW Wildlife	7 October 2010 20 August 2012 5 June 2014	[1]Locality	DECCW(2010a) OEH (Office of Environment and Heritage 2012a, 2014a)
PlantNet Database	7 October 2010 20 August 2012 5 June 2014	[1]Locality	Royal Botanic Gardens (2010, 2012, 2014)
Noxious Weeds Declaration Page	20 August 2012 5 June 2014	Liverpool Council Local Control Area	Department of Trade and Investment Regional Infrastructure and Services (2012a)
Threatened & protected species - records viewer (fish)	10 September 2012 5 June 2014	Liverpool Local Government Area, Sydney Metropolitan Catchment Management Authority region	Department of Trade and Investment Regional Infrastructure and Services (Department of Trade & Investment Region Infrastructure and Services 2014; 2012b)

n

1. Includes a 10 km x 10 km area around the centre of the IMT site(Latitude:-33.954 Longitude: 150.918).

2. DECCW is now the OEH within the Department of Premier and Cabinet

2.6 Field investigation

2.6.1 Field investigations on the IMT site

Field investigations were undertaken primarily to identify the species of terrestrial plant and animal occupying the IMT site and to assess the extent and condition of vegetation communities and habitats, especially for Threatened species (refer Figure 2.1, Figure 2.2). The floristic diversity and terrestrial vertebrate survey effort and design were designed and conducted in accordance with the SEWPAC *Survey Guidelines for Nationally Threatened Species*(Department of Sustainability Environment Water Population and Communities 2010a) and the NSW *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)*(Department of Environment and Conservation 2004) representing best practice methods.

The survey methods employed on the IMT site are described in section 2.6.3 to section 2.6.8.

Initial surveys of the IMT site were undertaken during daylight hours by a team of two ecologists over five consecutive days between 8 and 12 November 2010. Night surveys were conducted on 8, 10and 12 November 2010. The weather conditions on three of the five days were sunny and warm (maximum temperatures 28-30°C) with an afternoon thunderstorm and heavy afternoon/evening rainfall on 9 November 2010followed by a cooler day (maximum temperature 24°C) on 10November 2010.

The late spring timing of the initial surveys and the range of weather conditions experienced were optimal for the detection of animals such as microchiropteran bats, reptiles and frogs which are generally more active during warm conditions. The brief heavy rainfall experienced was particularly conducive to the detection of frogs. Conditions were suitable for the detection of all other animal species with the exception of winter migrants such as the Regent Honeyeater and Swift Parrot. The likely presence of such species was, therefore, based entirely on previous records and habitat assessment. The timing also coincided with the flowering period of a large proportion of local plant species and was therefore optimal for the identification plant communities and many of the threatened species of plant considered likely to occur.

Additional surveys have since been undertaken on the IMT site including:

- a tree hollow survey conducted in September 2011 to estimate the number of hollow-bearing trees likely to be affected by the Project
- nineteen additional vegetation and habitat assessment survey plot/transects conducted in May 2014 in accordance with the NSW biobanking survey methodology (BBAM) to quantify offset requirements.
- Targeted threatened species surveys in September 2014

2.6.2 Field investigations of the rail access options

Botanical survey and fauna habitat assessment of the land affected by the northern and the central rail access options was undertaken in February 2013 and May 2014. The survey methods used were consistent with that described for the IMT site as described in section 2.6.3 and section 2.6.7.

Due to access restrictions associated with the Glenfield Landfill site the assessment of the biodiversity values within the southern rail access option was limited to desktop investigations of existing mapping and previous reports and viewing from a distance with the aid of binoculars. While the presence or absence of threatened biodiversity in this area has not been verified through detailed fieldwork, these areas appear to be moderately to highly modified and hence have relatively low potential as habitat for most of the threatened biodiversity likely to occur in the locality.

2.6.3 Botanical survey

The floristic diversity, possible presence of Threatened species and the identity of vegetation communities was assessed using quadrat and random meander surveys.

Quadrat surveys involved the identification of all vascular plant species within selected 20 x 20 metre (m) areas representing each vegetation community present. Random meander transects were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a haphazard manner through the site. Attributes recorded during random meander transects included variation in species composition and vegetation structure, the presence or absence of Threatened and noxious species of plant and boundaries between vegetation communities.

The random meander surveys were used as a method of searching for Threatened species of plant undertaken in 13 locations throughout the IMT site covering all major native vegetation occurrences. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

Vegetation and habitat assessment was also conducted in May 2014, in accordance with the BBAM, to quantify offset requirements. This was supplemented by a targeted threatened species survey was conducted in September 2014 on both the IMT site and Wattle Grove offset area.

The following botanical survey effort (refer Table 2.5) was expended in search of Threatened species of plants, noxious weeds and in the identification of ecological communities and their boundaries. Survey locations are shown in Figure 2.2.

Table 2.5 Botanical field survey effort

Survey technique	Targeted species/population and communities	Effort expended
Random meander	Threatened plants, noxious weeds	45 person hours (13 locations, refer Figure 2-1)
Transects/ quadrats	Threatened plants, noxious weeds, Threatened ecological communities	17 person hours (seven locations)
BBAM survey	Threatened plants, noxious weeds, Threatened ecological communities	37.5 person hours (19 plots/transects)

2.6.4 Vegetation ecological integrity classification

The ecological integrity of vegetation was assessed through general observation and comparison against benchmark data for the described vegetation communities (e.g. NSW National Parks and Wildlife Service 2002a). Parameters such as intactness, diversity, history of disturbance, weed invasion and health were also assessed. Three categories were used to describe the ecological integrity of vegetation communities:

- Good: Vegetation still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation has usually changed very little over time and displays resilience to weed invasion due to intact groundcover, shrub and canopy layers.
- Moderate: Vegetation generally still retains its structural integrity, but has been disturbed and has lost some component of its original species complement. Weed invasion can be significant in such remnants.
- Poor: Vegetation that has lost most of its species and is significantly modified structurally. Often such areas have a discontinuous canopy of the original tree cover, with very few shrubs. Exotic species, such as introduced pasture grasses or herbaceous weeds, replace much of the indigenous groundcover. Environmental weeds are often dominant or co-dominant with the original indigenous species.

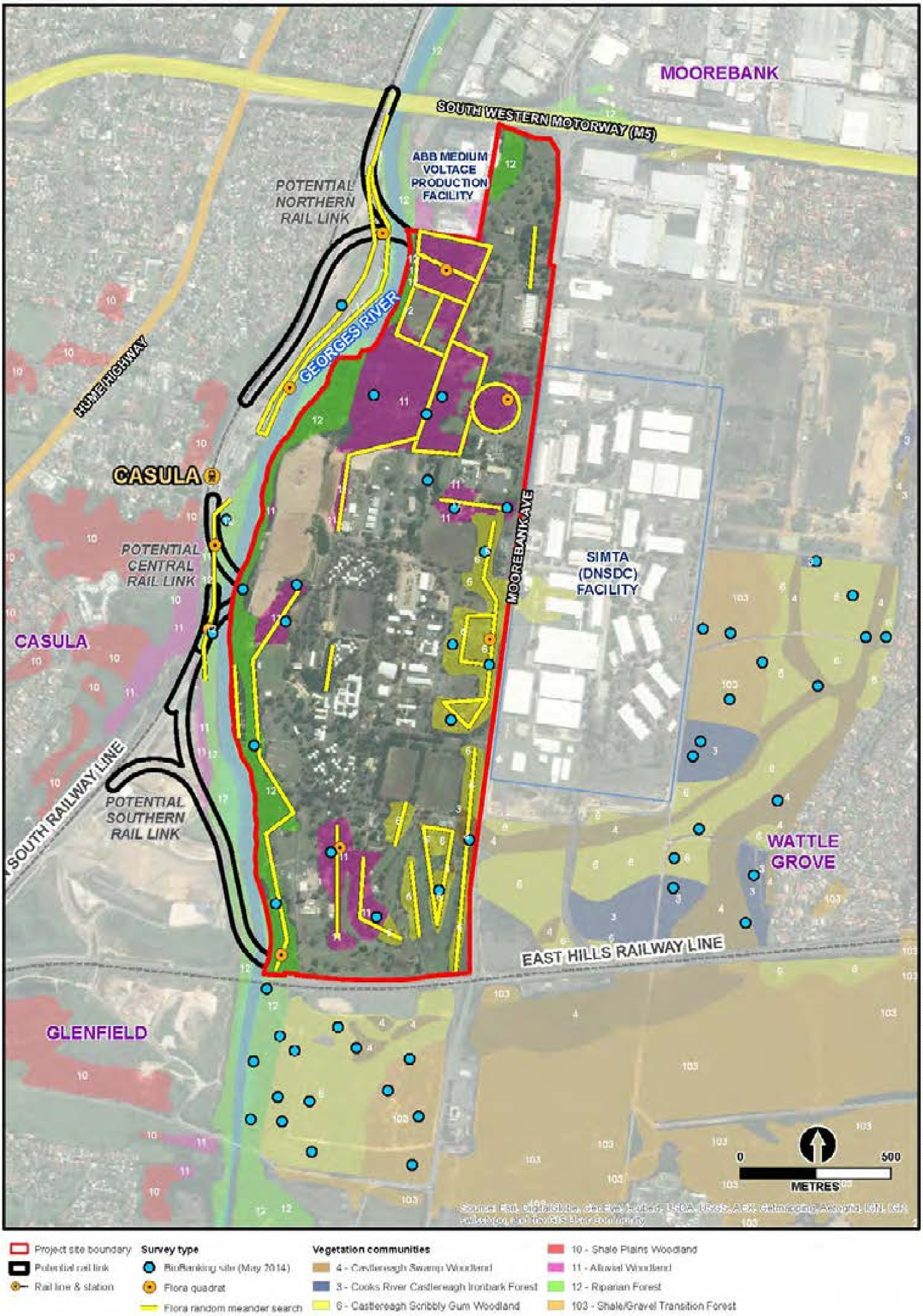

Figure 2.1 Flora survey locations (approximate)

2.6.5 Fauna survey

Fauna survey sites were chosen to represent the range of different habitat types within the IMT site and to give a broad spatial spread and coverage, maximising the chance of detecting a variety of species.

The following field survey methods were used to record the range of species on-site and any Threatened species of animals that may be utilising the site.

Survey methodology followed the Department of Primary Industry's (2004)*Director-General's Policy of Cage Trapping and Animal Care Guidelines for Wildlife Surveys*, as well as guidelines and policies for wildlife research as set by the Animal Research Review Panel (Australian Government 2004).

2.6.5.1 Bird surveys

Bird surveys were point surveys whereby all birds observed from a single point are noted for a set period of time (minimum 30 minutes). Survey points were located in each vegetation community.

2.6.5.2 Call playback

Nocturnal animals were surveyed using call playback, whereby recordings of the vocalisations of target species were broadcast in order to elicit a response, either vocal or behavioural. At each site there was an initial 10 minute listening period followed by a 5 minute call broadcast and then a five minute listening and spotlighting period for each target species.

A final listening period of 10 minutes and final spotlight of the survey site was conducted after call broadcasting was concluded. Calls of threatened nocturnal birds, arboreal mammals and frogs (Powerful Owl, Barking Owl, Masked Owl, Koala, Squirrel Glider and Green and Golden Bell Frog) were broadcast using a portable MP3 player and amplified through a megaphone.

2.6.5.3 Spotlighting

Spotlighting was undertaken along two transects in the IMT site by two persons on foot, each using a handheld 100 Watt spotlight. Spotlighting was used to target arboreal, flying and large ground-dwelling mammals, as well as nocturnal birds, reptiles and amphibians. Spotlighting was done after dusk. At least two person hours of survey effort, per transect, were completed on foot (refer Figure 2.2 and Table 2.5). The speed of the spotlight surveys was approximately 1 kilometre (km) per hour. Surveys concentrated on areas that contained suitable habitat for nocturnal species, with sighted animals identified to the species level.

2.6.5.4 Night-time waterbody searches

Night-time searches of waterbodies included listening surveys, call playback (refer section 2.4.3.2) and active spotlight searches for frogs. Species were either identified visually, by aural recognition of call or were captured by hand for more detailed inspection and identification. Waterbody searches were completed by two people over a one hour period at each site on each of three nights.

2.6.5.5 AnaBat Bat detection

AnaBat Bat detection (Z-CAIM) was used to record and identify the echolocation calls of microchiropteran bats. Bat detection included hand-held use during spotlighting, then stationary recording for the rest of the survey. A minimum of four hours of recording was undertaken on each of three nights.

The results were analysed by Paul Rossington and Lukas Clews with reference to Pennay *et al*(2004) and the associated bat call library for the Sydney region.

2.6.5.6 Cage trapping

Wire cage traps, located at each trapping site (refer Figure 2.2), were baited with chicken legs/necks and were located in the vicinity of Elliott trap lines. Three traps were set with a total of nine trap-nights recorded over a three-night trapping period (refer Table 2.5).

2.6.5.7 Small mammal trapping

Small mammals were surveyed using live capture/release methods. Small ground-dwelling mammals were surveyed with Elliott type A traps placed at ground level under suitable vegetation/fallen woody debris (as far as practicable).

Small tree-dwelling mammals were surveyed with a combination of Elliott type A and Elliott type B traps secured on tree-mounted brackets and set approximately 3 m above ground level in suitable habitat/ hollow-bearing trees (as far as practicable).

Each trap was baited with a mixture of rolled oats, peanut butter and honey and, where applicable, the trunk of the tree was sprayed with a mixture of honey and water as a lure. All traps were checked each morning at sunrise.

Traps were arranged in transects, with each line consisting of five tree-mounted and six ground traps, alternating and spaced approximately 20 m apart. Three trap transects were deployed across the study area and each transect line was left in place for three consecutive nights, providing a total of 33trap nights at each survey site (refer Table 2.5 and Figure 2.2).

2.6.5.8 Hair tubes

Hair sampling devices operate by passively sampling the hair from mammals that are lured to the device by bait. While animals attempt to get to the bait, their fur sticks to an adhesive insert that lines the upper inside surface of the tube or funnel. The inserts and the attached hair were removed at the end of the sampling period and analysed to determine the fauna species in question. Each survey site consisted of 10 tubes spaced 20 m apart. Bait consisted of rolled oats, peanut butter, honey and sardines. Each transect was deployed for a period of three nights (Table 2.6).

2.6.5.9 Harp trapping

Harp traps were used to trap foraging microchiropteran bats. Harp traps were located at sites that had the potential to be used as fly-ways by foraging microchiropteran bats. Two sites were targeted with harp traps set in each location for three consecutive nights (Figure 2.2 and Table 2.6). Harp traps were checked each evening following spotlighting events and again the following day within an hour of sunrise. Microchiropteran species caught by harp traps, were identified to species level. Microchiropteran bats caught before the evening harp trap checks were released the same night, while those caught after the evening checks were housed until the following evening for release.

2.6.5.10 Habitat searches

Daytime frog, reptile and Cumberland Land Snail searches were carried out opportunistically during random meander surveys conducted for habitat assessment. Species were surveyed by actively searching areas of suitable habitat. Rocks, bark, areas of deep leaf litter and other ground debris (e.g. rubbish) that provide potential shelter were hand-turned and replaced during searches.

2.6.5.11 Tracks, scats and signs search

Searches were conducted during habitat assessment for indirect evidence of the presence of animals such as scratches on trees, feeding scars, bones and scats.

2.6.5.12 Incidental observations

Incidental observations of animal species were recorded throughout the field surveys.

2.6.5.13 Fauna survey effort

In addition to the habitat condition assessment, the following survey effort was expended in search of animals with a focus on Threatened species (refer Table 2.6 and Figure 2.2).

Table 2.6 Fauna field survey effort

Survey technique	Targeted Threatened species/populations	Effort expended	Relevant SEWPaC survey guideline	Consistency with SEWPaC survey guidelines
Diurnal bird surveys	Threatened species of bird	8 person hours (2 sessions in each of 4 locations)	Regent Honeyeater (20 hours over 10 days) Swift Parrot (20 hours over 10 days – March to July)	Survey effort was less than that recommended for the Regent Honeyeater and Swift Parrot but it is considered adequate as much of the habitat of the site is marginal and previous surveys have been conducted of the site and surrounds. The species were presumed to occur intermittently on site based on habitat assessment.
Call playback	Nocturnal birds Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) Nocturnal mammals Squirrel Glider (*Petaurus norfolcensis*), Koala (*Phascolarctos cinereus*), Yellow-bellied Glider (*Petaurus australis*) Frogs Green and Golden Bell Frog (*Litoria aurea*)	12 person hours (two sessions in each of 2 locations on separate nights) Separate areas surveyed for the Green and Golden Bell Frog	Green and Golden Bell Frog (4 nights)	Survey effort was less than that recommended for but it is considered adequate given that spotlighting was also conducted and previous surveys have been conducted of the site and surrounds.
Spotlighting	Squirrel Glider (*Petaurus norfolcensis*), Yellow-Bellied Glider (*Petaurus australis*), Koala (*Phascolarctos cinereus*), Eastern Pygmy-possum (*Cercartetus nanus*), Spotted-tailed Quoll (*Dasyurus maculatus*) Grey-headed Flying-fox (*Pteropus poliocephalus*)	10 person hours (two ~2 km transects on each of two separate nights)	Grey-headed Flying-fox (Daytime field surveys for camp, Night time surveys. Conduct walking transects 100 m apart, Comprehensive vegetation survey).	Grey-headed Flying-fox survey consistent with guidelines as comprehensive vegetation survey, survey for camps and spotlighting surveys were conducted across the entire site (Refer section 2.4.1).
Anabat Bat detection	Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*), Large-footed Myotis (*Myotis macropus*) and other threatened microbat species	6 Anabat nights (two units in separate locations moved each night over 3 nights)	N/A	N/A

Survey technique	Targeted Threatened species/populations	Effort expended	Relevant SEWPaC survey guideline	Consistency with SEWPaC survey guidelines
Small mammal trapping (A-type Elliott Aluminium box trap; ground-based and tree-mounted and B-type tree-mounted)	Eastern Pygmy Possum *(Cercartetus nanus)*, Squirrel Glider (*Petaurus norfolcensis*), New Holland Mouse (*Pseudomys novaehollandiae*)	99 trap nights (three transects, each with 6 ground-based and 5 tree-mounted traps)	New Holland Mouse (Elliott A trapping surveys– 20 at each site, one sampling site per representative habitat, with a minimum of 2 sampling sites required per 5 hectares; set traps for 4 consecutive nights).	Survey effort was less than that recommended for but it is considered adequate as much of the habitat of the site is marginal and previous surveys have been conducted of the site and surrounds. The New Holland Mouse was considered unlikely to occur based on habitat assessment.
Mammal cage trapping	Spotted-tailed Quoll (*Dasyurus maculatus*)	9 trap nights (three traps for 3 nights)	10 cage traps at each sampling site. One sampling site per representative habitat, with a minimum of 2 sampling sites required per 5 hectares. Set traps for four consecutive nights.	Survey effort was less than that recommended for but it is considered adequate as hair-tube surveys were also conducted, much of the habitat of the site is marginal and previous surveys have been conducted of the site and surrounds. The Spotted-tailed Quoll was presumed to occur intermittently on site based on habitat assessment.
Hair tubes (small and large diameter)	Spotted-tailed Quoll (*Dasyurus maculatus*)	90 trap nights (three transects, each with 10 tubes)	20 hair sampling devices placed at each sampling site. One sampling site per representative habitat, at least 2 sampling sites required per 5 hectares. Hair funnels should be set for a minimum of 14 consecutive nights.	Survey effort was less than that recommended but it is considered adequate as cage trapping was also conducted, much of the habitat of the site is marginal and previous surveys have been conducted of the site and surrounds. The Spotted-tailed Quoll was presumed to occur intermittently on site based on habitat assessment.
Bat (Harp) trapping	Eastern Bent-wing Bat (*Miniopterusschreibersiioceanensis*), Large-footed Myotis (*Myotismacropus*) and other threatened microbat species	6 trap nights (two traps for 3 nights)	N/A	N/A

Survey technique	Targeted Threatened species/populations	Effort expended	Relevant SEWPaC survey guideline	Consistency with SEWPaC survey guidelines
Habitat searches	Cumberland Land Snail (*Meridolum corneovirens*)	6 person hours (opportunistically throughout IMT site)	N/A	N/A
Night-time water body searches	Green and Golden Bell Frog (*Litoria aurea*)	6 person hours (two sessions in each of two locations on separate nights)	Small wetlands (<50 metres at greatest length) at the study site should be covered in a period of about one hour over four nights under ideal conditions.	Survey effort was less than that recommended but it is considered adequate as call playback was also conducted and previous surveys have been conducted of the site and surrounds.
Incidental observations or evidence of fauna	Various	Opportunistically throughout the field study	N/A	N/A

2.6.6 Fauna habitat assessment

While targeted surveys can confirm the presence of species, a lack of records does not necessarily indicate the absence of the species from a site where suitable habitat is present. By the very nature of their rarity, Threatened species are often difficult to detect. Suitable habitat is, therefore, an important factor to consider when determining the potential presence of Threatened species.

2.6.6.1 Terrestrial fauna habitat assessment

A general terrestrial fauna features traverse was undertaken throughout the IMT site during the survey, covering all major native vegetation occurrences. Isolated mature trees which were considered to have potential as habitat for Threatened species (e.g. hollow-bearing trees, flowering eucalypts) were also inspected. The time spent in each area of potential habitat was generally proportional to the size of the area and the diversity of habitat features observed. The objective of this traverse was to identify any additional Threatened species and their habitats. During the traverse, opportunistic recordings of species were made through incidental sightings, aural recognition of calls, and observing indirect evidence of species' presence, such as scats, feathers, hair, tracks, diggings, and burrows.

Fauna habitat characteristics assessed included the:

- structure and floristic composition of the canopy, understorey and ground vegetation, including the presence of flowering and fruiting trees providing potential foraging resources
- presence of hollow-bearing trees providing potential roosting and breeding habitat for arboreal mammals, birds and reptiles
- presence of the groundcover vegetation, leaf litter, rock outcrops and fallen timber and potential to provide protection for ground-dwelling mammals, reptiles and amphibians
- presence of waterways (ephemeral or permanent) and waterbodies.

It is recognised that broad fauna habitat classifications can predict the likelihood of occurrence of most species of animal, but that some species are likely to have specialised habitat requirements.

The following criteria were used to evaluate habitat values:

- Good: A full range of fauna habitat components is usually present (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- Moderate: Some fauna habitat components are missing (for example, old-growth trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.
- Poor: Many fauna habitat elements in low quality remnants have been lost, including old-growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

2.6.6.2 Aquatic fauna habitat assessment

The conclusions in this report regarding aquatic habitat characteristics are based on a review of existing studies and database search results supplemented by aquatic fauna habitat assessment. The main sources of information regarding the existing aquatic fauna of the stretches of Anzac Creek and the Georges River affected include:

- *Biodiversity of the Georges River Catchment: Aquatic biodiversity- Freshwater Fishes* in which several locations along the Georges River were surveyed (Gehrke et al. 2004).
- *SIMTA Moorebank Intermodal Facility - Flora and Fauna Assessment aquatic ecology assessment* which included surveys in the lower reaches of Anzac Creek and the Georges River at the southern end of the IMT site (Hyder Consulting 2012).

Aquatic fauna habitat assessment included visual observation of the following habitat characteristics:

- riparian vegetation structure, extent and composition
- emergent aquatic vegetation structure, extent and composition
- the presence of emergent large woody debris in the waterway
- water flow velocity
- evidence of pollution (i.e. water discoloration, turbidity, surface films and floating rubbish)
- bank slope and evidence of erosion
- presence of introduced fish species (e.g. *Gambusia holbrooki*)

Due to the high turbidity of the river, visual observation of the substrate and any submerged aquatic plants present was not conducted as part of this habitat assessment.

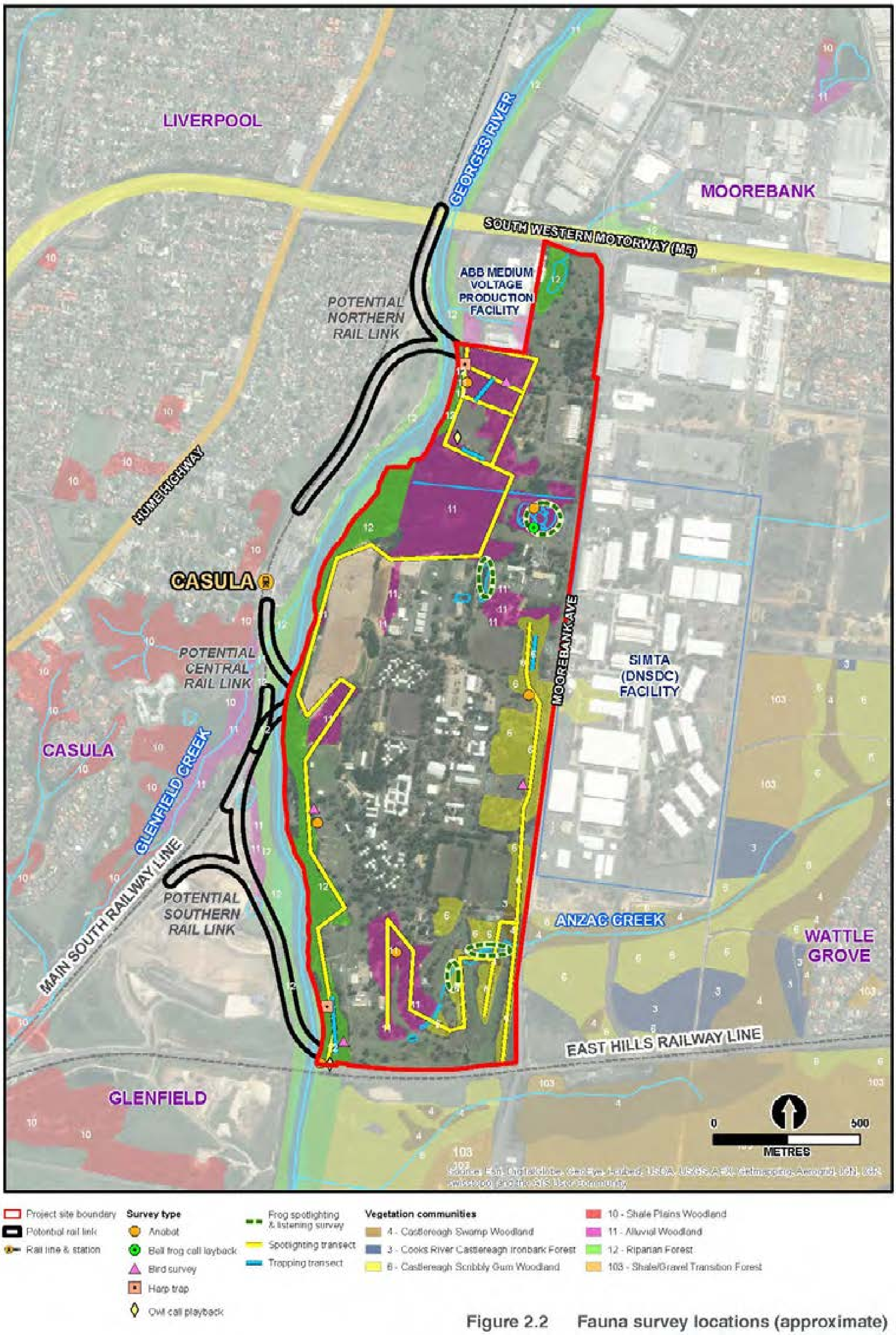

Figure 2.2 Fauna survey locations (approximate)

2.6.7 Field survey limitations

No sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis or may be present at very low densities. The conclusions in this report are based upon data acquired for the site and the ecological field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. Also, it should be recognised that site conditions, including the presence of threatened species, can change with time.

Where surveys were conducted outside the optimal time for detecting a particular species a precautionary approach was taken and it was assumed that the species was present if suitable habitat was observed.

Aquatic surveys were limited to assessment of the potential for water-bodies to provide habitat for Threatened species. This assessment was based on field observation of habitat characteristics such as water depth, turbidity, flow rate, aquatic vegetation, pollutants and the presence of exotic species of fish. A review of previous studies regarding the aquatic ecology of the Georges River and Anzac Creek revealed that the waterway is degraded and that systematic surveys have failed to detect any Threatened species in the locality (Gehrke *et al.* 2004; Hyder Consulting Pty Ltd 2012). Based on these existing studies, and field assessment of habitat characteristics, the aquatic habitats affected by the Project are unlikely to support any threatened aquatic biodiversity listed under the FM Act and additional aquatic surveys are considered unnecessary at this stage. This need would be reconfirmed during future assessment and approvals stages during detailed design.

Limited safe access was available to areas of riparian vegetation due to dense **Lantana camara* infestations, other dense vegetation and steep river banks.

Two sections of the Project site were not surveyed due to access restrictions:

- between Bapaume Road and the M5 Motorway(Titalka Park)
- the location of the potential southern rail access link on the western bank of the Georges River within the Glenfield Waste Services land.

Assessment of the biodiversity values of these areas was based on desktop investigations of existing mapping and previous reports and viewing from a distance with the aid of binoculars. While the presence or absence of Threatened biodiversity in these areas has not been verified through detailed fieldwork, these areas appear to be moderately to highly modified and hence have relatively low potential as habitat for most of the Threatened biodiversity likely to occur in the locality.

2.7 Ecological integrity classification

The *Significant Impact Guidelines 1.2: Action on or impacting upon Commonwealth land, and actions by Commonwealth agencies* (Department of the Environment Water Heritage and the Arts 2010) suggest that in describing the ecological values of a site an assessment should be made of the ecological integrity of vegetation and habitats. As of 22 August 2012, there was no Federal statutory method for determining the ecological integrity of vegetation communities and habitats; therefore a general and commonly used ranking criteria approach was used.

The following criteria were used to classify the importance of the ecological values in the Project site based on interpretation of the existing vegetation mapping, previous studies and flora and fauna surveys. This classification of ecological values was used in the identification of constraints and evaluation of potential design options for the Project (refer Figure 2.3).

2.7.1 High value

The high value classification includes all native vegetation communities of moderate to high ecological integrity, as all native communities on-site are Threatened communities under the TSC Act (although none are listed under the EPBC Act) and have similarly moderate to high value as potential habitat for Threatened species of animal and plant. Several patches of vegetation with high ecological integrity are inhabited by two plant species listed under the EPBC Act and TSC Act.

The Georges River is a major waterway and the aquatic environment of the river and major tributaries are a high constraint to development. Development within the waterway could affect fish habitat and hence best practice with regard to fish passage needs to be considered, as presented by the requirements of the *NSW Fisheries Management Act 1994* (FM Act).

Waterfront land is defined under the *Water Management Act 2000* (WM Act) as the bed of a waterway, together with any land lying between the bed and a line drawn parallel to and within 40 m inland of its highest bank (riparian land). Developments carried out in, on or under waterfront land may require a controlled activity approval under the WM Act to ensure that minimal harm will be done. Given the present Commonwealth ownership of the land, the requirement or otherwise for controlled activity approval under the WM Act will, however, be dependent on the land ownership arrangements and approval path for the Project.

Riparian land (within 50 m of the river and second order or larger tributaries) is also considered of high value due to the function of vegetation in this area as a wildlife corridor and a buffer for the protection of soil stability, water quality and aquatic habitats. Riparian land as defined by the NSW Office of Water includes a core riparian zone (40 m in the case of a major waterway) and a vegetated buffer zone (a recommended width of 10 m) (NSW Office of Water 2010). The precise location of the top of the bank of the river is assumed to be within 10 m of the mapped edge of the river for the purposes of mapping.

The high value areas are generally likely to remain viable as native vegetation communities and/or fauna habitats in the long term under appropriate management.

Figure 2.3 Ecological integrity classification

2.7.2 Moderate value

The moderate value classification includes all native vegetation communities with substantially reduced canopy cover that have poor to moderate ecological integrity. This vegetation has reduced value as potential habitat for Threatened species of animals and plants due to its modified vegetation structure and composition. This vegetation, despite its modified state, remains consistent with the Threatened communities listed under the TSC Act.

Riparian lands within 10 m of minor (first order) streams and artificial waterbodies are also of moderate value due to their potential as fauna habitat and their contribution to the protection of soil stability and water quality in downstream aquatic habitats. Due to surrounding land uses (e.g. the golf course) these waterbodies generally have relatively poor ecological integrity and are less sensitive to the potential impacts of the Project.

These moderate value areas are likely to have recovery potential under appropriate management, particularly where they are located in riparian lands and/or adjacent to vegetation of higher ecological integrity.

2.7.3 Low value

The low value classification includes all cleared and developed areas of the Project site (e.g. buildings, roads) and areas dominated by introduced plant species (e.g. lawns, weed-dominated areas). These areas are likely to be of low ecological value; however they may contain small areas of habitat for Threatened biodiversity that are not reflected in the vegetation mapping for the site due to their small spatial scale. These areas are generally considered to have low recovery potential.

2.8 Threatened species likelihood-of-occurrence assessment

Species subject to likelihood-of-occurrence assessments were those identified during the desktop and field-based investigations as having been previously recorded or predicted to occur in the Project locality. The likelihood of occurrence of each species was assigned to one of the following categories:

- Low likelihood-of-occurrence includes species not recorded during the field surveys that fit one or more of the following criteria:
  - Have not been recorded previously in the Project site and surrounds which are outside the current known geographic range.
  - Are dependent on specific habitat types or resources that are not present in the IMT site.
  - Are likely to be locally extinct.
- Moderate likelihood-of-occurrence includes species not recorded during the field surveys that fit one or more of the following criteria:
  - Have been recorded previously in the Project site and surrounds infrequently (i.e. vagrant individuals).
  - Use habitat types or resources that are present in the Project site, although generally in a poor or modified condition.

    - Are unlikely to maintain sedentary populations; however may sporadically utilise resources within the Project site during variable seasons, dispersal or migration.

- High likelihood-of-occurrence includes species not recorded that fit one or more of the following criteria:
    - Have been previously recorded in the Project site.
    - Are dependent on habitat types or resources that are present in the Project site that are abundant and/or in good condition within the Project site.
    - Are known or likely to maintain resident populations surrounding the Project site.
    - Are known or likely to visit the Project site or surrounds during regular seasonal movements or migration.
- Recorded: Where species have been recorded within the Project site this has been detailed.

3. Existing environment

This section outlines the existing environment and provides a description of the vegetation communities, the species and habitat present on the Project site. The description of the existing environment across the broader Project site includes the vegetation communities, threatened species and habitats found within the IMT site and on land affected by each of rail access options.

The Project is situated on land in the Sydney suburb of Moorebank, NSW, in the Liverpool local government area within the Sydney Basin Bioregion. The IMT site is approximately 220 hectares (ha) in area, and is in a locality that includes the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Defence land.

Much of the vegetation of the Project site has been cleared and replaced with roads, buildings, playing fields and exotic grassland, or substantially thinned, leaving only scattered remnant trees. Substantial areas of vegetation remain, however, in the west of the site within the riparian zone of the Georges River and in patches along the eastern boundary of the site adjacent to Moorebank Avenue.

The surrounding landscape to the north and west is part of the Cumberland Plain of western Sydney, in which clay soils overlay Wianamatta shales, creating gentle slopes, fertile soils and an ideal landscape for agriculture. Since the middle of the nineteenth century, the Cumberland Plain has undergone extensive clearing, grazing and disturbance for agricultural, urban and industrial development.

Hydrological and sediment regimes have been dramatically altered in the lower Georges River and its tributaries due to vegetation clearance and urbanisation, which have resulted in changes to the geomorphology and ecology of the watercourse. Stormwater from urban areas and agricultural runoff have contributed to reduced water quality. Introduced fish such as the Plague Minnow (*Gambusia holbrooki*) are also likely to have affected the aquatic ecosystem through predation and competition with native fish and frogs.

The landscape to the south and east of the Project site extends from the eastern edge of the Cumberland Plain through flat to slightly undulating areas with sandy soils derived from alluvium into the adjacent sandstone-dominated coastal hills and valleys. Vegetation on alluvial soils in this area has also been affected by clearing and other forms of disturbance including weed invasion and altered fire regimes; however, large tracts of vegetation remain in this area.

This vegetation is somewhat fragmented by roads, a railway line, electricity transmission easements and other cleared areas yet still retains significant habitat value and landscape connectivity. The proximity of this vegetation to the site and its connectivity with the riparian corridor of the Georges River contributes significantly to the ecological value of the habitat found on the Project site. The catchment of the upper reaches of the Georges River is more natural and the aquatic ecosystems there are less disturbed than the lower reaches of the river.

In order to maintain flexibility for future developers and operators of the Project, the proposal concept, as presented in the EIS, provides three indicative IMT internal layouts; one for each of three proposed rail access options. Once the selected developer/operator has been appointed, the Project would progress to the detailed design phase and one of the three rail access options identified above would be selected.

The northern and southern of the rail access options are located on predominantly disturbed land associated with the former Casula Powerhouse Golf Course and Glenfield Landfill site respectively, while the central rail access option passes through remnant vegetation within vacant Commonwealth land on the western bank of the Georges River (referred to as the 'hourglass land'). All of the rail access options cross Georges River riparian zone.

The vegetation communities in each of the rail access options are listed as threatened communities under the TSC Act. None are listed under the EPBC Act, and they have moderate to high value as potential habitat for threatened species of animal.

3.1.1.1 Connectivity

The Project site is located within an urban area and predominantly consists of defence land, urban development, internal road network and a golf course. The site is connected to riparian vegetation along George's River to the west which connects to extensive vegetation in the south and south east.

To determine the existing Linkage Width Class of the site, it was necessary to determine the narrowest (most limiting) link that connects site vegetation to adjoining vegetation. For the site this was within the site itself.

As the site currently occurs as fragmented remnant vegetation within an urban environment the development will not result in a change in the corridor width class. The condition of the site is at benchmark for the overstorey but is below benchmark for the understorey. The overstorey and understorey is not likely to decrease benchmark values.

Connectivity for the landscape assessment is summarised in Table 3.1.

Table 3.1 Connectivity

Site	Corridor values	Before development	After development	Connectivity description
IMT site	**Corridor width (m)**	>30-100 m	>30-100 m	The Development will have limited impact on the existing connectivity of the Georges River riparian zone as it will not decrease the corridor width or the overstorey and understorey benchmark values. Given the proposed rail crossing of the Georges river will be a bridge over the river and will not completely sever native vegetation or form a hard barrier this crossing is not considered in the connectivity assessment

3.2 Ecological characteristics of the rail access options

The vegetation communities found within all of the rail access options consist of open grassy woodland of the shale-derived soils of the Cumberland Plain in the west and shrubby riparian woodland of the alluvial plains adjoining the Georges River riparian corridor in the east (refer Figure 3.1, 3.2 and 3.3). These vegetation communities provide habitat for the same suite of Threatened species of fauna across all rail access options. Whilst survey undertaken in the IMT site confirmed the presence of Threatened flora species and habitat (refer section 3.4), no Threatened flora species present or with potential habitat were identified within the rail access options. A summary of the specific ecological characteristics relevant to each of the rail access options is provided in Table 3.1 below. As reflected in Table 3.1, the main difference between the existing ecological environments of the rail access options is the extent of vegetation, habitat and riparian zone associated with the Georges River.

A more detailed description of the vegetation communities identified, habitat requirements for species and ecological features is provided above in section 3.2 below.

3.2.1 Northern rail access option

On the eastern bank of the river, the northern rail access option traverses a strip of Riparian Forest, which is consistent with the River-Flat Eucalypt Forest on Coastal Floodplains Endangered ecological community listed under the NSW *Threatened Species Conservation Act1995* (TSC Act). The area of this community in the location has been previously disturbed during construction of an access track that runs parallel with the river and exhibits a moderate level of weed infestation and a reduced canopy cover.

The River-Flat Eucalypt Forest on the western bank of the Georges River, adjacent to parkland of the former golf course site, lacks a remnant shrub layer and has little remnant groundcover. Recent weed removal, mulching and tubestock planting in this location, including areas immediately adjacent to the rail access is likely, however, to substantially increase the condition of this vegetation and its value as wildlife habitat as planted understorey and groundcover vegetation matures.

The remainder of the area on the western bank of the Georges River crossed by the northern rail access option consists of cleared areas with scattered, predominantly if not exclusively planted, native and introduced trees and exotic groundcover.

3.2.2 Central rail access option

On the eastern bank of the river, the central rail access option traverses a patch of Alluvial Woodland and a strip Riparian Forest, both of which are consistent with the River-Flat Eucalypt Forest on Coastal Floodplains Endangered ecological community listed under the NSW TSC Act. The Alluvial Woodland has an intact eucalypt canopy and a sparse subcanopy of *Acacia* spp. but contains extensive woody weed cover in the understorey and groundcover strata. The Riparian Forest on the eastern bank has been disturbed by Defence activities on the margins of the adjacent heavy vehicle training area known as the ‘dust bowl’. Native vegetation here consists of a canopy of mature eucalypts consisting predominantly of *Eucalyptus saligna* x *botryoides*. The understorey and groundcover layers are dominated by woody weeds (e.g. *Ligustrum spp.* and *Lantana camara*) with occasional native shrubs such as *Breynia oblongifolia* and patches of native grasses such as *Microlaenastipoides.* On the eastern side of the river the central rail access option also crosses cleared areas within the ‘dust bowl’ which have been significantly disturbed by heavy vehicle movement and earthworks activates. Minimal native vegetation exists in this cleared area.

Vegetation on the western bank of the river within the alignment of the central rail access option consists of Riparian Forest dominated by *Eucalyptus saligna* x *botryoides* and *Angophora floribunda* with a subcanopy dominated by **Ligustrum spp.* and *Acacia decurrens*. The understorey is characterised by dense infestations of *Lantana camara with occasion native shrubs such as *Breynia longifolia*. Due to the dense subcanopy and understorey, groundcover vegetation is sparse. On the edges of the vegetation where more light reaches ground level, patches of native grasses such as *Austrostipa verticillata* and herbaceous weeds such as **Biden spilosa* were observed.

3.2.3 Southern rail access option

On the eastern bank of the river, the southern rail access option traverses a strip of Riparian Forest, which is consistent with the River-Flat Eucalypt Forest on Coastal Floodplains Endangered ecological community listed under the NSW TSC Act. The area of this community in the location has been previously disturbed during construction of the East Hills Railway Line and Tarakan Road and exhibits a moderate to high level of weed infestation. The vegetation of the eastern riverbank immediately adjacent to the Georges River exhibits a high degree of weed infestation and is in poor condition. Native vegetation here consists of a canopy of mature eucalypts including *Eucalyptus saligna* x *botryoides* and *E.longifolia*. The understorey and groundcover layers are dominated by woody weeds (e.g. *Ligustrum sinense* and *Lantana camara*) and vine weeds (e.g. *Cardiospermum grandiflorum* and *Delairea odorata*) (Hyder Consulting Pty Ltd 2012). Vegetation further upslope on the eastern bank is less disturbed and generally dominated by native plants in all layers with the exception of some highly disturbed land associated with East Hills Railway Line and Tarakan Road. In addition to the eucalypt canopy, this vegetation contains a sub-canopy dominated by *Acacia binervia* and moderately diverse native understorey and groundcover layers. Overall this vegetation is structurally intact and has a low to moderate level of weed invasion.

The River-Flat Eucalypt Forest on the western bank of the Georges River, within and adjacent to the Glenfield Waste Services (GWS) site, is similar in structure and condition to the vegetation on the eastern bank (Hyder Consulting Pty Ltd 2012). That is, it is mostly in poor condition and weed infested. The southern rail access also includes cleared areas within the GWS site which have been significantly disturbed by extensive sand/gravel extraction activities. Any native vegetation in these cleared areas would only be relatively recent regrowth that is likely to have low ecological conservation value.

Table 3.2 Summary of the ecological values in the rail access options

Rail access option	Vegetation community	Extent of vegetation and habitat	Conservation significance	Fauna Habitat types	Threatened Fauna Species with potential to occur	Threatened Flora species Habitat	Georges River riparian corridor	Ecological integrity and landscape context
Northern	Riparian Forest	0.24 ha	TSC Act listed endangered ecological community River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Riparian vegetation along the Georges River	Barking Owl Cumberland Land Snail Eastern Bent-wing Bat Eastern False Pipistrelle Eastern Free-tail bat Eastern Pygmy-possum Flame Robin Gang-gang Cockatoo Greater Broad-nosed Bat Grey-headed Flying-fox* Koala* Little Eagle Little Lorikeet Powerful Owl Regent Honeyeater* Scarlet Robin Southern Myotis	*NA*	A 70 m corridor crossing over the disturbed Georges River with approximately 10 metres of remnant vegetation.	Moderate to Poor Remnant vegetation corridor restricted to a 25 meter narrow linear strip on the western bank of the Georges River
Central	Alluvial Woodland and Riparian Forest	0.14ha and 2.14 ha					Two separate 70 m corridors over the Georges River, occupying approximately 300 metres of the remnant vegetation within the Georges River riparian zone. Alluvial Woodland community potentially groundwater dependent ecosystem.	Moderate to Poor Remnant vegetation corridor of an approximately 68 linear strip on the western bank of the Georges River

Rail access option	Vegetation community	Extent of vegetation and habitat	Conservation significance	Fauna Habitat types	Threatened Fauna Species with potential to occur	Threatened Flora species Habitat	Georges River riparian corridor	Ecological integrity and landscape context
Southern	Alluvial Woodland and Riparian Forest	0.48ha and 2.98 ha			Spotted Harrier Spotted-tailed Quoll* Square-tailed Kite Squirrel Glider Swift Parrot* Varied Sittella Yellow-bellied Sheathtail Bat		A narrow 70 m corridor crossing of the Georges River. However this option occupies approximately 500 metres of the remnant vegetation within the Georges River riparian zone. Alluvial Woodland community potentially groundwater dependent ecosystem.	Moderate to Poor Remnant vegetation corridor of an approximately 45 meter linear strip on the western bank of the Georges River

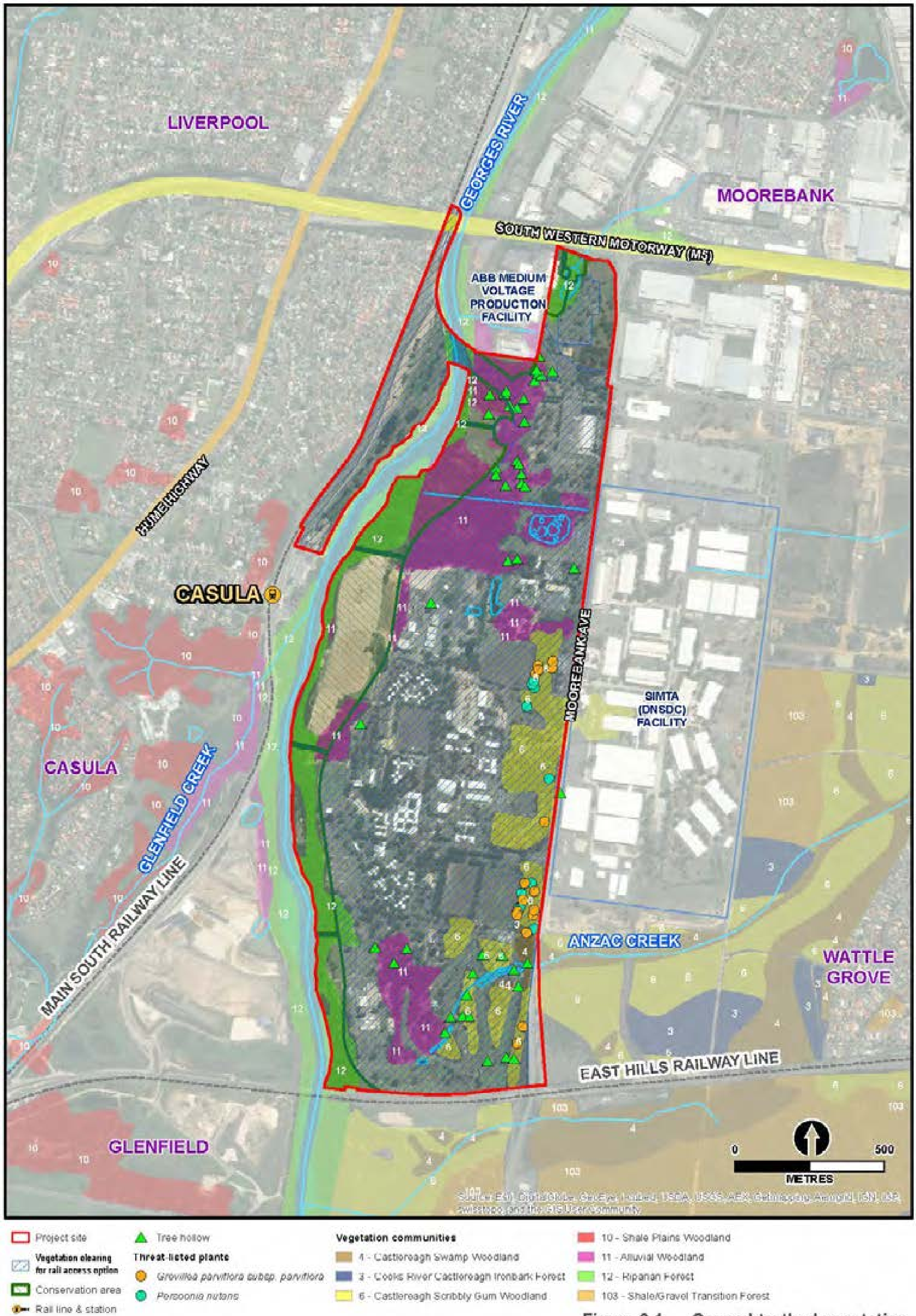

Figure 3.1 Ground-truthed vegetation communities, threatened species of plant and tree hollows - northern rail crossing option

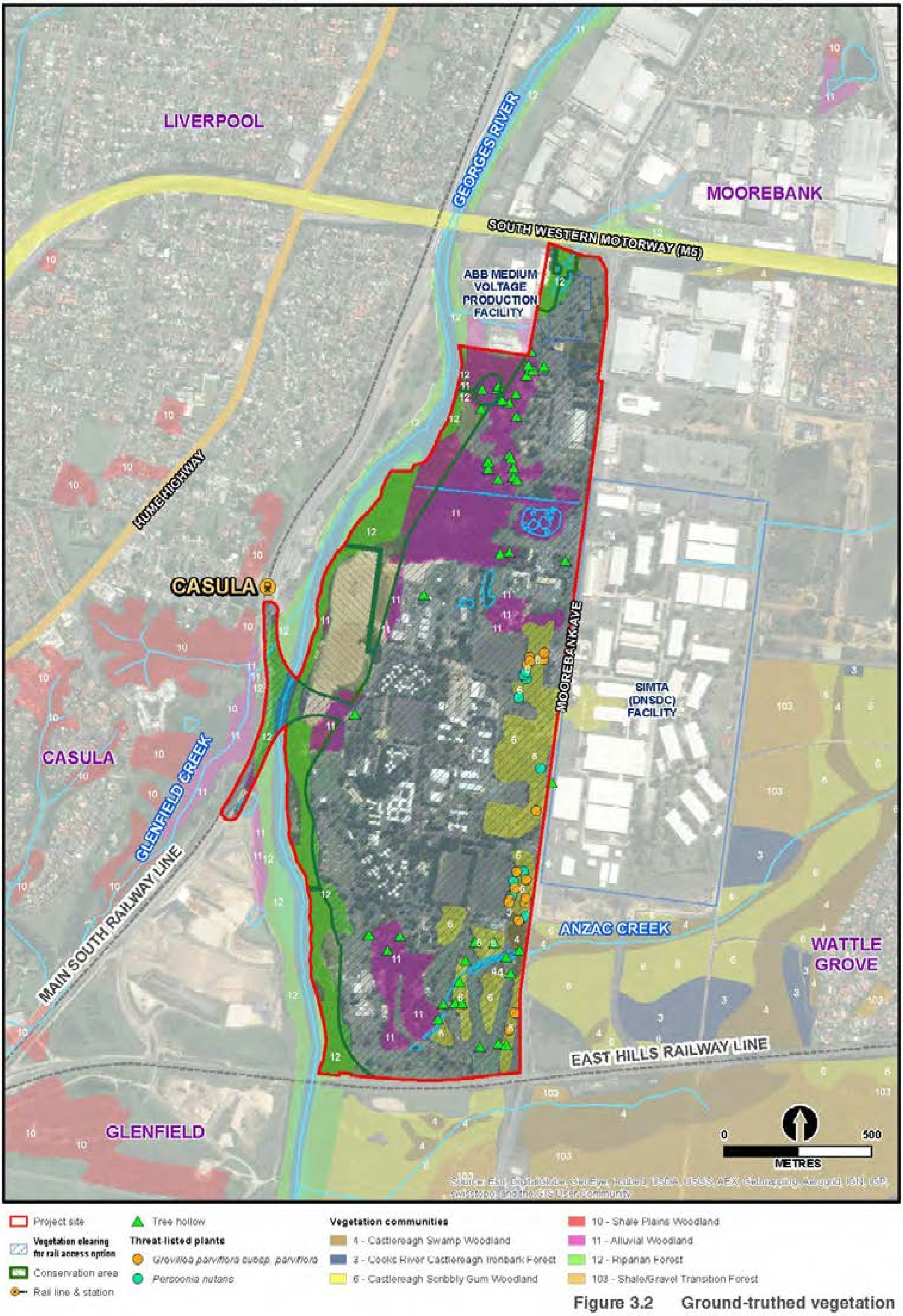

Figure 3.2 Ground-truthed vegetation communities, threatened species of plant and tree hollows - central rail crossing option

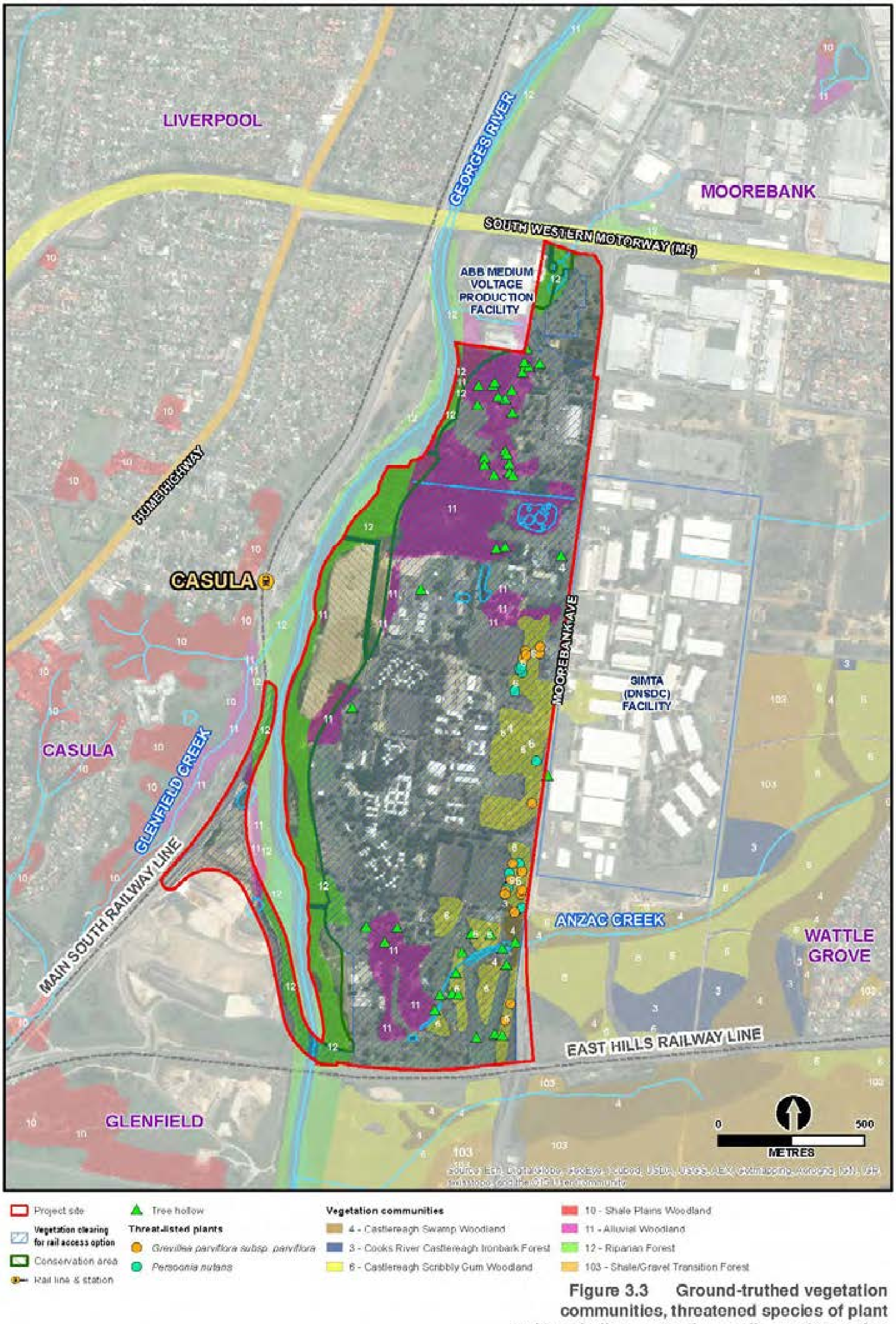

Figure 3.3 Ground-truthed vegetation communities, threatened species of plant and tree hollows - southern rail crossing option

3.3 Ecological characteristics of the IMT site

The detailed ecological description of the IMT site's vegetation communities, threatened species and their habitats are based on survey results completed across the broader Project site and as such, the information presented below is also representative of those vegetation communities and species found within each of the rail access options summarised in Table 3.2 above. The majority of the IMT site has low vegetation cover consisting of a sparse canopy of introduced and remnant trees within areas of cleared and disturbed land. These areas of land no longer contain the native species diversity or vegetation structure required for them to be classified as native vegetation communities. Patches of moderately to highly disturbed remnant native vegetation are found in the south and east of the Project site along Moorebank Avenue and near Anzac Creek (refer Figure 2.3). Vegetation that is moderate to high ecological integrity is mainly contained within the riparian corridor of the Georges River, a large patch in the north-west of the IMT site and some patches at the southern end of Moorebank Avenue.

3.3.1 Vegetation communities

The IMT site presents a complex ecology that sees a transition from the open grassy woodland of the shale-derived soils of the Cumberland Plain to the west of the Georges River, to the shrubby woodland of the alluvial plains to the east of the Georges River.

The majority of the IMT site has low vegetation cover consisting chiefly of a sparse canopy composed of a mixture of planted and remnant indigenous and introduced trees within areas of cleared and disturbed land arising from past land clearing and use of the IMT site for DoD purposes. These areas of land no longer contain the native species diversity or vegetation structure to be classified as native vegetation communities.

Patches of moderately to highly disturbed remnant native vegetation are found in the south and east of the IMT site particularly near Anzac Creek and parallel with Moorebank Avenue. Vegetation of moderate to high ecological integrity is largely restricted to the riparian corridor of the Georges River, a large patch in the north-west of the IMT site and several patches located adjacent to Moorebank Avenue (refer Figure 2.3).

3.3.2 Field verified vegetation communities on the IMT site

Four native vegetation communities were verified as present on-site by field investigations (refer Figure 3.1–Figure 3.3). While all four native vegetation communities present on-site form part of a Threatened ecological community listed under the TSC Act, none of these communities correspond with a Threatened community listed under the EPBC Act.

The observed vegetation on the site was generally in accordance with the previous mapping of the IMT site by URS (2004),but showed substantial differences from broad scale vegetation mapping based on remote sensing techniques such as aerial photograph interpretation (NSW National Parks and Wildlife Service 2002a; Tozer 2003; Tozer *et al.* 2006). This broad scale mapping indicates the possible presence of a further two vegetation communities in the IMT site: Cooks River Castlereagh Ironbark Forest and Shale/Gravel Transition Forest. The field survey for the Project and previous surveys that have included the IMT site(URS 2004) did not find these communities to be present. The patches mapped as these communities in the broad scale mapping have been attributed to Alluvial Woodland and Castlereagh Scribbly Gum Woodland based on the observed species composition as described below.

Diagnostic species are those species characteristic of a vegetation community and used in its definition and identification. Due to the disturbed condition and transitional form of much of the vegetation on the site, distinctions between closely related communities which naturally intergrade with one-another are not necessarily clear. To aid in the identification of these communities, a comparison of the number of diagnostic species between previously mapped and field verified communities is shown in Table 3.3 for the patches of vegetation that have been attributed to different vegetation communities from those shown in previous broad scale mapping.

This comparison shows that the vegetation mapped previously as Shale/Gravel Transition Forest is much more closely aligned with Alluvial Woodland due to the higher number of diagnostic species. The distinction between Cooks River Castlereagh Ironbark Forest and Castlereagh Scribbly Gum Woodland is not apparent, however, from comparison of the number of diagnostic species. In this case, the vegetation was assigned to Castlereagh Scribbly Gum Woodland based on overall species composition and dominant tree species, most notably the absence of ironbark eucalypts which are a prominent feature of Castlereagh Ironbark Forest.

Table 3.3 Comparison of the number of diagnostic species between previously mapped and field verified vegetation communities where a conflict between the two exists

Vegetation community according to broad scale mapping	Number of diagnostic species (Tozer 2003) observed in a 400 m^2 survey plot	Vegetation community according to URS (2004).	Number of diagnostic species (Tozer 2003) observed in a 400 m^2 survey plot	Vegetation mapped in Figure 3.1–3.3 and confirmed in this study
Cooks River Castlereagh Ironbark Forest	5	Castlereagh Scribbly Gum Woodland	5	Castlereagh Scribbly Gum Woodland
Shale/Gravel Transition Forest	2	Alluvial Woodland	8	Alluvial Woodland

Riparian Forest and Alluvial Woodland are found in the west of the IMT site situated on the Quaternary alluvial deposits fringing the Georges River and on the higher floodplain terraces. As two structurally and floristically distinct communities, the Riparian Forest is found in the wettest areas on the lower banks of the Georges River and contains shrub and small tree species including *Backhousia myrtifolia, Stenocarpus salignus, Westringia longifolia,* and*Santalum obtusifolium*. Alluvial Woodland occurs on the drier high alluvial terraces with an understorey dominated by *Acacia* spp. Both Riparian Forest and Alluvial Woodland are considered to be part of the River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions, which is anEndangered ecological community listed under the TSC Act.

Castlereagh Scribbly Gum Woodland and Castlereagh Swamp Woodland are two similar vegetation communities that have substantial structural and floristic similarities, with the main differences being in the relative abundance of component species. Poor localised drainage in low depressions separates these two communities in the IMT site, with a dense canopy of *Melaleuca decora* formed in ephemeral drainage lines at the eastern edge of the IMT site. Castlereagh Scribbly Gum Woodland and Castlereagh Swamp Woodland are listed as Vulnerable and Endangered ecological communities respectively under the TSC Act.A detailed summary of the dominant species recorded in each vegetation community present within the IMT site is provided below in Table 3.4.

Table 3.4 Composition of vegetation communities in the IMT site

Vegetation community	Biometric vegetation type PCT	Canopy height	Canopy species	Understorey species	Ground cover species	Conservation significance	Ecological integrity
Riparian Forest	ME044 Sydney Blue Gum Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin	25–30 m	*Eucalyptus bosistoana*, *Eucalyptus botryoides* x *saligna*, *Angophora floribunda*, *Casuarina cunninghamiana*	*Tristaniopsis laurina*, *Backhousia myrtifolia*, *Stenocarpus salignus*, *Jacksonia scoparia*, *Polyscias sambucifolia*, *Westringia longifolia*, *Santalum obtusifolium*, *Acacia binervia*, *Acacia decurrens*, *Callistemon salignus*, **Arundo donax*, *Melia azedarach*, **Ligustrum sinense*, *Phebalium squamulosum*	*Microlaena stipoides*, **Eragrostis curvula*, **Cardiospermum grandiflorum*, *Leucopogon juniperinus*, *Morinda jasminoides*, *Pteridium esculentum*, **Araujia sericifera*, **Verbena bonariensis*, **Asparagus* spp., *Gahnia aspera*, *Pratia purpurascens*, *Austrostipa ramosissima*	TSC Act listed Endangered ecological community *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*	Moderate to Poor
Alluvial Woodland	ME018 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	20–25 m	*Eucalyptus tereticornis*, *Eucalyptus botryoides* x *saligna*, *Eucalyptus baueriana*, *Angophora floribunda*	*Acacia decurrens*, *Acacia binervia*, *Ozothamnus diosmifolius*, *Kunzea ambigua*, **Lantana camara*	*Microlaena stipoides*, **Eragrostis curvula*, **Senecio madagascariensis*, **Conyza bonariensis*, *Tricoryne elatior*, *Pratia purpurascens*, **Bidens pilosa*, **Sida rhombifolia*, *Cynodon dactylon*	TSC Act listed Endangered ecological community *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*	Moderate to Poor
Castlereagh Scribbly Gum Woodland	ME003 Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin	8–15 m	*Eucalyptus sclerophylla*, *Eucalyptus parramattensis* subsp. *parramattensis*, *Melaleuca decora*, *Angophora floribunda*	*Melaleuca nodosa*, *Kunzea ambigua*, *Banksia spinulosa*, *Ozothamnus diosmifolius*, *Grevillea parviflora* var. *parviflora*, *Persoonia nutans*, *Daviesia ulicifolia*, *Petrophile sessilis*, *Hakea dactyloides*, *Acacia falcata*, *Persoonia linearis*, *Hakea sericea*, *Banksia oblongifolia*, *Pittosporum undulatum*, *Glochidion ferdinandi*	*Pomax umbellata*, *Lomandra longifolia*, *Dianella longifolia*, *Opercularia diphylla*, *Cheilanthes sieberi*, *Themeda australis*, *Austrodanthonia* spp., *Laxmannia gracilis*, *Cyathochaeta diandra*, *Billardiera scandens*, *Microlaena stipoides*, **Rubus fruticosus* complex, *Poranthera microphylla*, *Pratia purpurascens*, **Asparagus asparagoides*, *Gahnia aspera*, *Echinopogon caespitosus*	TSC Act listed Vulnerable ecological community *Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion*	Moderate to Good

Vegetation community	Biometric vegetation type PCT	Canopy height	Canopy species	Understorey species	Ground cover species	Conservation significance	Ecological integrity
Castlereagh Swamp Woodland	ME005 Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin	8–10 m	As for Castlereagh Scribbly Gum Woodland but denser canopy of *Melaleuca decora*[2]	As for Castlereagh Scribbly Gum Woodland[1]	As for Castlereagh Scribbly Gum Woodland[1]	TSC Act listed Endangered ecological community *Castlereagh Swamp Woodland Community*	Moderate to Poor

Note: Castlereagh Swamp Woodland is differentiated from Castlereagh Scribbly Gum Woodland only by location in the landscape, found in wet low-lying areas in ephemeral drainage channels. Castlereagh Swamp Woodland and Castlereagh Scribbly Gum Woodland are generally not distinct from one anotherin terms of their species composition or structure in the IMT site.

3.3.2.1 Detailed assessment of the occurrence of Threatened ecological communities

An assessment of the occurrence of Threatened ecological communities is provided in Table 3.5. The assessment included all Threatened communities recorded from the Sydney Cataract subregion of the Sydney Metropolitan catchment management authority region in which the site is located, and is based on the landform, soils and observed vegetation of the site. Bold text identifies that the community has been recorded on the site.

Table 3.5 Threatened ecological community occurrence assessment

Threatened ecological community	Legislative status		Occurrence within the Project site
	EPBC Act[1]	TSC Act[2]	
Cooks River/ Castlereagh Ironbark Forest in the Sydney Basin bioregion	–	E	Not present in the Project site. Broad scale mapping of the site(Tozer 2003) shows this community on-site; however field verification by URS (URS 2004) and Parsons Brinckerhoff (current study) did not detect this community on-site. Vegetation patches mapped as this community in Tozer(2003) have been attributed by URS and Parsons Brinckerhoff to River-flat Eucalypt Forest and Castlereagh Scribbly Gum Woodland communities based on floristic composition.
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	–	E	Not present in the Project site. This community is found in drainage lines and depressions on sandy alluvium and coastal sand flats (Tozer *et al.* 2006). While the Project site is located within the known range of this community, it does not contain the associated landform and soils and does not have the correct floristic composition.
River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	–	E	Present in the Project site. In the Sydney region this community is restricted to the Georges River and Hawkesbury-Nepean systems (Tozer *et al.* 2006). It is found on stream banks and alluvial flats on soils derived from Wianamatta Shale (Tozer et al. 2006). Mapped previously in the Project site and its distribution was verified during current surveys.
Shale Sandstone Transition Forest in the Sydney Basin bioregion	E	E	Not present in the Project site. This community occurs on clay soils derived from Wianamatta Shale on the margins of the Cumberland Plain where the underlying sandstone geology is close to the surface (Tozer et al. 2006). While the Project site is on the margin of the Cumberland Plain, it does not have the correct floristic composition. Transitional vegetation in this locality is consistent with the analogous yet distinct Castlereagh Scribbly Gum Woodland community.

Threatened ecological community	Legislative status		Occurrence within the Project site
	EPBC Act[1]	TSC Act[2]	
Swamp Oak Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	–	E	Not present in the Project site. In the locality, this community is found on sandy saline sediments fringing the high tide mark of tidal river estuaries (Tozer et al. 2006). While the Project site is located within the known range of this community, it does not contain the associated landform and soils and does not have the correct floristic composition.
Cumberland Plain Woodland (Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest)[3]	CE[3]	CE	Unlikely to be present in the Project site; however vegetation on the western side of the Georges River has not been subject to field verification. Occurs on clay soils derived from Wianamatta Group geology, or more rarely alluvial substrates, on the Cumberland Plain. Transitional stands between Cumberland Plain Woodland and other listed communities occur and should be assigned to the community with which they share greatest resemblance in species composition and other properties (NSW Scientific Committee 1997). Broad scale mapping of the site(Tozer 2003) does not show this community on-site and field verification by URS (URS 2004) and Parsons Brinckerhoff (current study) has not detected this community. Vegetation on-site which shares some characteristics with this community has been attributed by URS and Parsons Brinckerhoff to the River-flat Eucalypt Forest (Alluvial Woodland) communities based on floristic composition. It is possible, though unlikely, that a small area of the TSC Act listed community occurs on the site to the west of the Georges River. Due to the fragmentation of vegetation apparent from aerial photography and the current land use of areas to the west of the Georges River, the EPBC Act listed community is unlikely to occur there.
Shale Gravel Transition Forest in the Sydney Basin Bioregion (Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest)[3]	CE	E	Not present in the Project site. Occurs primarily in areas where shallow deposits of Tertiary alluvium overlie shale soils, but may also occur in association with localised concentrations of iron-indurated gravel. Transitional stands between Shale Gravel Transition Forest and other listed communities also occur. Broad scale mapping of the site(Tozer 2003) shows this community on-site; however field verification by URS (URS 2004) and Parsons Brinckerhoff (current study) has not detected this community on-site. Vegetation patches mapped as this community in Tozer (2003) have been attributed by URS and Parsons Brinckerhoff to River-flat Eucalypt Forest (Alluvial Woodland) and Castlereagh Scribbly Gum Woodland based on floristic composition.
Moist Shale Woodland in the Sydney Basin Bioregion	–	E	Not present in the Project site. Occurs on soils derived from Wianamatta Shale on higher country in the southern half of the Cumberland Plain (NSW Scientific Committee 2002). The IMT site does not contain the associated landform or floristic composition.

Threatened ecological community	Legislative status		Occurrence within the Project site
	EPBC Act[1]	TSC Act[2]	
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion	–	V	Present in the Project site. Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion occurs almost exclusively on soils derived from Tertiary alluvium, or on sites located on adjoining shale or Holocene alluvium (Tozer 2003). Mapped previously in the IMT site and its presence verified during current surveys.
Castlereagh Swamp Woodland Community	–	E	Present in the Project site. Occurs in western Sydney in the Castlereagh and Holsworthy areas, on deposits from ancient river systems and along today's intermittent creeklines, often in poorly drained depressions (Office of Environment and Heritage 2011b). Intergrades with Castlereagh Scribbly Gum Woodland in transitional areas between poorly drained and elevated areas. Mapped previously in the IMT site and its presence verified during current surveys.
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	–	E	Not present in the Project site. Typically associated with gullies and sheltered slopes of hilly, relatively steep sections of the generally elevated Cumberland Plain in the Razorback Range from Cobbitty to Picton, and sporadically elsewhere in Western Sydney (NSW Scientific Committee 2000). The IMT site does not contain the associated landform or floristic composition.
Sydney Turpentine-Ironbark Forest (Turpentine-Ironbark Forest in the Sydney Basin bioregion)[4]	CE	E	Not present in the Project site. This community occurs on undulating terrain and ridge tops on soils derived from Wianamatta Shale on the edge of the Cumberland Plain and lower Blue Mountains (Tozer *et al.* 2006). While the IMT site is on the edge of the Cumberland Plain it does not contain the associated landform or floristic composition.

Notes:
1) National conservation status as listed under the EPBC Act. V = Vulnerable, E = Endangered
2) Conservation status as listed under the TSC Act. CE = Critically endangered, E = Endangered, V = Vulnerable
3) National listing of *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* encompasses both of these communities which are listed separately under TSC Act.
4) Listed name under the EPBC Act.

3.4 Species of plant recorded in the Project site

A total of 233 species of plant were recorded within the Project site (refer Appendix A), comprising 155 native species and 78 introduced species. The high number of native species recorded reflects the presence of areas on-site with near-natural levels of plant diversity, particularly in the Castlereagh Scribbly Gum Woodland along Moorebank Avenue and the Riparian Forest community along the Georges River; however, native species diversity is much lower in degraded patches of vegetation in the core of the site.

3.5 Threatened species of plant

3.5.1 Threatened species of plant on the IMT site

Botanical surveys of the IMT site conducted for this study examined the extent and ecological integrity of the vegetation communities present and recorded the presence of two Threatened species of plant: *Persoonianutans* (listed as Endangered under the EPBC Act and TSC Act) and *Grevillea parviflora* subsp. *parviflora* (listed as Vulnerable under the EPBC Act and TSC Act). These plants were located in Castlereagh Scribbly Gum Woodland patches adjacent to Moorebank Avenue in the east of the IMT site (refer Figure 3.1 to Figure 3.3).

At least 16 apparent individuals (individual shrubs or groups of suckers) of *Grevillea parviflora* subsp. *parviflora* were recorded. The precise number of individuals of this species present is very difficult to gauge due to its suckering habit and the possible presence of a soil seedbank. Approximately 10 individuals of *Persoonia nutans* were present; however additional individuals may be also be represented in a soil seed bank.

Based on preferred habitats and known distribution, together with analysis of known vegetation and geological associations, six additional Threatened plant species have a moderate likelihood of occurrence within the IMT site (refer Table 3.6 and Appendix B). Targeted searches for these species were undertaken in areas of potential habitat within the IMT site. These species are not cryptic and are detectable and identifiable outside of the flowering period. Although the survey did not detect these species, they have been considered moderately likely to occur due to the presence of suitable habitat and historical records of these species from the locality. It is possible that some of these species may be represented in the IMT site in the form of soil-stored seed or have gone undetected due to occurrence in very low numbers.

It is unlikely that any of the remaining Threatened species of plant identified in the desktop assessment (refer Appendix B) are present for one or more of the following reasons:

- No suitable habitat was recorded in the IMT site.
- The area is outside the normal range of the species and records are likely to be invalid.
- The species is considered locally extinct.

Table 3.6 Threatened flora known or likely to occur on the Project site

Family	Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat	Likelihood of occurrence in Project site
Fabaceae (Mimosoideae)	*Acacia bynoeana*	Bynoe's Wattle	V	E1	No	Grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with *Corymbi agummifera, Eucalyptus haemastoma, Eucalyptus gummifera, Eucalyptus parramattensis, Eucalyptus sclerophylla, Banksia serrata* and *Angophora bakeri*(NSW National Parks and Wildlife Service 1999a).	Moderate No historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the IMT site. Unlikely to occur elsewhere in Project site.
Fabaceae (Mimosoideae)	*Acacia pubescens*	Downy Wattle	V	V	Yes 161 records exist in the locality including one near the IMT site from 1998	Restricted to the Sydney Region from Bilpin to the Georges River and also at Woodford where it usually grows in open sclerophyll forest and woodland on clay soils. Typically it occurs at the intergrade between shales and sandstones in gravely soils often with ironstone (Harden 2002; NSW National Parks and Wildlife Service 2003a).	Moderate Historic records of this species exist in the locality. Marginal habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the IMT site. Unlikely to occur elsewhere in Project site
Fabaceae (Faboideae)	*Dillwynia tenuifolia*		V	V	Yes One record exists near Kemps Creek	Occurs on the Cumberland Plain from the Blue Mountains to Howes Valley area where it grows in dry sclerophyll woodland on sandstone, shale or laterite (Harden 2002). Specifically, occurs within Castlereagh woodlands, particularly in shale gravel transition forest. Associated species include *Eucalyptus fibrosa, Eucalyptus sclerophylla, Melaleuca decora, Daviesia ulicifolia, Dillwynia juniperina* and *Allocasuarina littoralis*(James 1997).	Moderate One record of this species in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the IMT site.

Family	Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat	Likelihood of occurrence in Project site
Proteaceae	*Grevillea parviflora*subsp. *parviflora*	Small-flower Grevillea	V	V	Yes Two records exist near the IMT site with a recent record from 2002	Mainly known from the Prospect area (but now extinct there) and lower Georges River to Camden, Appin and Cordeaux Dam areas, with a disjunct populations near Putty, Cessnock and Cooranbong. Grows in heath or shrubby woodland in sandy or light clay soils usually over thin shales (Harden 2002; NSW Scientific Committee 1998a).	**Recorded** Recorded in Castlereagh Scribbly Gum Woodland along eastern boundary of the IMT site. Unlikely to occur elsewhere in the Project site.
Ericaceae	*Leucopogonexolasius*	Woronora Beard-heath	V	V	Yes Three records exist nearby with a record near the IMT site from the year 2000	Restricted chiefly to the Woronora and Grose Rivers and Stokes Creek, Sydney catchments and the Royal National Park. One old record from the Grose River. Grows in woodland on sandstone (Royal Botanic Gardens 2011).	Moderate Marginal habitat for this species exists in the Castlereagh Scribbly Gum Woodland along eastern boundary of the IMT site. Unlikely to occur elsewhere in the Project site.
Proteaceae	*Persooniahirsuta*	Hairy Geebung	E	E1	Yes Three records exist near Holsworthy	Occurs in central coast and central tableland districts where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) and rarely shale (NSW Scientific Committee 1998b). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997; Office of Environment and Heritage 2011b).	Moderate Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the IMT site. Unlikely to occur elsewhere in the Project site.
Proteaceae	*Persoonianutans*	Nodding Geebung	E	E1	Yes 31 records exist near the IMT site including a recent record from 2002	Confined to the western Sydney where it grows in Castlereagh Scribbly Gum Woodlands and Agnes Banks Woodlands (Harden 2002; James 1997; NSW National Parks and Wildlife Service 2001b).	**Recorded** Recorded in Castlereagh Scribbly Gum Woodland along eastern boundary of the Project site. Unlikely to occur elsewhere in Project site

Family	Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat	Likelihood of occurrence in Project site
Fabaceae (Faboideae)	*Pultenaeaparviflora*	Sydney Bush-pea	V	E1	Yes One record exists at Potts Hill	Restricted to the Cumberland Plain where it grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium (Harden 2002). Locally abundant within Castlereagh Ironbark Forest and Shale/Gravel Transition Forest on tertiary alluvium or laterised clays (James 1997; NSW National Parks and Wildlife Service 2002b).	Moderate Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the IMT site. Unlikely to occur elsewhere in Project site

Notes:

1) TSC Act - *Threatened Species and Conservation Act 1995*. E1 = Endangered V = Vulnerable
2) EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999*. E = Endangered, V = Vulnerable
4) Based on database searches and field surveys

Bold text identifies if the likelihood of occurrence in the IMT site is moderate, high, or if the species has been recorded on the site.

3.5.2 Habitat potential for threatened species of plant in the rail access option locations

The suitability of the habitat in the rail access option locations for threatened species of plants is discussed in Table3.7 below. No threatened flora species were recorded in the rail access options or considered to have a moderate likelihood of occurrence.

Table 3.7 Habitat potential for threatened species of plant in the rail access locations

Rail access options	Habitat characteristics	Potential as habitat for locally recorded threatened species of plant
Northern	Riparian Forest varying with moderately dense to minimal shrub cover with predominantly native groundcover. Riparian Forest with reduced canopy, a recently revegetated and minima native groundcover. Cleared areas with scattered, predominantly planted, trees and exotic groundcover.	**Low** Due to the lack of suitable vegetation communities and generally modified condition of vegetation.
Central	Riparian Forest with moderately dense to dense shrub cover with a mosaic of areas with native species (e.g. *Breynia oblongifolia*) dominant, exotic species (e.g. *Lantana camara*) dominant and mixed areas. Some patches of native groundcover apparent. Alluvial Woodland vegetation with minimal native shrub cover, dominated by exotic shrubs (e.g. *Lantana camara*). Cleared areas with bare ground and minimal vegetation.	**Low** Due to the lack of suitable vegetation communities and generally modified condition of vegetation.
Southern	Riparian Forest with moderately dense to dense shrub cover with a mosaic of areas with native species (e.g. *Breynia oblongifolia*) dominant, exotic species (e.g. *Lantana camara*) dominant and mixed areas. Some patches of native groundcover apparent. Riparian Forest and Alluvial Woodland of unknown but likely modified condition on the western side of the Georges River. Cleared areas with scattered, predominantly planted, trees and exotic groundcover.	**Low** Due to the lack of suitable vegetation communities and generally modified condition of vegetation.

3.6 Noxious and nationally significant weeds

Of the 72 non-indigenous species of plant recorded, 12 are listed under the *Noxious Weeds Act 1993* for the Liverpool noxious weed control area (refer Table 3.8) and nine of these species are listed as Weeds of National Significance (Australian Weeds Committee 2010).

Other highly invasive species recorded within the Project site included: **Araujia sericifera, *Ageratina adenophora, *Tradescantia fluminensis, *Cinnamomum camphora, *Ochna serrulata, *Eragrostis curvula, *Pennisetum clandestinum*and **Cardiospermum grandiflorum.*

The most abundant and invasive weeds onsite include **Lantana camara* and vine weeds, particularly **Cardiospermum grandiflorum*. These weeds are most abundant within and at the edges of the remnant vegetation of the riparian zone of the Georges River.

The aquatic weeds **Salvinia molesta, *Alternanthera philoxeroides*and**Sagittaria platyphylla* were recorded in patches in Anzac Creek and, in the case of **Sagittaria platyphylla,* in the artificial ponds of the site.

The remaining species occurred sporadically throughout the site in patches of native vegetation and areas not subject to frequent mowing.

Table 3.8 Noxious and nationally significant weeds within the Project site

Scientific name	Common name	*Noxious Weeds Act 1993* control class[1]	Weeds of National Significance
Alternanthera philoxeroides	Alligator Weed	3	Yes
Asparagus aethiopicus	Ground asparagus	-	Yes
Asparagus asparagoides	Bridal Creeper	4	Yes
*Chrysanthemoides monilifera*subsp.*monilifera*	Boneseed	2	Yes
*Chrysanthemoides monilifera*subsp.*rotundata*	Bitou Bush	3	Yes
Lantana camara	Lantana	4	Yes
Ligustrum lucidum	Large-leaved Privet	4	–
Ligustrum sinense	Small-leaved Privet	4	–
Ludwigia peruviana	–	4	–
*Olea europaea*subsp. *cuspidata*	African Olive	4	–
Rubus fruticosus	Blackberry complex	4	Yes
Sagittaria platyphylla		5	Yes
Salvinia molesta	–	2	Yes

Notes 1) Control Categories under the *Noxious Weeds Act 1993*: Class 2: The plant must be eradicated from the land and the land must be kept free of the plant. Class 3: The plant must be fully and continuously suppressed and destroyed. Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. Class 5: The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

3.7 Species of animal recorded in the Project site

A total of 92 species of animal were recorded within the Project site (refer Appendix A), comprising 87 native species and five introduced species.

The animals recorded comprised the following:

- Seven species of frog (all native)
- Fifty-seven species of bird (three species introduced)
- Nineteen species of mammal (three introduced)
- Nine species of reptile (all native).

The moderate to high number of native species recorded reflects the presence of areas on-site with substantial value as fauna habitat particularly in the Alluvial Woodland and Riparian Forest communities along the Georges River. However, native species diversity is much lower in degraded patches of vegetation in the core of the site.

3.8 Terrestrial fauna habitats and threatened animal species

3.8.1 Threatened species of animal

The fauna surveys completed in November 2010 detected the Grey-headed Flying-fox (listed as Vulnerable under the EPBC Act and TSC Act) flying over the site. The 2003 fauna study (LesryK Environmental Consultants 2003) recorded the presence of two threatened microbat species in the IMT site: Large-footed Myotis and Eastern Bent-wing Bat.

Analysis of ultrasonic bat calls collected on the site for the current study also revealed probable recordings of these species. Bat calls attributable to either the Greater Broad-nosed Bat or Eastern False Pipistrelle were also recorded in the current study. These calls were not of sufficient quality to reliably differentiate the species; however it is considered more likely that they are of the Greater Broad-nosed Bat based on the suitability of the habitat for the species and previous records in the locality.

The site is also likely to provide habitat for 23 additional Threatened species of animals not detected during surveys. It furthers an important role in the local and regional corridor network given its location adjacent to the Georges River and extensive areas of vegetation to the south.

Many of these species are only likely to utilise the intact riparian habitats along the Georges River and would only occasionally, if ever, utilise the more fragmented patches of vegetation in the central and eastern areas of the site. Most of these species have large home ranges that would likely extend well beyond the IMT site and/or are migratory or nomadic and likely to use the IMT site on a sporadic or seasonal basis.

It is unlikely that any of the remaining Threatened species of animal identified in the desktop assessment (refer Appendix B) are present for one or more of the following reasons:

- No suitable habitat was recorded in the IMT site.
- The area is outside the normal range of the species and records are likely to be invalid.
- The species is considered locally extinct.

3.8.2 Terrestrial fauna habitats and threatened animal species on the IMT site

The following detailed description of the terrestrial fauna habitats and Threatened fauna species within the IMT site are is also representative of those features identified within the rail access options described in section 3.1 (refer to Table 3.2) above.

Vegetation in the surrounding area, to the north of the IMT site is highly fragmented, with large expanses of urbanised land surrounding small vegetation remnants. Within the IMT site, most patches of vegetation especially to the east of the IMT site are small and are considered poor to moderate habitat for a range of fauna species that require large tracts of continuous habitat.

The riparian corridor along the Georges River is well connected to the vegetation within the south of the IMT site, which also contains other large areas of well-connected native vegetation. Habitat for terrestrial fauna (land animals) is described below. Habitat for aquatic animals is covered separately in section 3.2.8.

Vegetation within the locality region to the north of the IMT site is generally highly fragmented, with large expanses of urbanised land surrounding small vegetation remnants; however, substantial areas of well-connected native vegetation exist to the south.

Most patches of vegetation in the east of the IMT site are small and consequently can be considered poor to moderate habitat for a range of species that require large tracts of continuous habitat. However, in the context of the highly cleared landscape to the north of the site, these small patches are likely to play an important role in maintaining the biodiversity that remains in the locality.

The remnant riparian vegetation of the IMT site is connected to the vegetation of the Holsworthy Army base to the south through the Georges River riparian corridor.

The main terrestrial fauna habitats of the IMT site based on field verification include:

- riparian vegetation along the Georges River
- fragmented patches of shrubby woodland
- highly disturbed areas containing large remnant trees
- artificial wetlands.

Indicative photographs of these habitat types are shown in Photo 3.1 to Photo 3.4.

These habitats are described for the IMT site in Table 3.9 and the access options in Table 3.10 in terms of their potential use by Threatened species of animal that potentially occur on the Project site based on the characteristics of the habitat present and previous records of the species in the broader locality.

Species-specific discussion of habitat for threatened fauna on the Project site, covering both the IMT site and the access option locations, is presented in Table 3.11.

Photo3.1 Riparian vegetation along the Georges River

Photo3.2 Fragmented patch of shrubby woodland

Photo3.3 Highly disturbed area containing large remnant trees

Photo3.4 Artificial wetland

Table 3.9 Habitats for terrestrial fauna in the IMT site

Habitat	Description	Threatened animal species that may use habitat	Ecological integrity[1]
Riparian vegetation along the Georges River	Riparian forest/Alluvial Woodland corridor with tall eucalypt canopy; sparse subcanopy of *Acacia* spp and mesic shrubs and small trees; Understorey ranging from moderately dense native shrub layer to weed (e.g. *Lantana camara*) thickets; groundcover ranging from native herbs and grasses to areas of exotic vines (e.g. *Cardiospermum grandiflorum*), scramblers and grasses. Moderate connectivity to other habitat in the locality. Hollow-bearing trees moderately abundant.	Barking Owl Cumberland Land Snail Eastern Bent-wing Bat Eastern False Pipistrelle Eastern Free-tail bat Eastern Pygmy-possum Flame Robin Gang-gang Cockatoo Greater Broad-nosed Bat Grey-headed Flying-fox* Koala* Little Eagle Little Lorikeet Powerful Owl Regent Honeyeater* Scarlet Robin Southern Myotis Spotted Harrier Spotted-tailed Quoll* Square-tailed Kite Squirrel Glider Swift Parrot* Varied Sittella Yellow-bellied Sheathtail Bat	Moderate to High Provides foraging, roosting and/or breeding opportunities for a wide variety of Threatened fauna and has high value as a fauna movement corridor due to its connectivity north and south of the site.
Fragmented patches of shrubby woodland	Shrubby woodland with a eucalypt canopy of moderate height; Understorey ranging from moderately dense, high diversity native shrub layer to thickets of disturbance tolerant native shrubs (e.g. *Kunzea ambigua*) and weed patches (e.g. *Rubus* sp.) thickets; groundcover ranging from native herbs and grasses to mats of exotic scramblers and grasses. Low connectivity to other habitat in the locality. Very few hollow-bearing trees present. Ephemeral wetlands present after heavy rain.	Grey-headed Flying-fox* Scarlet Robin Little Lorikeet Swift Parrot* Flame Robin Yellow-bellied Sheathtail Bat Cumberland Land Snail	Moderate Provides foraging, roosting and/or breeding opportunities for a limited suite of threatened fauna; little opportunity for hollow-dependent species. Has only moderate value as a fauna movement corridor due to its fragmentation.
Highly disturbed areas containing large remnant trees	Sparse remnant canopy; Understorey generally absent or depauperate; groundcover ranging from a mixture of native herbs and grasses with exotic species (co-dominant) to areas dominated by exotic species. Low connectivity to other habitat in the locality. Hollow-bearing trees moderately abundant.	Powerful Owl Barking Owl Grey-headed Flying-fox* Eastern Free-tail bat Yellow-bellied Sheathtail Bat Regent Honeyeater* Gang-gang Cockatoo Spotted Harrier Little Eagle Square-tailed Kite	Poor to Moderate Incomplete vegetation structure and lack of canopy connectivity limits its value as habitat for many species. Tree hollows provide potential roost/breeding sites for species capable of using isolated trees.

Habitat	Description	Threatened animal species that may use habitat	Ecological integrity[1]
Artificial ponds/wetlands	Artificial ponds with varying cover of open water and aquatic macrophytes. Canopy absent or sparse consisting chiefly of relatively small trees; Understorey generally absent or depauperate; groundcover ranging from a mixture of native emergent aquatic herbs, grasses and sedges with exotic species (co-dominant) to areas dominated by native species. Low to moderate connectivity to other aquatic habitat in the locality. Hollow-bearing trees scarce. The exotic fish, Plague Minnow (*Gambusia holbrooki*) is present in some ponds and absent from others. Access to fresh water for birds and bats.	Eastern Bent-wing Bat Eastern False Pipistrelle Eastern Free-tail bat Greater Broad-nosed Bat Yellow-bellied Sheathtail Bat	Poor to Moderate Modified vegetation structure and limited connectivity makes this habitat unsuitable for many species.

Notes: Definitions of habitat ecological integrity are provided in section 2.5 above.
* indicates species listed under the EPBC Act.

3.8.3 Terrestrial fauna habitats and threatened animal species at the rail access locations

The terrestrial fauna habitats and threatened fauna species within the land potentially affected by the rail access options summarised in Table 3.10 below.

Table 3.10 Habitats for terrestrial fauna at the rail access locations

Rail access options	Description	Threatened animal species that may use habitat	Ecological integrity[1]
Northern	Tall eucalypt woodland with intact canopy, a sparse subcanopy of *Acacia* spp and native grass groundcover. Contains a small area of disturbed shrubby forest with reduced canopy and shrub cover. Moderate to Low connectivity to other habitat in the locality, chiefly to the south. Hollow-bearing trees moderately abundant.	Barking Owl Eastern Bent-wing Bat Eastern False Pipistrelle Eastern Free-tail bat Eastern Pygmy-possum Flame Robin Gang-gang Cockatoo Greater Broad-nosed Bat Grey-headed Flying-fox* Koala* Little Eagle Little Lorikeet Powerful Owl Regent Honeyeater* Scarlet Robin Southern Myotis Spotted Harrier Spotted-tailed Quoll* Square-tailed Kite Squirrel Glider Swift Parrot* Varied Sittella Yellow-bellied Sheathtail Bat	Moderate Provides foraging, roosting and/or breeding opportunities for a wide variety of threatened fauna and has moderate value as a fauna movement corridor due to its connectivity but relatively narrow width of riparian vegetation.
Central	Tall eucalypt woodland with extensive woody weed cover in the understorey and groundcover strata and a sparse subcanopy of *Acacia* spp. Tall shrubby forest with a dense understorey of native and introduced shrubs and occasional areas of native groundcover grasses and herbs. Moderate to High connectivity to other habitat in the locality. Hollow-bearing trees moderately abundant.	Barking Owl Eastern Bent-wing Bat Eastern False Pipistrelle Eastern Free-tail bat Eastern Pygmy-possum Flame Robin Gang-gang Cockatoo Greater Broad-nosed Bat Grey-headed Flying-fox* Koala* Little Eagle Little Lorikeet Powerful Owl Regent Honeyeater* Scarlet Robin Southern Myotis Spotted Harrier Spotted-tailed Quoll* Square-tailed Kite Squirrel Glider Swift Parrot* Varied Sittella Yellow-bellied Sheathtail Bat	Moderate to High Provides foraging, roosting and/or breeding opportunities for a wide variety of threatened fauna and has moderate value as a fauna movement corridor due to its connectivity north and south of the Project site but relatively narrow width of riparian vegetation.

Rail access options	Description	Threatened animal species that may use habitat	Ecological integrity[1]
Southern	Tall eucalypt forest with intact canopy. The condition and structure of the understorey and groundcover on the western bank of the river is unknown. Moderate to High connectivity to other habitat in the locality, chiefly to the south. Hollow-bearing trees moderately abundant.	Barking Owl Eastern Bent-wing Bat Eastern False Pipistrelle Eastern Free-tail bat Eastern Pygmy-possum Flame Robin Gang-gang Cockatoo Greater Broad-nosed Bat Grey-headed Flying-fox* Koala* Little Eagle Little Lorikeet Powerful Owl Regent Honeyeater* Scarlet Robin Southern Myotis Spotted Harrier Spotted-tailed Quoll* Square-tailed Kite Squirrel Glider Swift Parrot* Varied Sittella Yellow-bellied Sheathtail Bat	Moderate to High Provides foraging, roosting and/or breeding opportunities for a wide variety of threatened fauna and has high value as a fauna movement corridor due to its connectivity north and south of the Project site and relatively wide expanse of riparian vegetation.

Notes: Definitions of habitat ecological integrity are provided in section 2.5 above. * indicates species listed under the EPBC Act.

Table 3.11 **Threatened and Migratory fauna likely to occur in the Project site**

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Invertebrates						
Meridolumcorneovirens	Cumberland Land Snail	-	E1	Yes 208 records exist within the locality including records within the IMT site	Restricted to the Cumberland Plain and Castlereagh Woodlands of Western Sydney and also along the fringes of River Flat Forest, especially where it meets Cumberland Plain Woodland. It is typically found under logs and other debris, amongst leaf litter and bark around bases of trees. It is also sometimes found under grass clumps and where possible it will burrow into loose soil (NSW National Parks and Wildlife Service 1999b).	Moderate Species was apparently recorded on-site in 2006 (Office of Environment and Heritage 2012a); however it was not detected in targeted surveys in 2010. May be present on-site in low numbers or has gone extinct on-site. Mistaken identity is also a possibility as this species is sometimes confused with some colour variants of the exotic Asian Tramp Snail *Bradybaenasimilaris* which was recorded on the site in 2010 surveys.
Birds						
Anthochaeraphrygia	Regent Honeyeater	EM	CE	Yes Six records exist in the locality including near Warwick farm and Revesby	Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with *Casuarina cunninghamiana* and *Amyema cambagei* are important for feeding and breeding. Important food trees include *Eucalyptus sideroxylon*, *Eucalyptus albens*, *Eucalyptus melliodora* and *Eucalyptus leucoxylon*(Garnett & Crowley 2000a).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records are present. May forage sporadically on the site in winter but unlikely to breed locally. Unlikely elsewhere in the IMT site.
Apus pacificus	Fork-tailed Swift	M	-	No	Breeds from central Siberia eastwards through Asia, and is migratory, wintering south to Australia. Individuals never settle voluntarily on the ground and spend most of their lives in the air, living on the insects they catch in their beaks (Higgins 1999).	Moderate Marginal habitat present.
Ardea ibis	Cattle Egret	M		Yes Two records exist near the IMT site	The Cattle Egret is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia (McKilligan 2005).	Moderate Marginal habitat and local records present.

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Ardeamodesta	Eastern Great Egret	M		Yes 11 records exist in the locality near the Georges River	Great Egrets are common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species(Australian Museum 2003).	Moderate Marginal habitat and local records present.
Callocephalonfimbriatum	Gang-gang Cockatoo		V	Yes Three records exist in the locality with a record near the Georges River from 2006.	Occurs in wetter forests and woodland from sea level to an altitude over 2000 metres, timbered foothills and valleys, coastal scrubs, farmlands and suburban gardens (Pizzey & Knight 2007).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records present. May forage sporadically on the site, particularly in winter but unlikely to breed locally. Unlikely elsewhere in the IMT site.
Circus assimilis	Spotted Harrier		V	Yes One record exists at Hoxton Park	The Spotted Harrier occurs throughout the Australian mainland in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods) (Marchant & Higgins 1993). It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands (Department of Environment Climate Change and Water 2010d).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the IMT site.
Daphoenosittachrysoptera	Varied Sittella		V	Yes 28 records exist in the locality with recent records near the IMT site	The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland (Department of Environment Climate Change and Water 2010f).	Moderate The Varied Sittella is relatively common within the Greater Southern Sydney Region (Department of Environment and Climate Change 2007b). May occur in the Alluvial Woodland of the Georges River area. Less likely elsewhere in the IMT site.
Gallinagohardwickii	Latham's Snipe	M		Yes 51 records exist in the locality around the Bankstown Airport	Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett & Crowley 2000a).	Moderate Marginal habitat and local records present.

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Glossopsittapusilla	Little Lorikeet		V	Yes 13 records exist in the locality with 5 records near the IMT site from 2006.	The Little Lorikeet is found in forests, woodland, and in treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria (Higgins 1999).	High Potential habitat and local records present. A nomadic species which may forage in the IMT site, particularly in the Alluvial Woodland in the west. Unlikely to breed in the locality.
Haliaeetusleucogaster	White-bellied Sea-Eagle	M		Yes Three records exist in the locality along the Georges River	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a large nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 2007).	Moderate Marginal habitat and local records present.
Hieraaetusmorphnoides	Little Eagle		V	Yes 19 records exist in the locality with a record near the IMT site from 2006	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. She-oak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites, it requires a tall living tree within a remnant patch (Marchant & Higgins 1993).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the IMT site.
Hirundapuscaudacutus	White-throated Needletail	M		Yes Four records exist in the locality near the Georges River and near the IMT site	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 2007).	High Potential habitat and local records present. Likely to fly over the site only.
Lathamusdiscolor	Swift Parrot	E	E1	Yes 11 records exist in the locality with a record near the IMT site from 1998	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. On mainland Australia, the Swift Parrot is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering *Acacia pycnantha*, is indicated. sites used vary from year to year. (Garnett & Crowley 2000a; Swift Parrot Recovery Team 2001).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records present. May forage sporadically on the site in winter but extremely unlikely to breed locally.

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Lophoictiniaisura	Square-tailed Kite		V	Yes Two records exist in the locality from near Revesby and the Holsworthy restricted area as recently as 2006	The Square-tailed Kite hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects and seems to prefer structurally diverse landscapes (Garnett & Crowley 2000a). The species shows a particular preference for timbered watercourses and appears to occupy large hunting ranges of more than 100 km^2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs (Office of Environment and Heritage 2012b).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the IMT site.
Melithreptusgularisgularis	Black-chinned Honeyeater		V	Yes Seven records exist in the locality near Warwick Farm	Occurs within areas of annual rainfall between 400–700 mm. Feeds on insects, nectar and lerps(Garnett & Crowley 2000b). It occupies mostly in upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, Blakely's Red Gum and Forest Red Gum. Also inhabits open forests of smooth-barked gums, stringybarks, river sheoaks (nesting habitat) and tea-trees. Feeding territories are large, making the species locally nomadic. It tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 ha (Office of Environment and Heritage 2012b).	Moderate Marginal quality habitat in Alluvial Woodland. Considered rare in the region and is nomadic (Department of Environment and Climate Change 2007b). May forage in the IMT site when dominant eucalypts are in flower and possibly breed along the Georges River, unlikely elsewhere in the IMT site.
Monarchamelanopsis	Black-faced Monarch	M		Yes Eight records exist in the locality along the Georges River	Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp gullies in rainforest, eucalypt forest and in more open woodland when migrating (Pizzey & Knight 1997).	Moderate Marginal habitat and local records present.
Myiagracyanoleuca	Satin Flycatcher	M		Yes Two records exist in the locality at Hoxton Park and Warwick Farm	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 1997).	Moderate Marginal habitat and local records present.

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Ninoxconnivens	Barking Owl		V	Yes One record exists in the locality near Warwick Farm	Occurs in dry sclerophyll woodland. In the south-west, it is often associated with riparian vegetation, while in the south-east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett & Crowley 2000a).	Moderate Very rare in the region but considered to be widespread (Department of Environment and Climate Change 2007b). Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the IMT site.
Ninoxstrenua	Powerful Owl		V	Yes Seven records exist in the locality with a record near the IMT site (Leacock Regional Park) from 2006	A sedentary species with a home range of approximately 1000 ha, it occurs within open eucalypt, casuarina or callitris pine forest and woodland. It often roosts in dense vegetation including rainforest and exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands (Garnett & Crowley 2000a).	Moderate Relatively common in the region (Department of Environment and Climate Change 2007b). Potential breeding and foraging habitat present in the Alluvial Woodland of the Georges River riparian corridor as part of a much larger territory extending well beyond the IMT site. Unlikely elsewhere in the IMT site.
Petroicaboodang	Scarlet Robin		V	Yes Two records exist in the locality in the Holsworthy restricted area near the IMT site from 2006	In NSW, the Scarlet Robin occupies open forests and woodlands from the coast to the inland slopes. Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains. It prefers an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter, it migrates to open habitats such as grassy open woodland or paddocks with scattered trees (Department of Environment Climate Change and Water 2010c; Higgins & Peter 2002).	Moderate Marginal habitat and local records present. Likely only as a non-breeding migrant. Likely in the Alluvial Woodland of the IMT site only.

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Petroicaphoenicea	Flame Robin		V	Yes Three records exist in the locality near Revesby in 1992 and the Holsworthy restricted area from 1996	In NSW, the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats (Higgins & Peter 2002). The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank (Department of Environment Climate Change and Water 2010b).	Moderate Marginal habitat and local records present (Department of Environment and Climate Change 2007b). Likely only as a non-breeding migrant. Likely in the Alluvial Woodland of the IMT site only.
Rhipidurarufifrons	Rufous Fantail	M		Yes 54 records exist in the locality near the Georges River and in Sutherland	Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range (Pizzey & Knight 1997).	High Potential habitat and local records present.
Mammals						
Cercartetusnanus	Eastern Pygmy-possum		V	Yes Two records exists in the locality near the Georges River, recorded in 1993	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree hollows, between the wood and bark of a tree, abandoned birds' nests and/or shredded bark in the fork of trees (Turner & Ward 1995).	Moderate Marginal habitat and local records present. Likely only along the Georges River. Other vegetation unlikely to be occupied due to fragmentation.
Dasyurusmaculatus	Spotted-tailed Quoll	E	V	Yes Four records occur in the Holsworthy restricted area and in the Georges River National Park	In NSW, the Spotted-tailed Quoll occurs on both sides of the Great Dividing Range. Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heath. Nests in rock caves and hollow logs or trees (NSW National Parks and Wildlife Service 1999d, 1999f).	Moderate Marginal habitat and local records present. Moderately likely only along the Georges River. Other vegetation unlikely to be occupied due to fragmentation.

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Falsistrellustasmaniensis	Eastern False Pipistrelle		V	Yes Nine records exist in the locality near Sandy Point and to the east of the IMT site	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 m high (Churchill 2008).	Moderate (possible AnaBat record) Species recorded locally from ultrasonic calls only, which may be misidentifications. Predictive habitat quality mapping shows the locality with a low probability of occurrence (Department of Environment and Climate Change 2007b).
Miniopterusschreibersii	Eastern Bent-wing Bat		V	Yes 11 records exist in the locality near Glenfield, Warwick Farm and Sutherland	Usually found in well-timbered valleys where it forages on small insects above the canopy. Roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill 2008).	High The Eastern Bentwing-bat is common and widespread within the greater southern Sydney Region and is a lower conservation priority overall, with the exception of roosting and nursery sites (Department of Environment and Climate Change 2007b). Potential foraging habitat present. Marginal roosting habitat may be present in artificial structures. Nursery sites very unlikely.
Mormopterusnorfolkensis	Eastern Free-tail bat		V	Yes 26 records exist in the locality near the IMT site and at Glenfield	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in man-made structures (Churchill 2008). It will travel and forage in open country or along creek lines and may utilise remnants too isolated or disturbed for many other species. (Department of Environment and Climate Change 2007b).	High Local records exist in the locality and potential habitat present, chiefly in Alluvial Woodland along the Georges River Corridor; however may also occur elsewhere in the site including in mature isolated trees and patches of disturbed woodland. The Eastern Free-tail bat is rarely recorded within the greater southern Sydney Region and predictive habitat quality mapping shows the locality with a medium to high probability of occurrence (Department of Environment and Climate Change 2007b). Potential foraging and roost/breeding habitat is present mainly in Alluvial woodland along the Georges River.

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Myotisadversus	Large-footed Myotis		V	Yes 10 records exist in the locality including at Glenfield	Colonies occur in caves, mines, tunnels, under bridges and buildings. Colonies always occur close to bodies of water where this species feeds on aquatic insects (Churchill 2008).	High Within the Greater Southern Sydney Region, the Large-footed Myotis is strongly associated with the Cumberland Plain where it utilises waterways in relatively disturbed environments including the Georges River catchment around Liverpool and Campbelltown (Department of Environment and Climate Change 2007b). Potential foraging and roost/breeding habitat present mainly in Alluvial woodland along the Georges River.
Petaurusnorfolcensis	Squirrel Glider		V	Yes One record exists in the locality near the IMT site along the Georges River.	Found in dry sclerophyll forest and woodland but not found in dense coastal ranges. Nests in hollows and feeds on gum of acacias, eucalypt sap and invertebrates (NSW National Parks and Wildlife Service 1999e).	Moderate Marginal habitat and one local record only. Comprehensive surveys of the Cumberland Plain detected this species at only two locations one of which was at Holsworthy Military Reserve (Department of Environment and Climate Change 2007b). If present, it is likely to be restricted to the Georges River Corridor as other areas are too disturbed and fragmented.
Phascolarctoscinereus	Koala	V	V	Yes 97 records exist in the locality including a record near the IMT site from 2005	Found in sclerophyll forest. Throughout NSW, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include *Eucalyptus tereticornis*, *Eucalyptuspunctata*, *Eucalyptuscypellocarpa* and *Eucalyptusviminalis*(NSW National Parks and Wildlife Service 1999c, 2003b).	Moderate The species is frequently recorded in the locality along the transition of the Cumberland Plain and coastal sandstone areas in an area known as the Cumberland Koala Linkage which includes areas immediately adjacent to the southern end of the site(Department of Environment and Climate Change 2007b). If present, it is likely to be restricted to the Georges River Corridor as other areas are too disturbed and fragmented.

Scientific name	Common name	EPBC Act[2]	TSC Act[1]	Recorded in locality[4]	Preferred habitat[4]	Likelihood of occurrence
Pteropuspoliocephalus	Grey-headed Flying-fox	V	V	Yes 88 records exist in the locality including many near the IMT site	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lily pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001a)	Recorded Within the Greater Southern Sydney Region there is one large and regularly used Flying-fox camp site on Cabramatta Creek (Department of Environment and Climate Change 2007b). Recorded flying overhead and likely to forage throughout the IMT site. Vegetation along the Georges River is most suitable as foraging habitat and may have potential for roosting.
Saccolaimusflaviventris	Yellow-bellied Sheathtail Bat		V	Yes Four records exist in the locality including at Sandy Point and to the south-east of the IMT site	Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts in tree hollows. Thought to be migratory (Churchill 2008).	Moderate A rarely detected species; however, AnaBat ultrasonic call records have been made around the Holsworthy Military Area. The habitat and distribution of this species is very poorly known and it may occur regularly within the locality or only occur as a summer visitor (Department of Environment and Climate Change 2007b).
Scoteanaxrueppellii	Greater Broad-nosed Bat		V	Yes 12 records exist in the locality with five records near the IMT site along the Georges River and at Glenfield	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically, it forages at a height of 3–6 m but may fly as low as 1 m above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill 2008).	High (probable AnaBat record) Local records exist in the locality and potential habitat present along the Georges River Corridor. Rarely recorded within the greater southern Sydney Region and predictive habitat quality mapping shows the locality with a medium to high probability of occurrence(Department of Environment and Climate Change 2007b).

Notes: 1.V= Vulnerable, E1 = Endangered, E2 = Endangered Population (*Threatened Species Conservation Act 1995*)
2. V = Vulnerable, E = Endangered, M = Migratory (*Environment Protection and Biodiversity Conservation Act 1999*)
3. Previously recorded' refers to records of threatened species that were identified within the locality from the Atlas of NSW Wildlife(Office of Environment and Heritage 2011a).
4.Based on database searches and field surveys

3.9 Migratory species

The following discussion of the migratory species within the IMT site is also representative of their potential to occur and be impacted within the rail access options described in section 3.1 (refer to Table 3.2) above.

Ten migratory species have been predicted to occur within the proposal locality, based on database searches and habitat assessment; however no migratory species were recorded during the surveys.

Migratory species are protected under international agreements to which Australia is a signatory, including the *Japan Australia Migratory Bird Agreement* (JAMBA), the *China Australia Migratory Bird Agreement* (CAMBA), the *Republic of Korea Australia Migratory Bird Agreement* (RoKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species comprise 'Matters of National Environmental Significance' and are protected under the EPBC Act.

One migratory species that is also listed as Critically Endangered under the EPBC Act (Regent Honeyeater) has potential to occur in the IMT site. Impacts on this species are considered in Section 4 and Appendix C.

Other migratory species of bird may also use the area (refer Table 3.11). The site would not be classed as an 'important habitat' for any migratory species as defined under the EPBC Act Policy Statement 1.1 Significant Impact Guidelines (Department of the Environment Water Heritage and the Arts 2009) in that the site is unlikely to contain:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- habitat utilised by a migratory species which is at the limit of the species range
- habitat within an area where the species is declining.

As such, it is unlikely that the proposed development within the IMT site would significantly affect any migratory species and this group is not considered further in this report.

3.10 Aquatic fauna habitats and Threatened animal species

3.10.1.1 Aquatic fauna habitats and threatened aquatic animal species on the IMT site

No surveys for aquatic animals were undertaken for this study, however, an aquatic ecology assessment for the Sydney Intermodal Terminal Alliance (SIMTA) Intermodal Facility EIS which included surveys in the lower reaches of Anzac Creek. The only native fish species found during that study was Flathead Gudgeon (*Philypnodon grandiceps*).

Anzac Creek (located in the south-east of the IMT site, refer Figure 3.1 to Figure 3.3) is the IMT site's only major drainage line. The creek has been highly modified as a result of vegetation clearing and the construction of in-line water features associated with the Royal Australian Engineers (RAE) Golf Course(refer Photo 3.5). The aquatic habitat in this waterway is likely to have been adversely affected by pollutant laden runoff from the golf course, the presence of the exotic fish species Plague Minnow (**Gambusia holbrooki*) and aquatic weeds including **Salvinia molesta* and **Ludwigia peruviana*. Anzac Creek is a named waterway with ephemeral flow containing temporary to permanent (artificial) pools and is, therefore, classified as Class 3 (Minimal Fish Habitat) in accordance with Fairfull and Witheridge(2003). A concrete-lined drainage channel is also found on the site which contains very little water during dry weather, has minimal aquatic vegetation and provides no fish habitat.

Other on-site waterbodies include four detention basins, two of which have an extensive cover of emergent aquatic vegetation (including native and exotic species). These basins provide breeding and foraging habitat for a variety of frogs, reptiles and waterbirds.

Assessment of the potential for Threatened species of fish and aquatic invertebrates to occur in the IMT site is included in Appendix B.

No threatened species of aquatic animal are likely to occur on the IMT site.

Photo 3.5 Artificial pond on Anzac Creek

3.10.1.2 Aquatic fauna habitats and threatened aquatic animal species at the rail access option locations

The following description of aquatic fauna habitats and threatened aquatic fauna species applies to all of the rail access options.

The stretch of the Georges River within the IMT site varies between approximately 40 m and 50 m in width and is characterised by sluggish water flow. The riverbank varies from very steep in the north to gently sloping in the south. Bank erosion is evident on parts of the very steep eastern bank of the river in the north of the site.

The vegetation of the bank is also variable, being dominated by native shrubs in the north and mats of vines weeds (e.g. **Cardiospermum grandiflorum*) and shrubby thickets of **Lantana camara* in the centre and south of the site. Native emergent aquatic vegetation, chiefly comprising *Typha orientalis* and *Phragmites australis* occurs in patches along the river edge. The Georges River is a major permanently flowing waterway and is hence classified as Class 1 (major fish habitat) in accordance with Fairfull&Witheridge (2003).

The aquatic biodiversity of the lower freshwater reaches of the Georges River has been modified as a result of habitat degradation due to changes in abiotic condition such as water flow volumes and velocities, increased nutrients and chemical pollutants and the introduction of invasive species. Recent water quality assessment of the Georges River indicated that the upper catchment was generally in good condition, while the middle catchment (within which the project is located) was generally in poor condition (GRCCC August 2011). The degraded condition of this section of the Georges River has led to the presence of disturbance-tolerant species which are less sensitive to alterations in environmental conditions.

A study was previously conducted for the Georges River catchment in which several locations along the Georges River were surveyed (Gehrke et al. 2004). Two sites close to the project recorded a total of 18 fish species, including 15 native and three introduced species. The aquatic ecology assessment for the Sydney Intermodal Terminal Alliance(SIMTA) Intermodal Facility EIS (which included surveys in the lower reaches of Anzac Creek and the Georges River at the southern end of the IMT site) also recorded the presence of three species of fish (Hyder Consulting 2012). No species currently listed under the NSW *Fisheries Management Act 1994* (FM Act) were recorded in the catchment and none are likely to occur in the affected stretch of the Georges River.

Due to the degraded condition of this waterway, the native species that persist here are likely to consist of disturbance tolerant species which are less sensitive to alterations in environmental conditions than species restricted to relatively unmodified environments.

The results of existing fish surveys were used to determine which species of fish have been recorded in the locality. Studies used included the following:

- *Biodiversity of the Georges River Catchment study* (Gehrke *et al.* 2004).
- aquatic ecology assessment for the SIMTA Moorebank Intermodal Facility EIS(Hyder Consulting Pty Ltd 2012).

Surveys for freshwater fish for the *Biodiversity of the Georges River Catchment* study covered nine locations, varying from nearly pristine to highly urbanised locations (Gehrke *et al.* 2004). Two of these sites were located in close proximity to the IMT site. Site 200 was located approximately 2 km downstream of the Project (downstream of Liverpool Weir) and site 201 was located less than 1 km upstream of the IMT site (Cambridge Avenue). The species of fish recorded at these two sites are shown in Table 3.11. A total of 18 species of fish was recorded in the freshwater catchment of the Georges River, including 15 native and three alien species(Gehrke *et al.* 2004). No species currently listed under the FM Act were recorded in the catchment (Department of Trade and Investment Regional Infrastructure and Services 2011; Gehrke *et al.* 2004).

The aquatic ecology assessment for the SIMTA Moorebank Intermodal Facility EIS included surveys in the lower reaches of Anzac Creek and in the Georges River at the southern end of the IMT site (Hyder Consulting Pty Ltd 2012). This survey revealed the presence of three species of fish as shown in Table 3.12 (Hyder Consulting Pty Ltd 2012).

Table 3.12 Fish recorded in the vicinity of the IMT site

Common name	Scientific name	Site 200	Site 201	Hyder Consulting(2012)	FM Act status
Australian Bass	*Macquaria novemaculeata*		X		–
Blackfish[2]	*Girella tricuspidata*	x			–
Flathead Gudgeon	*Philypnodon grandiceps*			X	–
Goldfish[1]	*Carassius auratus*		X		–
Long-finned Eel	*Anguilla reinhardtii*	x	X		–
Plague Minnow[1] (Eastern Gambusia)	*Gambusia holbrooki*			X	–
Short-finned Eel	*Anguilla australis*			X	–
Striped Gudgeon	*Gobiomorphusaustralis*		X		–
Yellowfin Bream[2]	*Acanthopagrus australis*	x			–

1) Alien species
2) Marine species occasionally recorded in freshwater.

3.10.2 Groundwater dependent ecosystems

The following detailed description of groundwater dependent ecosystems within the IMT site is also representative of those ecosystems identified within the rail access options.

Groundwater dependent ecosystems are defined as ‘Ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater’(Serov P *et al.* 2012). The Alluvial Woodland community, found in the west of the site along the Georges River, is mapped as having a high potential for groundwater interaction (National Water Commission 2013). Retained areas of this vegetation within the environmental conservation area along the Georges River may utilise shallow groundwater present on the site and may be susceptible to any reduction in the abundance or quality of groundwater.

Potential groundwater impacts are discussed in Chapter 16 of the EIS. Without adequate controls, these impacts could affect retained vegetation in the Georges River riparian area, potentially resulting in changes in vegetation structure and composition as a result of changes to water availability and salinity levels. Changes to vegetation may include a reduction in the diversity and abundance of moisture dependent plants and an increase in species tolerant of higher salinity and lower soil moisture. This may slightly increase the susceptibility of riparian areas to fire and may reduce the suitability of habitat on site for some animal species. None of the threatened species of animal likely to utilise this area are considered to be susceptible to such changes as they are all species also known to utilise drier habitats.

Potential groundwater impacts would be considered during the development of the detailed design and in most cases, mitigated at the design phase. Where potential impacts are unable to be dealt with through the design, suitable mitigation and management measures would be established to ensure that no significant groundwater impacts result directly from the construction or operation of the Project.

4. Potential impacts on biodiversity

The Project would have both direct and indirect impacts on biodiversity during both the construction and operation phases (Table 4.1). These impacts are described in more detail below.

Table 4.1 Potential impacts of the Project on biodiversity

Impacts of the Project on biodiversity	Construction	Operation
Vegetation clearing and habitat loss	●	
Direct mortality	●	●
Fragmentation and loss of connectivity	●	
Noise impacts on fauna	●	●
Light impacts to fauna	●	●
Dust pollution	●	●
Introduction and spread of weeds	●	●
Increased edge effects[1]	●	
Disturbance of aquatic habitat	●	
Hydrological changes	●	

Note 1: Edge effects are zones of changed environmental conditions (i.e. altered light levels, wind speed and or temperature) along the edges of habitat fragments

Certain construction impacts such as vegetation clearing would have a permanent impact and, therefore, would continue into the operation phases of the Project. These impacts are described as ‘construction impacts’ in the following sections, as the impacts would occur first during construction.

A phased approach is proposed for the Project construction and operation (as outlined in Chapter 8 of the EIS – *Project development phasing and construction*), with the IMT site to be developed progressively until Full Build is reached in 2030.For the purposes of assessment of the impacts on biodiversity the Project has adopted a ‘worst-case’ development footprint ,being the combined development area for all Project development phases including associated construction compounds.

The Project development phasing is indicative and is subject to confirmation for the Stage 2 SSD approval. Therefore, while it is likely that the timing of vegetation clearing and associated impacts on biodiversity will be staged, a conservative approach of assessing all impacts jointly has been adopted. The staging of the Project would affect the timing of the implementation of mitigation measures and would provide opportunities for the establishment of offsets prior to the occurrence of impacts.

One exception to this is the Early Works development phase which has been considered separately in this biodiversity assessment (refer to section 4.1 below). This is because MIC is seeking approval to undertake the Early Works as part of this Stage 1 SSD application, without the need for further approvals.

The final layout and footprint of the IMT will depend on the location of the selected rail access option (either the northern, central or southern rail access option) and therefore there are three IMT layouts proposed in the EIS. As a result, while the impacts of the three rail access options and associated IMT layouts are likely to be similar in nature, there are differences in terms of the extent of vegetation and associated habitat affected. These differences are discussed throughout the following sections and are summarised in section 4.2 below.

4.1 Early Works impacts

The Early Works phase of the Project includes activities which would be required to prepare the Project site for the subsequent development phases. These activities are summarised below and described in more detail in Chapter 8 of the EIS – *Project development phasing and construction*:

- establishment of construction facilities;
- demolition or relocation of existing buildings, structures;
- some contaminated land remediation including removal of unexploded ordnance, explosive ordnance waste and asbestos buildings and remediation of an area known to contain asbestos;
- service utility terminations and diversions;
- heritage impact mitigation works including archaeological salvage of Aboriginal and European potential archaeological deposit (PAD) sites; and
- commencement of restoration works in the large area of bare land in the central portion of the conservation area involving re-contouring, topsoil spreading and revegetation with native species consistent with the natural vegetation of site.

The Early Works are unlikely to result in the clearing of any native vegetation communities; however, they are likely to result in the removal of scattered native and introduced trees and shrubs within the highly modified, park-like grounds in the east of the IMT site, associated with the built-up areas of the IMT site.

This vegetation does not constitute any threatened ecological community or contain any recorded locations of threatened plants and has relatively poor habitat values for threatened species.

The establishment of construction facilities and demolition or relocation of existing buildings, structures are also likely to result in increased dust and noise during construction. Given the relatively poor habitat values and highly disturbed nature of the area associated with the Early Works, these activities are unlikely to result in a significant adverse impact on biodiversity. Consequently, these potential impacts on biodiversity are not considered further.

4.2 Construction impacts

4.2.1 Direct impacts

4.2.1.1 Vegetation clearing and habitat loss

Clearing of native vegetation is listed as a Key Threatening Process under both the Commonwealth EPBC Act and the NSW TSC Act. Under the TSC Act, native vegetation includes plant communities, comprising primarily indigenous species. Clearing is defined as the destruction of a sufficient proportion of one or more strata layers within a stand or stands of native vegetation so as to result in the loss, or long-term modification, of the structure, composition and ecological function of a stand or stands (NSW Scientific Committee 2001).

Construction of the Project would require the clearing of vegetation and habitats as summarised in Table 4.2. This includes loss of habitat features including tree hollows (refer section 4.2.1.2).

Vegetation clearing would occur throughout the eastern part of the IMT site adjacent to Moorebank Avenue and would extend to the west through the middle of the site to the existing riparian vegetation corridor along the Georges River. The total vegetation clearing, based on the planned construction footprint for all stages of the Project combined, is referred to as 'Final Clearing'. Vegetation clearing would generally be excluded from land within 50–100 m of the Georges River, with the following exceptions:

- the area where the proposed rail link to the SSFL crosses the river
- the locations of three to four narrow overland drainage channels
- for the southern rail access only, an approximately 300 metre long section in the north of the site in which clearing may occur as little as 25 metres from the river (refer Figure 3.1, Figure 3.2, Figure 3.3).

The vegetation cleared varies substantially in condition across the IMT site. Moderate to good condition Castlereagh Scribbly Gum Woodland would be cleared from patches located in the east of the site parallel with Moorebank Avenue. Castlereagh Scribbly Gum Woodland, Castlereagh Swamp Woodland and Alluvial Woodland to be cleared from the east and central areas of the site is generally in poor condition with substantially reduced canopy cover and a low diversity and abundance of native species in the understorey and ground layers. The area of Riparian Forest and Alluvial Woodland which would be cleared varies from moderate condition, with intact canopy but weed-dominated understorey, to good condition with native species dominant in all layers.

Table 4.2 Potential total loss of vegetation and habitat for the Project associated with each rail access option indicative layout

Vegetation community/Fauna habitat	Extent within Project site (ha)	Indicative options		
		Northern rail access clearing (ha)	Central rail access clearing (ha)	Southern rail access clearing (ha)
Vegetation communities				
Castlereagh Swamp Woodland[1]	0.9	0.9	0.9	0.9
Castlereagh Scribbly Gum Woodland[2]	16.1	16.1	16.1	16.1
Riparian Forest (River-Flat Eucalypt Forest)[1]	16.2	2.2	4.7	5.3
Alluvial Woodland (River-Flat Eucalypt Forest)[1]	35.6	25.2	26.7	30.4
Total River-Flat Eucalypt Forest[3]	51.8	27.4	31.4	35.7
Totals	**68.8**	**44.4**	**48.4**	**52.7**
Fauna habitats				
Shrubby eucalypt woodland	17.0	17.0	17.0	17.0
Tall eucalypt forest	51.8	27.4	31.4	35.7
Waterbodies	2.0	2.0	2.0	2.0
Cleared land	130.1	n/a	n/a	n/a
Threatened flora				
Acacia bynoeana	17.0	17.0	17.0	17.0
Acacia pubescens	17.0	17.0	17.0	17.0
Dillwynia tenuifolia	17.0	17.0	17.0	17.0
Grevillea parviflora subsp. *parviflora*	17.0	17.0	17.0	17.0
Leucopogon exolasius	17.0	17.0	17.0	17.0
Persoonia hirsuta	17.0	17.0	17.0	17.0
Persoonia nutans	17.0	17.0	17.0	17.0
Pultenaea parviflora	17.0	17.0	17.0	17.0
Threatened fauna				
Barking Owl	51.8	27.4	31.4	35.7
Black-chinned Honeyeater	68.8	44.4	48.4	52.7
Eastern Bent-wing Bat	68.8	44.4	48.4	52.7
Eastern False Pipistrelle	51.8	27.4	31.4	35.7
Eastern Free-tail bat	68.8	44.4	48.4	52.7
Eastern Pygmy-possum	68.8	44.4	48.4	52.7
Flame Robin	68.8	44.4	48.4	52.7
Gang-gang Cockatoo	68.8	44.4	48.4	52.7
Greater Broad-nosed Bat	68.8	44.4	48.4	52.7
Grey-headed Flying-fox	68.8	44.4	48.4	52.7
Koala	51.8	27.4	31.4	35.7
Large-footed Myotis	51.8	27.4	31.4	35.7
Little Eagle	68.8	44.4	48.4	52.7
Little Lorikeet	68.8	44.4	48.4	52.7

Vegetation community/Fauna habitat	Extent within Project site (ha)	Indicative options		
		Northern rail access clearing (ha)	Central rail access clearing (ha)	Southern rail access clearing (ha)
Powerful Owl	51.8	27.4	31.4	35.7
Regent Honeyeater	68.8	44.4	48.4	52.7
Scarlet Robin	68.8	44.4	48.4	52.7
Spotted Harrier	68.8	44.4	48.4	52.7
Spotted-tailed Quoll	68.8	44.4	48.4	52.7
Square-tailed Kite	68.8	44.4	48.4	52.7
Squirrel Glider	68.8	44.4	48.4	52.7
Swift Parrot	68.8	44.4	48.4	52.7
Varied Sittella	68.8	44.4	48.4	52.7
Yellow-bellied Sheathtail Bat	68.8	44.4	48.4	52.7

Notes: 1 - Endangered Ecological Community as listed under the TSC Act;
2 – Vulnerable Ecological Community as listed under the TSC Act;
3–River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.

4.2.1.2 Loss of roosting and breeding habitat in hollow bearing trees

The Project would result in the removal of in excess of 46 hollow-bearing trees containing hollows of a wide variety of shapes and sizes, ranging from narrow cracks and fissures in dead wood, to hollows within tree trunks with very large entrance diameters (>300mm) and large internal volumes (refer Figure 3.1 to Figure 3.3). These hollows may be suitable as roosting and/or breeding habitat for a wide range of animal species including arboreal mammals, reptiles, frogs, microbats and hollow-nesting birds.

The majority of the hollows that would be lost are in trees located in heavily cleared areas of the site. This is likely to limit their suitability for some species such as the Spotted-tailed Quoll, Squirrel Glider and Powerful Owl due to the lack of surrounding understorey vegetation that would provide cover and foraging opportunities.

These trees are more likely to be utilised by species typical of more open environments including a number of exotic species (e.g. Common Myna, Common Starling) and opportunistic native species (e.g. Sulphur-crested Cockatoo). These trees still have potential, however, to be utilised by the following threatened species of birds and bats:

- Little Lorikeet (potential breeding habitat).
- Powerful Owl (potential breeding habitat).
- Eastern Free-tail bat(potential roosting and breeding habitat).
- Large-footed Myotis (potential roosting and breeding habitat).

4.2.1.3 Direct mortality

Specimens of *Grevillea parviflora* subsp*. parviflora* and *Persoonia nutans* on the site would be killed during clearing unless a translocation program for these species is implemented. The potential for translocation of these species as individuals or as part of a soil translocation process would be considered during the detailed development of the construction environmental management plan for the Project (refer section 6.3.3).

Fauna injury or death could occur as a result of the Project's construction phase, particularly when vegetation is being cleared and existing detention basins filled.

While some mobile species, such as birds, have the potential to move away from the path of clearing, other species that are less mobile, or those that are nocturnal and restricted to tree hollows, may have difficulty moving over relatively large distances. Threatened species that may be affected by vegetation clearing include microchiropteran bats, arboreal mammals and nestling birds. A variety of other non-threatened species of animal, including reptiles, frogs, microchiropteran bats, birds and arboreal mammals are also at risk of injury or mortality during construction works.

A clearing protocol would be implemented to minimise fauna injury and mortality as described in section 6.3.3.

4.2.1.4 Disturbance to aquatic habitat

Waterway crossings have potential to modify the natural hydrology of waterways, which affect the aquatic plant and animal assemblages that use an area (Fairfull & Witheridge 2003). The aquatic biodiversity of the Georges River is already modified (refer section 3.10) as a result habitat degradation due to changes to abiotic conditions and the introduction of invasive species. Due to the degraded condition of this waterway, the native species that persist here are likely to consist of disturbance tolerant species less sensitive to alterations in environmental conditions than species restricted to relatively unmodified environments.

Given that the access options are still at the conceptual design stage, the final design of the bridges associated with all of the rail access options will be subject to refinement. However, in each case it is likely that bridges would have multiple piers located both adjacent to the Georges River and within the Georges River floodplain. If possible, it is not intended to locate any bridge piers within the river channel itself.

Construction of the bridge is unlikely to require disturbance to the substrate of the river or removal of any submerged or emergent aquatic vegetation present. Changes to the amount of sunlight reaching the substrate of the river may however affect the ability of any submerged aquatic plants to photosynthesise. This may result in changes to the structure and extent of aquatic vegetation and associated habitat for aquatic animals. Given the relatively small area affected, and the existing degraded condition of the river, this possible reduction in vegetation and modification of habitat is unlikely to be significant.

Construction activity and runoff from bare ground created during earthworks also has potential to result in increased turbidity. This increased turbidity may have a negative impact on aquatic biodiversity through reduced light availability for aquatic plants and associated degradation to habitat for aquatic animals.

There is also the potential for accidental spillage/leakage of construction materials, including fuels, lubricants and hydraulic oils from construction and operational plant and equipment. With the implementation of appropriate sediment control and chemical handling measures, these impacts are unlikely to significantly affect aquatic biodiversity.

Changes to environmental conditions such as increased shading, loss of fringing and riparian vegetation are also likely; however these changes are likely to be restricted to the area underneath the bridge and its immediate surrounds. Runoff from the surface of the bridge is also likely to result in additional pollutants (e.g. oils and particulate matter) entering the waterway. Given the existing level of pollution in the waterway adjacent to the site and downstream, the additional impact of the Project on pollutant levels is unlikely to significantly change the ecology of the river. While these changes may alter the biodiversity present at the bridge location, they are unlikely to significantly affect fish passage or the broader aquatic ecosystem of the Georges River, provided that the bridge is designed according to NSW Department of Industry and Investment (Fisheries) guidelines on fish passage (Fairfull & Witheridge 2003), and damage to any aquatic habitat and riparian vegetation during construction is minimised.

The study contains only a single major drainage line, Anzac Creek, in the south-east. This drainage line is highly modified as a result of vegetation clearing and the construction of in-line water features associated with the RAE Golf Club. This first order stream is intermittently flowing, polluted, and weed-infested. The aquatic habitat in this waterway is affected by pollutant-laden runoff from the golf course, the presence of the exotic fish species Plague Minnow (**Gambusiaholbrooki*) and aquatic weeds including **Salviniamolesta*and **Ludwigiaperuviana*. A concrete-lined drainage channel is also found on the site that contains very little water during dry weather and minimal aquatic vegetation.

The section of Anzac Creek within the IMT site would be removed, and flows redirected through stormwater detention basins on the site. Removal of this creek and the concrete-lined drainage channel and redirection of overland flows through stormwater detention basins, are unlikely to result in a significant negative impact on the aquatic ecosystem of the receiving waters of the remainder of Anzac Creek or the Georges River as inflows from these small highly modified tributaries are likely be polluted with fertilisers, pesticides and silt and would constitute only a small proportion of total inflows to the receiving waters.

Areas of riparian vegetation along the Georges River likely to be damaged or removed during construction would be replanted on completion of works. Long-term weed control and vegetation restoration of riparian vegetation will be undertaken in the conservation area on the eastern bank of the river, in the Casula offset area and in other lands affected by the Project. This is likely to result in an overall improvement to the ecological condition of the riparian vegetation along this stretch of river in the long-term. In addition, appropriate erosion and sediment control measures would be put in place around the bridge construction site prior to construction, to ensure minimal change in water quality due to run-off.

Other waterbodies on the site include four detention basins, two of which have a substantial cover of emergent aquatic vegetation consisting of a mixture of native and introduced species. Three of these basins would be removed during construction of the Project with the remaining basin likely to be modified. These basins provide foraging and breeding habitat for a variety of native frogs, reptiles and waterbirds. While the Project would result in the removal of three of these basins, they would be replaced with four substantially larger detention basins. Opportunities for planting these detention basins with native aquatic emergent plants and fringing trees would be explored in the detailed design of the Project and, if practicable implemented, such that in the medium term they would provide similar habitat to that lost (refer section 6.2.2.5).

4.2.1.5 Disturbance of groundwater dependent ecosystems

Impacts to groundwater dependent ecosystems, such as drawdown of groundwater from the root zone, may occur as a result of earthworks and geotechnical construction activities (refer to Chapter 16 of the EIS – *Hydrology, groundwater and water quality*). This may have the potential to affect retained vegetation and habitat that may utilise the shallow groundwater aquifers present. The Alluvial Woodland community (located on the western side of the site along the Georges River) has been identified as having high potential for groundwater interaction.

Without adequate controls, these impacts could affect retained vegetation and habitat within the Project site, potentially resulting in changes in vegetation structure and composition as a result of changes to water availability and salinity levels. Changes to vegetation may include a reduction in the diversity and abundance of plants dependent on high water availability which would then allow for species tolerant of higher salinity and lower soil moisture to thrive. As a result, this may slightly increase the susceptibility of the riparian corridor to fire and may reduce the suitability of habitat on-site for some animal species.

Potential groundwater impacts would be considered and mitigation measures developed during detailed design.

4.2.1.6 Loss of foraging resources

In addition to the displacement of resident animals and loss of shelter (e.g. tree hollows), the vegetation clearing for the Project would result in the loss of potential foraging resources (e.g. seeds, nectar, foliage, sap and animal prey) for species which shelter and breed outside the IMT site. This loss may impact highly mobile species of animals which occur in adjacent habitat (e.g. Powerful Owl, Eastern Bentwing-bat) and migratory/nomadic species (e.g. Little Lorikeet, Grey-headed Flying-fox) which may commute regularly from roosting areas or utilise resources during seasonal movements.

4.2.2 Indirect impacts

4.2.2.1 Fragmentation, isolation and edge effects

Fragmentation and isolation

Habitat fragmentation through the clearing of vegetation can increase the isolation of remnant vegetation and create barriers to the movements of small and sedentary fauna such as ground dwelling mammals, reptiles and amphibians. Furthermore, habitat fragmentation can create barriers to the movement of pollinator vectors, such as insects, and thereby affect the life cycle of both common and Threatened flora.

The Project would result in the removal of a substantial area of woodland/forest within the construction footprint. The habitat within the construction footprint is already isolated/fragmented by existing rail infrastructure, internal and external roads, built and landscaped areas, sporting fields and a golf course.

The Project is not likely to significantly fragment or isolate retained vegetation along the Georges River Corridor. The proposed rail link across the Georges River would create a break in the canopy of the riparian vegetation approximately 50 m in width. However, the detailed design for the rail link and bridge would explore opportunities to create conditions suitable for vegetation to be established underneath the structure and habitat connectivity features (e.g. fauna furniture, rock piles) to provide cover for terrestrial animals and elevated movement pathways for arboreal species (refer section 6.2.2.4).

The proposed overland drainage channels which form part of the stormwater infrastructure for the Project would result in minor (<10m) wide gaps in the canopy in the short term; however vegetation restoration would restore canopy connectivity in the medium term to long term.

This minor and temporary fragmentation of habitat is unlikely to affect Threatened species of animals that are likely to occupy the site, particularly birds and bats, due to their ability to fly and or traverse narrow areas of open ground between vegetated habitats.

Edge effects

Edge effects are zones of changed environmental conditions (i.e. altered light levels, wind speed and/or temperature) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types and allow invasion by animals specialising in edge habitats and/or change the behaviour of resident animals. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators. Bali (2005), in a comparison of edge effects of roads in a variety of different habitat types, estimated that average edge effects generally occur up to 50 m away from the edge of the habitat fragment.

The area surrounding the IMT site on three sides consists of urban and materials storage areas. The IMT site has also been extensively cleared, leaving all habitat subject to substantial existing edge effects from areas of exotic grassland, roads and an adjacent railway line.

With the exception of the Georges River riparian corridor, woodland/forest vegetation occurs as small regenerating patches fragmented by the existing internal road network, mown exotic grassland and built areas. Due to the small size of native vegetation patches, the majority are likely to be subject to edge effects. As this vegetation would be entirely removed, there would be no increase in edge effects on these patches.

In the short term, the Project would result in increased edge effects on the habitat of the Georges River riparian corridor due to clearing, particularly for overland drainage infrastructure. Due to the relatively narrow width of this corridor and its high edge to area ratio, edge effects are already quite severe. The short-term increase in edge effects as a result of the Project is, therefore, unlikely to significantly alter the present edge effects on this habitat. In the medium to long term, the Project is likely to reduce edge effects on the habitat of the Georges River riparian corridor habitat due to the proposed restoration of vegetation (refer Appendix E and Appendix F), which would result in a reduction in the edge to area ratio.

4.2.2.2 Noise impacts on fauna

Substantial variation has been shown in scientific studies in the responses of wildlife to human-generated noise, ranging from serious to non-existent in different species and situations. The risk of hearing damage in wildlife is probably greater from exposure to very loud noises close to the source than from long-term exposure to lower noise levels. The presence or otherwise of direct physiological effects of noise on wildlife is poorly known (Larkin 1996).

The main impacts on wildlife associated with noise are behavioural. Vehicle noise has been shown, particularly in some species of birds and frogs, to interfere with communication essential for reproduction; however pedestrian activity may cause stronger behavioural reactions than people in vehicles. Noise may affect behaviour by causing animals to retreat from favourable habitat near noise sources, reducing time spent feeding and resulting in energy depletion and lower likelihood of survival and reproduction (Larkin 1996).

Serious effects such as decreased reproductive success have been documented in some studies and documented to be lacking in other studies on other species (Larkin 1996).

Decreased responsiveness of wildlife after repeated noises is frequently observed and usually attributed to habituation (Larkin 1996).

The wildlife of the Project area is likely to be habituated to frequent noise exposure from the existing rail lines to the west and south of the site, from vehicle movements in the internal road network, pedestrian activities, on-site DoD training activities and helicopter movements.

While the construction phases of the Project may cause temporary disturbance to animals, the impacts from noise emissions are likely to be localised close to the Project (up to100 m) and are not likely to have a significant, long-term, impact on wildlife populations.

It is likely that most animal species within the IMT site are already well habituated to periodic noise disturbance from regular military activities and the nearby railways and roads and are also unlikely to be significantly affected by the Project's operational noise.

4.2.2.3 Ecological light pollution impacts

Artificial light that alters the natural patterns of light and dark in ecosystems is referred to as 'ecological light pollution'(Longcore & Rich 2004). Types of ecological light pollution include chronic or periodically increased illumination, unexpected changes in illumination, and direct glare (Longcore & Rich 2004).

Impacts of ecological light pollution on animals include increased orientation or disorientation from additional illumination and attraction or repulsion responses which may affect foraging, reproduction, communication, and other critical behaviours (Longcore & Rich 2004). One of the most notable implications of light pollution is alteration of interspecific interactions (e.g. predator-prey and competitive interactions) (Longcore & Rich 2004).

Insects show a variety of responses to lights. Some insects are strongly attracted to lights; others are repelled, show little response or have variable responses depending on prevailing environmental conditions (Longcore & Rich 2004).

Some species of insectivorous bats (chiefly fast-flying species e.g. *Tadarida* spp.) forage on insects attracted to lights while other slow-flying bat (e.g. some foreign *Myotis* and *Rhinolophus* species) are thought to avoid lighted areas (Patriarca 2010). Artificially illuminated habitat may be avoided by nocturnal animals if lighting is perceived to increase the risk of predation (Longcore & Rich 2004).

Under present conditions there is little light pollution of the core habitat of the site, within the vegetation along the Georges River. Light pollution is likely to be substantially higher during the construction and operation of the Project due to fixed lighting within the facility and lighting from trucks and trains. The proposed vegetation restoration within the riparian corridor (refer Appendix E and Appendix F) and landscape planting in the interior of the site is, however, likely to mitigate some light pollution through the screening effects of increased vegetation. The proposed lighting for the site would also be designed to minimise light spill (as explained in the main EIS document), thereby minimising ecological light pollution impacts. With the proposed vegetation restoration, significant ecological light pollution impacts on the site are unlikely.

4.2.2.4 Dust pollution

Dust effects on vegetation may include alterations to processes such as photosynthesis, respiration and transpiration and result in increased penetration of toxic gaseous pollutants (Farmer 1993). These impacts may result in decreased productivity of plants and alteration to the structure of vegetation communities (Farmer 1993).

Soil dust is likely to be generated during the construction of the Project. Dust in the form of particulate matter from incomplete combustion of diesel fuel is also likely to be generated by trucks and diesel trains during the operation of the Project. If this dust is deposited onto the foliage of vegetation, it has potential to reduce photosynthesis, which may reduce the overall health of the vegetation adjacent to the IMT site through changes to vegetation structure and composition.

Retained vegetation within the IMT site is likely to be subject to existing dust impacts associated with heavy equipment training activities in the existing area of bare ground located in the riparian zone in the central west of the site (known as the dust bowl). The cessation of training activities and revegetation of this area would reduce this existing impact. Dust from the Landfill, located approximately 200 m west of the southern part of the IMT site may also be affecting the existing vegetation.

With the implementation of mitigation measures to minimise dust generation (as described in the main EIS document), cessation of training activities and revegetation of areas of bare ground within the riparian zone, the overall dust-related impacts on biodiversity are unlikely to be significantly increased from existing conditions.

4.2.2.5 Turbidity impacts

Construction activity and runoff from exposed ground during earthworks could potentially result in increased turbidity. An increase in turbidity would lead to reduced light availability for aquatic plants and habitat degradation for aquatic animals. However, with the implementation of appropriate sediment controls, these impacts are unlikely to significantly affect aquatic biodiversity.

4.2.2.6 Weeds, pests and pathogens

Weeds

The IMT site includes 12 weed species listed under *the Noxious Weeds Act1993* (see section 3.5). Nine of these are also recognised as Weeds of National Significance (Australian Weeds Committee 2010). Many other weeds are present on the site which contribute to five Key Threatening Processes listed under the EPBC Act and/or the TSC Act (refer Table 4.3for more detail). The existing vegetation that would be retained along the Georges River riparian corridor and the areas of the site that would be cleared for the Project contain considerable weed growth at present.

The Project has the potential to further disperse weeds into areas of native vegetation within the IMT site, particularly adjacent to cleared areas. The vegetation of the riparian corridor has a moderate to high level of weed invasion, particularly of woody and vine weeds. The greatest potential for weed dispersal and establishment associated with the Project would include earthworks, movement of soil and attachment of seed (and other propagules) to vehicles and machinery where these occur within or adjacent to retained vegetation.

The Project would also involve substantial weed control and native vegetation restoration works along the Georges River Corridor (refer section 5.1, Appendix E and Appendix F). With the weed management and vegetation restoration regime proposed, the overall impact of weed invasion on retained vegetation is likely to decrease in the medium to long term.

Pest animals

From a biodiversity conservation perspective, pest animals include all species that have a negative impact on the functioning of natural ecosystems and/or the conservation of Threatened biodiversity. Pests therefore include both exotic and native species. Exotic pests present or likely to occur on the site include the Fox, Rabbit, Brown Hare, Cat, Common Myna, Black Rat, Common Starling, Red-Whiskered Bulbul, Spotted Turtle-Dove and Plague Minnow.

Native species of bird that would have been uncommon or absent from the IMT site prior to European settlement and that have benefited from large scale habitat modification include the Noisy Miner, Bell Miner, Little Corella, Long-billed Corella, Sulphur-crested Cockatoo and Pied Currawong.

These species have the potential to affect uncommon or Threatened indigenous biodiversity through predation (e.g. Black Rat, cat, fox, Pied Currawong, Plague Minnow), grazing (e.g. rabbit, Brown Hare), competition for breeding habitat (e.g. Little Corella, Long-billed Corella, Sulphur-crested Cockatoo, Common Myna, Common Starling) or competitive exclusion (e.g. Noisy Miner, Bell Miner).

The habitat that would be removed for the Project is already affected by pest species. Removal of this habitat would result in a reduction in habitat available to these species. In the short term this may lead to increased competition for resources (e.g. tree hollows) and increased pressure on remaining habitats. The proposed removal of weeds (refer section 6.2.2.6) which provide food and shelter for pests and the installation of nest boxes prior to the commencement of construction (refer section 6.2.2.3) would reduce these short-term impacts.

The reduction in foraging habitat for many of these pest species and native vegetation restoration are likely to result in a population decline for these pests in the medium to long term.

Many highly invasive and destructive pest species which are found overseas or interstate have not yet become established or presently have restricted distributions in NSW. Several such species are the subject of Key Threatening Process listings (e.g. Red Imported Fire Ant, Yellow Crazy Ant, Large Earth Bumblebee, Cane Toad). The primary risk associated with these species is the importation of goods or materials from interstate or overseas locations where populations of these species are well established. As the Project involves warehousing of goods from overseas and interstate, it has the potential to bring novel species to the IMT site. Biosecurity measures would be required to minimise this risk, as described in section 6.2.2.7. With appropriate design and operational measures in place the risk of introducing pests would be low.

Plant and animal pathogens

Plant and animal pathogens can affect threatened biodiversity through direct mortality and modification to vegetation structure and composition. The following pathogens are considered to have potential to affect the biodiversity of the IMT site and are the subject of Key Threatening Process listings:

- Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*).
- Exotic Rust Fungi (order Pucciniales, e.g. Myrtle rust fungus *Uredo rangelii*).
- Phytophthora Root Rot Fungus (*Phytophthora cinnamomi*).

These three pathogens have all been recorded in the Sydney Basin bioregion and have potential to occur on the site at present or in the future. The main way in which Exotic Rust Fungi and Phytophthora Root Rot Fungus may be spread is through the movement of infected plant material and/or soil. The construction and operation of the Project may increase the risk of disturbing and spreading these pathogens. With the implementation of hygiene procedures for the use of vehicles and the importation of materials to the site, the risk of introducing these pathogens would, however, be low. Preferential use of plant materials sourced on-site (e.g. mulch, seeds) used for vegetation restoration would also help to minimise this risk (refer section 6.2.2.6).

Amphibian Chytrid Fungus can be spread through the movement of infected animals or water (including mud or moist soil) from infected areas. With the implementation of hygiene procedures for the use of vehicles and the importation of materials to the site, the risk of introducing this pathogen to uninfected areas is low.

4.2.2.7 Fire regimes

The IMT site has been identified as containing bushfire prone land. The key bushfire threats to the IMT site occur from the:

- south-eastern corner of the IMT site: extensive bushland vegetation occurs in this area and includes the Holsworthy Military Area; and
- western boundary: the Georges River corridor and proposed conservation area, extending north-south along the western boundary of the IMT site is heavily vegetated.

The proposed site layout and design provides some suitable measures to minimise bushfire risk in particular the provision of a perimeter road and location of commercial development and warehouses away from bushfire threat. Additional measures for site design and layout are proposed, including the development of landscaping/vegetation management and fire safety and evacuation plan as well as safety provisions relating to access, water and services.

With the implementation of these design and management measures, the risk of the project causing a change to fire regimes that would be detrimental to biodiversity is low. The management of the conservation lands along the Georges River would include management of fire regimes to promote biodiversity conservation.

4.3 Operational impacts

Most of the construction impacts on biodiversity would continue through to the operation of the Project. The operational impacts on biodiversity are not anticipated to be as great once mitigation measures are implemented and the conservation area matures along the Georges River.

4.3.1 Direct impacts

4.3.1.1 Direct mortality

During operation of the Project, operating equipment and the movement of trucks and trains in and out of the facility could potentially increase fauna injury or mortality. While some mobile species, such as birds can move away from moving vehicles and trains, other species that are less mobile and nocturnal may have difficulty moving over large distances.

Both threatened and non-threatened species of microchiropteran bats, arboreal mammals, nestling birds, frogs and reptiles would be at risk of injury or mortality. However controls would be put in place such as fencing which would keep land-based animals away from the operating terminals and would be designed to minimise collision by birds and bats. During operation, no further impacts would be expected to vegetation along the riparian corridor (the conservation area).

4.3.2 Indirect impacts

4.3.2.1 Noise impacts on fauna

Wildlife populations living in the Project site are unlikely to be affected by the Project's operational noise. Animals living in the Project site and surrounding area are likely to be habituated to frequent noise exposure from on-site Defence activities, the existing rail lines to the west and south of the Project site and vehicle movements on the internal and external road networks. Therefore, the operational noise from the Project such as the movement of trucks, trains and gantry operations is not likely to have a significant long-term impact on wildlife populations.

4.3.2.2 Light impacts on fauna

Light pollution is likely to increase relative to existing levels during operation of the Project, due to fixed lighting within the facility and lighting from trucks and trains. The light-related effects on fauna are mainly behavioural and can affect foraging behaviour, reproduction and communication, as well as causing orientation or disorientation from artificial light sources. The proposed vegetation restoration within the riparian corridor and landscape planting in the interior of the Project site could mitigate some light pollution through the screening effects of increased vegetation. Other measures would also be implemented to minimise light spill from the facility, as described in Chapter 22 of the EIS – *Visual and urban design.*

4.3.2.3 Dust pollution

During operation of the Project, dust in the form of particulate matter from incomplete combustion of diesel fuel would be generated by trucks and diesel trains. The retained vegetation on the riparian corridor and along the rail link to the SSFL may be affected by dust-related impacts, which could reduce the overall health of the vegetation as well as changing the vegetation structure composition. However, retained vegetation is likely to be subject to existing dust impacts from current on-site activities and, therefore, the overall impacts on biodiversity are unlikely to change substantially from existing conditions. Various measures would also be implemented to minimise dust emissions within and external to the Project site, as described in Chapter 17 of the EIS – *Local air quality.*

4.3.2.4 Fire regimes

As discussed above under construction impacts (refer to section 4.2.2.7.), the Project site has been identified as containing bushfire prone land. During operation, the risk of the Project causing a change to fire regimes is low if appropriate design and management measures are implemented during the design and pre-construction stages of the Project.

4.4 Key threatening processes

Key Threatening Processes are listed under Schedule 3 of the NSW TSC Act, NSW FM Act and also under the Commonwealth EPBC Act. Key Threatening Processes relevant to this Project are listed in Table 4.3.

Table 4.3 Key Threatening Processes likely to be occurring in the Project site and their relevance to the Project

Listed Key Threatening Process EPBC Act	TSC Act	FM Act	Project will affect this threat?
Pest animal			
Competition and land degradation by rabbits	Competition and grazing by the feral European rabbit	–	No. Project unlikely to increase this threat any more than that currently occurring in the IMT site.
Predation by European red fox	Predation by the European Red Fox	–	No. Project unlikely to increase this threat any more than that currently occurring in the IMT site.
–	Predation by the Plague Minnow (*Gambusia holbrooki*)	–	Possible. Plague Minnow was recorded in water features on the golf course in the IMT site and in the Georges River; however was absent from the largest detention basin of the site. Measures should be taken to minimise the likelihood of the species becoming established in new detention basins.
–	Predation by feral cats	–	No. Project unlikely to increase predation by feral cats.
–	Competition from feral honeybees	–	Possible. The Project could increase competition for tree hollows through displacement of bees in hollows cleared and a reduction in hollow availability. Any bee hives detected in trees to be removed would be destroyed and nest boxes would mitigate the loss in hollow availability. Nest boxes would be monitored and bee hives would be removed as specified in the flora and fauna management plan.
Weeds			
–	Invasion and establishment of exotic vines and scramblers	–	Yes. Exotic vines and scramblers recorded within IMT site; however weed control and native vegetation restoration would reduce this threat on retained vegetation (see section 6.2.2.6)
–	Invasion, establishment and spread of **Lantana camara*	–	Yes. Lantana recorded within IMT site; however weed control and native vegetation restoration would reduce this threat on retained vegetation (see section 6.2.2.6).
–	Invasion of native plant communities by bitou bush & boneseed (**Chrysanthemoide smonilifera*)	–	Yes. Bitou Bush and Boneseed recorded within IMT site; however weed control and native vegetation restoration would reduce this threat on retained vegetation (see section 6.2.2.6).

Listed Key Threatening Process EPBC Act	TSC Act	FM Act	Project will affect this threat?
–	Invasion of native plant communities by exotic perennial grasses	–	Yes. Exotic perennial grasses recorded within IMT site; however weed control and native vegetation restoration would reduce this threat on retained vegetation (see section 6.2.2.6).
–	Invasion of Native Plant Communities by African *Olive Olea europaea* L. subsp. *cuspidata* (Wall ex G.DonCiferri)	–	Yes. African Olive was recorded within IMT site; however weed control and native vegetation restoration would reduce this threat on retained vegetation (see section 6.2.2.6).
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	–	Yes. Escaped garden plants recorded within IMT site; however weed control and native vegetation restoration would reduce this threat on retained vegetation (see section 6.2.2.6).
Habitat loss or change			
Land clearance	Clearing of native vegetation[1]		Yes. See section 4.2.1.1.
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	Human-caused climate change	Human–caused climate change	Possible. Increased transport efficiencies as a result of the Project are likely to makes its impact on greenhouse gas emissions and climate change neutral or positive in the medium to long term (refer main EIS document).
–	Loss of hollow-bearing trees	–	Yes. Hollow trees were recorded in the IMT site (refer section 4.2.1.2)
–	Removal of dead wood and dead trees	–	Yes. Dead wood and dead trees were recorded in the IMT site at low density and chiefly within the riparian zone of the Georges River. Some of these would be removed. Dead wood within the clearing footprint and selected trunks and large branches and from cleared areas would, however, be used in riparian vegetation restoration.
–	Bush rock removal	–	No. Bush rock was recorded outside the construction footprint and occurred as deeply imbedded material.
–	Ecological consequences of high frequency fires	–	No. No evidence of high frequency fire regimes on the site and the Project is unlikely to result in the high frequency fire.
–	Loss and/or degradation of sites used for hill-topping by butterflies	–	No

Listed Key Threatening Process EPBC Act	TSC Act	FM Act	Project will affect this threat?
–	Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	–	Yes. Bell miners recorded within IMT site; however weed control and native vegetation restoration would be likely to reduce this threat on retained vegetation (see section 6.2.2.6).
–	Alteration of habitat following subsidence due to longwall mining	–	No. Project does not include longwall mining.
–	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	–	Yes. The project will have a minor impact on the flow regime of the Georges River. Given the low intensity of this impact and the already modified flow regime of the river, this impact is unlikely to be significant (refer section 4.2.1.4).
Disease			
Disease affecting endangered psittacine species	Infection by Psittacinecircoviral (beak & feather) disease affecting endangered psittacine species	–	No. Project is unlikely to increase frequency.
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis	–	Unlikely. Project is unlikely to spread chytrid fungus due to the proposed measures for minimising the spread of weeds and plant and animal pathogens.
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)	Infection of native plants by *Phytophthora cinnamomi*[2]	–	Unlikely. Project is unlikely to spread Phytophthora due to the proposed measures for minimising the spread of weeds and plant and animal pathogens.
–	Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	–	Unlikely. Project is unlikely to spread Exotic Rust Fungi due to the proposed measures for minimising the spread of weeds and plant and animal pathogens.

Listed Key Threatening Process EPBC Act	TSC Act	FM Act	Project will affect this threat?
Impacts to riparian habitats and species			
–	–	The degradation of native riparian vegetation along New South Wales water courses	The Project would require the construction of a bridge over the Georges River which would result in small scale degradation of already modified riparian vegetation.
–	–	Hook and line fishing in areas important for the survival of threatened fish species	No. Project would not include fishing.
–	–	The introduction of fish to fresh waters within a river catchment outside their natural range	No. Project would not include introduction of fish.
–	–	The removal of large woody debris from NSW rivers and streams	No. The Project would not remove large woody debris from rivers or streams.
–	–	Instream structures and other mechanisms that alter natural flow	The Project would require the construction of a bridge over the Georges River which may result in minor alteration to natural flow; however this is unlikely to significantly impact fish passage or aquatic habitat quality (refer section 4.2.1.4).

Note: Threatening processes affecting marine environments and oceanic islands are excluded. Bold text indicates processes likely to be affected by the Project.

4.5 Cumulative impacts

The incremental effect of multiple sources of impact (past, present and future) are referred to as cumulative impacts (Contant & Wiggins 1991; Council on Environmental Quality 1978). Cumulative impact assessment considers a project within the context of other past, present and likely future sources of impact. This is necessary to identify any impacts associated with the Project that may have an additive effect or interaction with impacts from other activities within the locality to the extent that the overall (cumulative) impact becomes significant when it would not otherwise have been significant.

The potential cumulative biodiversity impacts as a consequence of the construction and operation of the Project are discussed here within the context of the existing environment, present and likely future impacts.

Agricultural, residential and infrastructure development in the locality in historic and recent times has led to extensive vegetation clearing in the locality and at the catchment scale. Remaining remnant vegetation/habitat has also been affected by a variety of disturbance mechanisms, including clearing of undergrowth, grazing by domestic animals, altered fire regimes, feral animals and weed invasion. This habitat loss and disturbance has resulted in the local extinction of a number of species which are less tolerant of habitat loss and disturbance (e.g. woodland birds and small mammals) and an increased risk of extinction to a number of vegetation communities.

Isolated remnant populations of disturbance-sensitive threatened species in such a landscape may be susceptible to local extinction due to seemingly small reductions in habitat area or quality, if the habitat is near the lower limit in size or quality necessary to support a viable population and a critical threshold is reached.

In assessing the cumulative impact of a project, it is important to consider whether the additive effects of multiple projects may cause such a critical threshold to be reached for any threatened biodiversity affected.

The most significant developments underway and planned within the Project locality include residential development and associated infrastructure and the SIMTA IMT project.

Residential development and associated infrastructure include arterial road upgrades and rail upgrades etc. associated with the South-west Growth Centre development.

The Sydney Intermodal Terminal Alliance (SIMTA), a joint venture between Stockland, Qube Logistics and QR National, is proposing to develop the SIMTA Intermodal Terminal Facility (SIMTA proposal). The SIMTA proposal is located on Moorebank Avenue immediately to the west of the IMT site. The potential impacts of the SIMTA proposal which would also affect ecological values affected by the Project include:

- clearing of an unspecified area of native vegetation including the following threatened ecological communities:
  - Castlereagh Scribbly Gum Woodland
  - Castlereagh Swamp Woodland
  - River-flat Eucalypt Forest

- removal of an unknown number of individuals of the following threatened species of plant
  - *Persoonia nutans*
  - *Grevillea parviflora* subsp. *parviflora*
- removal of six hollow-bearing trees
- removal of an unknown area of fauna habitat
- degradation of aquatic habitats.

The combined cumulative impacts associated with the Project (Moorebank IMT) and the SIMTA IMT Project sites have been developed based on three cumulative scenarios comprising:

1. Development of the Moorebank IMT site as described in our EIS, development of 300,000 m^2 warehousing on the SIMTA site.
2. Development of both sites to include IMEX, each handing 500,000 TEU throughput, Interstate freight terminal on the Moorebank IMT site, 300,000m^2 warehousing on each site.
3. Development of Interstate freight terminal and 300,000m^2 warehousing on the Moorebank IMT site, SIMTA development as proposed.

In regards to impacts to biodiversity the only difference between these three scenarios will be the use of the IMT Projects northern rail access option or southern rail access option, with the SIMTA impacts remaining consistent between the scenarios. A summary of the cumulative impacts is provided below in Table 4.4.

Table 4.4 Cumulative potential loss of vegetation

<table>
<tr><th rowspan="2">Vegetation community/ habitat type</th><th colspan="2">Threatened Ecological Community Conservation Status</th><th colspan="2">Vegetation clearing (ha)</th><th rowspan="2">Cumulative total (ha)</th><th rowspan="2">Extent of vegetation within region (ha)[3]</th></tr>
<tr><th>TSC Act[1]</th><th>EPBC Act[2]</th><th>Moorebank IMT</th><th>SIMTA IMT</th></tr>
<tr><td>Vegetation</td><td colspan="6"></td></tr>
<tr><td>Castlereagh Swamp Woodland</td><td>Endangered</td><td>-</td><td>0.9</td><td>4.37</td><td>5.27</td><td>616</td></tr>
<tr><td>Castlereagh Scribbly Gum Woodland</td><td>Vulnerable</td><td>-</td><td>16.1</td><td>18.93</td><td>35.03</td><td>3083</td></tr>
<tr><td>Riparian Forest (River-Flat Eucalypt Forest)</td><td>Endangered</td><td>-</td><td>2.2–5.3</td><td rowspan="2">7.23</td><td rowspan="2">34.63-42.93</td><td>717</td></tr>
<tr><td>Alluvial woodland (River-Flat Eucalypt Forest)</td><td>Endangered</td><td>-</td><td>25.2–30.4</td><td>4698</td></tr>
<tr><td>Freshwater Wetlands</td><td>Endangered</td><td>-</td><td>-</td><td>0.66</td><td>0.66</td><td>664</td></tr>
<tr><td>Total area</td><td></td><td></td><td>44.4–52.7</td><td>31.19</td><td>75.59-83.89</td><td></td></tr>
</table>

Note:

1. *Threatened Species Conservation Act 1995*
2. *Environment Protection and Biodiversity Conservation Act 1999*
3. Vegetation extent in the region based on The Native Vegetation of the Cumberland Plain, Western Sydney **(Tozer 2003)**

A wide variety of other small scale developments are underway or planned in the locality, some of which would undoubtedly also impact threatened biodiversity.

These developments would have an additive effect on processes that increase the likelihood of extinction of threatened biodiversity. However, no population of any of the species or local occurrence of any ecological communities known or likely to be present on the Moorebank IMT site is considered likely to be on the verge of meeting a critical threshold for habitat loss or degradation for the following reasons:

- They are functionally isolated (e.g. for species such as Cumberland Plain Land Snail with very limited mobility and patches of threatened ecological communities separated by substantial barriers to movement of seeds and pollen).
- The species is likely to form part of a population centred on larger or more suitable patches of vegetation outside of the site, which are not likely to be subject to other substantial impacts.

4.6 Summary of key impacts on threatened species of animals and plants

The key potential impacts affecting threatened species of animals and plants on the site are summarised in section 4.6.1 and section 4.6.2 below.

4.6.1 Impacts on threatened species of plant

The key potential impacts affecting threatened flora species on the Project site are summarised in Table 4.5. This summary assumes the habitat loss for all threatened flora species relates to 16.1 ha of Castlereagh Scribbly Gum Woodland and 0.9 ha of Castlereagh Swamp Woodland vegetation that is restricted to the IMT site. No habitat for threatened flora species is present within the three rail access option locations and this habitat is affected to the same extent for all three rail access option concept designs. Impact significance assessments were undertaken for these species and are discussed in section 5 below.

Table 4.5 Potential impacts to Threatened plants known or likely to occur in the IMT site

Threatened species	Status		Potential habitat loss(ha)[4]	Direct mortality	Fragmentation, isolation and edge effects	Weeds, pests and pathogens
	EPBC Act[2]	TSC Act[1]				
Acacia bynoeana	V	E1	17.0	Possible minor[3]	Neutral or positive	Neutral or positive
Acacia pubescens	V	V	17.0	Possible minor[3]	Neutral or positive	Neutral or positive
Dillwynia tenuifolia	V	V	17.0	Possible minor[3]	Neutral or positive	Neutral or positive
Grevillea parviflora subsp. *parviflora*	V	V	17.0	Approximately 16 individuals	Neutral or positive	Neutral or positive
Leucopogon exolasius	V	V	17.0	Possible minor[3]	Neutral or positive	Neutral or positive
Persoonia hirsuta	E	E1	17.0	Possible minor[3]	Neutral or positive	Neutral or positive
Persoonia nutans	E	E1	17.0	Approximately 10 individuals	Neutral or positive	Neutral or positive
Pultenaea parviflora	V	E1	17.0	Possible minor[3]	Neutral or positive	Neutral or positive

Notes: 1.V= Vulnerable, E1 = Endangered, E2 = Endangered Population (*Threatened Species Conservation Act 1995*)
2. V = Vulnerable, E = Endangered, M = Migratory, C = Conservation Dependent (*Environment Protection and Biodiversity Conservation Act 1999*)
3. Species not recorded but impact possible if species occurs on the site in the soil seed bank
4. Habitat loss for *Grevillea parviflora* subsp. *Parviflora* and *Persoonia nutans* includes 6.5 ha of known habitat and 10.5 ha of apparently unoccupied, degraded potential habitat.

4.6.2 Impacts on threatened species of animal

The key potential impacts affecting threatened fauna species on the Project site are summarised in Table 4.6. The summary identifies the general nature and intensity of impacts and is hence applicable to all three rail access options and associated IMT concept designs.

Impact significance assessments were undertaken for these species and are discussed in section 5.

The rail access options differ in the amount of associated vegetation clearing and also in the extent to which they have potential to reduce fauna habitat connectivity. The potential impact on fauna habitat connectivity is described for each option below. While the access will disrupt connectivity most of the threatened species of animal likely to utilise the corridor are very mobile and are unlikely to be significantly impacted.

4.6.2.1 Northern rail access option

The northern rail access option would result in the removal of approximately 0.24 ha of Riparian Forest habitat on the eastern side of the river. The width of vegetation along the river narrows significantly immediately north of the northern access location and hence clearing here has less potential to affect the already quite limited fauna habitat connectivity in this location. The strip of riparian vegetation affected on the western bank is also narrow and with limited connectivity to the north. The northern rail access would therefore have a relatively low impact on fauna movement.

4.6.2.2 Central rail access option

The central rail access option would involve clearing approximately 0.14ha of Alluvial Woodland and 2.14 ha of Riparian Forest. It would create a break in the riparian vegetation along the eastern side of the river approximately 150 m in width. On the western side of the river the break in the riparian vegetation would be approximately 250 m in width leaving minimal space between the river and the existing railway line for terrestrial fauna habitat connectivity. The central rail access would therefore have a relatively high impact on fauna movement.

4.6.2.3 Southern rail access option

The southern rail access option would involve clearing approximately 0.48 ha of Alluvial Woodland and 2.98 ha of Riparian Forest. Clearing would occur on the eastern bank of the Georges River immediately adjacent to the existing East Hills Railway Line crossing. The existing East Hills Rail Line has created a narrow break in the riparian vegetation in this location and hence limits fauna habitat connectivity along the river however, some terrestrial fauna habitat connectivity remains underneath the rail bridge. The southern access would widen the break in vegetation on the eastern bank and has potential to further decrease fauna habitat connectivity and animal movement. On the western bank, the southern access would remove most remaining vegetation from an area of the riparian zone approximately of 300 m in length. This is also likely to adversely affect fauna movement along the western bank of the river. The southern rail access would therefore have a relatively high impact on fauna movement.

Table 4.6 Potential impacts to threatened animals known or likely to occur in the in the Project site (all rail access options)

Species	Status		Loss of discrete potential breeding resources (i.e. tree hollows)	Habitat loss (general)			Direct mortality	Fragmentation, isolation and edge effects	Weeds, pests and pathogens	Disturbance to aquatic habitat	Noise impacts	Light impacts
	EPBC Act[2]	TSC Act[1]		Potential habitat loss Northern Rail Access Option (ha)	Potential habitat loss Central Rail Access Option (ha)	Potential habitat loss Southern Rail Access Option (ha)						
Barking Owl	–	V	Yes	27.4	31.4	35.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	Minor negative
Black-chinned Honeyeater	–	V	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Cumberland Land Snail	–	E	No	44.4	48.4	52.7	Possible	Minor negative	Neutral or positive	N/A	No	No
Eastern Bent-wing Bat	–	V	No	44.4	48.8	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	Minor negative
Eastern False Pipistrelle	–	V	Yes	27.4	31.4	35.7	Possible	Neutral	Neutral or positive	N/A	Minor negative	Minor negative
Eastern Free-tail bat	–	V	Yes	44.4	48.4	52.7	Possible	Neutral	Neutral or positive	N/A	Minor negative	Minor negative
Eastern Pygmy-possum	–	V	Yes	44.4	48.4	52.7	Possible	Minor negative	Neutral or positive	N/A	Minor negative	Minor negative
Flame Robin	–	V	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Gang-gang Cockatoo	–	V	Yes	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Greater Broad-nosed Bat	–	V	Yes	44.4	48.4	52.7	Possible	Neutral	Neutral or positive	N/A	Minor negative	Minor negative
Grey-headed Flying-fox	V	V	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	Minor negative

Species	Status		Loss of discrete potential breeding resources (i.e. tree hollows)	Habitat loss (general)			Direct mortality	Fragmentation, isolation and edge effects	Weeds, pests and pathogens	Disturbance to aquatic habitat	Noise impacts	Light impacts
	EPBC Act[2]	TSC Act[1]		Potential habitat loss Northern Rail Access Option (ha)	Potential habitat loss Central Rail Access Option (ha)	Potential habitat loss Southern Rail Access Option (ha)						
Koala	–	V	No	27.4	31.4	35.7	Unlikely	Minor negative	Neutral or positive	N/A	Minor negative	No
Large-footed Myotis	–	V	Yes	27.4	31.4	35.7	Possible	Neutral	Neutral or positive	Neutral or positive	Minor negative	Minor negative
Little Eagle	–	V	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Little Lorikeet	–	V	Yes	44.4	48.4	52.7	Possible	Neutral	Neutral or positive	N/A	Minor negative	No
Powerful Owl	–	V	Yes	27.4	31.4	35.7	Possible	Neutral	Neutral or positive	N/A	Minor negative	No
Regent Honeyeater	E	CE	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Scarlet Robin	–	V	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Spotted Harrier	–	V	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Spotted-tailed Quoll	E	V	Yes	44.4	48.4	52.7	Possible	Minor negative	Neutral or positive	N/A	Minimal	No
Square-tailed Kite	–	V	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Squirrel Glider	–	V	Yes	44.4	48.4	52.7	Possible	Minor negative	Neutral or positive	N/A	Minor negative	Minor negative
Swift Parrot	E	E1	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No

Species	Status		Loss of discrete potential breeding resources (i.e. tree hollows)	Habitat loss (general)			Direct mortality	Fragmentation, isolation and edge effects	Weeds, pests and pathogens	Disturbance to aquatic habitat	Noise impacts	Light impacts
	EPBC Act[2]	TSC Act[1]		Potential habitat loss Northern Rail Access Option (ha)	Potential habitat loss Central Rail Access Option (ha)	Potential habitat loss Southern Rail Access Option (ha)						
Varied Sittella	–	V	No	44.4	48.4	52.7	Unlikely	Neutral	Neutral or positive	N/A	Minor negative	No
Yellow-bellied Sheathtail Bat	–	V	Yes	44.4	48.4	52.7	Possible	Neutral	Neutral or positive	N/A	Minor negative	Minor negative

Notes:
1.V= Vulnerable, E1 = Endangered, CE = Critically Endangered (*Threatened Species Conservation Act 1995*)
2. V = Vulnerable, E = Endangered, M = Migratory, C = Conservation Dependent (*Environment Protection and Biodiversity Conservation Act 1999*)
3. Impact possible during clearing if species inhabits tree hollows to be removed however this risk will be minimised through clearing protocols for habitat tress

5. Impact significance assessment

Impact significance assessments for threatened species populations and ecological communities have been conducted in accordance with the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance*(Department of the Environment 2013)and the *Threatened Species Assessment Guidelines* (DEC 2007) and the to consider the potential impacts of the Project and proposed mitigation measures (refer to Appendices C and D).A summary of these assessments relevant to the IMT site and each of rail access option is provided below.

5.1 IMT site

Based on these assessments, no threatened species population or ecological community is likely to be significantly impacted by the Project. The results of the impact assessments for EPBC Act listed threatened biodiversity and TSC Act listed biodiversity are provided in Tables 5.1 and Table 5.2 respectively.

The EPBC Act listed threatened species of animal considered to have the potential to occur on the Project site, all have large home ranges (the distance that the species will travel) that would extend well beyond the Project site and/or are migratory or nomadic and likely to use the Project site on a sporadic or seasonal basis. These species are hence unlikely to be significantly affected by the small proportion of locally occurring habitat likely to be affected by the Project.

No EPBC Act or TSC Act listed threatened species, population or ecological community is likely to be significantly affected by the Project.

5.2 Northern rail access option

Based on these assessments, no threatened species population or ecological community is likely to be significantly impacted by the Project. The results of the impact assessments for EPBC Act listed threatened biodiversity and TSC Act listed biodiversity are provided in Tables 5.1 and Table 5.2 respectively.

The EPBC Act listed threatened species of animal considered to have the potential to occur on the Project site, all have large home ranges (the distance that the species will travel) that would extend well beyond the Project site and/or are migratory or nomadic and likely to use the Project site on a sporadic or seasonal basis. These species are hence unlikely to be significantly affected by the small proportion of locally occurring habitat likely to be affected by the Project.

No EPBC Act or TSC Act listed threatened species, population or ecological community is likely to be significantly affected by the Project.

5.3 Central rail access option

Based on these assessments, no threatened species population or ecological community is likely to be significantly impacted by the Project. The results of the impact assessments for EPBC Act listed threatened biodiversity and TSC Act listed biodiversity are provided in Tables 5.1 and Table 5.2 respectively.

The EPBC Act listed threatened species of animal considered to have the potential to occur on the Project site, all have large home ranges (the distance that the species will travel) that would extend well beyond the Project site and/or are migratory or nomadic and likely to use the Project site on a sporadic or seasonal basis. These species are hence unlikely to be significantly affected by the small proportion of locally occurring habitat likely to be affected by the Project.

No EPBC Act or TSC Act listed threatened species, population or ecological community is likely to be significantly affected by the Project.

5.4 Southern rail access option

Based on these assessments, no threatened species population or ecological community is likely to be significantly impacted by the Project. The results of the impact assessments for EPBC Act listed threatened biodiversity and TSC Act listed biodiversity are provided in Tables 5.1 and Table 5.2 respectively.

The EPBC Act listed threatened species of animal considered to have the potential to occur on the Project site, all have large home ranges (the distance that the species will travel) that would extend well beyond the Project site and/or are migratory or nomadic and likely to use the Project site on a sporadic or seasonal basis. These species are hence unlikely to be significantly affected by the small proportion of locally occurring habitat likely to be affected by the Project.

No EPBC Act or TSC Act listed threatened species, population or ecological community is likely to be significantly affected by the Project.

Table 5.1 Impact assessment summary for EPBC Act listed Threatened biodiversity

Scientific name	Common name	EPBC Actstatus[1]	Assessment outcome	Key findings	Development			
					IMT site	Northern rail access	Central rail access	Southern rail access
Plants								
Acacia bynoeana	Bynoe's Wattle	V	Not significant	▪ None of these species was recorded within or adjacent to the study area however it is possible that they may exist in the study area as a soil-stored seedbank. ▪ The Project site does not contain a known occurrence of these species and is unlikely to contain an important population.	●	N/A	N/A	N/A
Acacia pubescens	Downy Wattle	V	Not significant		●	N/A	N/A	N/A
Dillwynia tenuifolia	–	V	Not significant		●	N/A	N/A	N/A
Leucopogon exolasius	Woronora Beard-heath	V	Not significant		●	N/A	N/A	N/A
Persoonia hirsuta	Hairy Geebung	E	Not significant		●	N/A	N/A	N/A
Pultenaea parviflora	Sydney Bush-pea	V	Not significant		●	N/A	N/A	N/A
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	Not significant	▪ The upper Georges River population of *Grevillea parviflorasubsp. parviflora* is recognised as being large. ▪ The Project will lead to a reduction in the size of the *Grevillea parviflorasubsp. parviflora* population (less than 2%). ▪ The habitat for *Grevillea parviflorasubsp. parviflora* that would be removed to the west of Moorebank Avenue, while in good to moderately degraded condition, is functionally isolated from other areas of *Grevillea parviflorasubsp. parviflora* habitat in the locality due to its limited seed dispersal.	●	N/A	N/A	N/A

Scientific name	Common name	EPBC Actstatus[1]	Assessment outcome	Key findings	Development			
					IMT site	Northern rail access	Central rail access	Southern rail access
Persoonia nutans	Nodding Geebung	E	Not significant	▪ The proposed action will result in the removal of 6.5 ha of habitat known to be occupied by *Persoonia nutans* and 10.5 of unoccupied habitat within the Project site but this is unlikely to result in a significant long-term reduction in the size of the population. ▪ The Project is unlikely to create any barriers to cross-pollination or seed dispersal between patches of habitat which would affect the breeding cycle of the species.	●	N/A	N/A	N/A
Animals								
Phascolarctos cinereus	Koala	V	Not significant	▪ The higher value riparian habitat that would be retained and rehabilitated has moderate potential as habitat for the species as it contains potential food sources and potential breeding habitat for the koala but is in moderately degraded condition and is largely surrounded by cleared areas. ▪ The Project is unlikely to result in a long-term reduction in the population of the species, nor to significantly reduce the area of occupancy of the species. ▪ There is unlikely to be a significant loss of habitat for the species.	●	●	●	●

Scientific name	Common name	EPBC Actstatus[1]	Assessment outcome	Key findings	Development			
					IMT site	Northern rail access	Central rail access	Southern rail access
Pteropus poliocephalus	Grey-headed Flying-fox	V	Not significant	▪ Much of the higher value riparian habitat containing winter food resources and potential camp site locations for the species would be retained and rehabilitated. ▪ The Project is unlikely to significantly reduce the availability of important habitat or area of occupancy. ▪ Fragmentation is highly unlikely to occur due to the mobility of the species.	●	●	●	●
Dasyurus maculatus	Spotted-tailed Quoll	E	Not significant	▪ The vegetation on site is considered to be marginal at best due to the paucity of potential den sites and fragmentation. ▪ The species was not recorded within the Project site but it is possible that the species may occupy the site as part of a large home range. ▪ If present in the locality, the species may utilise habitat along corridors of riparian vegetation.	●	●	●	●
Lathamus discolor	Swift Parrot	E	Not significant	▪ The site is not within the core breeding areas for the Swift Parrot and Regent Honeyeater and these species are unlikely to breed on the site. ▪ The Project site is a potential habitat but is only likely to be used as a foraging habitat by these species. ▪ Unlikely to be affected by minor habitat fragmentation due to the species being highly mobile.	●	●	●	●
Anthochaera phrygia	Regent Honeyeater	E, M	Not significant		●	●	●	●

Notes: V= Vulnerable, E= Endangered

Table 5.2 Impact assessment for TSC Act listed biodiversity

Scientific name	Common name	TSC Act[1]	Assessment outcome	Key findings	Development			
					IMT site	Northern rail access	Central Rail access	Southern rail access
Plants								
Persoonia nutans	Nodding Geebung	E1	Not significant	▪ The proposed action will result in the removal of 6.5 ha of habitat known to be occupied by *Persoonia nutans* within the proposed Project site and a further 10.5 ha of degraded, apparently unoccupied habitat. ▪ The habitat of the local population of the species is already fragmented by existing roadways and cleared areas. Thus the Project is unlikely to increase the fragmentation or isolation of patches of habitat. ▪ The larger areas of known occurrences of the species and potential habitat to the east of Moorebank Avenue are more likely to represent an area of habitat important to the survival of *Persoonia nutans*.	●	NA	NA	NA
Grevillea parviflora subspp*Parviflora*	Small-flower Grevillea	V	Not significant	▪ The proposed action may result in the removal of 6.5 ha of habitat known to be occupied by *Grevillea parviflora subsp. parviflora* within the proposed Project site and an additional 10.5 ha of degraded and apparently unoccupied habitat. ▪ The habitat of the local population of the species is already fragmented by existing roadways and cleared areas. ▪ The riparian corridor is likely to represent an area of habitat important to the survival of *Grevillea parviflora subsp. parviflora*	●	NA	NA	NA

Scientific name	Common name	TSC Act[1]	Assessment outcome	Key findings	Development			
					IMT site	Northern rail access	Central Rail access	Southern rail access
Acacia bynoeana	Bynoe's Wattle	E1	Not significant	▪ The project is unlikely to significantly affect processes such as pollination, seed dispersal and recruitment, which could affect the breeding cycle of these species. ▪ It is unknown whether a viable population of any of these species exists within the study area.	●	NA	NA	NA
Acacia pubescens	Downy Wattle	V	Not significant		●	NA	NA	NA
Dillwynia tenuifolia	–	V	Not significant		●	NA	NA	NA
Leucopogon exolasius	Woronora Beard-heath	V	Not significant		●	NA	NA	NA
Persoonia hirsute	Hairy Geebung	E1	Not significant		●	NA	NA	NA
Pultenaeaparviflora	Sydney Bush-pea	E1	Not significant		●	NA	NA	NA
Animals								
Cercartetus nanus	Eastern Pygmy-possum	V	Not significant	▪ The habitat for these species in the study area is considered to be marginal and it is unlikely that a significant proportion of any local population breeds on the site.	●	●	●	●
Petaurus norfolcensis	Squirrel Glider	V	Not significant		●	●	●	●
Meridolum corneovirens	Cumberland Land Snail	E1	Not significant	▪ Insufficient information about the population dynamics of the species is available to determine whether any extant sub-population that may exist within the study area is likely to be viable. ▪ The size and geographic extent of any extant sub-population is unknown however given the small number of individuals recorded it is presumed to be small.	●	●	●	●

<table>
<tr><th rowspan="2">Scientific name</th><th rowspan="2">Common name</th><th rowspan="2">TSC Act[1]</th><th rowspan="2">Assessment outcome</th><th rowspan="2">Key findings</th><th colspan="4">Development</th></tr>
<tr><th>IMT site</th><th>Northern rail access</th><th>Central Rail access</th><th>Southern rail access</th></tr>
<tr><td>Mormopterus norfolkensis</td><td>Eastern Free-tail bat</td><td>V</td><td>Not significant</td><td rowspan="6">▪ A significant proportion of the locally available breeding habitat for hollow-breeding bats may be affected by the removal of more than 46 hollows-bearing trees.
▪ The proposed nest box installation, hollow-relocation and vegetation restoration measures are likely to offset this loss of breeding habitat, to the extent that local populations of these species are unlikely to be placed at significantly increased likelihood of extinction.
▪ Potential foraging habitat for these species is considered to be relatively abundant in the locality.</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td>Scoteanax rueppellii</td><td>Greater Broad-nosed Bat</td><td>V</td><td>Not significant</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td>Falsistrellus tasmaniensis</td><td>Eastern False Pipistrelle</td><td>V</td><td>Not significant</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td>Saccolaimus flaviventris</td><td>Yellow-bellied Sheathtail Bat</td><td>V</td><td>Not significant</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td>Miniopterus schreibersii</td><td>Eastern Bent-wing Bat</td><td>V</td><td>Not significant</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td>Myotis adversus</td><td>Large-footed Myotis</td><td>V</td><td>Not significant</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td>Pteropus poliocephalus</td><td>Grey-headed Flying-fox</td><td>V</td><td>Not significant</td><td>▪ No camp sites (roosting and breeding habitat) for the Grey-headed Flying-fox are located within or adjacent to the study area. Breeding habitat for the species is therefore unlikely to be affected.
▪ Approximately 44.4 to 52.7 ha of woodland will be cleared. This woodland is likely to be used as a foraging habitat by this species on a seasonal basis, when the dominant eucalypt species are flowering heavily.
▪ As this species is highly mobile, it is unlikely that is would be significantly affected by the additional habitat fragmentation that would occur as a result of the Project.</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
</table>

Scientific name	Common name	TSC Act[1]	Assessment outcome	Key findings	Development			
					IMT site	Northern rail access	Central Rail access	Southern rail access
Glossopsitta pusilla	Little Lorikeet	V	Not significant	▪ The site is unlikely to contain significant breeding habitat. ▪ Approximately 44.4 to 52.7 ha of woodland would be cleared. This woodland may be used as a foraging habitat by these species on a seasonal basis when the dominant eucalypt species are flowering heavily. ▪ As these species are highly mobile, it is unlikely that they would be significantly affected by the additional habitat fragmentation that would occur as a result of the project.	●	●	●	●
Lathamus discolour	Swift Parrot	E1	Not significant		●	●	●	●
Melithreptus gularis gularis	Black-chinned Honeyeater	V	Not significant		●	●	●	●
Anthochaera phrygia	Regent Honeyeater	CE	Not significant		●	●	●	●
Callocephalon fimbriatum	Gang-gang Cockatoo	V	Not significant	▪ The approximately 44.4 to 52.7ha of affected tall forest may be used as a foraging habitat by these species on an occasional basis as part of a large home range. ▪ The vegetation of the riparian corridor is more likely to provide suitable nesting habitat for these species.	●	●	●	●
Ninox strenua	Powerful Owl	V	Not significant		●	●	●	●
Ninox connivens	Barking Owl	V	Not significant		●	●	●	●
Hieraaetus morphnoides	Little Eagle	V	Not significant		●	●	●	●
Circus assimilis	Spotted Harrier	V	Not significant		●	●	●	●
Lophoictinia isura	Square-tailed Kite	V	Not significant		●	●	●	●
Petroica boodang	Scarlet Robin	V	Not significant	▪ These are sedentary species which may breed in the locality, particularly utilising mature and rough-barked trees. ▪ Within the Project site, mature and rough-barked trees are almost exclusively found along the riparian corridor of the Georges River. Much of this vegetation would be retained and substantial vegetation restoration would also be conducted to improve the condition of this retained habitat.	●	●	●	●
Petroica phoenicea	Flame Robin	V	Not significant		●	●	●	●
Daphoenositta chrysoptera	Varied Sittella	V	Not significant		●	●	●	●

Scientific name	Common name	TSC Act[1]	Assessment outcome	Key findings	Development			
					IMT site	Northern rail access	Central Rail access	Southern rail access
Dasyurus maculatus	Spotted-tailed Quoll	V	Not significant	▪ The vegetation at the site is considered marginal at best due to the paucity of potential den sites and fragmentation. ▪ The species was not recorded within the Project site but it is possible that the species may occupy the site as part of a large home range. ▪ If present in the locality, the species is most likely to utilise habitat along corridors of riparian vegetation on the Georges River.	●	●	●	●
Phascolarctos cinereus	Koala	V	Not significant	▪ The higher value riparian habitat that would be retained and rehabilitated has moderate potential as habitat for the species as it contains potential food sources and potential breeding habitat for the koala but is in moderately degraded condition and is largely surrounded by cleared areas. ▪ The Project is unlikely to result in a long-term reduction in the population of the species, or to reduce the area of occupancy of the species. ▪ There is unlikely to be a significant loss of habitat for the species as a result of the Project.	●	●	●	●

Scientific name	Common name	TSC Act[1]	Assessment outcome	Key findings	Development			
					IMT site	Northern rail access	Central Rail access	Southern rail access
Threatened ecological communities								
River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions		E	Not significant	▪ The Project would result in the clearing of approximately 27.4 to 35.7 ha of River-Flat Eucalypt Forest on Coastal Floodplains, but is unlikely to negatively affect the long-term viability of the local occurrence of the community.	●	●	●	●
Castlereagh swamp woodland community		E	Not significant	▪ The Project would result in the clearing of 0.9 ha of Castlereagh Swamp Woodland: this represents a small proportion of the local ecological community. ▪ The Project is unlikely to result in processes such as substantial hydrological changes or increased weed invasion that would be likely to result in changes to the structure or composition of the community outside of the Project site.	●	●	●	●
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion		V	Not applicable[2]	N/A	●	●	●	●

Notes: 1. V = Vulnerable, E = Endangered, CE = Critically Endangered.
2. Vulnerable ecological communities are generally excluded from the provisions of the EP&A Act relating to threatened species, populations and ecological communities, including provisions that require the concurrence of the Director-General of the OEH or the Minister administering the TSC Act, or the preparation of a species impact statement, in respect of development or an activity that is likely to have a significant effect on threatened species, populations or ecological communities.

6. Management and mitigation

This Section outlines the impact mitigation measures and offsets strategy proposed for the Project. These measures would be refined during the detailed design phase of the Project.

A general principle of environmental management is to, in order of preference:

- avoid environmental impacts
- reduce impacts
- mitigate the impacts
- as a last resort, once the above options have been investigated, compensate for the residual impacts (offset).

The mitigation measures specific to the ecological impacts identified in section 4 are described below. Many of the general impact mitigation measures (e.g. dust suppression, sedimentation controls) would also contribute to the mitigation of construction and operation phase impacts on the ecological values of the Project site during all Project development phases. The proposed offsets package would address the remaining (residual) impacts which cannot be mitigated through the proposed management measures alone.

The mitigation measures outlined here relate to general construction and operational activities at the Project site. Therefore, these mitigation measures would apply to project development irrespective of which rail access option is selected.

Implementation of the offsets strategy would address the remaining (residual) impacts that cannot be mitigated through the proposed management measures alone. The offset strategy as outlined in section 6.3.3 has been developed to relate specifically to the impact of each individual rail access option.

6.1 Avoidance of impacts on ecological values

This section outlines the consideration and ability of the Project to avoid and minimise the direct and indirect impacts of a development proposal on biodiversity values as required by the Framework for Biodiversity Assessment (FBA) and NSW Offset Policy 2014. The site selection process and planning phased of this Project were completed prior to the development of the FBA methodology and as such can only generally apply the assessment methodology.

This Project has incorporated the principles of avoiding and minimising impacts to biodiversity into the entire life cycle of the Major Project consistent with the guidelines of the FBA at each of the following stages:

6.1.1 Site selection

The site selection for the process was restricted primarily by the need to be located close to supporting rail and road infrastructure, industry and warehouse facilities. The proposed site is located predominately within an existing disturbed environment currently under industrial uses. The site’s significant riparian corridor was identified as a constraint and unsuitable for development in this stage. The adjoining properties to the south and south east are significantly more constrained by high conservation values.

6.1.2 Planning

A detailed analysis of layout and functionality options for the Project site has been undertaken as discussed in Chapter 6 – *Project development and alternatives*.

When considering and analysing the Project site layout, the following matters were addressed:

(a) whether there are alternative sites within the property on which the proposed development is located where siting the proposed Major Project would avoid and minimise impacts on biodiversity values

(b) how the development site can be selected to avoid and minimise impacts on biodiversity values as far as practicable

(c) whether an alternative development site to the proposed development site, which would avoid adversely impacting on biodiversity values, might be feasible.

A detailed analysis of layout and functionality options for the Project site has been undertaken as discussed in Chapter 6 of the EIS – *Project development and alternatives*. Given the location and nature of the Project and its context with regard to existing road and rail infrastructure, there is limited scope for using alternative locations to entirely avoid impacts on biodiversity.

Given the location and nature of the Project and its context with regard to existing road and rail infrastructure, there is limited scope for using alternative locations to entirely avoid impacts on biodiversity. Given the scale and type of development, there are only limited possibilities for the incorporation of small isolated patches of vegetation into the design of a large industrial and warehouse development. The EIS is for a Stage 1 SSD development approval of a concept design and future avoidance of vegetation will be investigated during detailed design and Stage 2 SSD development approvals. It is acknowledged that the current proposal will clear approximately 44–52 ha of Threatened ecological communities; however the majority of this vegetation is made up of small, highly fragmented and disturbed patches of vegetation in low condition. The retention of these isolated patches within an industrial development precinct would provide little long term conservation benefit to the Threatened ecological community species.

Avoidance of vegetation was initially considered in the planning phase of the Project and was supported through the ecological integrity classification (Section 2.7 of the EA) which ‘classification of ecological values was used in the identification of constraints and evaluation of potential design options for the Project’. This assessment considered the full build development scenario and ensured the high conservation lands were considered for avoidance along with the range of other factors.

Reduction of impacts on areas of high ecological value was considered in the analysis and evaluation of design options for the Project, resulting in the retention of substantial areas of vegetation and habitat contiguous with the riparian vegetation of the Georges River (refer Section 6.4.4 of the EIS).

The areas of high ecological integrity to be impacted by the proposal (classed as high only because of the presence of threatened flora species and Threatened ecological communities) are restricted to narrow linear remnant adjoining Moorebank Avenue and the SIMTA facility that are considered of limited viability for conservation when considering the small fragmented size, high edge to area ratio, and surrounding land uses.

The Early Works also include the proposed restoration of the plant and equipment operation training area (referred to as the 'dust bowl') within the proposed conservation area. This would create an additional area of Riparian Forest and/or Alluvial Woodland vegetation thereby increasing the biodiversity value of this location.

6.2 Mitigation

6.2.1 Management of the mitigation process

Following detailed design and prior to construction, detailed flora and fauna mitigation measures would be developed and presented as part of the environmental management plans relating to the construction and operation of the Project. The plans, particularly the construction environmental management plan (CEMP), would address:

- general impact mitigation
- staff/contractor inductions
- vegetation clearing protocols
- pre-clearing surveys and fauna salvage/translocation
- rehabilitation and restitution of adjoining habitat
- weed control
- pest management
- monitoring.

The plans would include clear objectives and actions for the Project including how to:

- minimise human interferences to flora and fauna
- minimise vegetation clearing/disturbance
- minimise impact to threatened species and communities
- minimise impacts to aquatic habitats and species
- undertake flora and fauna monitoring at regular intervals.

The proposed management measures will mitigate the following impacts such that a significant impact would be unlikely:

- direct mortality of threatened animals
- light impacts on fauna
- impacts on aquatic habitat
- dust pollution
- introduction and spread of weeds.

Mitigation measures specific to ecological impacts are described below. Many of the general impact mitigation measures (e.g. dust suppression, sedimentation controls) would also contribute to the mitigation of construction and operation phase impacts on the ecological values of the site.

The proposed offsets package will address the remaining impacts which cannot be sufficiently mitigated through the proposed management measures alone (refer section 6.4).

6.2.2 Proposed management and mitigation measures

6.2.2.1 Vegetation clearing

Disturbance to areas of native vegetation and habitat would be unavoidable during the construction process. Vegetation clearing would be restricted to the construction footprint. In order to avoid unnecessary disturbance to sensitive areas outside of the construction footprint, vegetation clearing extents would be clearly identified during the construction process as 'no-go' areas. These would be marked on maps provided to contractors, as well as on the ground using high visibility fencing (such as barrier mesh). No direct disturbance would occur in these areas, including vehicle access.

A trained ecologist would accompany clearing crews in order to ensure disturbance is minimised and to assist any native animals to relocate to adjacent habitat (refer section 6.3.3). The adoption of these measures would limit the extent of vegetation disturbance, prevent soil compaction and minimise damage to trees near the edges of the clearing limits.

6.2.2.2 Direct mortality

Fauna injury or death has the greatest potential to occur during the break-out phase of construction when vegetation and habitats are being cleared. Threatened species that could be affected by the clearing include the various species of microbats and arboreal marsupials that may inhabit hollow trees in the clearing area, nestling birds, ground-dwelling animals such as small mammals, frogs, reptiles and the Cumberland Land Snail.

In order to minimise the likelihood of fauna injury or death during the clearing of vegetation, the following measures would be developed and presented as part of the environmental management plans:

- A staged habitat removal process would be developed and put in place. This protocol would include:
  - All habitat trees in the area to be cleared would be identified (by survey) and marked.
  - Clearing of hollow-bearing trees would be undertaken in March-April when most microbats are likely to be active (not in torpor) but are unlikely to be breeding or caring for young, and Threatened hollow-dependent birds in the locality are also unlikely to be breeding.
  - Pre-clearing surveys would be conducted 12 to 48 hours prior to vegetation clearing to search for native wildlife (e.g. reptiles, frogs, Cumberland Land Snail) which can be captured and relocated to the retained riparian vegetation of the Georges River Corridor.

- Vegetation would be cleared from a 10 m radius around habitat trees to encourage animals roosting in hollows to leave the tree. A minimum 48 hour waiting period would allow animals to leave.
- After the waiting period, standing habitat trees would be shaken (where safe and practicable) under the supervision of an ecologist to encourage animals roosting in hollows to leave the trees which would then be felled, commencing with the most distant trees from secure habitat. Felled habitat trees would be left on the ground for a further 24 hour waiting period prior to removal from the construction area or immediately moved to the edge of retained vegetation at the discretion of the supervising ecologist.
- All contractors would have the contact numbers of wildlife rescue groups in case animals are injured or orphaned during clearing and require veterinary assistance and/or extended care prior to release.

- Relocation of animals to adjacent retained habitat would be undertaken by an ecologist during the supervision of vegetation removal. This technique is unlikely to prevent the loss of individuals altogether; however, it is likely to reduce the intensity of the impact of the Project on animal populations by preserving a larger number of individuals and greater genetic diversity making populations more likely to remain viable. Relocation is likely to be successful in mitigating impacts, as the recipient area contains suitable habitat which is likely to be inhabited by the species such that the existing populations would be augmented. The availability of suitable sheltering and feeding opportunities is likely to limit the population size of many such species in the locality and hence the relocation of woody debris and installation of nest boxes is proposed to increase the carrying capacity of the recipient area.
- An ecologist would supervise the drainage of any waterbodies on the site and would relocate native fish (e.g. eels), tortoises and frogs to the edge of the Georges River and/or the existing pond at the northern end of the site.
- The design of site fencing and any overhead powerlines would consider the potential for collision by birds and bats and minimise this risk where practicable.
- The potential for translocation of threatened plant species as individuals or as part of a soil translocation process would be considered during the detailed development of the CEMP.

6.2.2.3 Habitat loss

Proposed measures to mitigate habitat loss include:

- Consideration would be given to fitting roost boxes to the bridge over the Georges River to provide roost sites for the Large-footed Myotis and other species of microbats (e.g. Eastern Bentwing-bat) which may utilise such structures. Provision of roost boxes under bridges has been identified as priority action for the recovery of the Large-footed Myotis.

- As the availability of habitat trees in the IMT site would be reduced through vegetation clearing, artificial hollows (nest boxes) would be installed in secure habitat within the Georges River riparian corridor before clearing at a one to one ratio to replace hollows lost. Nest/roost boxes would be installed in consultation with OEH. Nest boxes of a variety of designs would be installed including boxes suitable for roosting by microbats. Relocation of natural hollows by either affixing them to existing live retained trees or to poles/trunks of felled trees installed in revegetated areas would also be considered as an alternative to nest box installation. A review of the literature available on the use of artificial hollows by microbats(Goldingay & Stevens 2009) concluded that there is increasing evidence that roost boxes would be used by Australian microbats; however the extent to which this can result in valuable research and management applications is not well understood. Artificial hollows have been used in recovery programs for several Threatened bird species, but the deployment of roost boxes for threatened bats has only just begun (Goldingay & Stevens 2009). The Eastern False Pipistrelle has been recorded using nest boxes in Victoria suggesting there is potential to use roost boxes in the recovery of this species. If such a management application is used, monitoring over a 2–5 year period is recommended to document the outcome (Goldingay & Stevens 2009). Once clearing commences, an accurate count of tree hollows lost will be made by inspecting potential hollow-bearing trees as they are felled. The number of hollows recorded will guide further nest box installation.

- Important habitat elements (e.g. large woody debris) would be moved from the construction area to locations within the IMT site which would not be cleared during the Project or to stockpiles for later use in vegetation/habitat restoration.

- Winter-flowering trees would be preferentially planted in landscaped areas of the site to provide a winter foraging resource for migratory and nomadic nectar-feeding birds and the Grey-headed Flying-fox.

6.2.2.4 Fragmentation and connectivity

Proposed measures to mitigate fragmentation and reduced habitat connectivity include:

- A bridge/viaduct would be used for the railway access over the Georges River. This may allow connectivity of terrestrial habitat along the river banks underneath the bridge. The design of the access over f the Georges River is at concept level only and hence opportunities for maintaining habitat connectivity there have not yet been identified. Options for maintaining habitat connectivity would be investigated at the detailed design stage of the Project, including establishing native vegetation and placing habitat elements such as rock piles and large woody debris under the bridge to provide cover for fauna. Bridge structures can create adverse environments for vegetation and fauna due to intense shading and a lack of rainfall. In order to overcome the lack of rainfall, options would be explored (if connectivity is possible) for designing the landscaping in the vicinity of the bridge to funnel some surface water flow under the bridge, thereby allowing water to absorb into the soil and encourage plant growth.

- Plant species chosen for revegetation under the bridge would be chosen for their shade-tolerance (e.g. rainforest understorey species native to the Sydney Basin Bioregion) even if these species are not usually found in the Alluvial Woodland/Riparian Forest vegetation types. Some mesic species typical of the Riparian Forest community (e.g. *Backhousia myrtifolia, Stenocarpus salignus, Lomandra longifolia, Dichondra repens*) may also be suitable.

6.2.2.5 Impact on aquatic habitats

Proposed measures to mitigate impacts on aquatic habitats include:

- Erosion and sediment control measures such as silt-fencing and hay bales would be used to minimise sedimentation of streams and resultant impacts on aquatic habitats and water quality.
- The detailed design process for the bridge over the Georges River would consider disturbance to aquatic habitat and fish passage conditions. The design would as a minimum adhere to the fish friendly passage guidelines (Fairfull & Witheridge 2003) for waterway crossings.
- Opportunities for planting of detention basins with native aquatic emergent plants and fringing trees would be explored in the detailed design of the Project and, if practicable, implemented such that, in the medium term they would provide similar habitat to that lost through the removal of existing basins.

6.2.2.6 Weed invasion and introduction of pathogens

The operation of the Project has potential to result in additional weeds and plant and animal pathogens being introduced to the site on the tyres of vehicles or trains entering the site and on construction plant and materials. These weeds and pathogens could then spread into the retained native vegetation and habitat of the Georges River Corridor. The Construction Environmental Management Plan would include detailed measures for minimising the risk of introducing weeds and pathogens.

The Project would also include a long-term program of weed removal and riparian vegetation restoration in the Georges River corridor, which would include monitoring of the landscaped areas of the facility for the presence of noxious and environmental weeds. A preliminary weed management strategy is provided in Appendix E, setting out the principles for the management of the riparian zone.

6.2.2.7 Biosecurity

As the Project involves warehousing of goods from overseas and interstate, it has the potential to bring novel pest species to the IMT site. The Biosecurity division of the Commonwealth Department of Agriculture, Fisheries and Forestry (DAFF) should be consulted regarding the detailed design of the facility and its operation to ensure that all legal requirements and appropriate management measures related to biosecurity are implemented to minimise the risk of the introduction of pest species.

6.2.2.8 Operation phase mitigation

The operation of the Project has potential to impact retained biodiversity within the Georges River riparian corridor and other retained vegetation within the IMT site. During the operation phase, impacts on biodiversity could arise from weed invasion, introduction of pathogens or pollution (silt, dust, noise, light etc.) entering habitats from adjacent operational lands. The detailed design of the Project would ensure that the potential for operation phase impacts is minimised wherever practicable, however, residual impacts are possible. The management plan for the Georges River riparian corridor (refer Appendix E) includes a monitoring program designed to detect operational impacts and a procedure for reporting to inform any modification to the operation of the IMT site that may be necessary to minimise the identified impacts.

6.3 Offsets

Offsets will address the following impacts which cannot be sufficiently mitigated through the proposed management measures alone:

- vegetation clearing and habitat loss
- direct mortality of threatened plants
- fragmentation and loss of connectivity
- increased edge effects.

Offset requirements under Commonwealth and NSW legislation and a summary of the proposed offsets are described below. For further detail refer to Appendix F.

6.3.1 Offsets requirements under Commonwealth legislation

The Commonwealth Final EIS Guidelines for the Project include the following requirement regarding offsets:

- *'Provide a description of all residual impacts arising from the action once all avoidance and mitigation measures that can be applied to the project have occurred. Provide a description of the proposed environmental offset measures, including a proposed strategy to offset any impacts of the proposed action on matters of national environmental significance. The proposed strategy must demonstrate how it will meet each of the principles described in the Department's Environmental Offset Policy (October 2012) and Assessment Guideline for the use of environmental offsets under the EPBC Act which is available on the Department's website www.environment.gov.au/resource/epbc-act-environmental-offset-policy.'*

6.3.2 Offsets requirement under NSW legislation

The Department of Planning and Infrastructure's SEARs for the Project includes the following requirement regarding the offsetting of ecological impacts:

> *'…a strategy to offset unavoidable, residual ecological impacts and native vegetation clearance, consistent with the 'improve and maintain' principle of the NSW Bio-banking policy, and including an offset strategy for any impacts of the development on matters of environmental significance under the Environment Protection and Biodiversity Conservation Act 1999 and the EPBC Environmental Offsets Policy (October 2012) and on threatened species and endangered ecological communities and/or critical habitat under the Threatened Species Conservation Act 1995. The proposed strategy must demonstrate how it meets each of the overarching principles of State and Commonwealth offset policy to achieve long term conservation outcomes.'*

Biodiversity offsets are required to compensate for losses of native vegetation, threatened ecological communities and habitat for Threatened species.

6.3.3 Offset strategy

A biodiversity offsets strategy has been developed for the Project and included in Appendix F. The strategy outlines the residual biodiversity impacts to be offset, identifies the ecological values of the proposed offset areas, and outlines the compliance of the offset strategy with Commonwealth and State offsetting principles including:

- NSW Biodiversity Offsets Policy for Major Projects (Offset Policy) (NSW Office of Environment and Heritage 2014); and
- EPBC Act – Environmental Offsets Strategy (Department of Sustainability, Environment, Water, Population and Communities 2012).

Offset measures may include both on- and offsite or local area lands that contribute to the long-term conservation of threatened species and communities. Offsets would address the following impacts which cannot be mitigated through the proposed on-site management measures alone:

- vegetation clearing and habitat loss;
- direct mortality of threatened plants;
- fragmentation and loss of connectivity; and
- increased edge effects.

Offset measures may include both on and off site or local area proposals that contribute to the long term conservation of threatened species and communities. The offset measures chosen for the Project include a combination of:

- on-site offsets – improving the condition of existing habitat or providing a buffer to an area of existing habitat within the development site
- off-site offsets – securing and improving the condition of existing habitats at another site.

6.3.3.1 Residual biodiversity impacts to be offset

The Project would have direct and indirect impacts on biodiversity during the construction and operation phases. Construction of the Project would require the clearing of vegetation and habitats and this has been identified as the key residual impact of the Project.
The vegetation and habitat loss associated with the Project is outlined in Table 4.2.

While a phased development approach is proposed for the Project, the offset strategy has been developed with the intent to meet the ‘worst-case’ scenario in terms of the Full Build footprint, including the associated construction compounds. This is the combined development area for all Project development phases.

As the final layout and footprint of the IMT will depend on the location of the selected rail access option, there are three IMT layouts proposed in the EIS. The residual impacts of each of the three options on threatened biodiversity recorded or considered likely to occur within the study area, are listed in Table 4.2, along with an estimate of residual impacts associated with habitat removal for each of the rail connection options. Two EPBC Act listed flora species, *Grevillea parviflora* subsp. *parviflora* (Vulnerable) and *Persoonia nutans* (Endangered), would be directly affected by the Project. Approximately 16 *Grevillea parviflora* subsp. *parviflora* and 10 *Persoonia nutans* individuals would be removed. Additionally, the soil seed bank would also be removed.

6.3.3.2 Proposed offset areas

The offset strategies chosen for the Project include a combination of:

- on-site offsets – securely conserving and improving the condition of existing riparian habitat or providing a buffer to an area of existing habitat within the Project site; and
- off-site offsets – securing and improving the condition of existing habitats at other sites in the immediate locality of the Project site.

The currently proposed offset areas that have been identified as part of the offset strategy are on land owned by the Australian Government and therefore, State and local legislative obligations do not apply to these lands.

6.3.3.3 Identification of off-site offset areas

The offset strategy has identified the need for off-site offsets to supplement the existing on site offset. These areas will be identified and secured before clearing on the Project site commences. In identifying these offsets the following criteria have been considered:

- Presence of relevant threatened biodiversity: when determining offsets, threatened biodiversity must be targeted and the impacts should be offset on a ‘like for like or better’ basis. As the Project includes clearing of threatened ecological communities, and threated species, the offsets should include these species and communities.
- Distance from the Project: biodiversity offsets should be located within the same region and as close to the Project site as possible.
- Current condition and potential for improvement: the condition provides an indication of a site’s potential to support threatened species.
- Habitat connectivity: this is essential to the long-term survival of many species because it enables species to move from one habitat into another.

A desktop review, assessment and subsequent surveys identified a number of preferred offsets sites. When assessing and ranking these sites the following issues were investigated further:

- tenure and zoning of potential sites;
- proximity to the Project site;
- current land ownership and availability of land for purchase;

- likelihood of loss without protection as an offset; considering factors such as physical constraints on land use and proposed developments;
- potential interaction with adjacent land uses; e.g. required fire regimes with regard to bushfire hazard reduction and biodiversity conservation; and
- size, shape and connectivity with other vegetation/habitat.

The additional offset lands will need to contain the biodiversity values which are not fully offset by the two proposed areas identified to date. These additional offset areas will need to include:

- known occurrences of *Persoonia nutans* and *Grevillea parviflora* subsp. *parviflora*;
- potential habitat for the other threatened species of animals and plants considered likely to occur in the Project area; and
- the same threatened ecological communities affected by the Project.

Three areas are currently proposed for offsets (refer to Figure 6.1to Figure 6.3) and include:

- Moorebank offset area: Georges River riparian zone: restoration and management of the Georges River riparian zone (approximately 32.3–36.7 ha) including the eastern side of the river corridor from approximately 300 m south of the M5 Motorway for a length of approximately 2.5 km south to the East Hills Railway Line. This offset conserves a corridor extending from the Georges River to the 1 in 1% annual exceedance probability flood line; however it is possible this corridor will be extended beyond the boundary subject to future development stages not the subject of this EIS.
- Casula offset area: management and restoration of vegetation within Lot 4 DP 1130937 (Casula Offset Area) is proposed. The Casula Offset Area is an irregular shaped allotment (known as the 'hourglass' land) of approximately 3.2 ha on the western side of the Georges River opposite the main IMT operations.
- Wattle Grove offset area: Approximately 73.8 ha of the eastern portion of Lot 3001 DP 1125930 (east of Moorebank Avenue) containing native vegetation that is proposed to be used to offset vegetation to be cleared for the Project. This area of vegetation adjoins the East Hills Railway Line to the south, land owned by the SIMTA consortium to the northwest, and the residential area of the suburb of Wattle Grove to the east. This area is currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure - Defence) under the Liverpool Local Environmental Plan 2008. This land would need to be actively managed in order to maintain or improve the condition of the vegetation and habitats.

In regards to the proposed on-site offsets, the final size of both the Moorebank offset area – Georges River riparian zone and Casula offset area (as identified above) will depend on the location of the selected rail access option. Therefore, there are three potential IMT offset layouts proposed in this EIS (refer to Figure 6.1 to Figure 6.53).

Detailed ecological surveys and assessments of these offset sites have been undertaken in accordance with the BBAM. These surveys included ecological vegetation mapping and targeted threatened flora surveys and built on previous ecological surveys within the Casula offset area and Wattle Grove Offset Area (GHD 2014). The general conditions, fauna habitat and vegetation communities of the proposed offset areas are summarised in Table 6.1 below. Detailed vegetation mapping of each of the offsets is provided in Figures 6.4 to 6.5.

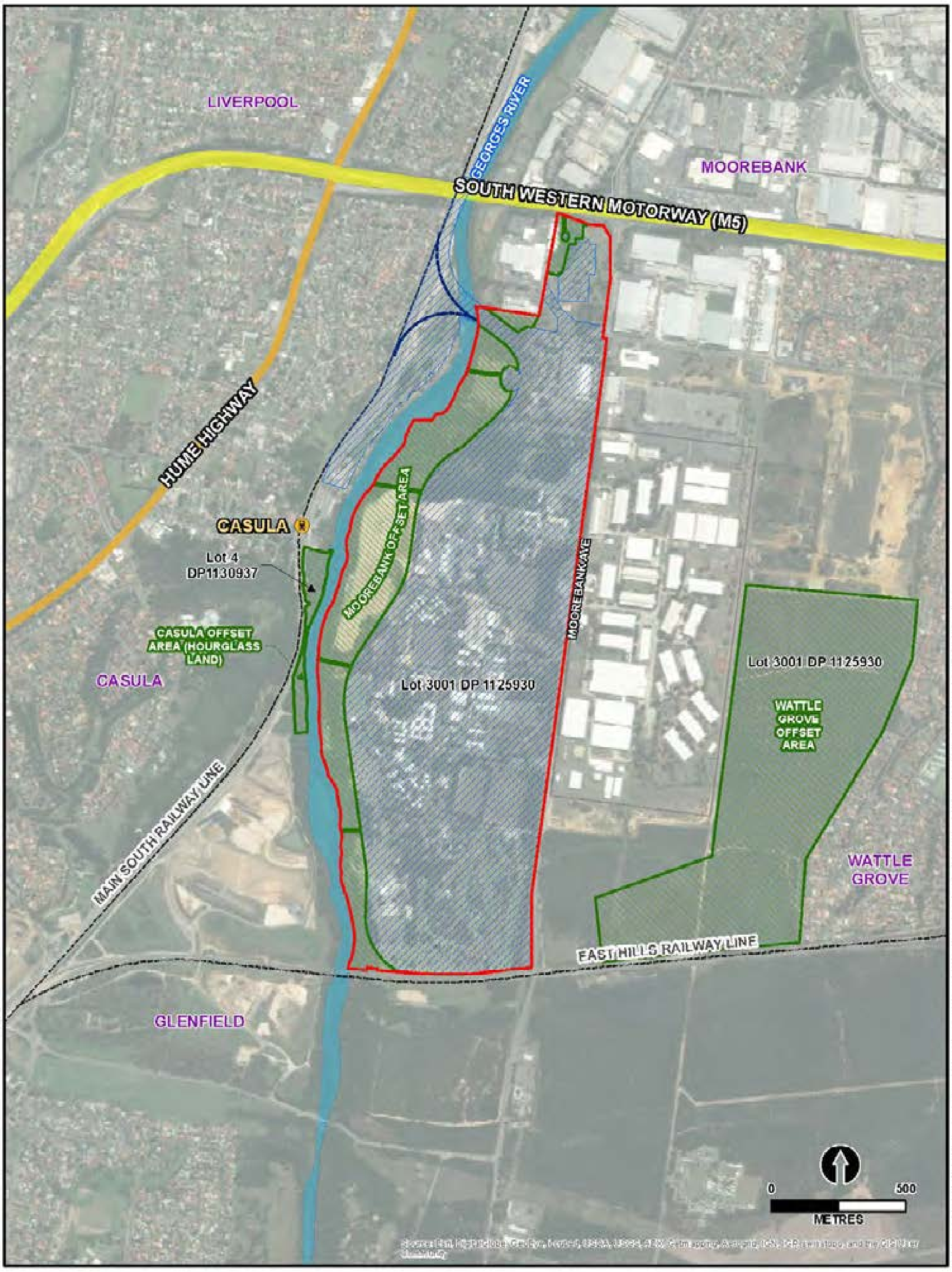

Figure 6.1 Location of proposed biodiversity offset areas - northern rail access option

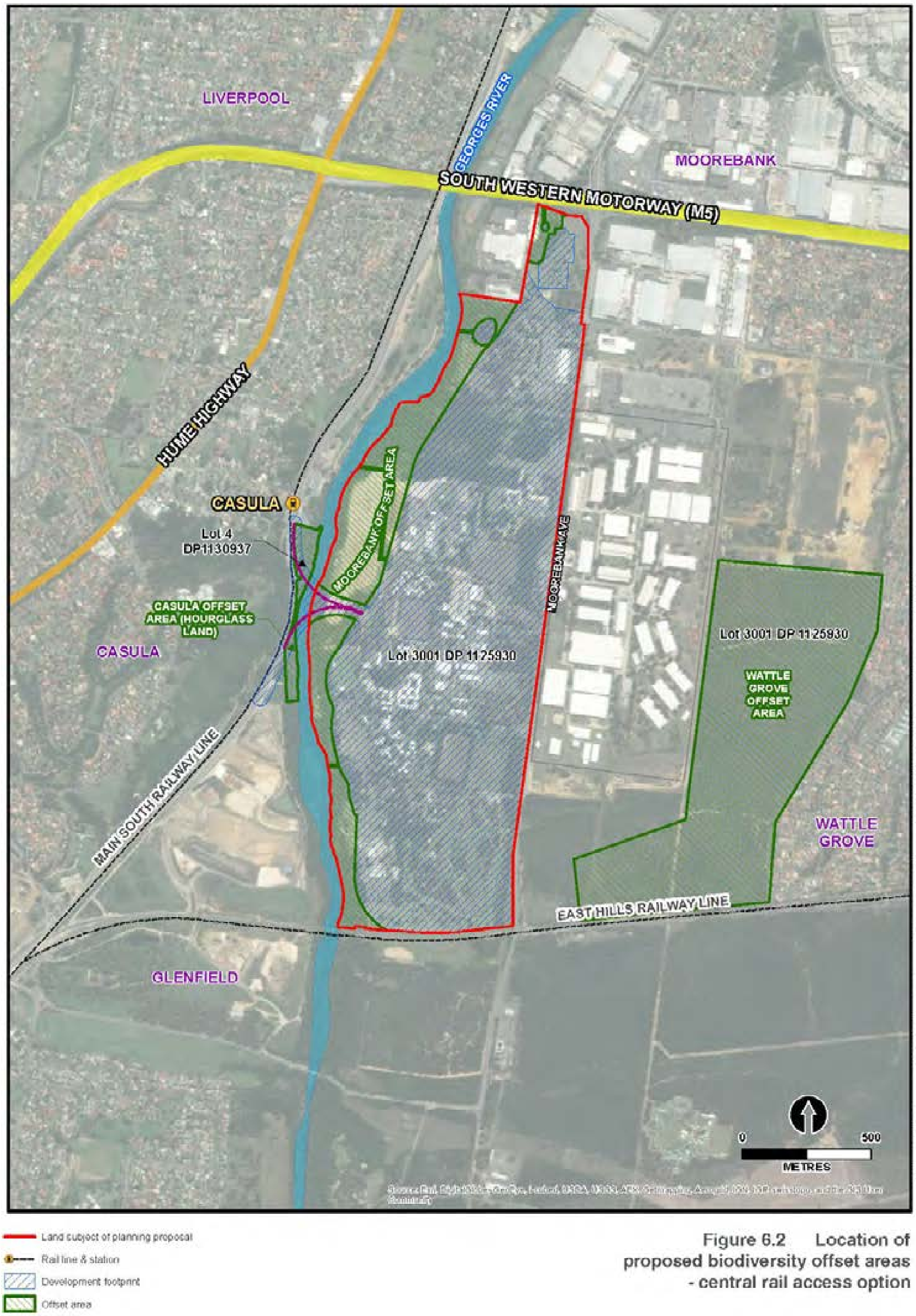

Figure 6.2 Location of proposed biodiversity offset areas - central rail access option

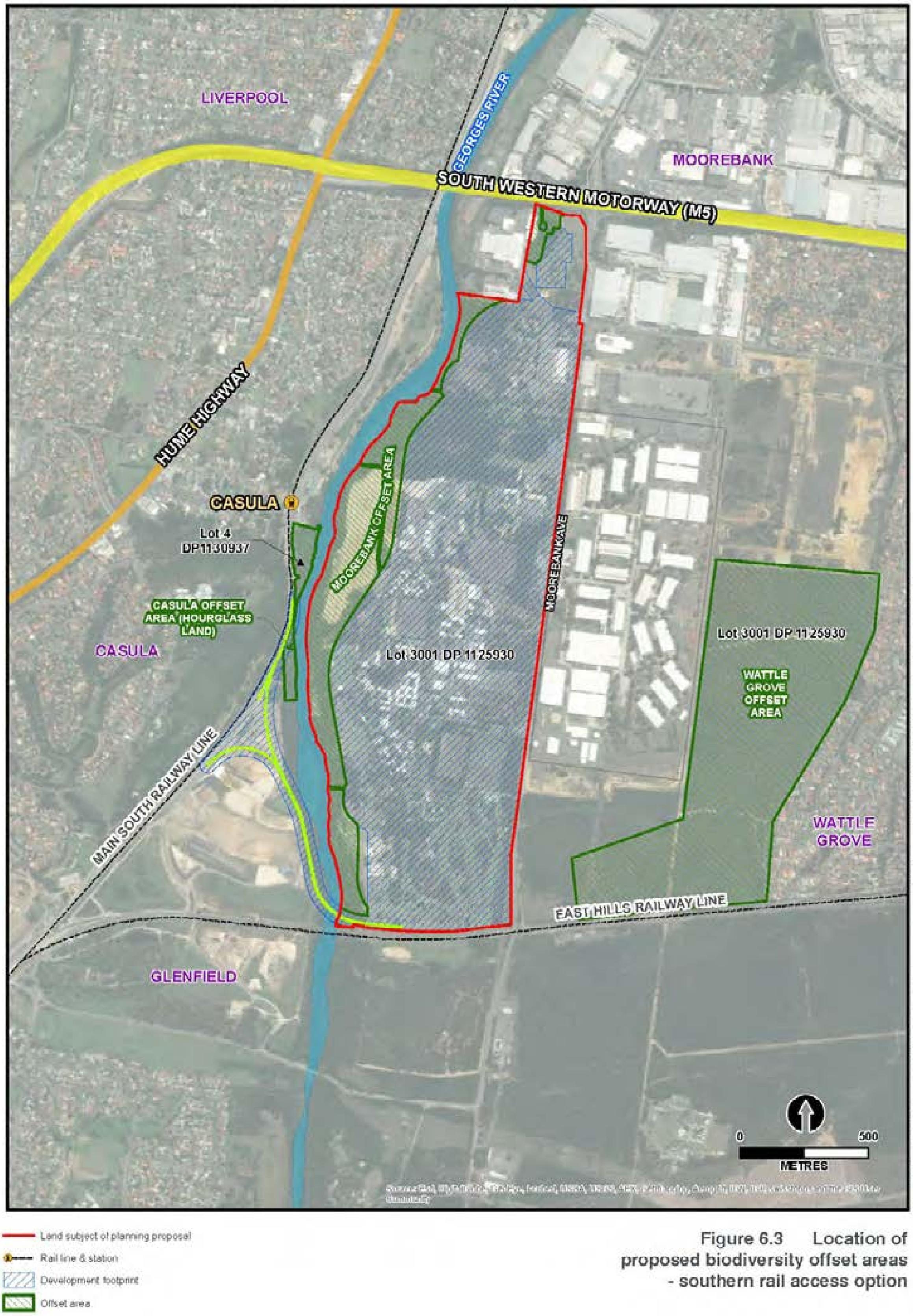

Figure 6.3 Location of proposed biodiversity offset areas - southern rail access option

Table 6.1 General conditions, fauna habitat and vegetation communities of the offset areas

Offset areas	General condition of offset sites	Fauna Habitat	Vegetation communities	Threatened Biodiversity
Moorebank offset area	The mapped vegetation of the site varies from patches with native species dominant in all vegetation layers to patches with the understorey and ground layer dominated by introduced vines and shrubs (e.g. *Lantana camara*). Under present conditions there is little light pollution affecting the vegetation along the Georges River. Light pollution is likely to be substantially higher during the construction and operation of the Project due to fixed lighting within the facility and lighting from trucks and trains. The proposed vegetation restoration within the riparian corridor and landscape planting in the interior of the site is, is likely to mitigate light pollution through the screening effects of increased vegetation.	The fauna habitat of the Georges River riparian corridor consists of a tall eucalypt forest with an understorey varying in its structure and composition including areas with dense weed thickets, diverse native shrubbery and sparse understorey consisting mainly of grasses, leaf litter and scattered shrubs (Refer to Figure 13.3). Large mature hollow-bearing trees, potentially hollow-bearing trees and fallen woody debris are moderately abundant in this area. Habitat in this area is connected via the riverbank underneath the East Hills railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve. Overall, the fauna habitat in the site is in moderate condition.	Riparian Forest Alluvial Woodland (For list of dominant species refer to Table 3.2 in Appendix F).	TSC Act listed Endangered ecological community: ▪ River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
Casula offset area (hourglass land)	The vegetation of the site is mapped as Riparian Forest (Tozer 2003). Field verification of the site on 18 February 2013 revealed that most of the site is covered by disturbed Riparian Forest with the exception of an area in the north which is dominated by the woody weeds *Ligustrum lucidum*, *Ligustrum sinense* and *Lantana camara*. The Riparian Forest of the site has a largely intact canopy layer with an understory varying from a mixture of native species (e.g. *Breynia oblongifolia*) to areas dominated by *Lantana camara*. Overall, the native vegetation mapped in the site is in moderate condition. Existing ecological light pollution is likely to affect the Casula Offset Area due to its location immediately adjacent to the Southern Sydney Freight Line. The light conditions here may limit the suitability of the site for some nocturnal animal species, however, some nocturnal species are likely to be habituated to increased light levels and to persist in utilizing this habitat.	The fauna habitat of the Casula Offset Area (Refer Figure 13.3) consists of a tall eucalypt forest with an understorey varying in its structure and composition including areas with dense weed thickets and native shrubbery. Hollow-bearing trees and fallen woody debris are present in these areas which provide potential microhabitat features for a variety of species of animal. Habitat in this area is connected via the riverbank underneath the East Hills railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve. Connectivity to substantial areas of fauna habitat to the north is less pronounced due to the presence of intervening areas with only very narrow bands of riparian vegetation.	Riparian Forest (For list of dominant species refer to Table 3.2 in Appendix F).	TSC Act listed Endangered ecological community: ▪ River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Offset areas	General condition of offset sites	Fauna Habitat	Vegetation communities	Threatened Biodiversity
Wattle Grove offset area	Mapped areas of native vegetation in this site are generally dominated by native species with only minor weed invasion. Areas of more intense weed invasion, where introduced species are dominant in the ground layer, are limited to the periphery of the site and patches of regrowth vegetation in the south-west of the site (refer areas with no vegetation mapped in Figure 6.5). Sporadic weed occurrences also exist along track edges in the core of the site. The site is subject to periodic hazard reduction burning for the protection of the adjacent suburban area of Wattle Grove. The frequency and intensity of burning of the vegetation on the site is likely to influence its suitability as habitat for threatened species. Overall, the native vegetation mapped in the site is in moderate to good condition. Areas with no vegetation mapped generally consist of regrowth native trees and large shrubs with an understorey dominated by introduced species.	The fauna habitat of the Wattle Grove offset area consists of eucalypt woodland with an understory varying in its structure and composition including areas with dense thickets of native shrubbery and areas of sparse understory consisting mainly of grasses, leaf litter and scattered shrubs. Large mature hollow-bearing and potentially hollow-bearing trees occur at low. Fallen woody debris generally occurs at low density, likely as a result of fuel reduction burning activities. *Habitat in this area is separated by a fenced rail corridor limiting connectivity for terrestrial and arboreal fauna. Due to its size (73.8 ha), it is likely to have potential to support viable populations of a variety of fauna species under appropriate management. If populations of less mobile animal species (i.e. non-flying species) are lost, there is limited scope for natural repopulation of this habitat due to its limited connectivity. Overall, the fauna habitat in the site is in moderate to good condition.	Riparian Forest Alluvial Woodland Shale/Gravel Transition Forest Castlereagh Swamp Woodland Castlereagh Scribbly Gum Woodland (For list of dominant species refer to Table 3.2 in Appendix F).	TSC Act listed Vulnerable ecological community: ▪ *Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion* TSC Act listed Endangered ecological communities: ▪ *Castlereagh Swamp Woodland Community* ▪ *Cooks River Castlereagh Ironbark Forest* ▪ *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* ▪ *Shale Gravel Transition Forest in the Sydney Basin Bioregion* EPBC Act listed Critically endangered ecological community: ▪ *Shale Gravel Transition Forest in the Sydney Basin Bioregion* EPBC Act listed species: ▪ *Acacia pubescens* ▪ *Persoonia nutans* ▪ *Grevillea parviflora subsp. Parviflora*

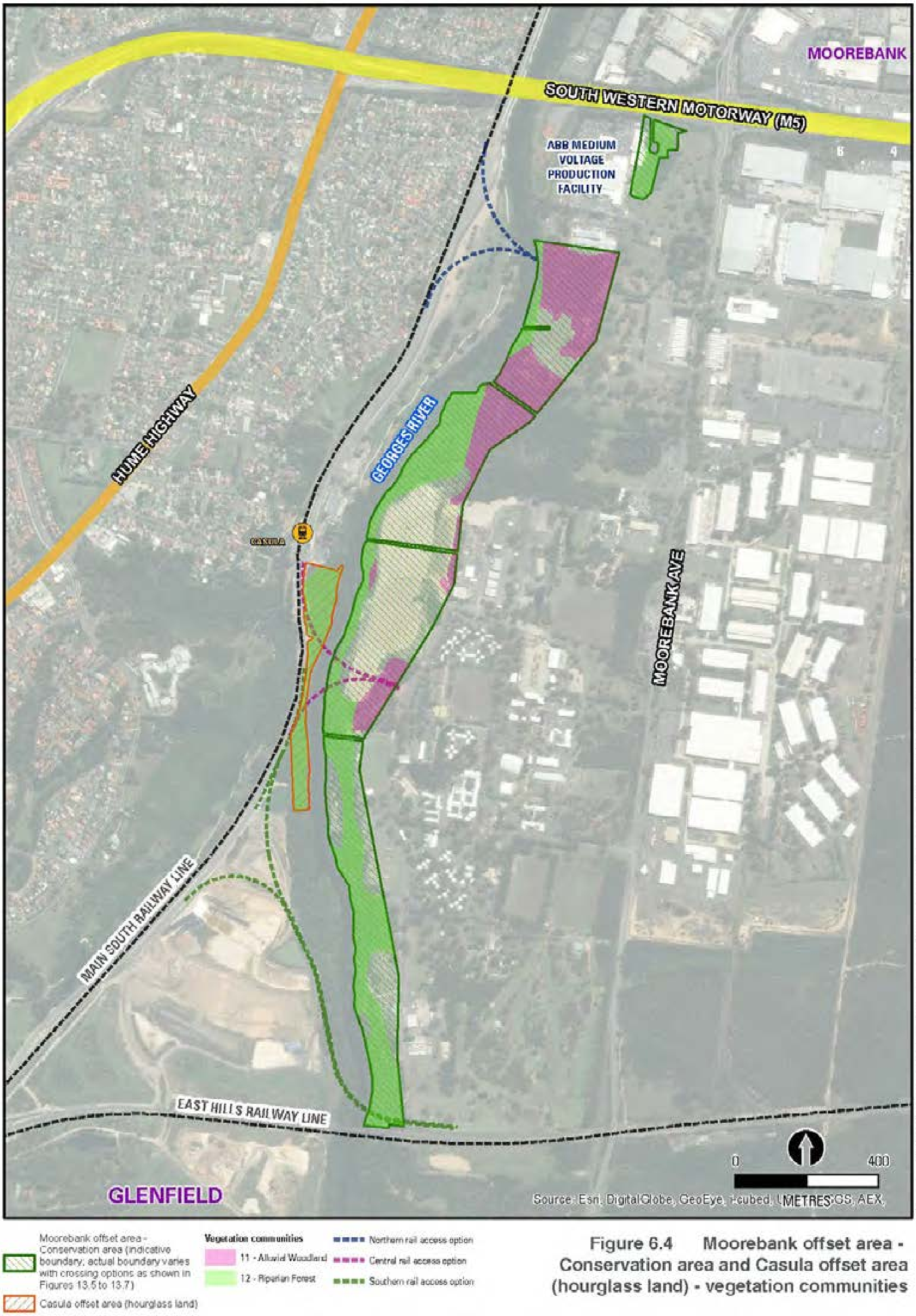

Figure 6.4 Moorebank offset area - Conservation area and Casula offset area (hourglass land) - vegetation communities

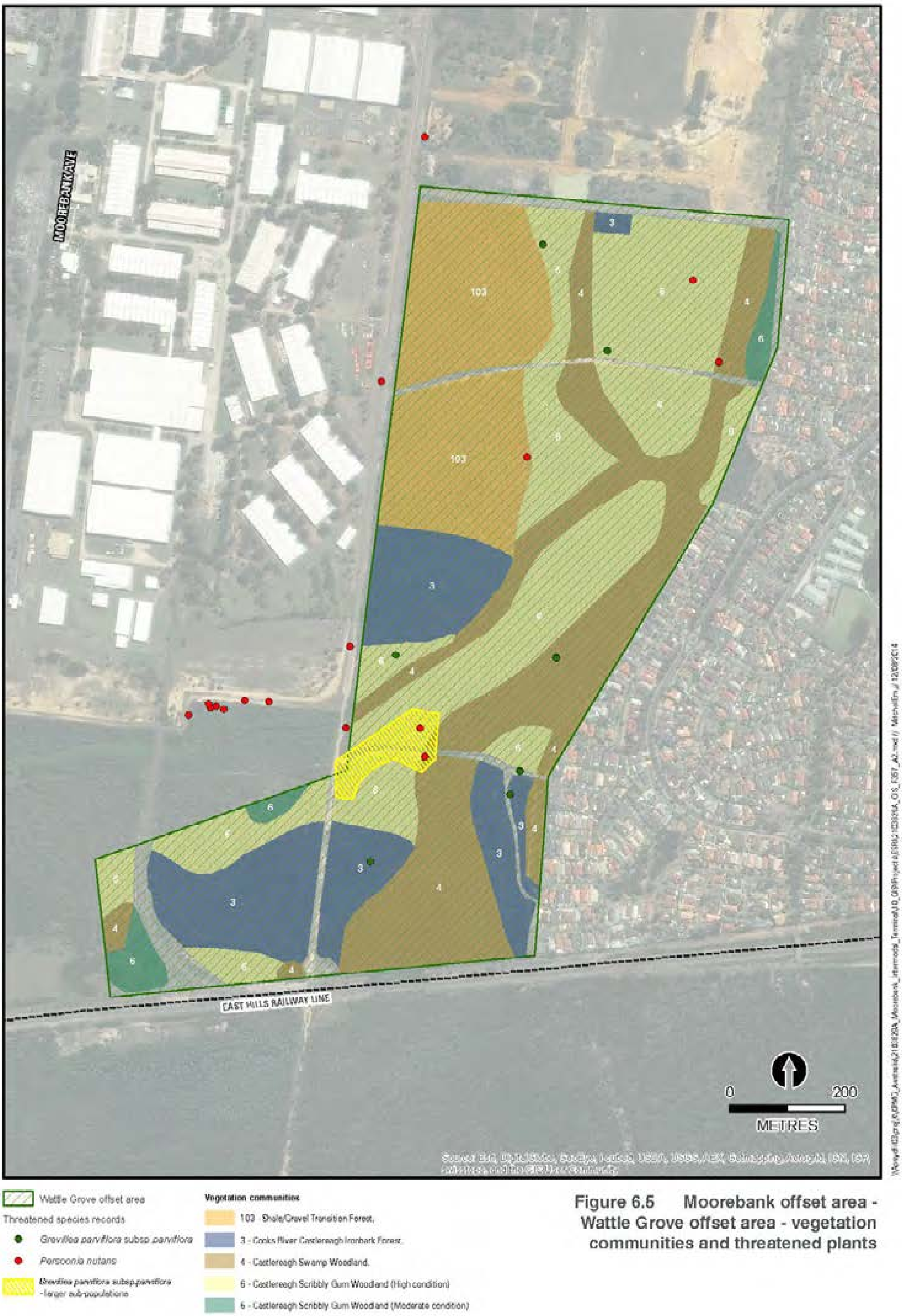

Figure 6.5 Moorebank offset area - Wattle Grove offset area - vegetation communities and threatened plants

The proposed offset sites are currently managed by the Commonwealth Department of Defence (Defence). A Weed Management Plan has been prepared by AECOM Pty Ltd (AECOM) for Defence Maintenance Management Pty Ltd (DMM) on behalf of Defence (AECOM Australia 2010). The scope of the plan was to develop and implement all works related to the management and control of weeds on Liverpool Military Area for a period of three years (from 1 February 2010 to 31 January 2013) (AECOM Australia 2010). Current and proposed management of biodiversity values on Defence lands in the Liverpool Military Area (LMA) primarily involves weed management, with a focus on minimising the spread of environmental weeds such as the African Lovegrass (*Eragrostis curvula*) (AECOM Australia 2010). The current management regime of these sites is currently focused on containing the further spread of weeds rather than large scale reduction in existing weed infestation.

The proposed management described below includes an intensification of weed management and other measures to actively improve the biodiversity values of the offset sites.

6.3.3.4 Proposed restoration and management of the Moorebank offset area (i.e. Georges River Riparian zone)

A riparian restoration plan for this area has been developed (refer Appendix E). The purpose of this restoration plan is to guide the restoration of the riparian landform, vegetation and fauna habitat of the site and to improve the quality of water entering the Georges River. The objectives of the plan include:

- restoration and revegetation of the riparian zone of the site to be consistent with, and complementary to, areas of remnant indigenous vegetation within the Georges River Corridor (approximately 16.7 ha of land to be revegetated);
- long-term eradication and suppression of the most detrimental weed species on the site including vine and woody weeds (approximately 20.0 ha of land to undergo a weed control program);
- consolidation and widening of the existing vegetation corridor of Georges River where feasible. It is currently proposed to revegetate and conserve a corridor extending from the riverbank to the 1 in 100 year flood line, however opportunities will be explored during detailed design to extend the conservation area beyond the 1 in 100 year flood line. This opportunity will be subject to future development approval (DA) stages and is not the subject of this EIS;
- improved habitat values for native animals and plants, particularly threatened species; and
- management of undesirable animal species including introduced animal species and some Australian native animals which may be detrimental to the biodiversity of the Project site.

Successful implementation of this strategy would require detailed planning, monitoring and adaptive management.

The detailed planning stage may include management actions involving project management, sourcing of soil and obtaining plants and seeds. A variety of issues may arise in the implementation of the plan which would require actions to be modified or additional actions to be implemented. A monitoring program is thus required to detect issues at an early stage such that appropriate adaptations may be made to strategies to ensure that the relevant objectives can be met. Adaptive management actions may include trial treatments (such as trial weed-control) and subsequent modified and/or substitute actions to find alternative methods to achieve the same outcomes if the proposed actions are unsuccessful.

6.3.3.5 Management of undesirable animal species

Successful management of undesirable animal species requires an integrated approach including habitat manipulation and/or culling programs. Culling of undesirable species over a small spatial area is likely to result in constant re-invasion from adjacent lands and is unlikely to be effective in substantially reducing the impact of these species. Proposed measures to manage undesirable animal species include:

- Monitoring of undesirable animal species. Monitor the site for the presence of introduced and undesirable animal species as part of fauna monitoring;
- Co-operate with government bodies, interest groups and adjacent landowners in regional pest management programs including the NSW Department of Primary Industries, the OEH, and the Invasive Animal Cooperative Research Centre interest groups (e.g. Australasian Pest Bird Network and local landowners);
- Manage the use of nest boxes by undesirable species by removing the eggs and/or young of introduced animals (e.g. Black Rat and Common Myna) found utilising nest boxes under appropriate permit conditions;
- Remove any insect colonies (bees, wasps, termites, ants found in nest boxes); and
- Modify or move nest boxes to discourage use by undesirable species.

6.3.3.6 Security of offset lands

Offsets sites need to demonstrate ongoing conservation of land in perpetuity for the benefit of future generations. Offset sites must be enduring and must offset the impact of the development for at least the period that the impact occurs. The security of land tenure and ongoing management of offset site(s) is critical to the long-term viability of offsets and must be carefully considered.

To ensure the conservation of lands in-perpetuity, the offset strategy will require the dedication of any identified offset sites under a secure conservation arrangement. There are a number of options available to secure land under permanent conservation agreements. The most suitable conservation arrangement for land should be explored and identified in consultation with the relevant stakeholders. Potential options in order of preference may include:

- obtaining a BioBanking agreement;
- Voluntary Conservation Agreements under the NSW *National Parks and Wildlife Act 1974*;'
- Trust Agreements under the NSW *Nature Conservation Trust Act 2001*;

- a Property Vegetation Plan registered on title under the NSW *Native Vegetation Act 2003*; and
- a Planning Agreement under s93F of the NSW *Environmental Planning and Assessment Act1979.*

If not conserved under a BioBanking agreement or National Park Estate however, the offset sites may be subject to discounting. If public use of offset lands was proposed, this could also reduce the offset credits generated by the offset lands subject to public use. Such issues would increase the total area of land required to be conserved. This issue should be further considered when formulating the final offset package.

6.3.3.7 Comparison of vegetation and habitat removal to the extent provided in the currently proposed offset areas

Table 6.2 shows the ratios of the areas proposed as offsets against the extent to be removed by the Project. The comparison assessment and following offset calculations for the quantification of offset requirements against Commonwealth and State policy's provide a range of values, reflecting the differences between the impacts of the central, northern and southern rail access options.

Offsets must be proportionate to the impact, in terms of size, scale and habitat type (Department of Sustainability Environment Water Population and Communities 2012). The proposed biodiversity offset strategy is based around a dual direct offset approach to achieve an improved conservation outcome by combining the long-term protection of existing habitat in good condition at the IMT site with the restoration, rehabilitation and re-establishment of habitat in poor condition along the Georges River riparian corridor. A ratio (offset: clearing) of 2.0–2.6:1 would be achieved through the securing of the currently proposed offsets.

In addition, a comparison of the extent of habitat for threatened biodiversity to be cleared with the extent of habitat provided in the currently proposed offset areas is provided in Table 6.3. For the majority of threatened biodiversity, the ratio of offsets to clearing is 2.0–4.3:1.

Table 6.2 Comparison of vegetation and habitat removal (as a range to reflect variation between the northern, central and southern rail access options) to the extent provided in offset areas

Vegetation community/ habitat type	Extent to be removed by the Project (ha)[1]	Extent provided in offset areas (ha)						Ratio (offset: clearing)
		Moorebank Offset Area – Georges River Riparian Zone		Casula Offset Area		Wattle Grove Offset Area	Combined offset areas	
		Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Area	
Vegetation								
Castlereagh Swamp Woodland[1]	0.9	-	-	-	-	19.77	**19.77**	22:1
Castlereagh Scribbly Gum Woodland[2]	16.1	-	-	-	-	27.46	**27.46**	1.7:1
Riparian Forest (River-Flat Eucalypt Forest)[1]	2.2–5.3	13.1–13.5	-	0.5–3.0	1.1	-	**14.7–17.6**	2.7–8.0:1
Alluvial woodland (River-Flat Eucalypt Forest)[1]	25.2–30.4	2.5–6.5	16.7	-	-	-	**19.2–23.2**	0.6–0.9-:1
Shale/Gravel Transition Forest	-	-	-	-	-	13.35	**13.35**	13.35:1
Cooks River Castlereagh Ironbark Forest	-	-	-	-	-	13.23	**13.23**	13.23:1
Total area	**44.4–52.7**	**15.6–20.0**	**16.7**	**0.5-3.0**	**1.1**	**73.81**	**107.7–114.6**	**2.0–2.6:1**
Habitat								
Shrubby eucalypt woodland	17.0	-	-	-	-	73.81	**73.81**	4.3:1
Tall eucalypt forest	27.4–35.7	15.6-20.0	16.7	0.5-3.0	1.1	-	33.9–40.8	0.9–1.5 : 1
Total area	**44.4–52.7**	**15.6–20.0**	**16.7**	**0.5–3.0**	**1.1**	**73.81**	**107.7–114.6**	**2.0–2.6:1**

Notes: 1 - Endangered Ecological Communities as listed under the NSW *Threatened Species Conservation Act 1995*; 2 – Vulnerable Ecological Community as listed under the TSC Act. 3) Critically Endangered ecological community as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Table 6.3 Comparison of impacts to Threatened biodiversity to extent of habitat provided in offset areas (range presented to address all access options)

Threatened biodiversity	Status		Extent of known or potential habitat to be removed by the Project (ha) Population estimate (where applicable)	Extent provided in offset areas (ha) and population estimate (where applicable)						Ratio offset: clearing
				Moorebank Offset Area – Georges River Riparian Zone		Casula Offset Area		Wattle Grove	Combined offset areas	
	EPBC Act[1]	TSC Act[2]		Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Revegetation			
Threatened ecological communities										
Castlereagh Swamp Woodland	-	E	0.9	-	-	-	-	19.77	**19.77**	22:1
Castlereagh Scribbly Gum Woodland	-	V	16.1	-	-	-	-	27.46	**27.46**	1.7:1
River-Flat Eucalypt Forest	-	E	27.4–35.7	15.6–20.0	16.7	0.5–3.0	1.1	-	**33.9–40.8**	0.9–1.5:1
Shale/Gravel Transition Forest	CE	E	-	-	-	-	-	13.35	**13.35**	13.35:1
Cooks River Castlereagh Ironbark Forest		E	-	-	-	-	-	13.23	**13.23**	13.23:1
Total TEC	-	-	**44.4–52.7**	**15.6–20.0**	**16.7**	**0.5–3.0**	**1.1**	**73.81**	**107.7–114.6**	**2.0–2.6:1**

Threatened biodiversity	Status		Extent of known or potential habitat to be removed by the Project (ha) Population estimate (where applicable)	Extent provided in offset areas (ha) and population estimate (where applicable)						Ratio offset: clearing
				Moorebank Offset Area – Georges River Riparian Zone		Casula Offset Area		Wattle Grove	Combined offset areas	
	EPBC Act[1]	TSC Act[2]		Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Revegetation			
Threatened flora										
Acacia bynoeana	V	E1	17.0	-	-	-	-	73.81	73.81	**4.3:1**
Acacia pubescens	V	V	17.0	-	-	-	-	73.81	73.81**(>250 individuals**)	**4.3:1**
Dillwynia tenuifolia	V	V	17.0	-	-	-	-	73.81	73.81	**4.3:1**
*Grevillea parviflora*subsp. *parviflora*	V	V	17.0 (≈16 individuals ≈50 stems)	-	-	-	-	73.81	73.81(>200 individuals)	**4.3:1**
Leucopogonexolasius	V	V	17.0	-	-	-	-	73.81	73.81	**4.3:1**
Persooniahirsuta	E	E1	17.0	-	-	-	-	73.81	73.81	**4.3:1**
Persoonianutans	E	E1	17.0 (≈10 individuals)	-	-	-	-	73.81	73.81(>2 individuals)	**4.3:1**
Pultenaeaparviflora	V	E1	17.0	-	-	-	-	73.81	73.81	4.3:**1**

Threatened biodiversity	Status		Extent of known or potential habitat to be removed by the Project (ha) Population estimate (where applicable)	Extent provided in offset areas (ha) and population estimate (where applicable)						Ratio offset: clearing
				Moorebank Offset Area – Georges River Riparian Zone		Casula Offset Area		Wattle Grove	Combined offset areas	
	EPBC Act[1]	TSC Act[2]		Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Revegetation			
Threatened fauna										
Barking Owl	-	V	27.4–35.7	15.6-20.0	16.7	0.5-3.0	1.1	-	33.9–40.8	**0.9–1.5:1**
Black-chinned Honeyeater	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Eastern Bent-wing Bat	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Eastern False Pipistrelle	-	V	27.4–35.7	15.6-20.0	16.7	0.5-3.0	1.1	-	33.9–40.8	**0.9–1.5:1**
Eastern Free-tail bat	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Eastern Pygmy-possum	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Flame Robin	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Gang-gang Cockatoo	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Greater Broad-nosed Bat	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Grey-headed Flying-fox	V	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Koala	V	V	27.4-35.7	15.6-20.0	16.7	0.5-3.0	1.1	-	33.9–40.8	**1.0–1.5:1**
Large-footed Myotis	-	V	27.4-35.7	15.6-20.0	16.7	0.5-3.0	1.1	-	33.9–40.8	**1.0–1.5:1**
Little Eagle	-	V	44.4-52.7	15.6-20.0	16.7	0.5-3.0	1.1	63.2	97.1–104	**1.8–2.3:1**

Threatened biodiversity	Status		Extent of known or potential habitat to be removed by the Project (ha) Population estimate (where applicable)	Extent provided in offset areas (ha) and population estimate (where applicable)						Ratio offset: clearing
				Moorebank Offset Area – Georges River Riparian Zone		Casula Offset Area		Wattle Grove	Combined offset areas	
	EPBC Act[1]	TSC Act[2]		Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Revegetation			
Little Lorikeet	-	V	44.4-52.7	15.6-20.0	16.7	0.5-3.0	1.1	63.2	97.1–104	**2.02–2.641.8–2.3:1**
Powerful Owl	-	V	27.4–35.7	15.6-20.0	16.7	0.5-3.0	1.1	-	33.9–40.8	**0.9–1.5 : 1**
Regent Honeyeater	E	CE	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Scarlet Robin	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Spotted Harrier	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Spotted-tailed Quoll	E	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Square-tailed Kite	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Squirrel Glider	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Swift Parrot	E	E	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Varied Sittella	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**
Yellow-bellied Sheathtail Bat	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	73.81	107.7–114.6	**2.0–2.6:1**

Notes: 1) - V = Vulnerable, E = Endangered, CE = Critically Endangered (Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*) (EPBC Act). 2) V= Vulnerable, E1 = Endangered (Threatened Species Conservation Act 1995).

6.3.3.8 Compliance with offsetting principles

This section provides a brief summary of the Project's biodiversity offset strategy against the principles for the use of environmental offsets under the EPBC Act, (as outlined in the current *Environment Protection and Biodiversity Conservation Act 1999Environmental Biodiversity Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012), the *Principles for the use of biodiversity offsets in NSW* (Department of Environment and Climate Change 2008) and the NSW Offset Policy.

Principles for the use of environmental offsets under the EPBC Act

DoE has developed principles for the use of environmental offsets under the EPBC Act which assess any proposed environmental offsets for matters of National Environmental Significance (including Threatened species and communities). This is done to ensure consistency, transparency and equity under the EPBC Act. The applicable principles are as follows:

- suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter;
- suitable offsets must be built around direct offsets but may include other compensatory measures;
- suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter;
- suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter;
- suitable offsets must effectively account for and manage the risks of the offset not succeeding;
- suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs;
- suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable; and
- suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

The potential impacts of the Project and the proposed offsets have been assessed against the eight principles and are discussed further in section 4.1of Appendix F)

The tool used to quantify the adequacy of biodiversity offsets under the EPBC Act is known as the Offsets Assessment Guide (Department of Sustainability Environment Water Population and Communities 2012).

The key steps in the process under this policy (once impacts have been avoided as far as practicable) are to:

- identify the residual impacts to threatened species, their habitats or threatened ecological communities;

- determine likely offsets required via use of the Offsets Assessment Guide calculator; and
- develop an offset strategy and subsequent offset package to formalise appropriate offsets in consultation with DoE.

For the Project the following approach was taken:

- current known direct impacts of the northern rail option to threatened species, habitats and ecological communities were confirmed; and
- a flora offset calculation and a fauna habitat calculation were undertaken to determine sufficient offset areas in hectares.

Assumptions for the calculation included:

- The impacts of the project (that will require offsetting) are assumed to be those as identified in this report.
- The flora offset calculation was based on habitat for the endangered *Persoonia nutans* and the vulnerable *Grevillea parviflora*subsp. *parviflora*, as the endangered status for *Persoonia results* in the maximum offset requirement for threatened flora overall.
- The fauna offset calculation was based on fauna habitat for recorded species such as the Grey-headed Flying Fox, which is listed as vulnerable under the EPBC Act and potential habitat for endangered species like the Regent Honeyeater and Swift Parrot. These species would utilise any of the forested habitats on the site for potential foraging. The calculation was based on these species likely presence and the assumption that all native forested habitats formed habitat for this fauna species.
- No threatened vegetation communities listed under the EPBC Act were recorded on the site, although the use of fauna habitat for all native forested vegetation impacts ensures that all vegetation impacts are considered for offsetting, whether they are listed as threatened under the EPBC Act or not.

Table 6.4 outlines the Commonwealth offset balance requirements generated by the calculations using the Commonwealth Offset Guide.

Table 6.4 Commonwealth offset requirement balance

Vegetation community or species	Area to be Impacted (ha)	Area to be impacted (adjusted hectares)	Estimated offset area required (ha) using Offset Guide	Proposed Offset Area (ha)	% of impact offset
Persoonia nutans habitat (Endangered)	17	8.5	40	73.8	187.7%
Grevillea parviflora habitat (Vulnerable)	17	8.5	35	73.8	210%
Grey-headed Flying Fox habitat (Vulnerable)	44.4–52.7	22–26.3	92–107	107.1–114.6	100–124.8%
Potential Habitat for Swift Parrot and Regent Honeyeater (Endangered)	44.4–52.7	22-26	103–121	107.1–114.6.	90–111.6%
Total*	**44.4–52.7**		**147***	**107.1–114.6**	**N/A**

Note: * indicates that the total equates to the total cumulative requirement of the Threatened fauna and flora, however the proposed offsets fauna habitat includes the flora habitat requirement.

To compensate for the impact upon threatened flora, a minimum area of suitable habitat of 40 ha is required. The current offsets would provide 73.8 ha of suitable habitat with demonstrated occurrence of *Persoonia nutans* and *Grevillea parviflora* subsp. *parviflora* and would fulfil this requirement.

In terms of native forest fauna habitat impacts of the project, the calculations have identified that a total offset area of approximately 92–121 ha needs to be provided. Of this, the current offsets would provide 107.1–114.6 ha of similar suitable habitat and would fulfil this requirement.

In summary, the proposed biodiversity offset strategy consists of a dual direct offset approach including offsets both within and outside the Project site to achieve an improved conservation outcome combining the long-term protection and/or enhancement of existing habitat in moderate to good condition with the restoration, rehabilitation and re-establishment of habitat in poor condition. The offsets are proportionate to the impact in both size and scale, providing between 90% and 210% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.0-2.6:1 has been secured under the currently proposed offsets with additional offsets still yet to be determined.

The proposed offsets strategy is:

- Efficient – the proposed offset areas are close to the development site and are capable of achieving the desired result with the minimum use of resources, time, and effort.
- Effective – will result in the intended result (i.e. an improved conservation outcome), specifically targeting the biodiversity to be impacted by the project.
- Timely – will be secured and functional prior to vegetation clearing within the Project area.

- Transparent – clearly recognisable as to what the offset strategy is trying to achieve and how it has been quantified.
- Scientifically robust – the proposed offset strategy is straightforward, addresses Commonwealth biodiversity offset policy and conforms to current thinking in conservation science and ecological restoration.
- Reasonable – the proposed offset strategy does not promise more than is possible or achievable.

Principles for the use of biodiversity offsets in NSW

The revised NSW Secretary's Environmental Assessment Requirements (SEARs) for the Project suggest the offsets strategy must demonstrate how it achieves the overarching principles of current policy. In March 2014, the Draft NSW Biodiversity Offsets Policy for Major Projects (Draft Policy) was released for public exhibition. The Draft Policy has now been finalised (Offset Policy 2014) and will be implemented from 1 October 2014 when it will be mandatory for all SSD and SSI projects.

The Offset Policy reduces the number of offset principles from the 13 principles identified in *Principles for the use of biodiversity offsets in NSW* (DECC 2008) to six principles. The offset strategy for the Project has been developed in accordance with the principles of the Offset Policy, as outlined in detail in section 4.2 of Appendix F.

In addition, the Offset Policy introduces a new assessment methodology, the Framework for Biodiversity Assessment (FBA), and this framework has been used as the basis of assessing impacts on biodiversity and to determine the key offsets required for the Project. Refer to section 4.2.1 of Appendix F for further detail on the assessment of the Project under the FBA methodology.

The maximum offset requirements of the Project under the current *Offset Policy 2014* has been quantified using FBA calculator as up to 1324 ecosystem credits or approximately 134 ha (refer to Table 6.5).

Table 6.5 Summary of vegetation and plants to be impacted and FBA ecosystem credits required to offset the impacts

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation (Cleared estimate)	Area or number to be Impacted (ha)	Red Flag	Conservation Status	Estimated credits required	Area (ha)	Estimated credits Provided	Proposed Offset Area (ha)	Balance Credits	Balance Area
Alluvial Woodland	ME018 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Coastal Valley Grassy Woodlands (95)16.1	25.2–30.4	Yes	TSC Act E	571–690	63.3–69	183	19.2–23.2	-388–507	-38.8–50.7
Riparian Forest	ME044 Sydney Blue GumXBangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin[1]	Wet Sclerophyll Forests (45)	2.2–5.3	Yes[2]	TSC Act E	53–129	5.3–12.9	149	14.7–17.6	20–96	2–9.6
Castlereagh Swamp Woodland	ME005 Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (45)	0.9	Yes	TSC Act E	30	3	180	19.77	177	17.7
Castlereagh Scribbly Gum Woodland	ME003 Hard-leaved Scribbly Gum – Parramatta Red Gum heathy	Dry Sclerophyll Forests(50)	16.1	Yes[2]	TSC Act V	485	48.5	260	27.46	-225	-22.5

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation (Cleared estimate)	Area or number to be Impacted (ha)	Red Flag	Conservation Status	Estimated credits required	Area (ha)	Estimated credits Provided	Proposed Offset Area (ha)	Balance Credits	Balance Area
	woodland of the Cumberland Plain, Sydney Basin										
Shale/Gravel Transition Forest	ME004 Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (75)	-	Yes	TSC Act CE EPBC Act CE	-	-	152	13.35	152	13.35
Cooks River Castlereagh Ironbark Forest	ME002 Broad-leaved Ironbark - *Melaleuca decora* shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (95)	-	Yes	TSC Act E	-	-	156	13.23	156	13.23
TOTAL			**44.4-52.7**			**1139-1334**	**113-133.4**	**1080**	**107.7-114.6**	**-59-254**	**-5.9-25.4**

Note: [1] indicates closest available similar vegetation type in the BBAM calculator.
[2] indicates that a threatened ecological community could not be selected in the calculator despite the observed communities being threatened ecological communities.

The proposed offsets meet the majority of the proposal ecosystem credits requirements in accordance with the FBA and NSW Offset Policy 2014. Short falls in the required ecosystem credits for the Alluvial Woodland and Castlereagh Scribbly Gum Woodland vegetation communities are partially provided by the proposed offsets through the use of the FBA variation and supplementary measures rules. A residual offset of between 22–224 ecosystem credits (2.2 and 22.4 ha) of Alluvial woodland is required. MIC is committed to providing an offsets strategy that adequately meets the quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offset for Alluvial Woodland.

Overall, the proposed offset strategy is underpinned by sound ecological principles to improve or maintain the existing biodiversity values of the local area. Over time this should result in a net improvement in biodiversity. The currently proposed offsets strategy offers a dual offset approach (combining long-term protection of existing habitat and restoration, rehabilitation and re-establishment of the degraded habitats) which would protect, actively manage, and create habitat for the range of threatened species and ecological communities affected by the Project.

7. Conclusion

The Project is situated on land in the suburb of Moorebank in a locality that includes the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Department of Defence land. With the exception of the rail access areas, lands affected by the project are on land owned and utilised by the Department of Defence. Much of the vegetation of the Project site has been cleared and replaced with roads, buildings, playing fields and exotic grassland, or substantially thinned, leaving only scattered remnant trees. Substantial areas of vegetation remain, however, in the west of the site within the riparian zone of the Georges River and in patches along the eastern boundary of the site adjacent to Moorebank Avenue.

The surrounding landscape to the north and west is part of the Cumberland Plain of western Sydney which has undergone extensive clearing, grazing and disturbance for agricultural, urban and industrial development. The landscape to the south and east of the Project has also been affected by clearing and other forms of disturbance such as weed invasion and altered fire regimes; however, large tracts of vegetation remain in this area.

Hydrological and sediment regimes have been dramatically altered in the lower Georges River and its tributaries due to vegetation clearance and urbanisation, which have resulted in changes to the geomorphology and ecology of the watercourse, including the stretch of river within the Project site.

The remaining riparian vegetation along the Georges River is somewhat fragmented by existing roads, a railway line, electricity transmission easements and other cleared areas and affected by substantial weed invasion yet still retains significant habitat value and landscape connectivity.

The Project would involve the removal of between 44.4 ha and 52.7 ha of native vegetation from the site comprising three Threatened ecological communities listed under the TSC Act: Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion; Castlereagh Swamp Woodland Community; and River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregion. None of these communities are listed under the EPBC Act.

All of the patches of Threatened ecological communities affected are likely to be utilised as habitat for threatened species of plants and/or animals listed under the TSC Act and/or the EPBC Act.

The Project would affect two Threatened species of plant, *Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans,* which are listed under the EPBC Act and the TSC Act and recorded during field surveys for this study. Impacts on these species would include direct loss of individuals and loss of habitat. Potential habitat for six additional Threatened species of plant, which were not recorded, but were considered to have a moderate potential to occur in low numbers, would also be affected.

Potential habitat for 25 Threatened species of animal was recorded on the site. Four of these species are listed under the EPBC Act and all are listed under the TSC Act. Of these, the Grey-headed Flying-fox was the only species positively identified through field surveys. Possible records of two other Threatened species of bat were collected via ultrasonic bat call recordings; however the quality of these calls were insufficient to make a definitive identification.

The Project would affect aquatic habitat through the loss of a section of the headwaters of Anzac Creek and changes to runoff entering the Georges River and Anzac Creek.
The bridge access over the Georges River also has potential to impact the aquatic ecosystem in its immediate location. Where possible, it is not intended to locate any bridge piers within the river channel itself and construction of the bridge is unlikely to require disturbance to the substrate of the river or removal of any submerged or emergent aquatic vegetation present. Changes to the amount of sunlight reaching the substrate of the river may however affect the ability of any submerged aquatic plants to photosynthesise. This may result in changes to the structure and extent of aquatic vegetation and associated habitat for aquatic animals. Given the relatively small area affected, and the existing degraded condition of the river, this possible reduction in vegetation and modification of habitat is unlikely to be significant.

These impacts would be mitigated through a variety of measures designed to reduce and offset impacts. Options to reduce vegetation clearing and maintain or create habitat within the currently proposed clearing limits would be considered in the detailed design of the Project. Substantial areas of vegetation would be retained and enhanced along the Georges River riparian corridor (including a permanent conservation area within the IMT site) and an offset strategy would be implemented to mitigate unavoidable residual impacts.

Further assessment of the potential impacts of the Project and more detailed development of mitigation measures would be conducted during the detailed design phase of the Project, and future development assessments.

Impact significance assessments for Threatened species populations and ecological communities have been conducted considering the potential impacts of the Project and proposed mitigation measures. Based on these assessments, no Threatened species population or ecological community listed under either the Commonwealth EPBC Act or the NSW TSC Act, is likely to be significantly impacted by the Project.

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Appendix A

Flora and fauna inventories

Flora inventory

Family Name	Scientific Name	Common Name	Native	*EPBC Act* Status[1]	*TSC Act* Status[2]
Adiantaceae	*Cheilanthes sieberi*	Mulga Fern	Y		
Alismataceae	*Sagittaria platyphylla*		N		
Alliaceae	*Nothoscordum borbonicum*	Onion Weed	N		
Amaranthaceae	*Alternanthera philoxeroides*	Alligator Weed	N		
Anthericaceae	*Caesia parviflora var. vittata*		Y		
	Laxmannia gracilis		Y		
	Thysanotus sp.		Y		
Anthericaceae	*Tricoryne elatior*	Yellow Autumn-lily	Y		
Apiaceae	*Foeniculum vulgare*	Fennel	N		
	Trachymene incisa		Y		
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax	Y		
Araucariaceae	*Araucaria cunninghamii*	Hoop Pine	N		
Arecaceae	*Phoenix canariensis*	Canary Island Date Palm	N		
Asclepiadaceae	*Araujia sericifera*	Moth Vine	N		
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	N		
	Asparagus asparagoides		N		
	Asparagus officinalis	Asparagus	N		
Asteraceae	*Ageratina adenophora*	Crofton Weed	N		
	Bidens pilosa	Cobbler's Pegs	N		
	Chrysanthemoides monilifera ssp. monilifera	Boneseed	N		
	Chrysanthemoides monilifera ssp. rotundata	Bitou Bush	N		
	Cirsium vulgare	Spear Thistle	N		
	Conyza bonariensis	Flaxleaf Fleabane	N		
	Gamochaeta americana	American Cudweed	N		
	Helichrysum collinum		Y		
	Hypochoeris radicata	Catsear	N		
	Olearia microphylla		Y		
	Ozothamnus adnatus	Winged Everlasting	Y		
	Ozothamnus diosmifolius	White Dogwood	Y		
	Senecio madagascariensis	Fireweed	N		
	Solenogyne bellioides		Y		
	Sonchus oleraceus	Common Sowthistle	N		
	Taraxacum officinale	Dandelion	N		
	Triptilodicus pygmaeus		Y		
Bignoniaceae	*Jacaranda mimosifolia*	Jacaranda	N		
Boraginaceae	*Echium vulgare*	Viper's Bugloss	N		
Brassicaceae	*Lepidium africanum*		N		
Campanulaceae	*Wahlenbergia gracilis*	Sprawling or Australian Bluebell	Y		
Caprifoliaceae	*Lonicera japonica*	Japanese Honeysuckle	N		
Caryophyllaceae	*Paronychia brasiliana*	Chilean Whitlow Wort	N		
	Petrorhagia nanteulii	Proliferous Pink	N		
Casuarinaceae	*Allocasuarina littoralis*	Black Sheoak	Y		
	Casuarina cunninghamiana	River Oak	Y		
	Casuarina glauca	Swamp Oak	Y		
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	Y		
Clusiaceae	*Hypericum gramineum*	Small St John's Wort	Y		
Commelinaceae	*Tradescantia fluminensis*	Wandering Jew	N		
Convolvulaceae	*Convolvulus arvensis*		N		
	Dichondra repens	Kidney Weed	Y		
	Dichondra sp. A sensu Harden (1992)		Y		
Crassulaceae	*Crassula sieberiana*	Australian Stonecrop	Y		
Cyperaceae	*Cyathochaeta diandra*		Y		
	Cyperus eragrostis	Umbrella Sedge	N		
	Eleocharis sphacelata	Tall Spike Rush	Y		
	Gahnia clarkei		Y		
	Gahnia sp.		Y		
	Lepidosperma laterale		Y		
Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern	Y		
	Pteridium esculentum	Bracken	Y		
Dilleniaceae	*Hibbertia aspera*		Y		
	Hibbertia diffusa		Y		
Droseraceae	*Drosera peltata*		Y		
Epacridaceae	*Astroloma humifusum*	Native Cranberry	Y		

Family Name	Scientific Name	Common Name	Native	*EPBC Act* Status[1]	*TSC Act* Status[2]
	Leucopogon juniperinus	Bearded Heath	Y		
Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush	Y		
	Glochidion ferdinandi	Cheese Tree	Y		
	Micrantheum ericoides		Y		
	Phyllanthus gunnii		Y		
	Poranthera microphylla		Y		
Fabaceae (Caesalpinioideae)	*Senna pendula*	Easter Cassia	N		
Fabaceae (Faboideae)	*Bossiaea heterophylla*	Variable Bossiaea	Y		
	Bossiaea scolopendria		Y		
	Daviesa alata		Y		
	Daviesia genistifolia	Broom Bitter Pea	Y		
	Daviesia ulicifolia	Gorse Bitter Pea	Y		
	Dillwynia parvifolia		Y		
	Glycine clandestina		Y		
	Gompholobium glabratum	Dainty Wedge Pea	Y		
	Gompholobium minus	Dwarf Wedge Pea	Y		
	Hardenbergia violacea	False Sarsaparilla	Y		
	Jacksonia scoparia	Dogwood	Y		
	Pultenaea elliptica		Y		
	Pultenaea villosa	Hairy Bush-pea	Y		
Fabaceae (Mimosoideae)	*Acacia baileyana*	Cootamundra Wattle	N		
	Acacia binervia	Coast Myall	Y		
	Acacia brownii	Heath Wattle	Y		
	Acacia decurrens	Black Wattle	Y		
	Acacia falcata		Y		
	Acacia fimbriata	Fringed Wattle	Y		
	Acacia longifolia	Sydney Golden Wattle	Y		
	Acacia podalyriifolia	Queensland Silver Wattle	N		
Fumariaceae	*Fumaria muralis*		N		
Geraniaceae	*Geranium homeanum*		Y		
Goodeniaceae	*Goodenia hederacea*	Variable-leaved Goodenia	Y		
	Goodenia paniculata	Swamp Goodenia	Y		
Hydrocharitaceae	*Ottelia ovalifolia*	Swamp Lily	Y		
Iridaceae	*Crocosmia X crocosmiiflora*	Montbretia	N		
	Patersonia sericea		Y		
Juncaceae	*Juncus articulatus*		N		
	Juncus usitatus		Y		
Lamiaceae	*Westringia longifolia*		Y		
Lauraceae	*Cassytha pubescens*		Y		
	Cinnamomum camphora	Camphor Laurel	N		
Linaceae	*Linum marginale*	Native Flax	Y		
	Linum trigynum	French Flax	N		
Lobeliaceae	*Pratia purpurascens*	Whiteroot	Y		
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	Y		
Loranthaceae	*Amyema gaudichaudii*		Y		
	Amyema miquelii		Y		
	Muellerina eucalyptoides		Y		
Malvaceae	*Lagunaria patersonia*	Norfolk Island Hibiscus	N		
	Modiola caroliniana	Red-flowered Mallow	N		
	Sida rhombifolia	Paddy's Lucerne	N		
Marsileaceae	*Marsilea hirsuta*		Y		
Meliaceae	*Melia azedarach*	White Cedar	Y		
Menyanthaceae	*Nymphoides geminata*		Y		
Myrtaceae [3]	*Angophora floribunda*	Rough-barked Apple	Y		
	Backhousia myrtifolia	Grey Myrtle	Y		
	Callistemon rigidus	Stiff Bottlebrush	Y		
	Callistemon salignus	Willow Bottlebrush	Y		
	Callistemon viminalis	Weeping Bottlebrush	N		
	Corymbia maculata	Spotted Gum	Y		
	Eucalyptus baueriana	Blue Box	Y		
	Eucalyptus bosistoana	Coast Grey Gum	Y		
	Eucalyptus botryoides	Bangalay	Y		
	Eucalyptus crebra	Narrow-leaved Ironbark	Y		
	Eucalyptus mannifera	Brittle Gum	Y		
	Eucalyptus microcorys	Tallowwood	N		
	Eucalyptus nicholii	Narrow-leaved Black Peppermint	N	V	V
	Eucalyptus parramattensis	Parramatta Red Gum	Y		

Family Name	Scientific Name	Common Name	Native	*EPBC Act* Status[1]	*TSC Act* Status[2]
	Eucalyptus racemosa	Narrow-leaved Scribbly Gum	Y		
	Eucalyptus resinifera	Red Mahogany	Y		
	Eucalyptus saligna	Sydney Blue Gum	Y		
	Eucalyptus sideroxylon	Mugga Ironbark	Y		
	Kunzea ambigua	Tick Bush	Y		
	Kunzea capitata		Y		
	Leptospermum lanigerum	Woolly Tea-tree	Y		
	Leptospermum morrisonii		Y		
	Leptospermum parvifolium	Small-leaf Tea-tree	Y		
	Lophostemon confertus	Brush Box	N		
	Melaleuca erubescens	Rosy Paperbark	Y		
	Melaleuca linariifolia	Flax-leaved Paperbark	Y		
	Melaleuca nodosa	Prickly-leaved Paperbark	Y		
	Micromyrtus ciliata		Y		
	Tristaniopsis laurina	Kanuka	Y		
Nandinaceae	*Nandina domestica*		N		
Ochnaceae	*Ochna serrulata*	Mickey Mouse Plant	N		
Oleaceae	*Ligustrum lucidum*	Large-leaved Privet	N		
	Ligustrum sinense	Small-leaved Privet	N		
	Olea europaea ssp. cuspidata		N		
Onagraceae	*Ludwigia peruviana*		N		
	Oenothera sp.		N		
Orchidaceae	*Calochilus sp.*		Y		
	Microtis unifolia	Common Onion Orchid	Y		
	Pterostylis sp.		Y		
Oxalidaceae	*Oxalis corniculata*	Creeping Oxalis	N		
	Oxalis perennans		Y		
	Oxalis sp.		Y		
Phormiaceae	*Dianella caerulea*		Y		
	Dianella longifolia		Y		
	Dianella revoluta		Y		
Pittosporaceae	*Billardiera scandens*	Appleberry	Y		
	Bursaria spinosa	Native Blackthorn	Y		
	Pittosporum undulatum	Sweet Pittosporum	Y		
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	N		
	Plantago major	Large Plantain	N		
Poaceae	*Anisopogon avenaceus*	Oat Speargrass	Y		
	Arundo donax	Giant Reed	N		
	Austrodanthonia fulva		Y		
	Austrodanthonia tenuior		Y		
	Austrostipa mollis	Speargrass	Y		
	Austrostipa ramosissima	Stout Bamboo Grass	Y		
	Bothriochloa macra	Red Grass	Y		
	Briza maxima	Quaking Grass	N		
	Briza subaristata		N		
	Bromus catharticus	Prairie Grass	N		
	Cynodon dactylon	Common Couch	Y		
	Echinopogon caespitosus	Bushy Hedgehog-grass	Y		
	Ehrharta erecta	Panic Veldtgrass	N		
	Entolasia marginata	Bordered Panic	Y		
	Eragrostis curvula	African Lovegrass	N		
	Imperata cylindrica	Bladey Grass	Y		
	Lolium perenne	Perennial Ryegrass	N		
	Microlaena stipoides		Y		
	Oplismenus aemulus var. aemulus	Basket Grass	Y		
	Pennisetum clandestinum	Kikuyu Grass	N		
	Themeda australis	Kangaroo Grass	Y		
	Vulpia myuros	Rat's Tail Fescue	N		
Polygalaceae	*Comesperma ericinum*		Y		
	Acetosa sagittata	Rambling Dock	N		
Primulaceae	*Anagallis arvensis*	Scarlet/Blue Pimpernel	N		
Proteaceae	*Banksia oblongifolia*	Fern-leaved Banksia	Y		
	Banksia spinulosa	Hairpin Banksia	Y		
	Grevillea parviflora	Small-flowered Grevillea	Y	V	V
	Grevillea robusta	Silky Oak	N		
	Grevillea sericea		Y		

Family Name	Scientific Name	Common Name	Native	*EPBC Act* Status[1]	*TSC Act* Status[2]
	Hakea dactyloides	Broad-leaved Hakea	Y		
	Hakea sericea		Y		
	Lambertia formosa	Mountain Devil	Y		
	Persoonia linearis	Narrow-leaved Geebung	Y		
	Persoonia nutans	Nodding Geebung	Y	E	E
	Petrophile sessilis		Y		
	Stenocarpus salignus	Scrub Beefwood	Y		
Ranunculaceae	*Clematis aristata*	Old Man's Beard	Y		
Restionaceae	*Lepyrodia scariosa*		Y		
	Saropsis fastigiata		Y		
Rosaceae	*Rubus fruiticosus*	Blackberry complex	N		
	Rubus parvifolius	Native Raspberry	Y		
Rubiaceae	*Morinda jasminoides*		Y		
	Opercularia diphylla	Stinkweed	Y		
	Pomax umbellata	Pomax	Y		
	Richardia brasiliensis	Mexican Clover	N		
	Phebalium dentatum	Toothed Phebalium	Y		
Rutaceae	*Phebalium squamulosum*	Scaly Phebalium	Y		
Salicaceae	*Populus nigra*	Black Poplar	N		
	Salix babylonica	Weeping Willow	N		
Salviniaceae	*Salvinia molesta*		N		
Santalaceae	*Exocarpos cupressiformis*	Native Cherry	Y		
	Santalum obtusifolium	Sandalwood	Y		
Sapindaceae	*Cardiospermum grandiflorum*	Balloon Vine	N		
	Dodonaea triquetra	Hop Bush	Y		
Scrophulariaceae	*Gratiola pedunculata*		Y		
	Veronica plebeia	Trailing Speedwell	Y		
Solanaceae	*Solanum chenopodioides*	Whitetip Nightshade	N		
	Solanum mauritianum	Wild Tobacco Bush	N		
	Solanum nigrum	Black-berry Nightshade	N		
Sterculiaceae	*Lasiopetalum ferrugineum*		Y		
	Stylidium graminifolium	Grass Triggerplant	Y		
Thymelaeaceae	*Pimelea linifolia*		Y		
Verbenaceae	*Lantana camara*	Lantana	N		
	Verbena bonariensis	Purpletop	N		
Vitaceae	*Cayratia clematidea*	Slender Grape	Y		
Xanthorrhoeaceae	*Xanthorrhoea media*		Y		

Notes:
1. Listed as Vulnerable (V) or Endangered (E) under the Environment Protection Biodiversity Conservation Act.
2. Listed as Vulnerable (V) or Endangered (E) under the Threatened Species Conservation Act.
3. *Eucalyptus nicholii* (Narrow-leaved Black Peppermint) occurred as a planted trees, did not occur naturally within any native vegetation community.

Fauna inventory

Type of animal	Common name	Scientific name	Observation type[1]	EPBC Act Status[2]	TSC Act Status[3]
Amphibians	Bleating Tree Frog	*Litoria dentata*	O		
	Eastern Dwarf Tree Frog	*Litoria fallax*	O		
	Peron's Tree Frog	*Litoria peronii*	O		
	Tyler's Tree Frog	*Litoria tyleri*	O		
	Brown-striped Frog	*Limnodynastes peronii*	O		
	Common Eastern Froglet	*Crinia signifera*	O		
	Smooth Toadlet	*Uperoleia laevigata*	O		
Birds - Introduced	Rock Dove	*Columba livia*	O		
	Common Myna	*Acridotheres tristis*	O		
	Common Starling	*Sturnus vulgaris*	O		
Birds - Native	Brown Goshawk	*Accipiter fasciatus*	O		
	Australian Wood Duck	*Chenonetta jubata*	O		
	Chestnut Teal	*Anas castanea*	O		
	Pacific Black Duck	*Anas superciliosa*	O		
	White-faced Heron	*Egretta novaehollandiae*	O		
	Australian Magpie	*Gymnorhina tibicen*	O		
	Grey Butcherbird	*Cracticus torquatus*	O		
	Pied Currawong	*Strepera graculina*	O		
	Galah	*Cacatua roseicapilla*	O		
	Little Corella	*Cacatua sanguinea*	O		
	Long-billed Corella	*Cacatua tenuirostris*	O		
	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	O		
	Masked Lapwing	*Vanellus miles*	O		
	Eastern Whipbird	*Psophodes olivaceus*	O		
	Crested Pigeon	*Ocyphaps lophotes*	O		
	Dollarbird	*Eurystomus orientalis*	O		
	Australian Raven	*Corvus coronoides*	O		
	Channel-billed Cuckoo	*Scythrops novaehollandiae*	O		
	Common Koel	*Eudynamys scolopacea*	O		
	Fan-tailed Cuckoo	*Cacomantis flabelliformis*	O		
	Magpie-lark	*Grallina cyanoleuca*	O		
	Willie Wagtail	*Rhipidura leucophrys*	O		
	Laughing Kookaburra	*Dacelo novaeguineae*	O		
	Sacred Kingfisher	*Todiramphus sanctus*	O		
	Fairy Martin	*Hirundo ariel*	O		
	Welcome Swallow	*Hirundo neoxena*	O		
	Superb Fairy-wren	*Malurus cyaneus*	O		
	Variegated Fairy-wren	*Malurus lamberti*	O		
	Bell Miner	*Manorina melanophrys*	O		
	Noisy Friarbird	*Philemon corniculatus*	O		
	Noisy Miner	*Manorina melanocephala*	O		
	Red Wattlebird	*Anthochaera carunculata*	O		
	White-plumed Honeyeater	*Lichenostomus penicillatus*	O		
	Yellow-faced Honeyeater	*Lichenostomus chrysops*	O		
	Golden Whistler	*Pachycephala pectoralis*	O		
	Brown Thornbill	*Acanthiza pusilla*	O		
	Spotted Pardalote	*Pardalotus punctatus*	O		
	Striated Thornbill	*Acanthiza lineata*	O		
	White-browed Scrubwren	*Sericornis frontalis*	O		
	White-throated Gerygone	*Gerygone olivacea*	O		
	Yellow Thornbill	*Acanthiza nana*	O		
	Double-barred Finch	*Taeniopygia bichenovii*	O		
	Red-browed Finch	*Neochmia temporalis*	O		
	Eastern Yellow Robin	*Eopsaltria australis*	O		
	Australasian Grebe	*Tachybaptus novaehollandiae*	O		
	Eastern Rosella	*Platycercus eximius*	O		
	Rainbow Lorikeet	*Trichoglossus haematodus*	O		
	Red-rumped Parrot	*Psephotus haematonotus*	O		
	Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	O		
	Satin Bowerbird	*Ptilonorhynchus violaceus*	O		
	Dusky Moorhen	*Gallinula tenebrosa*	O		
	Purple Swamphen	*Porphyrio porphyrio*	O		
	Southern Boobook	*Ninox novaeseelandiae*	V		
	Australian White Ibis	*Threskiornis molucca*	O		
Mammals - Introduced	Brown Hare	*Lepus capensis*	O		
	Rabbit	*Oryctolagus cuniculus*	O		
Mammals - Native	Brown Antechinus	*Antechinus stuartii*	C		
	Swamp Wallaby	*Wallabia bicolor*	O		
	Eastern Bent-wing Bat	*Miniopterus schreibersii oceanensis*	A		V
	East-coast Free-tailed Bat	*Mormopterus norfolkensis*	A		V
	White-striped freetail bat	*Tadarida australis*	V, A		

Type of animal	Common name	Scientific name	Observation type[1]	EPBC Act Status[2]	TSC Act Status[3]
	rat	*Rattus sp.*	H		
	Sugar Glider	*Petaurus breviceps*	O		
	Common Brushtail Possum	*Trichosurus vulpecula*	O		
	Grey-headed Flying-fox	*Pteropus poliocephalus*	O	V	V
	Eastern Broad-nosed Bat	*Scotorepens orion*	A		
	Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	A		V
	Gould's Long-eared Bat	*Nyctophilus gouldii*	C		
	Gould's Wattled Bat	*Chalinolobus gouldii*	A		
	Greater Broad-nosed Bat	*Scoteanax rueppellii*	A		V
	Large-footed Myotis	*Myotis macropus*	A		V
	Lesser Long-eared Bat	*Nyctophilus geoffroyi*	C		
	Little Forest Bat	*Vespadelus vulturnus*	A		
Reptiles	Eastern Water Dragon	*Physignathus lesueurii*	O		
	Eastern Long-necked Tortoise	*Chelodina longicollis*	O		
	Red-bellied Black Snake	*Pseudechis porphyriacus*	O		
	Copper-tailed Skink	*Ctenotus taeniolatus*	O		
	Eastern Blue-tongued Lizard	*Tiliqua scincoides*	O		
	Eastern Water Skink	*Eulamprus quoyii*	O		
	Garden Skink	*Lampropholis guichenoti*	O		
	Grass Skink	*Lampropholis delicata*	O		
	Wall Lizard	*Cryptoblepharus virgatus*	O		

Notes:
1. Observation types: O = visual observation, H = Hair analysis, A = Anabat ultrasonic bat call recording and analysis, V = audible vocalisation
2. Listed as Vulnerable (V) under the Environment Protection Biodiversity Conservation Act.
3. Listed as Vulnerable (V) under the Threatened Species Conservation Act.

Appendix B

Threatened and migratory species likelihood of occurrence assessment

Threat-listed and Migratory fauna likelihood of occurrence assessment

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Amphibians							
Heleioporus australiacus	Giant Burrowing Frog	V	V		Yes 2 records exist in the locality in the Holsworthy restricted area	The Giant Burrowing Frog has a marked preference for sandstone ridgetop habitat and broader upland valleys. In these locations, the frog is associated with small headwater creeklines and along slow flowing to intermittent creeklines. They have also been observed occupying artificial ponded structures including dams, detention basins and box drains that are still surrounded by undisturbed habitat. Does not appear to inhabit areas that have been cleared for agriculture or for urban development. (Cogger 2000; NSW National Parks and Wildlife Service 2001a).	Low Habitat unsuitable
Litoria aurea	Green and Golden Bell Frog	V	E1		Yes 30 records exist in the locality including 2 near the study area	For breeding the Green and Golden Bell Frog uses waterbodies including natural and man-made structures (marshes, dams and stream sides, and ephemeral pools). Also, found in small pockets of habitat in developed areas. Habitat attributes associated with preferred waterbodies include that the water body is shallow, still or slow flowing, ephemeral and/or widely fluctuating, unpolluted and without heavy shading. Permanent waterbodies are also known to be used (Department of Environment and Conservation 2004, 2005) .	Low Marginal habitat and local records in Holsworthy area however local population considered likely to be extinct (White & Pyke 2010). Not detected despite targeted surveys conducted in ideal conditions.
Litoria littlejohni	Heath Frog	V	V		No	Distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest south to Buchan in north-eastern Victoria. It is restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats (NSW Scientific Committee 2000).	Low No suitable habitat or historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Litoria raniformis	Southern Bell Frog	V	E1		No	Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. They are also found in irrigated rice crops, particularly where there is no available natural habitat (Office of Environment and Heritage 2011c)	Low No suitable habitat or historic records of this species exist in the locality.
Mixophyes balbus	Stuttering Frog	V	E1		No	A Terrestrial species, found in rainforest, Antarctic beech forest or wet sclerophyll forest. The species depends on freshwater streams and riparian vegetation for breeding and habitation. No records are known from riparian habitat that has been disturbed (Cogger 2000; NSW Scientific Committee 2003).	Low No suitable habitat or historic records of this species exist in the locality.
Pseudophryne australis	Red-crowned Toadlet		V		Yes 7 records exist in the locality in the Holsworthy restricted area	Occurs within 160 km of Sydney where it is restricted to Hawkesbury Sandstone. It breeds in deep grass and debris adjacent to ephemeral drainage lines. When not breeding individuals are found scattered on sandstone ridges under rocks and logs (Cogger 2000).	Low Habitat unsuitable
Fish							
Macquaria australasica	Macquarie Perch	E		E	No	The natural range of Macquarie Perch included the upper and middle reaches of the Murray-Darling basin as well as the Shoalhaven and Hawkesbury Rivers. However, this species has recently been sighted in only a few localities within these river systems. Preferred habitat is deep holes covered with rocks, and spawning occurs above shallow running water. Macquarie Perch is a schooling species (Department of the Environment and Heritage 2004).	Low No suitable habitat or historic records of this species exist in the locality.
Prototroctes maraena	Australian Grayling	V		P	No	It is a mid-water, freshwater species that occurs most commonly in clear, gravelly streams with a moderate flow. Prefers deep, slow flowing pools (NSW Fisheries 2004).	Low No suitable habitat or historic records of this species exist in the locality. Unlikely to occur in the Georges River.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Invertebrates							
Meridolum corneovirens	Cumberland Land Snail		E1		Yes 208 records exist within the locality including records within the study area	Restricted to the Cumberland Plain and Castlereagh Woodlands of Western Sydney and also along the fringes of River Flat Forest, especially where it meets Cumberland Plain Woodland. It is typically found under logs and other debris, amongst leaf litter and bark around bases of trees. It is also sometimes found under grass clumps and where possible it will burrow into loose soil (NSW National Parks and Wildlife Service 1999b).	Moderate Species was apparently recorded on site in 2006 (Office of Environment and Heritage 2012a) however it was not detected in targeted surveys in 2010. May be present on site in low numbers or have gone extinct on site. Mistaken identity is also a possibility as this species is sometimes confused with some colour variants of the exotic Asian Tramp Snail *Bradybaena similaris* which was recorded on the site in 2010 surveys.
Archaeophya adamsi	Adam's Emerald Dragonfly			E	No	Only five adults have ever been collected, and the species is only known from a few sites in the greater Sydney region. Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation {Department of Environment and Conservation, 2006 #1093}.	Low No suitable habitat or historic records of this species exist in the locality. Unlikely to occur in the degraded sections of the Georges River or Anzac Creek within or adjacent to the Project site.
Austrocordulia leonardi	Sydney Hawk Dragonfly			E	No	The Sydney Hawk dragonfly has specific habitat requirements, and has only ever been collected from deep and shady river pools with cooler water. Larvae are found under rocks where they coexist with the Eastern Hawk dragonfly. It has a very restricted distribution including three locations in a small area south of Sydney, from Audley to Picton. The species is known from the Hawkesbury-Nepean, Georges River, Port Hacking and Karuah drainages {Department of Trade and Investment Regional Infrastructure and Services, 2011 #3488}.	Low No suitable habitat or historic records of this species exist in the locality. Unlikely to occur in the degraded sections of the Georges River or Anzac Creek within or adjacent to the Project site.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Birds							
Anthochaera phrygia	Regent Honeyeater	EM	CE		Yes 6 records exist in the locality including near Warwick farm and Revesby	Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with *Casuarina cunninghamiana* and *Amyema cambagei* are important for feeding and breeding. Important food trees include *Eucalyptus sideroxylon*, *Eucalyptus albens* , *Eucalyptus melliodora* and *Eucalyptus leucoxylon* (Garnett & Crowley 2000).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records are present. May forage sporadically on the site in winter but unlikely to breed locally. Unlikely elsewhere in the study area.
Apus pacificus	Fork-tailed Swift	M			No	Breeds from central Siberia eastwards through Asia, and is migratory, wintering south to Australia. Individuals never settle voluntarily on the ground and spend most of their lives in the air, living on the insects they catch in their beaks (Higgins 1999).	Moderate Marginal habitat present.
Ardea ibis	Cattle Egret	M			Yes 2 records exist near the study area	The Cattle Egret is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia (McKilligan 2005).	Moderate Marginal habitat and local records present.
Ardea modesta	Eastern Great Egret	M			Yes 11 records exist in the locality near the Georges River	Great Egrets are common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species (Australian Museum 2003).	Moderate Marginal habitat and local records present.
Burhinus grallarius	Bush Stone-curlew		E1		Yes 4 records exist in the locality near Bankstown Airport in 1996 and Hoxton Park in 1950	Require sparsely grassed, lightly timbered, open forest of woodland. In southern Australia they often occur where there is a well-structured litter layer and fallen timber debris. Feed on a range of invertebrates and small vertebrates, as well as seeds and shoots (NSW National Parks and Wildlife Service 1999a, 2003b).	Low Poor quality habitat and few recent records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Callocephalon fimbriatum	Gang-gang Cockatoo		V		Yes 3 records exist in the locality with a record near the Georges River from 2006.	Occurs in wetter forests and woodland from sea level to an altitude over 2000 metres, timbered foothills and valleys, coastal scrubs, farmlands and suburban gardens (Pizzey & Knight 2007).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records present. May forage sporadically on the site, particularly in winter but unlikely to breed locally. Unlikely elsewhere in the study area.
Callocephalon fimbriatum Endangered population	Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai LGAs		E2		No	A population of Gang-gang Cockatoos found in the Hornsby and Ku-ring-gai LGAs.	N/A Endangered population is only listed in the Hornsby and Ku-ring-gai LGAs but birds are likely to disperse to other areas including the study area.
Calyptorhynchus lathami	Glossy Black-Cockatoo		V		No	Occurs in eucalypt woodland and forest with *Casuarina*/*Allocasuarina* spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key *Allocasuarina* species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 1999c).	Low No suitable habitat or historic records of this species exist in the locality.
Circus assimilis	Spotted Harrier		V		Yes 1 record exists at Hoxton Park	The Spotted Harrier occurs throughout the Australian mainland in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods) (Marchant & Higgins 1993). It is found mostly commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands (Department of Environment Climate Change and Water 2010c).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the study area.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Climacteris picumnus victoriae	Brown Treecreeper (eastern subsp)		V		Yes 1 record exists near Menai	Found in eucalypt woodlands and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly in habits woodlands dominated by stringybarks or other rough-barked eucalypts. Nesting occurs in tree hollows (Office of Environment and Heritage 2011b).	Low One local record only. Species likely to be extinct in the locality as it is considered to be virtually extinct on the Cumberland Plain (Department of Environment and Climate Change 2007).
Daphoenositta chrysoptera	Varied Sittella		V		Yes 28 records exist in the locality with recent records near the study area	The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland (Department of Environment Climate Change and Water 2010d).	Moderate The Varied Sittella is relatively common within the Greater Southern Sydney Region (Department of Environment and Climate Change 2007). May occur in the Alluvial Woodland of the Georges River area. Unlikely elsewhere in the study area.
Ephippiorhynchus asiaticus	Black-necked Stork		E1		Yes 1 record exists near Revesby from 1978	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites (Garnett & Crowley 2000).	Low No suitable habitat for this species exists in the study area.
Epthianura albifrons	White-fronted Chat		V		Yes 2 records exist from the Holsworthy restricted area and the Georges River NP at Sutherland	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level. In New South Wales, the White-fronted Chat occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, White-fronted Chats are found predominantly in saltmarsh vegetation although they are also observed in open grasslands and sometimes in low shrubs bordering wetland areas (Department of Environment Climate Change and Water 2009; Higgins *et al.* 2001; Pizzey & Knight 2007).	Low No suitable habitat for this species exists in the study area.
Epthianura albifrons Endangered population	White-fronted Chat in the Sydney Metropolitan Catchment Management Authority Area		E2		Yes 2 records exist from the Holsworthy restricted area and the Georges River NP at Sutherland	As above for the White-fronted Chat	Low No suitable habitat for this species exists in the study area.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Gallinago hardwickii	Latham's Snipe	M			Yes 51 records exist in the locality around the Bankstown Airport	Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett & Crowley 2000).	Moderate Marginal habitat and local records present.
Glossopsitta pusilla	Little Lorikeet		V		Yes 13 records exist in the locality with 5 records near the study area from 2006.	The Little Lorikeet is found in forests, woodland, and in treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria (Higgins 1999).	High Potential habitat and local records present. A nomadic species which may forage in the study area, particularly in the Alluvial Woodland in the west. Unlikely to breed in the locality.
Grantiella picta	Painted Honeyeater		V		No	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus *Amyema*, though it will take some nectar and insects. Its breeding distribution is dictated by presence of mistletoes which are largely restricted to older trees (Garnett & Crowley 2000).	Low No suitable habitat or historic records of this species exist in the locality.
Haliaeetus leucogaster	White-bellied Sea-Eagle	M			Yes 3 records exist in the locality along the Georges River	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a large nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 2007).	Moderate Marginal habitat and local records present.
Hieraaetus morphnoides	Little Eagle		V		Yes 19 records exist in the locality with a record near the study area from 2006	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. She-oak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites, it requires a tall living tree within a remnant patch (Marchant & Higgins 1993).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the study area.
Hirundapus caudacutus	White-throated Needletail	M			Yes 4 records exist in the locality near the Georges River and near the study area	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 2007).	High Potential habitat and local records present.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Lathamus discolor	Swift Parrot	E	E1		Yes 11 records exist in the locality with a record near the study area from 1998	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. On mainland Australia, the Swift Parrot is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering *Acacia pycnantha*, is indicated. Sites used vary from year to year. (Garnett & Crowley 2000; Swift Parrot Recovery Team 2001).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records present. May forage sporadically on the site in winter but extremely unlikely to breed locally.
Limosa limosa	Black-tailed Godwit	M	V		No	A coastal species found on tidal mudflats, swamps, shallow river margins and sewage farms. Also, found inland on larger shallow fresh or brackish waters. A migratory species visiting Australia between September and May (Pizzey & Knight 2007).	Low No suitable habitat or historic records of this species exist in the locality.
Lophoictinia isura	Square-tailed Kite		V		Yes 2 records exist in the locality from near Revesby and the Holsworthy restricted area as recently as 2006	The Square-tailed Kite hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects and seems to prefer structurally diverse landscapes (Garnett & Crowley 2000). The species shows a particular preference for timbered watercourses and appears to occupy large hunting ranges of more than 100km2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs (Office of Environment and Heritage 2012b).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the study area.
Melanodryas cucullata	Hooded Robin		V		No	Found in south-eastern Australia, generally east of the Great Dividing Range. Found in eucalypt woodland and mallee and acacia shrubland. This is one of a suite of species that has declined in woodland areas in south-eastern Australia (Garnett & Crowley 2000).	Low Marginal quality habitat and no historic records of this species exist in the locality. Considered near extinct on the Cumberland Plain (Department of Environment and Climate Change 2007).

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Melithreptus gularis gularis	Black-chinned Honeyeater		V		Yes 7 records exist in the locality near Warwick Farm	Occurs within areas of annual rainfall between 400-700 mm. Feed on insects, nectar and lerps {Garnett, 2000 #21}. It occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, Blakely's Red Gum and Forest Red Gum. Also inhabits open forests of smooth-barked gums, stringybarks, river sheoaks (nesting habitat) and tea-trees. Feeding territories are large making the species locally nomadic. It tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares (Office of Environment and Heritage 2012b).	Moderate Marginal quality habitat in Alluvial Woodland. Considered rare in the region and is nomadic (Department of Environment and Climate Change 2007). May forage in the study area when dominant eucalypts are in flower and possibly breed along the Georges River, unlikely elsewhere in the study area.
Merops ornatus	Rainbow Bee-eater	M			No	Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings (Higgins 1999).	Low Marginal habitat and no historic records of this species exist in the locality.
Monarcha melanopsis	Black-faced Monarch	M			Yes 8 records exist in the locality along the Georges River	Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp gullies in rainforest, eucalypt forest and in more open woodland when migrating (Pizzey & Knight 1997).	Moderate Marginal habitat and local records present.
Myiagra cyanoleuca	Satin Flycatcher	M			Yes 2 records exist in the locality at Hoxton Park and Warwick Farm	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 1997).	Moderate Marginal habitat and local records present.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Ninox connivens	Barking Owl		V		Yes 1 record exists in the locality near Warwick Farm	Occurs in dry sclerophyll woodland. In the south west, it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season (Garnett & Crowley 2000).	Moderate Very rare in the region but considered to be widespread (Department of Environment and Climate Change 2007). Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the study area.
Ninox strenua	Powerful Owl		V		Yes 7 records exist in the locality with a record near the study area (Leacock Regional Park) from 2006	A sedentary species with a home range of approximately 1000 hectares it occurs within open eucalypt, casuarina or callitris pine forest and woodland. It often roosts in dense vegetation including rainforest and exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands (Garnett & Crowley 2000).	Moderate Relatively common in the region (Department of Environment and Climate Change 2007) . Potential breeding and foraging habitat present in the Alluvial Woodland of the Georges River riparian corridor as part of a much larger territory extending well beyond the study area. Unlikely elsewhere in the study area.
Petroica boodang	Scarlet Robin		V		Yes 2 records exist in the locality in the Holsworthy restricted area near the study area from 2006	In NSW, the Scarlet Robin occupies open forests and woodlands from the coast to the inland slopes. Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains. It prefers an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter, it migrates to open habitats such as grassy open woodland or paddocks with scattered trees (Department of Environment Climate Change and Water 2010b; Higgins & Peter 2002).	Moderate Marginal habitat and local records present. Likely only as a non-breeding migrant. Likely in the Alluvial Woodland of the study area only.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Petroica phoenicea	Flame Robin		V		Yes 3 records exist in the locality near Revesby in 1992 and the Holsworthy restricted area from 1996	In NSW, the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats (Higgins & Peter 2002). The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank (Department of Environment Climate Change and Water 2010a).	Moderate Marginal habitat and local records present (Department of Environment and Climate Change 2007). Likely only as a non-breeding migrant. Likely in the Alluvial Woodland of the study area only.
Petroica rodinogaster	Pink Robin		V		Yes 1 record exists in the locality the Georges River NP from 1972	Found in open forest and woodland including native tea-tree scrubs. Rarely found in open cleared areas. Breeds in dense gullies in temperate rainforests (Pizzey & Knight 1997).	Low One local record only. Species likely to occur in the locality as very rare visitor only (Department of Environment and Climate Change 2007).
Pyrrholaemus sagittatus	Speckled Warbler		V		Yes 1 record exists in the locality near Hoxton Park	The Speckled Warbler occurs in a wide range of eucalypt dominated vegetation with a grassy understorey and is often found on rocky ridges or in gullies. It feeds on seeds and insects and builds domed nests on the ground (Garnett & Crowley 2000).	Low One local record only. Species very rare in the locality (Department of Environment and Climate Change 2007). Likely to be locally extinct.
Rhipidura rufifrons	Rufous Fantail	M			Yes 54 records exist in the locality near the Georges River and in Sutherland	Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range (Pizzey & Knight 1997).	High Potential habitat and local records present.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Rostratula australis	Australian Painted Snipe	VM	E1		No	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as *Eucalyptus camaldulensis*, *Eucalyptus populnea* or shrubs such as *Muehlenbeckia florulenta* or *Sarcocornia quinqueflora*. Feeds at the water's edge and on mud flats, on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000).	Low No suitable habitat or historic records of this species exist in the locality.
Stagonopleura guttata	Diamond Firetail		V		No	Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range. Feed on seeds, mostly of grasses (Garnett & Crowley 2000).	Low Poor quality habitat and no historic records of this species exist in the locality.
Mammals							
Cercartetus nanus	Eastern Pygmy-possum		V		Yes 2 records exists in the locality near the Georges River, recorded in 1993	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree hollows, between the wood and bark of a tree, abandoned birds' nests and/or shredded bark in the fork of trees (Turner & Ward 1995).	Moderate Marginal habitat and local records present. Likely only along the Georges River. Other vegetation unlikely to be occupied due to fragmentation.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V		No	Occurs in moderately wooded habitats and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins. Thought to forage below the forest canopy for small flying insects (Churchill 2008).	Low No suitable habitat or historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Dasyurus maculatus	Spotted-tailed Quoll	E	V		Yes 4 records occur in the Holsworthy restricted area and in the Georges Rover National Park	In NSW, the Spotted-tailed Quoll occurs on both sides of the Great Dividing Range. Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heath. Nests in rock caves and hollow logs or trees (NSW National Parks and Wildlife Service 1999e, 1999g).	Moderate Marginal habitat and local records present. Moderately likely only along the Georges River. Other vegetation unlikely to be occupied due to fragmentation.
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V		Yes 9 records exist in the locality near Sandy Point and to the east of the study area	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 metres high (Churchill 2008).	Moderate Species recorded locally from ultrasonic calls only which may be misidentifications and predictive habitat quality mapping shows the locality with a low probability of occurrence (Department of Environment and Climate Change 2007).
Miniopterus schreibersii	Eastern Bent-wing Bat	C	V		Yes 11 records exist in the locality near Glenfield, Warwick Farm and Sutherland	Usually found in well-timbered valleys where it forages on small insects above the canopy. Roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill 2008).	High The Eastern Bentwing-bat is common and widespread within the greater southern Sydney Region and is a lower conservation priority overall, with the exception of roosting and nursery sites (Department of Environment and Climate Change 2007). Potential foraging habitat present. Marginal roosting habitat may be present in artificial structures. Nursery sites very unlikely.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Mormopterus norfolkensis	Eastern Free-tail bat		V		Yes 26 records exist in the locality near the study area and at Glenfield	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (Churchill 2008). It will travel and forage in open country or along creek lines and may utilise remnants too isolated or disturbed for many other species. (Department of Environment and Climate Change 2007).	High Local records exist in the locality and potential habitat present, chiefly in Alluvial Woodland along the Georges River Corridor however may also occur elsewhere in the site including in mature isolated trees and patches of disturbed woodland. The Eastern Free-tail bat is rarely recorded within the greater southern Sydney Region and predictive habitat quality mapping shows the locality with a medium to high probability of occurrence (Department of Environment and Climate Change 2007). Potential foraging and roost/breeding habitat present mainly in Alluvial woodland along the Georges River.
Myotis adversus	Large-footed Myotis		V		Yes 10 records exist in the locality including at Glenfield	Colonies occur in caves, mines, tunnels, under bridges and buildings. Colonies always occur close to bodies of water where this species feeds on aquatic insects (Churchill 2008).	High Within the Greater Southern Sydney Region, the Large-footed Myotis is strongly associated with the Cumberland Plain where it utilises waterways in relatively disturbed environments including the Georges River catchment around Liverpool and Campbelltown (Department of Environment and Climate Change 2007). Potential foraging and roost/breeding habitat present mainly in Alluvial woodland along the Georges River.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Perameles nasuta Endangered Inner Western Sydney population	Long-nosed Bandicoot population, Inner Western Sydney		E2		Yes Restricted to the Marrickville and Canada Bay LGAs. May also be found in Canterbury, Ashfield and Leichardt LGAs	Occurs in a range of habitats from rainforest through wet and dry woodland areas with little ground cover. Nests in a shallow hollow on the surface of the ground (Strahan 1995). The Endangered Inner Western Sydney population is restricted to the LGAs of Marrickville and Canada Bay, with the likelihood that it also includes Canterbury, Ashfield and Leichhardt LGAs.	N/A While Long-nosed Bandicoots are likely to occur in the study area they would not be considered part of the Endangered Inner Western Sydney Population
Petaurus australis	Yellow-bellied Glider		V		Yes 1 record exists in the locality on the Georges River National Park near Menai	Restricted to tall, mature eucalypt forest in high rainfall areas of temperate to sub-tropical eastern Australia. Feeds on nectar, pollen, the sap of eucalypts and sometimes insects. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows and year round food resources are available from a mixture of eucalypt species (NSW National Parks and Wildlife Service 1999h, 2003d).	Low One local record only. Species likely to be extinct in the study area or record a misidentification. Predictive habitat modelling shows to area with a low probability of occurrence (Department of Environment and Climate Change 2007).
Petaurus norfolcensis	Squirrel Glider		V		Yes 1 record exists in the locality near the study area along the Georges River.	Found in dry sclerophyll forest and woodland but not found in dense coastal ranges. Nests in hollows and feeds on gum of acacias, eucalypt sap and invertebrates (NSW National Parks and Wildlife Service 1999f).	Moderate Marginal habitat and one local record only. Comprehensive surveys of the Cumberland Plain detected this species at only two locations one of which was at Holsworthy Army Reserve (Department of Environment and Climate Change 2007). If present, likely to be restricted to the Georges River Corridor as other areas too disturbed and fragmented.
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1		Yes 1 record exists in the locality in the Holsworthy restricted area	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups each usually separated by hundreds of metres (NSW National Parks and Wildlife Service 2003a).	Low Inappropriate habitat and one local record only. Likely to be locally extinct.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Phascolarctos cinereus	Koala	V	V		Yes 97 records exist in the locality including a record near the study area from 2005	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include *Eucalyptus tereticornis*, *Eucalyptus punctata*, *Eucalyptus cypellocarpa* and *Eucalyptus viminalis* (NSW National Parks and Wildlife Service 1999d, 2003c).	Moderate The species is frequently recorded in the locality along the transition of the Cumberland Plain and coastal sandstone areas in an area known as the Cumberland Koala Linkage which includes areas immediately adjacent to the southern end of the site (Department of Environment and Climate Change 2007). If present, likely to be restricted to the Georges River Corridor as other areas too disturbed and fragmented.
Potorous tridactylus	Long-nosed Potoroo	V	V		No	In NSW, the Long-nosed Potoroo is found throughout coastal and subcoastal areas. Occurs in a range of habitats: coastal forest and woodland with a moderately dense heathy understorey, dense coastal scrubs or heath, wet and dry sclerophyll forest and sub-tropical, warm temperate and cool temperate rainforest of the eastern slopes and highlands. Often associated with gullies and forest ecotones. Open areas are used for foraging while areas of dense groundcover or understorey provide areas for shelter and protection from predators. Relatively thick ground cover is a major habitat requirement and it seems to prefer areas with light sandy soils (Johnston 1995; NSW National Parks and Wildlife Service 1999g).	Low No suitable habitat or historic records of this species exist in the locality.
Pseudomys novaehollandiae	New Holland Mouse	E			No	The New Holland Mouse is a small, burrowing native rodent. The species is similar in size and appearance to the introduced house mouse (*Mus musculus*), although it can be distinguished by its slightly larger ears and eyes, the absence of a notch on the upper incisors and the absence of a distinctive 'mousy' odour. Known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes (Threatened Species Scientific Committee 2010).	Low Marginal habitat and no local records present.

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Pteropus poliocephalus	Grey-headed Flying-fox	V	V		Yes 88 records exist in the locality including many near the study area	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lilly pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001b)	Recorded Within the Greater Southern Sydney Region there is one large and regularly used Flying-fox camp site on Cabramatta Creek (Department of Environment and Climate Change 2007). Recorded flying overhead and likely to forage throughout the study area. Vegetation along the Georges River is most suitable as foraging habitat and may have potential for roosting.
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat		V		Yes 4 records exist in the locality including at Sandy Point and to the south east of the study area	Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts in tree hollows. Thought to be migratory (Churchill 2008).	Moderate A rarely detected species however, Anabat ultrasonic call records have been made around the Holsworthy Military Area. The habitat and distribution of this species is very poorly known and it may occur regularly within the locality or only occur as a summer visitor (Department of Environment and Climate Change 2007).
Scoteanax rueppellii	Greater Broad-nosed Bat		V		Yes 12 records exist in the locality with 5 records near the study area along the Georges River and at Glenfield	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically, it forages at a height of 3-6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill 2008).	High Local records exist in the locality and potential habitat present along the Georges River Corridor. Rarely recorded within the greater southern Sydney Region and predictive habitat quality mapping shows the locality with a medium to high probability of occurrence. (Department of Environment and Climate Change 2007).

Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	FM Act[3]	Recorded in locality [4]	Preferred Habitat [5]	Likelihood of occurrence
Reptiles							
Hoplocephalus bungaroides	Broad-headed Snake	V	E1		No However, records exist in the Holsworthy restricted area	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb & Shine 1998).	Low Marginal habitat local records restricted to sandstone soils of the Holsworthy range. Study site within an area mapped with low probability of occurrence (Department of Environment and Climate Change 2007).
Varanus rosenbergi	Heath Monitor		V		Yes 2 records exist in the locality near Menai and Lucas Heights	Found in coastal heaths, humid woodlands, and wet and dry sclerophyll forests. Mostly a terrestrial species it shelters in burrows, hollow logs and rock crevices (Cogger 2000).	Low Marginal habitat and few local records present. Site mapped as having medium probability of occurrence in predictive habitat modelling (Department of Environment and Climate Change 2007).

Notes: 1. V = Vulnerable, E = Endangered, M = Migratory, C = Conservation Dependent (*Environment Protection and Biodiversity Conservation Act 1999*))
2. V= Vulnerable, E1 = Endangered, E2 = Endangered Population (Threatened Species Conservation Act 1995)
3. E = Endangered, P = protected (*Fisheries Management Act 1994*)
4. Previously recorded' refers to records of Threatened species that were identified within the locality from the Atlas of NSW Wildlife (Office of Environment and Heritage 2011a).
5. Based on database searches and field surveys

Bold text identifies if the likelihood of occurrence in the study area is moderate, high or if the species has been recorded on the site

Threat-listed flora likelihood of occurrence assessment

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Fabaceae (Mimosoideae)	*Acacia bynoeana*	Bynoe's Wattle	V	E1	No	Grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with *Corymbia gummifera, Eucalyptus haemastoma, Eucalyptus gummifera, Eucalyptus parramattensis, Eucalyptus sclerophylla, Banksia serrata* and *Angophora bakeri* (NSW National Parks and Wildlife Service 1999a).	Moderate No historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
Fabaceae (Mimosoideae)	*Acacia prominens* Endangered population	*Acacia prominens* population in the Hurstville and Kogarah LGAs		E2	Yes 1 record of this species exists at Bankstown Airport	Occurs on clay, loam or sand soils, often requiring a moist, protected habitat in wet sclerophyll forest (Royal Botanic Gardens 2011). The Endangered population is known as isolated trees from a few sites at Penshurst and Oatley (Office of Environment and Heritage 2011e).	Low Only considered Endangered in the Hurstville and Kogarah LGAs.
Fabaceae (Mimosoideae)	*Acacia pubescens*	Downy Wattle	V	V	Yes 161 records exist in the locality including one near the study area from 1998	Restricted to the Sydney Region from Bilpin to the Georges River and also at Woodford where it usually grows in open sclerophyll forest and woodland on clay soils. Typically it occurs at the intergrade between shales and sandstones in gravely soils often with ironstone (Harden 2002; NSW National Parks and Wildlife Service 2003a).	Moderate Historic records of this species exist in the locality. Marginal habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Casuarinaceae	*Allocasuarina glareicola*		E	E1	Yes 1 record occurs nearby at Holsworthy from 1996	Restricted to the Sydney basin where it occurs north east of Penrith in or near Castlereagh State Forest. Grows on lateritic soil in open forest (Harden 2000).	Low One record of this species in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area, however, this species was not recorded on the site and is unlikely to exist in a soil-stored seed bank as *Allocasuarina* species have canopy-stored seed and do not form persistent soil seed banks (Lunt 1997).
Anthericaceae	*Caesia parviflora* var. *minor*	Small Pale Grass-lily		E1	Yes 1 record near Panania	Occurs south from Corindi area where it grows in heath woodland and dry sclerorophyll forest on sandstone derived soils (Harden 1993).	Low No suitable habitat for this species exists in the study area.
Orchidaceae	*Caladenia tessellata*	Thick Lip Spider Orchid	V	E1	No	Occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). Prefers low open forest with a heathy or sometimes grassy understorey (Bishop 2000). Within NSW, currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Previously known also from Sydney and South Coast areas (NSW Scientific Committee 2002a).	Low No suitable habitat or historic records of this species exist in the locality.
Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush		V	Yes 4 records exist including the Holsworthy restricted area	Occurs chiefly from Georges to the Hawkesbury River where it grows in dry sclerophyll forest, open forest, scrubland or woodland on sandstone. Found in damp places, usually in gullies (Fairley, A. & Moore 2002; Harden 2002; Robinson 1994). Within the Sydney region, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (NSW Scientific Committee 1999a).	Low No suitable habitat for this species in the study area.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Hygrophoraceae	*Camarophyllopsis kearneyi*			E1	No	Small, pale, gilled fungus and is known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002a).	Low No suitable habitat or historic records of this species exist in the locality.
Euphorbiaceae	*Chamaesyce psammogeton*	Sand Spurge		E1	No	Occurs in coastal regions of NSW where it grows on sand dunes near the sea (Harden 2000). Grows on fore-dunes and exposed headlands, often with Spinifex (*Spinifex sericeus*) (Office of Environment and Heritage 2011e).	Low No suitable habitat or historic records of this species exist in the locality.
Orchidaceae	*Cryptostylis hunteriana*	Leafless Tongue Orchid	V	V	No	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats (Harden 1993; NSW National Parks and Wildlife Service 1999h).	Low No suitable habitat or historic records of this species exist in the locality.
Asclepiadaceae	*Cynanchum elegans*	White-flowered Wax Plant	E	E1	Yes 2 records in Western Sydney Regional Parklands	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes (Harden 1992). This species typically occurs at the ecotone between dry subtropical forest/woodland communities (James 1997b; NSW National Parks and Wildlife Service 2002b).	Low No suitable habitat for this species exists in the study area.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Myrtaceae	*Darwinia biflora*		V	V	No	Occurs from Cheltenham to Hawkesbury River where it grows in heath on sandstone or in the understorey of woodland on shale-capped ridges (Harden 2002). Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include *Eucalyptus haemastoma, Corymbia gummifera* and/or *Eucalyptus squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath (Office of Environment and Heritage 2011e).	Low No suitable habitat or historic records of this species exist in the locality.
Poaceae	*Deyeuxia appressa*		E	E1	Yes 1 record exists near Revesby from 1930	Occurs in the Hornsby area on wet ground (Harden 1993; Sharp & Simon 2002).	Low No suitable habitat for this species exists in the study area. Thought to be restricted to the Hornsby area.
Fabaceae (Faboideae)	*Dillwynia tenuifolia*		V	V	Yes 1 record exists near Kemps Creek	Occurs on the Cumberland Plain from the Blue Mountains to Howes Valley area where it grows in dry sclerophyll woodland on sandstone, shale or laterite (Harden 2002). Specifically, occurs within Castlereagh woodlands, particularly in shale gravel transition forest. Associated species include *Eucalyptus fibrosa, Eucalyptus sclerophylla, Melaleuca decora, Daviesia ulicifolia, Dillwynia juniperina* and *Allocasuarina littoralis* (James 1997b).	Moderate One record of this species in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area.
Orchidaceae	*Diuris aequalis*	Buttercup Doubletail	V	E1	Yes 1 record exists from 1905 near Hoxton Park	Occurs chiefly in the ranges and tablelands from Braidwood to Kanangra and Liverpool where it grows among grass in sclerophyll forest (Harden 1993). It typically occurs on gentle slopes, in gravely clay-loam soil within montane eucalypt forest with a grass or heath understorey (Bishop 2000). Three small populations are known to occur within Kanangra Boyd National Park, other populations are restricted to remnant vegetation within roadsides and agricultural lands (NSW Scientific Committee 2002c).	Low No suitable habitat for this species exists in the study area and this species hasn't been found nearby since 1905.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Ericaceae	*Epacris purpurascens* var. *purpurascens*			V	Yes 4 records exist nearby at Bankstown	Occurs in the Gosford and Sydney districts where it grows in sclerophyll forest, scrub and swamps (Harden 1992). Usually found in sites with a strong shale influence (NSW National Parks and Wildlife Service 2002c).	Low Species not associated with the vegetation communities of the site.
Myrtaceae	*Eucalyptus camfieldii*	Heart-leaved Stringybark	V	V	Yes 1 record exists in the Georges River NP in Sutherland	Restricted distribution in a narrow band with the most northerly records in the Raymond Terrace Area south to Waterfall. Localised and scattered distribution includes sites at Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites in Royal National Park (Office of Environment and Heritage 2011d). Occurs within poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges.	Low No suitable habitat for this species exists in the study area.
Myrtaceae	*Eucalyptus nicholii*	Narrow-leaved Black Peppermint	V	V	Yes 1 record exists near Warwick Farm	Occurs from Niangala to Glenn Innes where it grows in grassy sclerophyll woodland on shallow relatively infertile soils on shales and slates, mainly on granite. Endemic on the NSW Northern Tablelands, of limited occurrence, particularly in the area from Walcha to Glen Innes; often on porphyry or granite (Brooker & Kleinig 1999; Office of Environment and Heritage 2011c).	Low This New England Tableland species is not native to the Sydney area and is planted near Warwick Farm.
Myrtaceae	*Eucalyptus scoparia*		V	E1	Yes 1 record exists near Hoxton Park	Occurs in Queensland and reaches its southern limit in NSW. In NSW it is known from three locations all near Tenterfield in the far northern New England Tableland Bioregion where it grows on well drained granitic hilltops, slopes and outcrops, often as scattered trees in open forest and woodland (Royal Botanic Gardens 2011).	Low This New England Tableland species is not native to the Sydney area and is planted near Hoxton Park.
Orchidaceae	*Genoplesium baueri*	Bauer's Midge Orchid		V	No	Grows in sparse sclerophyll forest and moss gardens over sandstone; from the Hunter Valley to Nowra district (Royal Botanic Gardens 2011).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Grammitaceae	*Grammitis stenophylla*	Narrow-leaf Finger Fern		E1	No	Fern which occurs in coastal regions from Queensland to the NSW south coast where it grows in moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest (Harden 2000).	Low No suitable habitat or historic records of this species exist in the locality.
Proteaceae	*Grevillea parviflora* subsp. *parviflora*	Small-flower Grevillea	V	V	Yes 2 records exist near the study area with a recent record from 2002	Mainly known from the Prospect area (but now extinct there) and lower Georges River to Camden, Appin and Cordeaux Dam areas, with a disjunct populations near Putty, Cessnock and Cooranbong. Grows in heath or shrubby woodland in sandy or light clay soils usually over thin shales (Harden 2002; NSW Scientific Committee 1998a).	Recorded Recorded in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
Gyrostemonaceae	*Gyrostemon thesioides*			E1	Yes 31 records exist with the closest to the study area from Ingleburn	Confined to the Colo, Georges and Nepean Rivers where it occurred on river banks. It is a fire-opportunist (James 1997b; NSW Scientific Committee 1998b; Royal Botanic Gardens 2011).	Low Not recorded on the Georges River for 30 years despite searches (Office of Environment and Heritage 2011e).
Haloragaceae	*Haloragodendron lucasii*		E	E1	No	Confined to the Sydney area where it grows in dry sclerophyll open forest on sheltered slopes near creeks on sandstone (Harden 2002). Reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland. Associated with high soil moisture and relatively high soil-phosphorus levels (Office of Environment and Heritage 2011e).	Low No suitable habitat or historic records of this species exist in the locality.
Dilleniaceae	*Hibbertia* sp. Bankstown		CE	E4A	Yes 1 record exists nearby at Bankstown Airport	Endemic to New South Wales and is currently known to occur in only one population at Bankstown Airport in Sydney's southern suburbs, in the Bankstown LGA. The species is not known from any conservation reserves. The population comprises fewer than 50 individuals.	Low The only population is known from Bankstown Airport.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Dilleniaceae	*Hibbertia superans*			E1	No	Occurs from Castle Hill to South Maroota where it grows in ridgetop woodlands usually near Shale/Sandstone Transition Forest. It is often associated with other threatened flora including *Pimelea curviflora* var. *curviflora*, *Darwinia biflora, Epacris purpurascens* var. *purpurascens, Leucopogon fletcheri* subsp. flet*cheri, Acacia bynoeana, Eucalyptus* sp. Cattai and *Persoonia hirsuta* (NSW Scientific Committee 2001a).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	*Hygrocybe anomala* var. *ianthinomarginata*			V	No	Small, brightly-coloured gilled fungus and has been found in Lane Cove Bushland Park in the Lane Cove LGA in Sydney, and from Royal and Blue Mountains National Parks (NSW National Parks and Wildlife Service 2002d).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	*Hygrocybe aurantipes*			V	No	Small, brightly-coloured gilled fungus known only from its type locality in the Lane Cove Bushland Park in the Lane Cove LGA in Sydney and from the Blue Mountains National Park and Hazelbrook (NSW National Parks and Wildlife Service 2002e).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	*Hygrocybe austropratensis*			E1	No	Small, brightly-coloured gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002f).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	*Hygrocybe collucera*			E1	No	Small, brightly-coloured red gilled fungus known only from its type locality in the Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002g).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	*Hygrocybe griseoramosa*			E1	No	Small, buff to brown gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002h).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Hygrophoraceae	*Hygrocybe lanecovensis*			E1	No	Small, brightly-coloured gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002i).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	*Hygrocybe reesiae*			V	No	Small, lilac coloured gilled fungus known in New South Wales only from its type locality in the Lane Cove Bushland Park in the Lane Cove LGA in Sydney, and from the Blue Mountains National Park. It is also found in Tasmania (NSW National Parks and Wildlife Service 2002j).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	*Hygrocybe rubronivea*			V	No	Small, brightly-coloured gilled fungus and is known only from its type locality in the Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002k).	Low No suitable habitat or historic records of this species exist in the locality.
Lobeliaceae	*Hypsela sessiliflora*		X	E1	No	Previously thought to be extinct, recently rediscovered in Erskine Park on the Cumberland Plain in western Sydney. Past records include Homebush and South Creek in Blacktown LGA (James 1997b). It has been reported from damp places (NSW Scientific Committee 2003a) such as river banks (James 1997b). Specifically it is known to occur within Sydney Coastal River-flat Forest (Upper Parramatta River Catchment Trust 1999).	Low Marginal habitat present, however no historic records of this species exist in the locality.
Ericaceae	*Leucopogon exolasius*	Woronora Beard-heath	V	V	Yes 3 records exist nearby with a record near the study area from the year 2000	Restricted chiefly to the Woronora and Grose Rivers and Stokes Creek, Sydney catchments and the Royal National Park. One old record from the Grose River. Grows in woodland on sandstone (Royal Botanic Gardens 2011).	Moderate Marginal habitat for this species exists in the Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Ericaceae	*Leucopogon fletcheri* subsp. *fletcheri*			E1	Yes 1 record exists on the Holsworthy prohibited area	Grows in dry eucalypt woodland or in shrubland on clay, lateritic soils or Hawkesbury sandstone (Fairley, Alan 2004). Found on sandstone ridges and upper slopes in heath or woodland, sometimes in or below sandstone-shale ecotone; often associated with lateritic soils with some clay influence (James 1997a; James *et al.* 1999).	Low Species not associated with the vegetation communities of the site.
Asclepiadaceae	*Marsdenia viridiflora* subsp. *viridiflora* Endangered population	*Marsdenia viridiflora* subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs		E2	Yes 10 records from Hoxton Park, Prestons and Potts Hill	*Marsdenia viridiflora subsp. viridiflora* has a wide distribution in subcoastal and southern Queensland but has been recorded rarely in NSW and from a disjunct occurrence near Sydney. The Endangered *Marsdenia viridiflora* subsp. *viridiflora* population occurs as very scattered plants in areas of remnant vegetation (NSW Scientific Committee 2000b).	Low Species not associated with the vegetation communities of the site.
Juncaginaceae	*Maundia triglochinoides*	-		V	No	Occurs north from Sydney. Grows in swamps, creeks or shallow freshwater 30 to 60 cm deep on heavy clay, low nutrients. Associated with wetland species such as *Triglochin procerum* (Harden 1993).	Low No suitable habitat or historic records of this species exist in the locality.
Myrtaceae	*Melaleuca biconvexa*	Biconvex Paperbark	V	V	No	Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, with the main concentration of records is in the Gosford/Wyong area (NSW Scientific Committee 1998c). Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects (Harden 2002).	Low No suitable habitat or historic records of this species exist in the locality.
Myrtaceae	*Melaleuca deanei*	Deane's Paperbark	V	V	Yes 14 records exist in the locality with 6 occurring at Sandy Point	Occurs in coastal districts, including western Sydney (e.g. Baulkham Hills, Liverpool shires) from Berowra to Nowra where it grows in wet heath on sandstone and shallow/skeletal soils near streams or perched swamps (Harden 2002; James 1997b).	Low No suitable habitat for this species exists in the study area.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Proteaceae	*Persoonia hirsuta*	Hairy Geebung	E	E1	Yes 3 records exist near Holsworthy	Occurs in central coast and central tableland districts where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) and rarely shale (NSW Scientific Committee 1998d). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997b; Office of Environment and Heritage 2011e).	Moderate Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
Proteaceae	*Persoonia nutans*	Nodding Geebung	E	E1	Yes 31 records exist near the study area including a recent record from 2002	Confined to the western Sydney where it grows in Castlereagh Scribbly Gum Woodlands and Agnes Banks Woodlands (Harden 2002; James 1997b; NSW National Parks and Wildlife Service 2001c).	Recorded Recorded in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
Thymelaeaceae	*Pimelea curviflora* var. *curviflora*		V	V	No	Confined to coastal areas around Sydney where it grows on sandstone and laterite soils. It is found between South Maroota, Cowan, Narrabeen, Allambie Heights, Northmead and Kellyville. Usually occurs in woodland in the transition between shale and sandstone (Harden 2000; James 1997b; James *et al.* 1999; NSW Scientific Committee 1998e).	Low No suitable habitat or historic records of this species exist in the locality.
Thymelaeaceae	*Pimelea spicata*	Spiked Rice-flower	E	E1	Yes 39 records exist in the locality with records from Glenfield in 2004.	In western Sydney, *Pimelea spicata* grows on Wianamatta Shales in Greybox - Ironbark Woodland with *Bursaria spinosa* and *Themeda australis* (Harden 2000; James 1997b; NSW National Parks and Wildlife Service 2000).	Low Species not associated with the vegetation communities of the site.
Rhamnaceae	*Pomaderris brunnea*		V	V	No	Confined to the Colo and Upper Nepean Rivers where it grows in open forest (Harden 2000); in western Sydney (Camden to Picton area) known from sandy alluvium on levee and creek banks (James 1997b).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Rhamnaceae	*Pomaderris prunifolia* Endangered population	*Pomaderris prunifolia* population in the Parramatta, Auburn, Strathfield and Bankstown LGAs		E2	Yes 3 records exist near Bankstown Airport and in Sutherland	Occurs on rocky slopes, often along creeks (Harden 2000). Within Parramatta, Auburn, Strathfield and Bankstown LGAs, the only recent record of this species is from Rydalmere, where only 3 plants occur (NSW Scientific Committee 1999b).	Low N/A - The Endangered population is restricted to the Parramatta, Auburn, Strathfield and Bankstown LGAs
Orchidaceae	*Pterostylis gibbosa*		E	E1	Yes 1 record exists near Menai found in 1949	Occurs in the southern part of the Central Coast region with a disjunct population in the Hunter Valley. Grows among grass in sclerophyll forest (Harden 2002).	Low No suitable habitat for this species exists in the study area.
Orchidaceae	*Pterostylis nigricans*	Dark Greenhood		V	Yes 1 record exists near Prestons from 1967	Grows in coastal heathland with *Banksia ericifolia*, and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils (Bishop 2000; Royal Botanic Gardens 2011).	Low No suitable habitat for this species exists in the study area.
Orchidaceae	*Pterostylis saxicola*	Sydney Plains Greenhood	E	E1	Yes 5 records exist near the Holsworthy restricted area including a record from 2007	Grows in Sydney Sandstone Gully Forest in shallow or skeletal soils over sandstone shelves, often near streams (Harden 1993; James 1997b; Office of Environment and Heritage 2011e)	Low No suitable habitat for this species exists in the study area.
Fabaceae (Faboideae)	*Pultenaea parviflora*	Sydney Bush-pea	V	E1	Yes 1 record exists at Potts Hill	Restricted to the Cumberland Plain where it grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium (Harden 2002). Locally abundant within Castlereagh Ironbark Forest and Shale/Gravel Transition Forest on tertiary alluvium or laterised clays (James 1997b; NSW National Parks and Wildlife Service 2002m).	Moderate Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Fabaceae (Faboideae)	*Pultenaea pedunculata*	Matted Bush-pea		E1	Yes 23 records exist near Hoxton Park, Prestons and Potts Hill	Restricted to Wianamatta Shales of the Cumberland Plain from Bankstown to Liverpool and on the South Coast in the Southeast Corner Bioregion at Bournda. It grows on a variety of soils in dry sclerophyll forest and disturbed sites (Harden 2000; NSW National Parks and Wildlife Service 2002n; NSW Scientific Committee 1999c).	Low No suitable habitat for this species exists in the study area.
Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	V	E1	No	Occurs between Buladelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea (Harden 2002). On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (Office of Environment and Heritage 2011e).	Low No suitable habitat or historic records of this species exist in the locality.
Elaeocarpaceae	*Tetratheca glandulosa*		V	V	No	Occurs from Mangrove Mountain to the Blue Mountains where it grows in sandy or rocky heath or scrub (Harden 1992). Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest (Office of Environment and Heritage 2011e).	Low No suitable habitat or historic records of this species exist in the locality.
Orchidaceae	*Thelymitra* sp. Kangaloon	Kangaloon Sun Orchid	CE		No	The Kangaloon Sun-orchid is known from three locations near Robertson in the Southern Highlands. The Kangaloon Sun-orchid has an estimated area of occupancy of 10 km². The three localities are Butler's Swamp, Stockyard Swamp (once known as Molly Morgan Swamp) and Wildes Meadow Swamp. All swamps are located above what is known as the Kangaloon Aquifer (Department of the Environment Water Heritage and the Arts 2009b).	Low No suitable habitat or historic records of this species exist in the locality. *Thelymitra* sp. Kangaloon is only found in upland swamps near the town of Kangaloon.

Family	Scientific Name	Common Name	EPBC Act[1]	TSC Act[2]	Recorded in locality [3]	Preferred Habitat	Likelihood of occurrence in study area
Campanulaceae	*Wahlenbergia multicaulis* Endangered population	Tadgell's Bluebell population in the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs		E2	No	Occurs in coastal and tableland districts south from Sydney and the Blue Mountains west along the Murray River to Mathoura where it grows in a variety of habitats including forest, woodland, grassland (Harden 1992), forest, scrub and the edges of watercourses and wetlands. It is a coloniser and typically occurs in damp, disturbed sites (NSW Scientific Committee 2003c).	Low N/A - Only considered Endangered in the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs
Convolvulaceae	*Wilsonia backhousei*	Narrow-leafed Wilsonia		V	Yes 2 records exist near Bankstown Airport and Revesby	Occurs chiefly in the Sydney district but also common at Jervis Bay (Harden 2000). A salt tolerant species, it is found in intertidal saltmarshes and sometimes on seacliffs (NSW Scientific Committee 2000d).	Low No suitable habitat for this species exists in the study area.

Notes:

1. EPBC Act - *Environment Protection and Biodiversity Conservation Act 1999*. X = Extinct, CE = Critically Endangered, E = Endangered V = Vulnerable

2: TSC Act - *Threatened Species and Conservation Act 1995*. E4A = Extinct, CE = Critically Endangered, E1 = Endangered V = Vulnerable E2= Endangered Population,

3. Based on database searches and field surveys

Bold text identifies if the likelihood of occurrence in the study area is moderate, high, or if the species has been recorded on the site.

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Appendix C

EPBC Act Significance assessments

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C1. EPBC Act significance assessment criteria

For species and communities listed under the EPBC Act, the significance of impacts is assessed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment Water Heritage and the Arts 2009b) where a 'significant impact' is defined as an impact which is important, notable, or of consequence, having regard to its context or intensity.

Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is affected, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of the Environment Water Heritage and the Arts 2009b). Importantly, for a 'significant impact' to be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility (Department of the Environment Water Heritage and the Arts 2009b).

1.1 Vulnerable species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species.
- Reduce the area of occupancy of an important population.
- Fragment an existing important population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of an important population.
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere substantially with the recovery of the species (Department of the Environment and Heritage 2006).

An important population of a vulnerable species is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- Key source populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity.
- Populations that are near the limit of the species range.

1.2 Endangered species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population.
- Reduce the area of occupancy of the species.
- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of a population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species (Department of the Environment Water Heritage and the Arts 2009b).

C2. Threatened species of animal

2.1 Koala

2.1.1 Status

The Koala is listed as Vulnerable under the EPBC Act.

2.1.2 Description

The Koala is an arboreal marsupial found in areas where there are suitable feed trees, ranging from open eucalypt woodlands to dense forests. Like other folivores, this species tends to be associated with forests growing on high-nutrient soils along river flats and drainage lines, most of which have been cleared for farmland (NSW National Parks and Wildlife Service 1999b).

The suitability of forest and woodland communities as habitat for Koalas is influenced by the size and species of trees present, soil nutrients, climate, rainfall and the size and disturbance history of the habitat patches. Koalas feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species (Moore & Foley 2000).

They spend most of their time in trees, but will descend and traverse open ground to move between trees. They are generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery. Home range size varies with quality of habitat, ranging from less than two hectares to several hundred hectares in size (Lunney *et al.* 2000).

Dispersal distances of young generally range from 1-11 km, although movements in excess of 50 km have been recorded (NSW National Parks and Wildlife Service 2003b). Most young disperse at two to three years of age and females remain in their natal area. If no suitable habitat is found by young individuals then they become nomadic (Lunney *et al.* 2000).

2.1.3 Surveys conducted

The following surveys were conducted for the Koala:

- Call playback - 12 person hours (two sessions in each of two locations on separate nights)
- Spotlighting - 10 person hours (two ~2 km transects on each of two separate nights)
- Searches for scats, tracks and signs – opportunistically throughout surveys.

Survey effort was considered adequate given that previous surveys have been conducted of the site and surrounds (LesryK Environmental Consultants 2003; URS 2004).

The Koala was presumed to occur intermittently on site based on habitat assessment.

2.1.4 Specific impacts

No Koalas or signs of their presence were recorded during field surveys, however, the species has frequently been recorded in the locality along the transition of the Cumberland Plain and coastal sandstone areas in an area known as the Cumberland Koala Linkage which includes areas immediately adjacent to the southern end of the site (Department of Environment and Climate Change 2007). If present, Koalas are likely to be largely restricted to the Georges River Corridor as other areas within the site are fragmented and are less suitable as foraging habitat due to a paucity of preferred food trees.

The Castlereagh Scribbly Gum Woodland is unlikely to be used by Koalas as the dominant trees in this community (*Eucalyptus sclerophylla* and *Melaleuca* spp.) are not amongst the preferred food trees in the locality and these patches of woodland are fragmented and separated from larger patches of vegetation in the riparian corridor by open expanses of cleared land.

Eucalyptus tereticornis, a preferred food species, is one of the dominant trees in the Alluvial Woodland and Riparian Forest communities.

The approximately 27.4 ha to 35.7 ha of Alluvial Woodland and Riparian Forest to be removed is likely to be of moderate value as habitat for this species. As a substantial (15.6-20.0 ha) area of riparian vegetation will be retained and rehabilitation of existing cleared and weed-dominated areas within the riparian corridor (17.8 ha) will be undertaken, potential habitat for the species is unlikely to be significantly affected.

2.1.5 Significance assessment

Any Koalas occupying the site are likely to be part of the Wedderburn/Campbelltown population which is considered to be an important population (Department of Environment and Climate Change 2008).

Would the action lead to a long-term decrease in the size of an important population of a species?

The higher value riparian habitat containing an abundance of preferred food resources and connectivity to larger areas of habitat for the species will largely be retained and rehabilitated and biodiversity offsets will be provided for all native vegetation communities cleared.

The project is, therefore, unlikely to result in a long-term decrease in the population of the species.

Would the action reduce the area of occupancy of an important population?

The higher value riparian habitat containing an abundance of preferred food resources and connectivity to larger areas of habitat for the species will largely be retained and rehabilitated. Substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored.

The project is, therefore, unlikely to significantly reduce the area of occupancy of the species.

Would the action fragment an existing important population into two or more populations?

Fragmentation is highly unlikely to occur as the project is not likely to create any significant barriers to fauna movement along the riparian corridor of the Georges River and the species is moderately mobile and capable of traversing narrow tracts of cleared land between forested areas.

Would the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for this species to date. The land within the site is likely to be of only moderate value to the species due to its fragmented condition and location at the interface with cleared areas. As such this area is unlikely to be critical to the survival of this species.

Would the action disrupt the breeding cycle of an important population?

If breeding occurs on the site, it is likely to be restricted to the higher quality habitat along the riparian corridor of the Georges River. As this habitat will largely be retained and rehabilitated and biodiversity offsets will be provided for all native vegetation communities cleared, the breeding cycle of any population of the species on the site is unlikely to be significantly disrupted.

Would the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Approximately 27.4 ha to 35.7 ha of potential habitat for the species will be removed, however, substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

A significant long-term net loss of habitat for the species is unlikely and the project is, therefore, unlikely to reduce the availability or quality of habitat to the extent that the species is likely to decline.

Would the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled in accordance with a weed management plan.

The action is unlikely to result in invasive species becoming established in this vulnerable species' habitat.

Would the action interfere substantially with the recovery of the species?

Substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

There is unlikely to be a significant net loss of habitat for the species and the action is unlikely to interfere substantially with the recovery of the species.

2.1.6 Conclusion

The Koala is unlikely to be significantly affected by the project.

2.2 Grey-headed Flying-fox

2.2.1 Status

The Grey-headed Flying-fox is listed as Vulnerable under the EPBC Act.

2.2.2 Description

The Grey-headed Flying-fox is found in a variety of habitats including subtropical and temperate rainforest, mangroves, paper bark swamps, heathland, sclerophyll forests, urban gardens and cultivated areas from South-east Queensland, through eastern NSW into south-eastern areas of Victoria with occasional occurrences in eastern South Australia. It forages on blossoms and fruits of over 80 species of plants (Parry-Jones & Augee 1991). The major foraging resource for Grey-headed Flying-fox includes the nectar and pollen of a variety of native plants including *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines, and native figs (*Ficus* spp.). They have also been found to chew leaves and appear to eat the salt glands from mangroves (Parry-Jones & Augee 1991).

Grey-headed Flying-foxes congregate in camps of up to 200,000 individuals with camp size influenced by the availability of the local blossom, with the camps usually being located close to water, in vegetation within a dense canopy. These bats have nightly feeding ranges of up to 20 to 50 km from their daytime camp (Eby 1991).

Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Annual mating commences in January and a single young is born each October or November. For the first three weeks females carry their young when they forage, after this, the young are left together in the camp when they forage (Churchill 2008).

Site fidelity to camps is high with some camps being used for over a century. Individuals are highly mobile and regularly move between camp sites in response to local food availability (Parry-Jones & Augee 1991; Parry-Jones & Augee 1992; Spencer *et al.* 1991).

2.2.3 Surveys conducted

The following surveys were conducted for the Grey-headed Flying-fox:

- comprehensive vegetation survey
- survey for camps
- spotlighting surveys.

This assessment was consistent with Grey-headed Flying-fox commonwealth survey guidelines. The Grey-headed flying-fox was observed foraging in trees on the site.

2.2.4 Specific impacts

Grey-headed Flying-foxes have been previously recorded in the locality and a single individual was recorded flying over the investigation area during field surveys. No flying-fox colonies were recorded on the site.

Food resources for the Grey-headed Flying-fox (nectar and fruit) are generally varied and abundant in the summer months and scarce in winter (Department of Sustainability Environment Water Population and Communities 2012). Vegetation dominated by winter-flowering trees is, therefore, of particular importance as foraging habitat for the species.

The Castlereagh Scribbly Gum Woodland of the site may provide a foraging resource for the Grey-headed Flying-fox when the dominant trees are in flower. The dominant trees in this community (*Eucalyptus sclerophylla* and *Melaleuca* spp.) are summer-flowering and do not provide a substantial winter food source for the species. *Eucalyptus tereticornis*, a winter-flowering species, is one of the dominant trees in the Alluvial Woodland and Riparian Forest communities.

Flying-foxes roost and breed in large colonies (camps) which are typically located in tall, at least moderately dense vegetation usually in close proximity to water bodies. The only vegetation on the site with potential to provide suitable conditions for a flying-fox camp is the riparian vegetation along the Georges River. The nearest known camp is at Cabramatta, approximately 4.5 km north-east of the subject site.

The approximately 17 ha of Castlereagh Scribbly Gum Woodland and Castlereagh Scribbly Gum Woodland to be removed is only likely to be used as a foraging habitat by this species in summer when the dominant tree species are flowering heavily and is unlikely to be significant habitat.

The approximately 27.4 ha to 35.7 ha of Alluvial Woodland and Riparian Forest to be removed is likely to be of moderate to high value as winter foraging habitat for this species.

2.2.5 Significance assessment

Grey-headed Flying-foxes occur as a single population throughout their range with individuals dispersing between temporary and permanent camps during nomadic feeding movement (Office of Environment and Heritage 2012). The concept of important populations of this species is therefore problematic. Important habitat is used here as a surrogate for important populations.

Would the action lead to a long-term decrease in the size of an important population of a species?

The higher value riparian habitat containing winter food resources and potential camp sites for the species will largely be retained and rehabilitated and biodiversity offsets will be provided for all native vegetation communities cleared.

The project is, therefore, unlikely to reduce the availability of important habitat to an extent that it would result in a long-term decrease in the population of the species.

Would the action reduce the area of occupancy of an important population?

The higher value riparian habitat containing winter food resources and potential camp sites for the species will largely be retained and rehabilitated.

Substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

The project is, therefore, unlikely to significantly reduce the area of occupancy of the species.

Would the action fragment an existing important population into two or more populations?

Fragmentation is highly unlikely to occur as the species is highly mobile, capable of traversing large tracts of unsuitable habitat and occurs as a single population.

Would the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for this species to date. The land within the subject site does not contain any known camp sites and a relatively small area (27.4 ha to 35.7 ha) of moderate to high value foraging habitat. As such this area is unlikely to be critical to the survival of this species.

Would the action disrupt the breeding cycle of an important population?

No camp sites were recorded on the site and no historical camps are known from the location. The site is therefore unlikely to be important for the breeding cycle of the species.

Would the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Approximately 36.7 ha of habitat for the species (including 27.4 ha to 35.7 ha of higher quality winter-foraging habitat) will be removed, however, substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

The long-term net loss of habitat for the species on site is unlikely to reduce the availability or quality of habitat to the extent that the species is likely to decline.

Would the action result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled in accordance with a weed management plan.

The action is unlikely to result in invasive species becoming established in this vulnerable species' habitat.

Would the action interfere substantially with the recovery of the species?

Substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

There is unlikely to be a significant net loss of habitat for the species and the action is unlikely to interfere with the recovery of the species.

2.2.6 Conclusion

The Grey-headed Flying Fox is unlikely to be significantly affected by the project.

2.3 Spotted-tailed Quoll

2.3.1 Status

The Spotted-tailed Quoll is listed as an Endangered species under the EPBC Act.

2.3.2 Description

The Spotted-tailed Quoll occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service 1999d). The species occurs in wide range of forest types, although appears to prefer moist sclerophyll forest, rainforest, and riparian habitat. It is most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. It nests in rock caves and hollow logs or trees and feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service 1999c, 1999d).

2.3.3 Surveys conducted

The following surveys were conducted which were of relevance to the Spotted-tailed Quoll:

- cage trapping survey for camps
- Hair tubes - hair sampling and analyis
- spotlighting surveys.

The survey effort was less than that recommended in the Commonwelath guidelines but it is considered adequate as much of the habitat of the site is marginal and previous surveys have been conducted of the site and surrounds (LesryK Environmental Consultants 2003; URS 2004).The Spotted-tailed Quoll was presumed to occur intermittently on site based on habitat assessment.

2.3.4 Specific impacts

Most of the vegetation of the site is considered to be at best marginal as habitat due to the paucity of tree hollows or fallen hollow logs, fragmentation of woodland remnants, sparse groundcover vegetation and likely low density of potential prey.

Only the riparian vegetation along the Georges River is likely to provide suitable conditions for permanent occupation and breeding due to its continuity with larger vegetation remnants to the south and the presence of potential prey and den sites (rock outcropping, hollow logs, tree hollows).

The approximately 27.4 ha to 35.7 ha of Alluvial Woodland to be removed has potential to provide foraging, shelter and breeding habitat for this species.

Substantial (23 ha) area of riparian vegetation will be retained, existing cleared areas and areas dominated by woody weed thickets (17.8 ha) will be regenerated and additional biodiversity offseting activities will be undertaken.

2.3.5 Significance assessment

Would the action lead to a long-term decrease in the size of a population?

The species was not recorded within the study area however it is possible that the species may occupy the site as part of a large home range extending several or more kilometres beyond the study area through areas of contiguous bushland. The small amount of habitat clearing that would occur as a result of the project is unlikely to change the carrying capacity of the locality. As the species is unlikely to shelter in most of the habitat found within the site and measures would be implemented to reduce the risk of injury to fauna during vegetation clearing, the risk of direct mortality of individuals of this species is low. The project is thus unlikely to lead to a reduction the population of the species.

Would the action reduce the area of occupancy of the species?

Substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

The project is, therefore, unlikely to reduce the area of occupancy of the species.

Would the action fragment an existing population into two or more populations?

The Spotted-tailed Quoll often inhabits open woodland habitats agricultural lands and is hence unlikely to be significantly affected by the minor fragmentation of habitat that is likely to occur. If present in the locality, the Spotted-tailed Quoll is likely to move along corridors of riparian vegetation in the locality and to forage in nearby woodland/forest remnants. These riparian corridors are unlikely to be significantly fragmented by the project.

Would the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for this species. The chiefly marginal, fragmented habitat that the species would lose is considered to be of only moderate importance to any local occurrence of this species.

Would the action disrupt the breeding cycle of a population?

The project is only likely to result in a small reduction in the availability of potential breeding habitat for the species on the site. Given the small proportion of potential breeding habitat to be lost and the proposed revegetation of the riparian area which would enhance retained habitat, no significant impact on the breeding cycle of the species is likely to occur as result of the project.

Would the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The 27.4–35.7 ha of habitat that would be cleared which would form only part of the home range of a single individual or breeding pair of the species.

The habitat for the species which would be modified is considered to be of only moderate importance to any local occurrence of this species due to its disturbed condition.

The removal of habitat will be offset through revegetation within the riparian corridor and additional biodiversity offsets. As such, the project is unlikely to result in the long-term decline of the species.

Would the action result in invasive species that are harmful an endangered species becoming established in the endangered species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled during the project. The project is unlikely to provide a food source or otherwise affect local populations of invasive pest species such as feral cats and foxes which may compete with, prey on or spread disease to the Spotted-tailed Quoll.

The action is unlikely to result in invasive species becoming established in vulnerable species habitat.

Would the action introduce disease that may cause the species to decline?

Mitigation measures provided would minimise the potential for the introduction of pathogens (e.g. plant pathogens) into adjacent areas of habitat and the introduction of disease is unlikely.

Would the action interfere with the recovery of the species?

Substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

There is unlikely to be a net loss of habitat for the species and the action is unlikely to interfere with the recovery of the species.

2.3.6 Conclusion

The project is unlikely to substantially affect the availability of potential breeding/den or foraging habitat for the species in the study area or broader locality.

The Spotted-tailed Quoll is unlikely to be significantly affected by the project.

2.4 Swift Parrot and Regent Honeyeater

The following two species of bird are Endangered migratory or nomadic nectar-eating species that are only likely to utilise the subject site on a seasonal or sporadic basis in response to the flowering of the dominant eucalypt species.

2.4.1 Status

The Swift Parrot and Regent Honeyeater are listed as Endangered species under the EPBC Act.

2.4.2 Swift Parrot

Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, Swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coast's including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering *Acacia pycnantha*, is indicated. Sites used vary from year to year. (Garnett & Crowley 2000),(Swift Parrot Recovery Team 2001).

2.4.3 Regent Honeyeater

Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with *Casuarina cunninghamiana* and *Amyema cambagei* are important for feeding and breeding. Important food trees include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), E. melliodora (Yellow Box) and *E. leucoxylon* (Yellow Gum) (Garnett & Crowley 2000).

Regent Honeyeaters are highly mobile, rarely remaining long in one place unless breeding. Even then, they usually depart as soon as their young are independent. During winter, Regent Honeyeaters disperse widely in small groups. In spring they concentrate into the main breeding areas around Chiltern and Benalla in Victoria and Capertee Valley and Bundarra District in NSW. Other sites regularly visited include Canberra and the Warrumbungles, Mudgee and Gosford areas in New South Wales (Garnett & Crowley 2000).

The species also utilises the woodland communities of the Cumberland Plain.

2.4.4 Surveys conducted

The following surveys were conducted which were of relevance to the Regent Honeyeater:

- Diurnal bird surveys

The survey effort was less than that recommended in the Commonwelath guidelines but it is considered adequate as much of the habitat of the site is marginal and previous surveys have been conducted of the site and surrounds (LesryK Environmental Consultants 2003; URS 2004).

Survey effort was less than that recommended in the relvant Commonwelath survey guidelines but it is considered adequate as much of the habitat of the site is marginal and previous surveys have been conducted of the site and surrounds (LesryK Environmental Consultants 2003; URS 2004).

The Regent Honeyeater and Swift Parrot were presumed to occur intermittently on site based on habitat assessment.

2.4.5 Specific impacts

The approximately 27.4–35.7 ha of Alluvial Woodland and Riparian Forest affected may be used as a foraging habitat by these species on a seasonal or sporadic basis when the dominant eucalypt species are flowering heavily. The remaining vegetation communities of the site are dominated by summer-flowering trees and are unlikely to provide substantial foraging habitat for these species.

As a substantial (>50m wide) area of riparian vegetation will be retained and substantial rehabilitation of existing cleared and weed-dominated areas (17.8 ha) will be undertaken, potential foraging habitat for the species is unlikely to be affected.

The Swift parrot has only ever been recorded as breeding in Tasmania. The site is not within any of the core breeding areas for the Regent Honeyeater. Neither of these species are likely to breed on the site.

2.4.6 Significance assessment

Would the action lead to a long-term decrease in the size of a population?

The marginal potential habitat for these species to be removed is only likely to be used as a foraging habitat by these species on a sporadic basis when the dominant eucalypt species are flowering heavily. Furthermore, the higher value riparian habitat containing winter food resources for the species will largely be retained and rehabilitated and biodiversity offsets will be provided for all native vegetation communities cleared.

The project is unlikely, therefore, to result in a long-term decrease in the size of a population of either species.

Would the action reduce the area of occupancy of the species?

Substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

The project is, therefore, unlikely to reduce the area of occupancy of the species.

Would the action fragment an existing population into two or more populations?

As these species are highly mobile it is unlikely that they would be significantly affected by the minor additional habitat fragmentation that would occur as a result of the proposal. Any existing population is unlikely to be split.

Would the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for these species to date. Potential foraging habitat for these species is likely to be relatively abundant in the locality. The foraging habitat that the species would lose is likely to be of only moderate importance to the local occurrence of these species. As such this area is unlikely to be critical to the survival of the species.

Would the action disrupt the breeding cycle of a population?

The Swift Parrot only breeds in Tasmania. The Regent Honeyeater chiefly breeds in several main breeding areas and is unlikely to breed in the disturbed habitat of the site. No significant impact on the lifecycle of these species is likely to occur as result of the proposal.

Would the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The approximately 27.4–35.7 ha of marginal quality woodland habitat that would be removed is unlikely to be significant habitat for these species. These species are highly mobile and forage over a large area on resources that are widely available in the proposal locality.

The action would not result in significant isolation or fragmentation of habitat for these species which are wide-ranging species capable of foraging in highly fragmented landscapes.

The action would not remove significant habitat or result in isolation of habitat. As such, the proposal is unlikely to result in the long-term decline of the species.

Would the action result in invasive species that are harmful an endangered species becoming established in the endangered species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled in accordance with a weed management plan.

The action is unlikely to result in invasive species becoming established in the habitat of these species.

Would the action introduce disease that may cause the species to decline?

The action is unlikely to result in disease introduction as it does not involve the movement of animals or other potential bird disease vectors into the area.

Would the action interfere with the recovery of the species?

Substantial areas (17.8 ha) that are currently dominated by exotic grasses or woody weed thickets with little or no canopy cover will have woodland vegetation restored and biodiversity offsets will be provided for all native vegetation communities cleared.

There is unlikely to be a net loss of habitat for the species and the action is unlikely to interfere with the recovery of the species.

2.4.7 Conclusion

The Swift Parrot is listed as an Endangered species under the EPBC Act and the Regent Honeyeater is listed as Critically Endangered.

The Swift Parrot and Regent Honeyeater are unlikely to be significantly affected by the project.

C3. Threatened species of plant

3.1 Persoonia nutans

3.1.1 Status

Persoonia nutans is listed as EPBC Act) and the TSC Act (NSW Department of Environment and Conservation 2005).

3.1.2 Description

Persoonia nutans is an erect to spreading shrub in the family Proteaceae with yellow flowers and reddish stems and branches (NSW Department of Environment and Conservation 2005).

3.1.2.1 Limits of known distribution

The species is a NSW endemic, restricted to western Sydney, between Richmond in the north and Macquarie Fields in the south (NSW Department of Environment and Conservation 2005).

3.1.2.2 Large and important populations

Persoonia nutans does not typically appear in discrete populations, but rather, occurs as scattered individuals throughout suitable habitat. It is therefore difficult to place precise limits on the boundaries of known populations. The majority of populations (and 99% of individuals) occur in the north of the species range in the Agnes Banks, Londonderry, Castlereagh, Berkshire Park and Windsor Downs areas. The smaller disjunct populations located in the southern portion of the species' distribution are estimated to constitute less than 1% of the population of the entire species (NSW Department of Environment and Conservation 2005).

3.1.2.3 Local population

It is estimated that approximately 420 ha of potential habitat for this species exists within the Holsworthy area to the south and lands to the west of the site (refer Figure E-1). Potential habitat for *Persoonia nutans* is mapped in Figure E-1 and represents those areas that possess suitable soil types (Agnes Banks and Berkshire Park soil formations) and also support suitable vegetation communities. Recent records of the species from surveys conducted by Parsons Brinckerhoff in late 2012 are also shown on the figure.

Whilst the total population of the species in this area is unknown, approximately 50 individuals of the species were recently recorded during investigations by Parsons Brinckerhoff in late 2012 in vegetation to the east of the site (refer Figure E-1). It is hence considered likely that this habitat, and other habitat to the south, contains a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants within the subject site are therefore likely to make up a small proportion of this population.

Project site boundary

Rail line & station

Grevillea parviflora subsp. parviflora

Persoonia nutans

Grevillea parviflora subsp.*parviflora* - larger sub-populations

Potential habitat

Figure E-1 Potential *Persoonia nutans* & *Grevillea parviflora* habitat

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3.1.2.4 Habitat

The species is confined to western Sydney where it grows on to aeolian and alluvial sediments primarily on the Agnes Banks and Berkshire Park soil landscapes. The species is associated with the following vegetation communities; Agnes Banks Woodlands, Castlereagh Scribbly Gum Woodlands, Cooks River Castlereagh Ironbark Forest, Shale/Gravel Transition Forest, Shale Sandstone Transition Forest and Castlereagh Swamp Woodland (Harden 2002; James 1997; NSW Department of Environment and Conservation 2005; NSW National Parks and Wildlife Service 2001).

3.1.2.5 Critical habitat

To date, critical habitat has not been declared for *P. nutans* under the EPBC Act or TSC Act. However, the large populations located in the Agnes Banks, Londonderry, Castlereagh, Berkshire Park and Windsor Downs areas would contain habitat that is critical to the survival of the species. The smaller disjunct populations located in the southern portion of the species' distribution are estimated to constitute less than 1% of the population of the entire species are unlikely to be critical to the survival of the species (NSW Department of Environment and Conservation 2005).

3.1.2.6 Life-history

Persoonia nutans is an obligate seed regenerator (Benson & McDougall 2000; NSW National Parks and Wildlife Service 2002a). In the event of a fire all existing plants of *P. nutans* are killed and regeneration is dependent upon recruitment from a soil stored seed bank. Consequently, *P. nutans* populations are likely to be dynamic throughout the landscape and fluctuations in space and time of above ground individuals will be a natural occurrence.

Bees and wasps appear to be the major foragers on the flowers of *Persoonia* in eastern Australia (Bernhardt & Weston 1996).

Plants appear to set abundant fruit which is likely to be dispersed by large birds such as Currawongs and mammals such as rats, macropods and possums (Benson & McDougall 2000).

Nothing is known of the longevity of the soil-stored seed bank of *P. nutans*. It appears germination is promoted, not only by fire, but also by physical disturbance (NSW Department of Environment and Conservation 2005; NSW National Parks and Wildlife Service 1996).

3.1.2.7 Diseases and invasive species

Typically, a major consequence of habitat degradation and fragmentation is weed invasion however survey of *P. nutans* sites in 1996 revealed that weed invasion did not then pose a major threat to any populations (NSW National Parks and Wildlife Service 1996). The Castlereagh Scribbly Gum Woodlands and Agnes Banks Woodlands (the predominant habitat for *P. nutans*) grow on acidic, nutrient poor soil which is not highly susceptible to extensive weed invasion (Benson 1992).

It is possible however that some populations of the species are threatened by weed invasion, particularly by exotic perennial grasses. The species may also be affected by introduced animals including grazing by the feral European rabbit and disruption of reproduction due to competition between feral honey bees and the species' native pollinators.

P. nutans may be adversely affected by the soil borne pathogen *Phytophthora cinnamomi* either because of direct infection or degradation of habitat.

3.1.2.8 Susceptibility to fragmentation

Habitat fragmentation can potentially reduce the long-term viability of remnant populations of *P. nutans* because the species is dependent upon recolonisation via seed dispersal in the event of local extinction (NSW Department of Environment and Conservation 2005). Given the relatively large distance seed dispersal capabilities of the bird and mammal species that fed on the fruit of the species however it is unlikely to be sensitive to small scale fragmentation of habitat.

3.1.2.9 Threatening processes

The following key threatening processes listed under the EPBC Act and/or TSC Act are known or considered likely to affect the species:

- Land clearance / Clearing of native vegetation
- Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)
- Competition from feral honey bees (*Apis mellifera*)
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Invasion of native plant communities by exotic perennial grasses
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) / Infection of native plants by *Phytophthora cinnamomi* (Department of Sustainability Environment Water Population and Communities 2011b; Office of Environment and Heritage 2011).

3.1.2.10 Recovery strategies

The following strategies for the recovery of the species have been identified in the combined National and NSW State Recovery Plan recovery plan for the species:

- minimise the loss and fragmentation of *P. nutans* habitat
- identify and minimise the operation of threats at sites where *P. nutans* occurs
- implement a survey and monitoring program that will provide information on the extent and viability of *P. nutans*
- provide public authorities with information that assists in conserving the species
- raise awareness of the species and involve the community in the recovery program
- promote research questions that will assist future management decisions (NSW Department of Environment and Conservation 2005).

3.1.3 Specific impacts

The proposed action will result in the removal of 6.5 ha of habitat known to be occupied by *Persoonia nutans* within the proposed project site and a further 10.5 ha of apparently unoccupied, degraded habitat. This will result in the loss of at least 10 individuals of the species however additional individuals may be represented in a soil seed bank.

It is estimated that approximately 420 ha of potential habitat exists within the Holsworthy area to the south and lands to the west of the site. The areas of known habitat to be cleared for the project therefore equates to approximately 1.5 % of the local habitat for the species. Whilst the total population of the species in this area is unknown, nine individuals of the species were recorded in four distinct locations in vegetation located immediately to the east of the site (URS 2004). The presence of a population of *Persoonia nutans* (>25 individuals) was revealed during surveys conducted for the *SIMTA Moorebank Intermodal Facility - Flora and Fauna Assessment*(Hyder 2012).It is therefore considered likely that this habitat and other habitat to the south contain a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants within the subject site are therefore likely to make up a small proportion of the local population.

3.1.4 Significance assessment

An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will result in one or more of the following.

Lead to a long-term decrease in the size of a population of a species

The project will lead to a reduction in the size of the *Persoonia nutans* population. As only a small proportion of the population of the species would be affected however, this impact is unlikely to result in a significant long-term decrease in the size of the population.

Reduce the area of occupancy of the species

The project will lead to a small (less than 2%) reduction in the area of habitat of the *Persoonia nutans* population. As only a small proportion of habitat of the population would be affected however, this impact is unlikely to result in a significant reduction in the area of occupancy of the population.

Fragment an existing population into two or more populations

In the context of this species high dispersal ability, minimal habitat fragmentation (i.e. the breaking apart of habitat into smaller pieces) will occur as

- only spatially isolated areas of habitat and habitat at or very near the edge of a patch will be removed, and
- the species is capable of dispersal between patches of habitat separated by small breaks due to its bird and mammal vectored seed dispersal mechanism.

The project will not fragment the population into two or more populations.

Adversely affect habitat critical to the survival of a species

The smaller disjunct populations (including that of the subject site) located in the southern portion of the species' distribution are estimated to constitute less than 1% of the population of the entire species are unlikely to be critical to the survival of the species (NSW Department of Environment and Conservation 2005).

The larger areas of potential habitat to the east of Moorebank Ave and further to the south are more likely to represent an area of importance to the survival of *Persoonia nutans* but are unlikely to be critical habitat.

Given the small proportion of this potential habitat (< 2 %) that would be affected, a significant adverse impact on critical habitat for the species is unlikely.

Disrupt the breeding cycle of a population

The project is unlikely to create any barriers to cross-pollination or seed dispersal between patches of habitat within the population and is hence unlikely to significantly affect the breeding cycle of the population.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed action will result in the removal of 6.5 ha of habitat known to be occupied by *Persoonia nutans* and the loss of at least 10 individuals.

The areas to be cleared for the project therefore equates to approximately 1.5 % of the local habitat for the species. Whilst the population of the species in this area is unknown, nine individuals of the species were recorded in four distinct locations in vegetation to the east of the site (URS 2004). It is hence considered likely that this habitat and other habitat to the south contain a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants affected by the project are therefore likely to make up a small proportion of the local population.

The large areas of suitable habitat for *Persoonia nutans* in the locality particularly to the east of Moorebank Ave mean that only a very small proportion of the available habitat for this species in the locality will be removed by the project. Therefore, it is unlikely that the project would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that *Persoonia nutans* is likely to decline.

Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat

The habitat for *Persoonia nutans* in the subject site will be completely removed by the project. Consequently, no invasive species harmful to *Persoonia nutans* would become established in habitat for the species in this area.

It is unlikely that the works would introduce European rabbits or feral honey bees into the habitat of *Persoonia nutans* and it is likely that these species are already present.

Introduce disease that may cause the species to decline

The field survey did not detect the presence of any dieback that may indicate the presence of *Phytophthora cinnamomi* in the project site or the surrounding area. However, construction works may provide a source of introduction for this pathogen into the habitat of *Persoonia nutans*. Mitigation measures would be provided to minimise the chance of *P. cinnamomi* introduction and therefore the project would be unlikely to introduce a disease that may cause *Persoonia nutans* to decline.

Interfere substantially with the recovery of the species.

A recovery plan has been prepared for the species. Most of the identified recovery actions will not be interfered with however, as the project involves removal of individuals of the species and its habitat, the project will interfere with two recovery actions:

- minimise the loss and fragmentation of *P. nutans* habitat
- identify and minimise the operation of threats at sites where *P. nutans* occurs

As the proportion of the population affected is small and the area of habitat affected constitutes a small proportion of habitat for the population, the project is unlikely to interfere substantially with the recovery of the species.

3.1.5 Conclusion

Taking into consideration the significant impact criteria, and based on the fact that the *Persoonia nutans* population in the project site is likely to make up a small proportion of the population under the definition of the EPBC Act, the project is unlikely to result in a significant impact to *Persoonia nutans*. Overall, the potential impact from the project on *Persoonia nutans* is not considered significant with regard to its context and intensity.

3.2 Grevillea parviflora subsp. parviflora

3.2.1 Status

Grevillea parviflora subsp. *parviflora* is listed as Vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the NSW *Threatened Species Conservation Act 1995* (TSC Act).

3.2.2 Description

Grevillea parviflora subsp. *parviflora*, family Proteaceae, is a low open to erect shrub usually 0.3−1 m high with narrow leaves and white flowers with rusty brown hairs (Benson & McDougall 2000; Royal Botanic Gardens 2011). The flowers are spider like, and are white or pinkish with rusty brown hairs. The fruiting capsule is 8-10 mm long with 1-2 seeds per capsule (NSW National Parks and Wildlife Service 2002c).

3.2.2.1 Life history

Little is known of the life history of *Grevillea parviflora* subsp. *parviflora* and most knowledge on this species has arisen from general observation rather than direct scientific study (NSW National Parks and Wildlife Service 2002c). However, it is known that this species is relatively long lived with generation times between 25-60 years (Benson & McDougall 2000).

Flowers are produced between April and May and between July and December and are insect pollinated (Makinson 2000). One to two seeds are released at maturity, with short range (probably <2 m) seed dispersal most likely to be via gravity and ant dispersal (Benson & McDougall 2000; NSW National Parks and Wildlife Service 2002b). Little is known about the production and viability of seed, seed predation or germination rates and requirements (NSW National Parks and Wildlife Service 2002c).

Plants are capable of suckering or regenerating from a rootstock after disturbance (NSW National Parks and Wildlife Service 2002c). After fire or other disturbance, regeneration can occur from both the rhizomes and seed in the soil seed bank; however, after fire, adult plants are killed and seedling recruitment is uncommon (Benson & McDougall 2000). Most populations of *Grevillea parviflora* subsp. *parviflora* appear relatively large as a result of suckering.

3.2.2.2 Habitat requirements

Grevillea parviflora subsp. *parviflora* inhabits ridge crests, upper slopes, or flat plains in low-lying areas between 30–65 m above sea level (in the Lower Hunter Valley and Lake Macquarie) and on higher topography between 200–300 m above sea level south of Sydney (NSW National Parks and Wildlife Service 2002c). *Grevillea parviflora* subsp. *parviflora* prefers areas of shale/sandstone transition geology with sandy or light clay soils derived from Tertiary sands or alluvium that are deposited over thin shales, often with lateritic ironstone gravels that are infertile and poorly drained. Soils from the Mittagong Formation with alternating shale and fine-grained sandstones are also suitable (NSW National Parks and Wildlife Service 2002c).

This species has been recorded in a range of habitats, from heath and shrubby woodland to open forest and can often occur in exposed and disturbed sites such as beside tracks and roadways (NSW National Parks and Wildlife Service 2002c). Specifically, in the Sydney region, *Grevillea parviflora* subsp. *parviflora* is known to occur in the Shale Sandstone Transition Forest, Sydney Sandstone Ridgetop Woodland and Castlereagh Ironbark Forest (NSW National Parks and Wildlife Service 2002c) and in Castlereagh Scribbly Gum Woodland (NSW Scientific Committee 2010).

3.2.2.3 Critical habitat

Critical habitat cannot be declared for *Grevillea parviflora* subsp. *parviflora* under the EPBC Act or TSC Act as it is a Vulnerable species. However, this does not mean that habitat critical for the survival of this species does not exist.

Habitat critical to the survival of a species may include areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts 2009a).

According to the NSW National Parks and Wildlife service (2002b), until there is adequate protection of *Grevillea parviflora* subsp. *parviflora*, all sites where this species occurs are considered important and the habitat is considered significant. Sites of particular significance would include the following:

- sites with a population of >50 plants
- sites with a population that has a varied age structure including active recruitment of seedlings
- sites in an area of intact habitat away from high disturbance areas (NSW National Parks and Wildlife Service 2002b).

3.2.2.4 Limits of known distribution

Grevillea parviflora subsp. *parviflora* is restricted to the Sydney Basin bioregion and occurs in scattered coastal locations in three disjunct populations, one in south-western Sydney (the focus of this assessment), one on the Central Coast and Lower Hunter Valley, and a northern population at Karuah and Tea Gardens (Makinson 2000; NSW National Parks and Wildlife Service 2002c)

Presently, the northern limit of *Grevillea parviflora* subsp. *parviflora* is at Heddon Greta in the Lower Hunter Valley. The southern and western limit is Bargo and the eastern limit is Awaba, near Newcastle (NSW National Parks and Wildlife Service 2002b).

3.2.2.5 Large and important populations

Grevillea parviflora subsp*. parviflora* occurs in substantial numbers in Werakata National Park to the south-west of Kurri Kurri (NSW National Parks and Wildlife Service 2002c). There are at least 21 known populations of *Grevillea parviflora subsp. parviflora* with several other older records requiring confirmation (NSW National Parks and Wildlife Service 2002c) (refer Table 3.1).

Table 3.1 Locality and number of plants in each known population

Locality	Number of plants (stems)
Appin, Wollondilly LGA	Unknown
Picton, Wollondilly LGA	Unknown
Bargo, Bargo Rd, Wollondilly LGA	Approximately 2,000
Wirrimbirra, Bargo, Wollondilly LGA	50
Kemps Creek, Liverpool LGA	1
Voyager Point, Liverpool LGA	Small
Tahmoor, Wollondilly LGA	Extinct
Thirlmere, Wollondilly LGA	Extinct
Prospect LGA	Extinct
Upper Georges River, Liverpool LGA	**Large**
Wedderburn, Campbelltown LGA	Unknown
Maldon, Wollondilly LGA	Unknown
Sydney Water	at least 2
Moss Vale, Wingecarribee LGA	To be confirmed
Kurri Kurri, Cessnock LGA	Unknown
Heddon Greta, Cessnock LGA	Unknown
Dooralong, Wyong LGA	Unknown
Cooranbong, Freemans Drive Macquarie LGA	Unknown
Awaba, Lake Macquarie LGA	Unknown
Karuah	Unknown
Wyong to Putty, Wyong LGA	Unknown
Werakata National Park (Kitchener area)	Substantial numbers
Cessnock LGA	At least 94
West Wallsend, Lake Macquarie LGA	Unknown

Due to the suckering nature of *Grevillea parviflora* subsp. *parviflora* it is often difficult to determine the number of plants at a site. All population estimates for this species are therefore a reflection of the number of suckers rather than individual plants and populations may be smaller than previously thought (Department of Sustainability Environment Water Population and Communities 2011a). The *Grevillea parviflora* subsp. *parviflora* subject to this assessment belong to the Upper Georges River population as highlighted in bold in the table.

Population sizes of *Grevillea parviflora* subsp*. parviflora* are variable but are mostly small (less than 20 plants) to medium size (50–100 plants) with few large populations (greater than 200 plants) (Department of Sustainability Environment Water Population and Communities 2011a; NSW National Parks and Wildlife Service 2002c). The largest known population occurs north of Bargo (refer Table 2.1) with an estimated 2,000 or more plants. The viable population size for *Grevillea parviflora* subsp*. parviflora* is unknown and until such information is available all populations should be assumed to be viable (NSW National Parks and Wildlife Service 2002b).

3.2.2.6 *Diseases and invasive species harmful to Grevillea parviflora subsp. parviflora*

Soil-borne fungal diseases and oomycetes (water moulds) are perhaps the greatest threat to the family Proteaceae in Australia. The genus Grevillea, common with other members of the family Proteaceae, is generally considered susceptible to infection from *Phytophthora cinnamomi* which causes dieback. *Grevillea parviflora* subsp. *parviflora* is identified as a species that may be adversely affected by *P. cinnamomi* either because populations are threatened by direct infestation or by degradation of habitat (NSW Scientific Committee 2002).

Weed invasion is recognised as a threat to *Grevillea parviflora* subsp. *parviflora* (NSW National Parks and Wildlife Service 2002c). Aggressive native species such as *Imperata cylindrica* and *Kunzea ambigua* can reduce available habitat and create barriers for *Grevillea parviflora* subsp. *parviflora* (Department of Sustainability Environment Water Population and Communities 2011a; NSW National Parks and Wildlife Service 2002c).

Grevillea parviflora subsp. *parviflora* may also be affected by introduced animals including grazing by the feral European rabbit and disruption of reproduction due to competition between feral honey bees and the species' native pollinators.

3.2.2.7 *Susceptibility of Grevillea parviflora subsp. parviflora to fragmentation*

While direct habitat loss is the most important threat to *Grevillea parviflora* subsp. *parviflora*, fragmentation of populations and habitat are also an issue. The creation of barriers as a result of vegetation clearing and degradation of habitat due to weed invasion, frequent fires, dumping of fill or rubbish, and grazing by domestic animals may isolate populations of *Grevillea parviflora* subsp. *parviflora* resulting in a reduction in gene flow, lowering the genetic diversity of populations (NSW National Parks and Wildlife Service 2002b). The naturally limited seed dispersal range of *Grevillea parviflora* subsp. *parviflora* means that even minimal clearing may act as an effective barrier for this species (NSW National Parks and Wildlife Service 2002b).

Connectivity between populations of *Grevillea parviflora* subsp. *parviflora* is likely to be good in southern parts of its distribution (i.e. around Bargo) and in some areas in the Lower Hunter Valley (NSW National Parks and Wildlife Service 2002b). However, in more urbanised areas closer to Sydney (such as the study area), isolation of populations is likely to be increasing and presents more of an issue (NSW National Parks and Wildlife Service 2002b).

3.2.2.8 *Key threatening processes relevant to Grevillea parviflora subsp. parviflora*

The following key threatening processes listed under the EPBC Act and/or TSC Act are known or considered likely to affect *Grevillea parviflora* subsp. *parviflora*:

- Land clearance / Clearing of native vegetation
- Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)
- Competition from feral honey bees (*Apis mellifera*)
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Invasion of native plant communities by exotic perennial grasses
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) / Infection of native plants by *Phytophthora cinnamomi* (Department of Sustainability Environment Water Population and Communities 2011b; Office of Environment and Heritage 2011).

3.2.2.9 *Recovery strategies for Grevillea parviflora subsp. parviflora*

A recovery plan has not been developed for *Grevillea parviflora* subsp. *parviflora* under the EPBC Act or TSC Act. However, there are recovery strategies and actions recognised by the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for implementation at a regional and local scale. Regional priority actions include:

- Habitat Loss, Disturbance and Modification
- Identify populations of high conservation priority.
- Manage threats to areas of vegetation that contain populations/occurrences/remnants of Grevillea parviflora subsp. parviflora.
- Ensure road widening and maintenance activities (or other infrastructure or development activities) in areas where the species occurs do not adversely impact on known populations.
- Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on Grevillea parviflora subsp. parviflora.
- Investigate formal conservation arrangements, such as the use of covenants, conservation agreements or inclusion in reserve tenure.
- Conservation Information
- Raise awareness of Grevillea parviflora subsp. parviflora within the local community.
- Liaise with land managers to encourage the preparation of site management plans and the implementation of appropriate threat abatement measures, particularly in fire management, bush regeneration, roadside management, weed control, fencing and signage.
  - Ensure this species is considered in all planning matters on land that contains or may contain populations of the species.
- Enable Recovery of Additional Sites and/or Populations
  - Investigate options for linking, enhancing or establishing additional populations.
  - Implement appropriate national translocation protocols if establishing additional populations is considered necessary and feasible.
  - Undertake seed collection and storage.

Local Priority Actions include:

- Habitat Loss, Disturbance and Modification
  - Monitor known populations to identify key threats.
  - Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
  - Control access routes to suitably constrain public access to known sites on public land.

- Undertake survey work in suitable habitat and potential habitat to locate any additional populations.
- Minimise adverse impacts from land use at known sites.
- Mark and fence off sites during development/road maintenance activities.
- Ensure that personnel responsible for planning and undertaking maintenance activities are able to identify the species and are aware of its habitat.
- Avoid use of heavy machinery in areas of known populations.

- Invasive Weeds
  - Identify and remove weeds in the local area, which could become a threat to Small-flower Grevillea, using appropriate methods.
  - Manage sites to prevent introduction of invasive weeds, which could become a threat to *Grevillea parviflora* subsp. *parviflora*, using appropriate methods.
- Fire
  - Reinstate an appropriate fire regime for *Grevillea parviflora* subsp. *parviflora*; either restrict fire or undertake ecological burns as required.

3.2.3 Specific impacts

The proposed action may result in the removal of 6.5 ha of habitat known to be occupied by *Grevillea parviflora* subsp. *parviflora* and a further 10.5 ha of degraded, apparently unoccupied, potential habitat within the proposed project site. This will result in the loss of at least 16 individuals of the species with many suckers; however, additional individuals may be represented in a soil seed bank.

Potential habitat for *Grevillea parviflora subsp. parviflora* is mapped in Figure E-1 and represents those areas that possess suitable soil types (Agnes Banks and Berkshire Park soil formations) and also support suitable vegetation communities. Recent records of the species from surveys conducted by Parsons Brinckerhoff in late 2012 are also shown on the figure. It is estimated that at least 420 ha of potential habitat exists within the Holsworthy area to the south of the site. The areas to be cleared for the project therefore equates to approximately 1.5% of the local habitat for the species.

Whilst the precise Upper Georges River local population of the species is unknown, it is considered to be large; i.e. in excess of 200 plants (Department of Sustainability Environment Water Population and Communities 2011a). The plants within the subject site are therefore likely to make up a small proportion of the local population. Whilst the total population of the species in this area is unknown, in excess of 300 stems of the species were recently recorded during investigations by Parsons Brinckerhoff in late 2012 in vegetation to the east of the site (refer Figure E-1). It is hence considered likely that this habitat, and other habitat to the south, contains a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants within the subject site are therefore likely to make up a small proportion of this population.

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3.2.4 Significance assessment

Defining the population subject to this assessment

A ‘population of a species’ is defined under the EPBC Act as an occurrence of the species in a particular area and includes:

- geographically distinct regional populations or collections of local populations or
- populations, or collections of local populations, that occur within a particular bioregion. (Department of the Environment Water Heritage and the Arts 2009b).

Accordingly, the population of *Grevillea parviflora* subsp. *parviflora* that is subject to this assessment is the Upper Georges River population in the Liverpool LGA.

Whether or not an action is likely to have a significant impact on a Vulnerable species, such as *Grevillea parviflora* subsp*. parviflora*, is influenced by the importance of the population under assessment. An important population, as defined under the EPBC Act, is a population that is necessary for a species’ long-term survival and recovery (Department of the Environment Water Heritage and the Arts 2009b). This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity
- populations that are near the limit of the species range.

Is the population within the subject site an important population?

A recovery plan for *Grevillea parviflora* subsp. *parviflora* has not been prepared and as such, no important populations have been identified in this manner. A discussion of the likely importance of the population of *Grevillea parviflora* subsp. *parviflora* subject to this assessment under the definition of the EPBC Act is provided below.

The Upper Georges River population of *Grevillea parviflora* subsp. *parviflora* is recognised as being large (see Department of Sustainability Environment Water Population and Communities 2011a).

Although no studies on the genetics of the population have been conducted it is considered possible that the Upper Georges River population is genetically distinct from other populations in the bioregion.

The Upper Georges River *Grevillea parviflora* subsp. *parviflora* population lies in the central portion of this species distributional range. However, as this species is distributed in a narrow north - south band from Bargo to the Lower Hunter Valley this population is near the easternmost extent of this species’ distribution.

The Upper Georges River population may therefore be an important population.

In accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment Water Heritage and the Arts 2009b), an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will result in one or more of the following.

Lead to a long-term decrease in the size of an important population of a species

The project will lead to a reduction in the size of the *Grevillea parviflora* subsp. *parviflora* population. As only a small proportion of the population of the species would be affected however, this impact is unlikely to result in a significant long-term decrease in the size of the population.

Reduce the area of occupancy of an important population

The project will lead to a small (less than 2%) reduction in the area of habitat of the *Grevillea parviflora* subsp. *parviflora* population. As only a small proportion of habitat of the population would be affected, this impact is unlikely to result in a significant reduction in the area of occupancy of the population.

Fragment an existing important population into two or more populations

In the context of this species' limited dispersal ability, minimal habitat fragmentation (i.e. the breaking apart of habitat into smaller pieces) will occur due to the project as only functionally isolated areas of habitat and habitat at or very near the edge of a patch will be removed.

The project will not fragment the population into two or more populations.

Adversely affect habitat critical to the survival of a species

The habitat for *Grevillea parviflora* subsp. *parviflora* that would be removed to the west of Moorebank Ave, while in good to moderately degraded condition, is functionally isolated (for this species due to its limited seed dispersal) from other areas of *Grevillea parviflora* subsp. *parviflora* habitat in the locality. This habitat is in an area of high disturbance and based on the data collected during the field survey, the population is composed of approximately 16 mature plants with many suckers. Due to the suckering nature of *Grevillea parviflora* subsp. *parviflora* it is impossible to determine if active recruitment of seedlings is occurring as the smaller plants may have been suckers or seedlings.

The larger areas of potential habitat to the east of Moorebank Ave and further to the south that retain functional connectivity for this species are more likely to represent an area of habitat critical to the survival of *Grevillea parviflora* subsp. *parviflora*.

Given the small proportion of this potential habitat (~1.5%) that would be affected, a significant adverse impact on critical habitat for the species is unlikely.

Disrupt the breeding cycle of an important population

The project is unlikely to create any barriers to cross-pollination or seed dispersal between patches of habitat within the population and is hence unlikely to significantly affect the breeding cycle of the population.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The project would result in the direct removal of approximately 6.5 ha of habitat for *Grevillea parviflora* subsp. *parviflora* in the subject site that contains approximately 16 genetic individuals. With the presence of large areas of suitable habitat for *Grevillea parviflora* subsp. *parviflora* in the locality (approximately 420 ha), particularly to the east of Moorebank Avenue, only a very small proportion of the available habitat for this species in the locality will be removed by the project. The project would result in the loss of approximately 1.5% of the currently available habitat for *Grevillea parviflora* subsp. *parviflora* in the locality. Therefore, it is unlikely that the project would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that *Grevillea parviflora* subsp. *parviflora* is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The habitat for *Grevillea parviflora* subsp. *parviflora* in the subject site to the will be completely removed by the project. Consequently, no invasive species harmful to *Grevillea parviflora* subsp. *parviflora* would become established in habitat for the species in this area.

Introduce disease that may cause the species to decline

The field survey did not detect the presence of any dieback that may indicate the presence of *Phytophthora cinnamomi* in the project site or the surrounding area. However, construction works may provide a source of introduction for this pathogen into the habitat of *Grevillea parviflora* subsp. *parviflora*. Mitigation measures would be provided to minimise the chance of *P. cinnamomi* introduction and therefore the project would be unlikely to introduce a disease that may cause *Grevillea parviflora* subsp. *parviflora* to decline.

Interfere substantially with the recovery of the species.

A recovery plan has not been prepared for *Grevillea parviflora* subsp. *parviflora* however, several regional and local scale recovery actions have been identified (see Section 2.9). Most of the identified recovery actions will not be interfered with however, as the project involves removal of *Grevillea parviflora* subsp. *parviflora* plants and habitat, the project will interfere with two recovery actions:

- Ensure road widening and maintenance activities (or other infrastructure or development activities) in areas where the species occurs do not adversely impact on known populations.

- Avoid use of heavy machinery in areas of known populations.

As the proportion of the population affected is small and only a small proportion of potential habitat for the population will be affected, the project is unlikely to interfere substantially with the recovery of the species.

3.2.5 Conclusion

Taking into consideration the significant impact criteria, and based on the fact that the *Grevillea parviflora* subsp. *parviflora* in the project site is likely to make up a small proportion of the population under the definition of the EPBC Act, the project is unlikely to result in a significant impact to *Grevillea parviflora* subsp. *parviflora*. Overall, the potential impact from the project on *Grevillea parviflora* subsp. *parviflora* is not considered significant with regard to its context and intensity.

3.3 Persoonia hirsuta

3.3.1 Status

Persoonia hirsuta is listed as Endangered species under the EPBC Act.

3.3.2 Description

Persoonia hirsuta occurs in central coast and central tableland districts where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) and rarely shale (NSW Scientific Committee 1998). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997).

3.3.3 Specific impacts

Approximately 16.1 ha of potential habitat for the species corresponding to Castlereagh Scribbly Gum Woodland will be cleared.

3.3.4 Significance assessment

Would the action lead to a long-term decrease in the size of a population?

The species was not recorded within the study area however it is possible that individuals of the species may be present in the form of a soil-stored seedbank. If present these individuals are likely to be present in low numbers and to represent a small proportion of any broader population. The potential loss of a small number of individuals would be unlikely to lead to a long term decrease in population size.

Would the action reduce the area of occupancy of the species?

The species was not recorded within the study area however it is possible that individuals of the species may be present in the form of a soil-stored seedbank. If present these individuals are likely to occupy a small area representing a small proportion of an area potentially occupied by the species. The potential loss of a small proportion of the potential area of occupancy would be unlikely to lead to a long term significant decrease the species' area of occupancy.

Would the action fragment an existing population into two or more populations?

The species was not recorded within the study area however it is possible that individuals of the species may be present in the form of a soil-stored seedbank. As the potential habitat for the species in the study area is already fragmented, and will be cleared for development, it is unlikely that it would further fragment any population that may occur in the locality.

Would the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for the species to date. The species was not recorded within the study area however it is possible that individuals of the species may be present in the form of a soil-stored seedbank. Any such occurrence is however likely to be small and as such this area is unlikely to be critical to the survival of the species.

Would the action disrupt the breeding cycle of a population?

The species was not recorded within the study area however it is possible that individuals of the species may be present in the form of a soil-stored seedbank.

The project is unlikely to significantly affect processes such as pollination, seed dispersal and recruitment which could affect the breeding of any population in the broader locality outside of the study area.

No significant impact on the breeding cycle of the species is likely to occur as result of the project.

Would the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Approximately16.1 ha of potential habitat would be removed and this is unlikely to be important habitat for the species.

The action would not remove important habitat or result in isolation of habitat. As such, the project is unlikely to result in the long-term decline of the species.

Would the action result in invasive species that are harmful an endangered species becoming established in the endangered species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat. Invasive weeds within the site would be controlled during the project.

The action is unlikely to result in invasive species becoming established in an endangered species' habitat however the disturbance created may cause existing weed species to proliferate. The proposed weed management measures for the site would however minimise this potential impact.

Would the action introduce disease that may cause the species to decline?

Mitigation measures provided would minimise the potential for the introduction of plant pathogens into adjacent areas of habitat and the introduction of disease is unlikely.

Would the action interfere with the recovery of the species?

The species was not recorded within the study area however it is possible that individuals of the species may be present in the form of a soil-stored seedbank.

It is unknown whether a viable population of any of the species exists within the study area. The presence of a substantial population of the species with potential for long-term viability is unlikely as the species were not recorded on the site. If present, this species would most likely exist as a small, isolated population or as a small part of a broader population extending beyond the study area.

As such, the habitat within the site is not likely to be important to the recovery of the species in the locality.

3.3.5 Conclusion

Persoonia hirsuta is listed as Endangered species under the EPBC Act.

Persoonia hirsuta is unlikely to be significantly affected by the project.

3.4 Other species of plant

The following species which are listed as Vulnerable species under the EPBC Act are considered to have a moderate likelihood of occurring on the site:

- *Acacia bynoeana*
- *Acacia pubescens*
- *Dillwynia tenuifolia*
- *Leucopogon exolasius*
- *Pultenaea parviflora*

These species have been as a group as they are all shrubs which were not recorded on the site but are considered to have a moderate likelihood of occurrence on the site as isolated individuals and/or in the form of a soil-stored seed bank.

3.4.1 Description

The habitat of these species is summarised in Table 3-2.

Table 3.2 Habitat of Commonwealth listed Vulnerable species of plant

Species Name	Habitat
Acacia bynoeana	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with Corymbia gummifera, Eucalyptus haemastoma, E. gummifera, E. parramattensis, E. sclerophylla, Banksia serrata and Angophora bakeri (NSW National Parks and Wildlife Service 1999a). No historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
Acacia pubescens	Restricted to the Sydney Region from Bilpin to the Georges River and also at Woodford where it usually grows in open sclerophyll forest and woodland on clay soils. Typically it occurs at the intergrade between shales and sandstones in gravely soils often with ironstone (Harden 2002; NSW National Parks and Wildlife Service 2003a). Historic records of this species exist in the locality. Marginal habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
Dillwynia tenuifolia	Occurs on the Cumberland Plain from the Blue Mountains to Howes Valley area where it grows in dry sclerophyll woodland on sandstone, shale or laterite (Harden 2002). Specifically, occurs within Castlereagh woodlands, particularly in shale gravel transition forest. Associated species include Eucalyptus fibrosa, Eucalyptus sclerophylla, Melaleuca decora, Daviesia ulicifolia, Dillwynia juniperina and Allocasuarina littoralis (James 1997).
Leucopogon exolasius	Restricted chiefly to the Woronora and Grose Rivers and Stokes Creek, Sydney catchments and the Royal National Park. One old record from the Grose River. Grows in woodland on sandstone (Royal Botanic Gardens 2011). Marginal habitat for this species exists in the study area along the Georges River corridor. Three local records. Unlikely to occur elsewhere in study area.
Pultenaea parviflora	Restricted to the Cumberland Plain where it grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium (Harden 2002). Locally abundant within Castlereagh Ironbark Forest and Shale/Gravel Transition Forest on tertiary alluvium or laterised clays (James 1997; NSW National Parks and Wildlife Service 2002d). Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.

3.4.2 Specific impacts

Approximately 16.1 ha of potential habitat for these species corresponding to the Castlereagh Scribbly Gum Woodland will be cleared.

3.4.3 Significance assessment

None of these species were recorded within or adjacent to the study area however it is possible that they may exist in the study area as a soil-stored seedbank. If present they are likely to occur in low numbers and to be isolated from nearby occurrences due to habitat fragmentation. Due to the resultant reduction in the potential for interaction via pollination and/or seed dispersal, the study area is unlikely to contain an important population of any of these species.

Would the action lead to a long-term decrease in the size of an important population of a species?

Not applicable

Would the action reduce the area of occupancy of an important population?

Not applicable

Would the action fragment an existing important population into two or more populations?

Not applicable

Would the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for this species to date. The habitat within the subject site is of marginal suitability for these species due to previous disturbance and weed invasion and the species were not recorded in the study area. As such this area is unlikely to contain important habitat and is unlikely to be critical to the survival of these species.

Would the action disrupt the breeding cycle of an important population?

Not applicable

Would the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The 16.1 ha of marginal quality habitat that would be affected is not likely to be significant habitat for the species.

The action would not result in a significant increase in the isolation or fragmentation of habitat for any individuals of these species in the locality post-development or result in the removal of significant habitat for the species. As such, the project is unlikely to result in the long-term decline of the species.

Would the action result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat?

Mitigation measures provided would minimise potential weed invasion into adjacent areas of habitat and invasive weeds within the site would be controlled.

The action is unlikely to result in invasive species becoming established in the habitat of these Vulnerable species.

Would the action interfere substantially with the recovery of the species?

The subject site does not contain a known occurrence of these species and is unlikely to contain an important population. As such, the habitat within the site would not be important to the long-term survival of these species. The action is unlikely to interfere with the recovery of these species.

Conclusion

The site contains marginal potential habitat for *Persoonia hirsuta, Acacia pubescens, Dillwynia tenuifolia, Leucopogon exolasius, Pultenaea parviflora* which are listed as Vulnerable species under the EPBC Act.

These species are unlikely to be significantly affected by the project.

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Appendix D

State impact assessments

Contents

D1. River-Flat Eucalypt Forest on Coastal Floodplains

1.1 Status

River-Flat Eucalypt Forest on Coastal Floodplain of the NSW North Coast, Sydney Basin and South East Corner bioregions is listed as an Endangered Ecological Community under the TSC Act. This ecological community is not listed under the EPBC Act.

1.2 Description

River-Flat Eucalypt Forest on Coastal Floodplains is a variable community consisting of a tall open tree layer of eucalypts associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. Typically these forests and woodlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water.

River-Flat Eucalypt Forest on Coastal Floodplains is distinguished from other floodplain threatened ecological communities by its dominance of either a mixed or single species eucalypt tree layer (including *Angophora* spp.), with few *Casuarina* spp. or *Eucalyptus robusta*, and a prominent groundcover of soft leaved herbs and grasses (Department of Environment and Climate Change 2007a). While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis*, *E. amplifolia*, *Angophora floribunda* and *A. subvelutina* and *Casuarina glauca*.

1.3 Specific impacts

Approximately 27.4-35.7 ha of River-Flat Eucalypt Forest on Coastal Floodplains will be removed. This vegetation ranges from good condition with all structural layers intact and high native species diversity to poor condition with native canopy over an understorey/groundcover dominated by exotic shrubs and vines (e.g. *Lantana camara, Cardiospermum grandiflorum*) or exotic grasses and forbs.

This distribution of this community on the site is concentrated along the riparian corridor of the Georges River, with fragmented, structurally modified patches extending into the centre of the site near its northern and southern extents.

Adjacent areas would initially be subject to increased edge effects, however substantial areas (16.7 ha) that are currently dominated by exotic grasses with little or no canopy cover will have River-Flat Eucalypt Forest on Coastal Floodplains vegetation restored which will reduce the fragmentation of the local occurrence of this community in the medium to long term.

1.4 Threats

Recognised threats to this community include:

- Further clearing for urban and rural development, and the subsequent impacts from fragmentation.
- Flood mitigation and drainage works.
- Landfilling and earthworks associated with urban and industrial development.
- Gazing and trampling by stock and feral animals (particularly pigs).
- Changes in water quality, particularly increased nutrients and sedimentation.
- Weed invasion.
- Climate change.
- Activation of acid sulfate soils.
- Removal of dead wood.
- Rubbish dumping.
- Frequent burning which reduces the diversity of woody plant species.

Key threatening processes that may affect this community include:

- Clearing of native vegetation.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.
- Invasion of native plant communities by exotic perennial grasses.
- High frequency fire.
- Removal of dead wood and trees.
- *Lantana camara*.

1.5 Recovery

A multi-entity recovery plan (Department of Environment Climate Change and Water 2010a) has been prepared for the threatened biodiversity of the Cumberland Plain, which includes actions relevant to the River-Flat Eucalypt Forest on Coastal Floodplains ecological community. Recovery actions relevant to the project are shown in Table 1.1.

Table 1.1 Relevant Cumberland Plain Recovery Plan priority actions

Recovery action[1]	Relationship of action to the Project
1.5 In circumstances where impacts on the threatened biodiversity listed … are unavoidable, as part of any consent, approval or license that is issued, ensure that offset measures are undertaken within the priority conservation lands where practicable.	Offset locations will be identified in consultation with the Office of Environment and Heritage and located in priority conservation lands where practicable.
2.2 Support and promote the adoption of best practice standards for bushland management and restoration … on public and private lands within the Cumberland Plain.	The Conservation Zone within the site and external offset sites will be managed and restored in accordance with best practice guidelines.
2.5 State and Australian government agencies will manage, to best practice standards (as specified in Appendix 2), any lands which are under their ownership or for which they have care, control and management and: - contain any of the threatened biodiversity listed in Table 1 - are located within the priority conservation lands or, if located outside these lands, have conservation as a primary management objective	The Conservation Zone within the site and external offset sites will be managed and restored in accordance with best practice guidelines.

1.6 Significance assessment

Section 5A of the EP&A Act requires the following factors, plus any assessment guidelines, to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable to a threatened ecological community.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable to a threatened ecological community.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The project will result in the clearing of 27.4-35.7 ha of River-Flat Eucalypt Forest on Coastal Floodplains.

The areas affected represent 48% of the ecological community within the Project Site.
This ecological community extends north and south of the study area with a particularly substantial occurrence in association with the Georges River. This loss of the local extent of the ecological community is unlikely to negatively affect the long-term viability of the local occurrence of the community.

The project is unlikely to result in processes such as substantial hydrological changes or increased weed invasion that would be likely to result in changes to the structure or composition of River-Flat Eucalypt Forest on Coastal Floodplains outside of the subject site.

In relation to the habitat of a threatened species, population or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The project will result in the clearing of 27.4-35.7 ha of River-Flat Eucalypt Forest on Coastal Floodplains. The areas affected represent 48% of the ecological community within the Project Site. This ecological community extends north and south of the study area on both banks of the Georges River. The temporary reduction in the local occurrence of the ecological community is unlikely to negatively affect the long-term viability of the local occurrence of the community to the extent that it would be at significantly higher risk of local extinction.

The vegetation affected is already fragmented by existing roadways and cleared areas. The clearing associated with the project is unlikely to substantially increase the fragmentation or isolation of patches of this community. The crossing of the Georges River would be elevated and designed to ensure that connectivity of terrestrial vegetation and fauna habitat is maintained. This would allow for functional connectivity along the corridor through the movement of animals which act as seed and pollen vectors.

The patch of this community in association with the Georges River forms an important link between vegetation to the north and south. With the weed management and riparian vegetation restoration proposed however, the important linkage function of this vegetation is likely to be retained.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for River-Flat Eucalypt Forest on Coastal Floodplains under the TSC Act. The habitat within the study area is unlikely to be critical to the survival of River-Flat Eucalypt Forest on Coastal Floodplains in accordance with Section 37 of the TSC Act.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The Cumberland Plain Recovery Plan (Department of Environment Climate Change and Water 2010a) includes management of this community. The project will not interfere with any recovery actions of relevance to the community (refer Table 1.1).

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project will constitute three key threatening processes (KTPs) under the TSC Act:

- Clearing of native vegetation.
- Loss of hollow bearing trees.
- Removal of dead wood and dead trees.

The project also has potential to contribute to three additional KTPs, *Invasion and establishment of exotic vines, and scramblers*, *Invasion, establishment and spread of Lantana* and *Invasion of native plant communities by exotic perennial grasses,* as a result of earthworks and vegetation fragmentation. Weed management during and after construction will however minimise this potential impact and is likely in the long term to reduce the overall impacts of these processes in the locality.

1.7 Conclusion

River-Flat Eucalypt Forest is listed as an Endangered Ecological Community under the TSC Act.

27.4-35.7 ha of this community will be cleared.

Given the limited extent of River-Flat Eucalypt Forest that will be affected by the development both directly and indirectly, the impact to the ecological community is unlikely to be significant.

D2. Castlereagh Swamp Woodland Community

2.1 Status

The Castlereagh Swamp Woodland Community is listed as an Endangered Ecological Community under the TSC Act. This ecological community is not listed under the EPBC Act.

2.2 Description

Castlereagh Swamp Woodland is a low woodland, often having dense stands of Paperbark trees (*Melaleuca decora*) along with other canopy trees, such as Drooping Red Gum (*Eucalyptus parramattensis* subsp. *parramattensis*). The shrub layer is not well developed and is mostly made up of young paperbark trees (*Melaleuca* spp.). The ground layer has a diversity of plants that tolerate waterlogged conditions, such as Swamp Pennywort (*Centella asiatica*), Common Rush (*Juncus usitatus*) and *Goodenia paniculata*. It occurs in western Sydney in the Castlereagh and Holsworthy areas, on deposits from ancient river systems along today's intermittent creeklines, often in poorly drained depressions (Office of Environment and Heritage 2012b).

2.3 Specific impacts

This community is found in the east of the site, along Anzac Creek and in slightly low-lying areas adjacent to Castlereagh Scribbly Gum Woodland.

Approximately 0.9 ha of Castlereagh Swamp Woodland will be removed. This vegetation ranges from good condition with all structural layers intact and high native species diversity to poor condition with native canopy over an understorey/groundcover dominated by exotic shrubs and vines (e.g. *Rubus fruticosus* spp. complex) or exotic grasses and forbs.

2.4 Threats

Recognised threats to this community include:

- The main threat is further clearing for rural residential/rural development or clay/shale extraction, and the subsequent impacts from fragmentation.
- Grazing and mowing, which stops regrowth.
- Inappropriate water run-off entering the site, which leads to increased nutrients and sedimentation.
- Weed invasion.
- Inappropriate fire regimes, which have altered the appropriate floristic and structural diversity.

Key threatening processes that may affect this community include:

- Clearing of native vegetation.
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.
- Invasion of native plant communities by exotic perennial grasses.

- High frequency fire.
- Removal of dead wood and trees.
- *Lantana camara*.

2.5 Recovery

A multi-entity recovery plan (Department of Environment Climate Change and Water 2010a) has been prepared for the threatened biodiversity of the Cumberland Plain which includes actions relevant to the Castlereagh Swamp Woodland Community. Recovery actions relevant to the project are shown in Table 1.1.

2.6 Significance assessment

Section 5A of the EP&A Act requires the following factors, plus any assessment guidelines, to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable to a threatened ecological community.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable to a threatened ecological community.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The project will result in the clearing of 0.9 ha of Castlereagh Swamp Woodland..

The areas affected (0.9 ha) represents a small proportion of the ecological community within close proximity of the locality. Large stands of this ecological community are mapped to the south-east of the study area with a particularly large occurrence in association with Anzac Creek. This loss of the local extent of the ecological community is unlikely to negatively affect the long-term viability of the local occurrence of the community.

The project is unlikely to result in processes such as substantial hydrological changes or increased weed invasion that would be likely to result in changes to the structure or composition of the community outside of the subject site.

In relation to the habitat of a threatened species, population or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The project will result in the clearing of 0.9 ha of Castlereagh Swamp Woodland. The areas affected represent a small proportion of the ecological community in the locality.

Large stands of this ecological community are mapped to the south-east of the study area with a particularly large occurrence in association with Anzac Creek. This loss of the local extent of the ecological community is unlikely to negatively affect the long-term viability of the local occurrence of the community.

The vegetation affected is already fragmented by existing roadways, rail and cleared areas. The clearing associated with the project is unlikely to substantially increase the fragmentation or isolation of patches of this community.

The reduction in the local occurrence of the ecological community caused by the project is unlikely to negatively affect the long-term viability of the local occurrence of the community to the extent that it would be at significantly higher risk of local extinction.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for Castlereagh Swamp Woodland under the TSC Act. The habitat within the study area is unlikely to be critical to the survival of Castlereagh Swamp Woodland in accordance with Section 37 of the TSC Act.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The Cumberland Plain Recovery Plan (Department of Environment Climate Change and Water 2010a) includes management of this community. The project will not interfere with any recovery actions of relevance to the community and project (refer Table 1.1).

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project will constitute three key threatening processes (KTPs) under the TSC Act:

- Clearing of native vegetation.
- Loss of hollow bearing trees.
- Removal of dead wood and dead trees.

The project also has potential to contribute to three additional KTPs, *Invasion and establishment of exotic vines, and scramblers*, *Invasion, establishment and spread of Lantana* and *Invasion of native plant communities by exotic perennial grasses,* as a result of earthworks and vegetation fragmentation. Weed management during and after construction will however minimise this potential impact and is likely in the long term to reduce the overall impacts of these processes in the locality.

D3. Persoonia nutans

3.1 Description

Persoonia nutans is an erect to spreading shrub in the family Proteaceae with yellow flowers and reddish stems and branches (NSW Department of Environment and Conservation 2005).

3.2 Conservation status

Persoonia nutans is listed as EPBC Act) and the TSC Act (NSW Department of Environment and Conservation 2005).

3.3 Distribution

3.3.1 Limits of known distribution

The species is a NSW endemic, restricted to western Sydney, between Richmond in the north and Macquarie Fields in the south (NSW Department of Environment and Conservation 2005).

3.3.2 Large and important populations

Persoonia nutans does not typically appear in discrete populations, but rather, occurs as scattered individuals throughout suitable habitat. It is therefore difficult to place precise limits on the boundaries of known populations. The majority of populations (and 99% of individuals) occur in the north of the species range in the Agnes Banks, Londonderry, Castlereagh, Berkshire Park and Windsor Downs areas. The smaller disjunct populations located in the southern portion of the species' distribution are estimated to constitute less than 1% of the population of the entire species (NSW Department of Environment and Conservation 2005).

3.3.3 Local population

It is estimated that approximately 420 ha of potential habitat for this species exists within the Holsworthy area to the south and lands to the west of the site (refer Figure D-1). Potential habitat for *Persoonia nutans* is mapped in Figure D-1 and represents those areas that possess suitable soil types (Agnes Banks and Berkshire Park soil formations) and also support suitable vegetation communities. Recent records of the species from surveys conducted by Parsons Brinckerhoff in late 2012 are also shown on the figure.

Whilst the total population of the species in this area is unknown, approximately 50 individuals of the species were recently recorded during investigations by Parsons Brinckerhoff in late 2012 in vegetation to the east of the site (refer Figure D-1). It is hence considered likely that this habitat, and other habitat to the south, contains a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants within the subject site are therefore likely to make up a small proportion of this population.

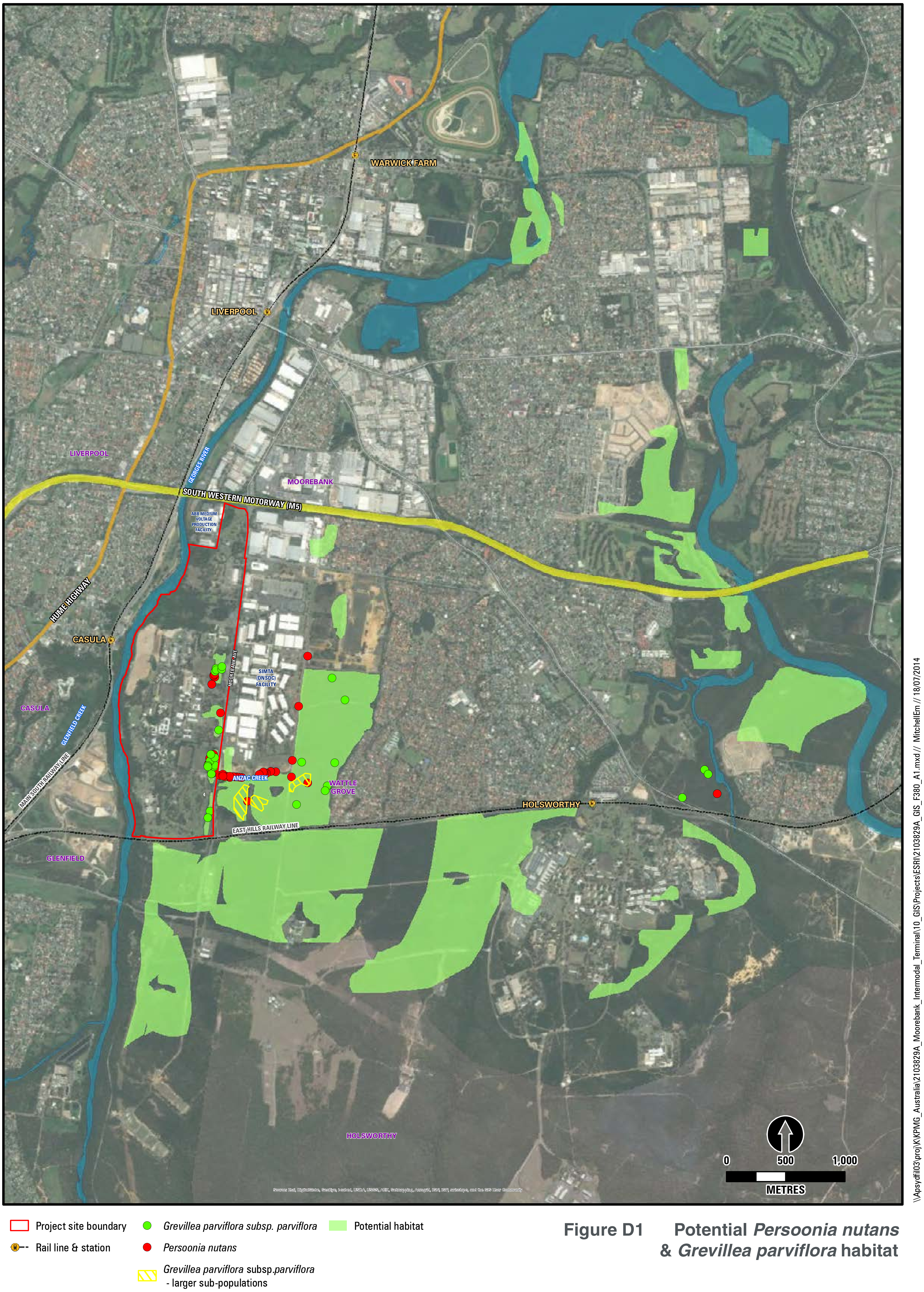

Figure D1 Potential *Persoonia nutans* & *Grevillea parviflora* habitat

3.4 Habitat

3.4.1 Habitat requirements

The species is confined to western Sydney where it grows on to aeolian and alluvial sediments primarily on the Agnes Banks and Berkshire Park soil landscapes. The species is associated with the following vegetation communities; Agnes Banks Woodlands, Castlereagh Scribbly Gum Woodlands, Cooks River Castlereagh Ironbark Forest, Shale/Gravel Transition Forest, Shale Sandstone Transition Forest and Castlereagh Swamp Woodland (Harden 2002; James 1997; NSW Department of Environment and Conservation 2005; NSW National Parks and Wildlife Service 2001).

3.4.2 Critical habitat

To date, critical habitat has not been declared for *P. nutans* under the EPBC Act or TSC Act. However, the large populations located in the Agnes Banks, Londonderry, Castlereagh, Berkshire Park and Windsor Downs areas would contain habitat that is critical to the survival of the species. The smaller disjunct populations located in the southern portion of the species' distribution are estimated to constitute less than 1% of the population of the entire species are unlikely to be critical to the survival of the species (NSW Department of Environment and Conservation 2005).

3.4.3 Life-history

Persoonia nutans is an obligate seed regenerator (Benson & McDougall 2000; NSW National Parks and Wildlife Service 2002a). In the event of a fire all existing plants of *P. nutans* are killed and regeneration is dependent upon recruitment from a soil stored seed bank. Consequently, *P. nutans* populations are likely to be dynamic throughout the landscape and fluctuations in space and time of above ground individuals will be a natural occurrence.

Bees and wasps appear to be the major foragers on the flowers of *Persoonia* in eastern Australia (Bernhardt & Weston 1996).

Plants appear to set abundant fruit which is likely to be dispersed by large birds such as Currawongs and mammals such as rats, macropods and possums (Benson & McDougall 2000).

Nothing is known of the longevity of the soil-stored seed bank of *P. nutans*. It appears germination is promoted, not only by fire, but also by physical disturbance (NSW Department of Environment and Conservation 2005; NSW National Parks and Wildlife Service 1996).

3.5 Diseases and invasive species

Typically, a major consequence of habitat degradation and fragmentation is weed invasion however survey of *P. nutans* sites in 1996 revealed that weed invasion did not then pose a major threat to any populations (NSW National Parks and Wildlife Service 1996). The Castlereagh Scribbly Gum Woodlands and Agnes Banks Woodlands (the predominant habitat for *P. nutans*) grow on acidic, nutrient poor soil which is not highly susceptible to extensive weed invasion (Benson 1992).

It is possible however that some populations of the species are threatened by weed invasion, particularly by exotic perennial grasses. The species may also be affected by introduced animals including grazing by the feral European rabbit and disruption of reproduction due to competition between feral honey bees and the species' native pollinators.

P. nutans may be adversely affected by the soil borne pathogen *Phytophthora cinnamomi* either because of direct infection or degradation of habitat.

3.6 Susceptibility to fragmentation

Habitat fragmentation can potentially reduce the long-term viability of remnant populations of *P. nutans* because the species is dependent upon recolonisation via seed dispersal in the event of local extinction (NSW Department of Environment and Conservation 2005). Given the relatively large distance seed dispersal capabilities of the bird and mammal species that feed on the fruit of the species, however, it is unlikely to be sensitive to small scale fragmentation of habitat.

3.7 Threatening processes

The following key threatening processes listed under the EPBC Act and/or TSC Act are known or considered likely to affect the species:

- Land clearance / Clearing of native vegetation.
- Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*).
- Competition from feral honey bees (*Apis mellifera*).
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Invasion of native plant communities by exotic perennial grasses.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) / Infection of native plants by *Phytophthora cinnamomi* (Department of Sustainability Environment Water Population and Communities 2011b; Office of Environment and Heritage 2011).

3.8 Recovery strategies

The following strategies for the recovery of the species have been identified in the combined National and NSW State Recovery Plan recovery plan for the species:

- minimise the loss and fragmentation of *P. nutans* habitat
- identify and minimise the operation of threats at sites where *P. nutans* occurs
- implement a survey and monitoring program that will provide information on the extent and viability of *P. nutans*
- provide public authorities with information that assists in conserving the species
- raise awareness of the species and involve the community in the recovery program
- promote research questions that will assist future management decisions (NSW Department of Environment and Conservation 2005).

3.9 Project specific impacts

The proposed action will result in the removal of 6.5 ha of habitat known to be occupied by *Persoonia nutans* within the proposed project site and a further 10.5 ha of degraded, apparently unoccupied habitat. This will result in the loss of at least 10 individuals of the species however additional individuals may be represented in a soil seed bank.

It is estimated that approximately 420 ha of potential habitat exists within the Holsworthy area to the south and lands to the west of the site (refer Figure D-1). The areas to be cleared for the project therefore equates to approximately 1.5 % of the local habitat for the species. Whilst the total population of the species in this area is unknown, approximately 50 individuals of the species were recently recorded during investigations by Parsons Brinckerhoff in late 2012 in vegetation to the east of the site (refer Figure D-1).

It is hence considered likely that this habitat and other habitat to the south contain a moderately large population of the species as mature plants and/or as a soil-stored seed bank.

The plants within the subject site are therefore likely to make up a small proportion of the local population.

3.10 Significance assessment

Section 5A of the EP&A Act requires the following factors, plus any assessment guidelines, to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The project is unlikely to create any barriers to cross-pollination or seed dispersal between patches of habitat within the distribution of the local population. Only a small proportion of the local population would be removed and therefore its genetic diversity and viability are unlikely to be significantly reduced. The project is therefore unlikely to significantly affect the life cycle of the local population.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The project will result in the clearing of approximately 6.5 ha of occupied habitat for the species. With the presence of large areas of suitable habitat for *Persoonia nutans* in the locality (approximately 420 ha), particularly to the east of Moorebank Avenue, only a very small proportion of the available habitat for this species in the locality will be removed by the Project. The Project would result in the loss of approximately 1.5% of the currently available habitat for *Persoonia nutans* in the locality. Therefore, it is unlikely that the Project would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the local population of *Persoonia nutans* is likely to be at significantly increased risk of extinction.

The habitat of the local population of the species is already fragmented by existing roadways and cleared areas. In the context of this species' dispersal ability, minimal habitat fragmentation (i.e. the breaking apart of habitat into smaller pieces) will occur due to the Project as the large animal species (particularly birds) that disperse the species' seed are able to traverse small to moderately large gaps in native vegetation .The clearing associated with the project is, therefore, unlikely to substantially increase the fragmentation or isolation of patches of habitat occupied by the local population of the species.

The habitat for *Persoonia nutans* that would be removed, while in good to moderately degraded condition, is functionally isolated (for this species due to its limited seed dispersal) from other areas of *Persoonia nutans* habitat in the locality. This habitat is in an area of high disturbance and based on the data collected during the field survey, the population is composed of approximately 16 mature plants with many suckers. Due to the suckering nature of *Persoonia nutans* it is difficult to determine if active recruitment of seedlings is occurring as the smaller plants may have been suckers or seedlings.

The larger areas of potential habitat to the east of Moorebank Ave and further to the south that retain functional connectivity for this species are more likely to represent an area of habitat important to the survival of *Persoonia nutans*.

Given the small proportion of this potential habitat (1.5%) that would be affected a significant adverse impact on important habitat for the species is unlikely.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for this species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The recovery plans and strategies of relevance to these species are described in Section 4.8.

These strategies primarily relate to management of threats to known populations of the species, research and policy development and are of limited relevance to the project. The project is not considered likely to substantially contribute to or interfere with the implementation of these recovery plans and strategies.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project will constitute three key threatening processes (KTPs) under the *Threatened Species Conservation Act 1995*:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.

The habitat for *Persoonia nutans* in the study area will be completely removed by the Project. Consequently, no invasive species harmful to *Persoonia nutans* would become established in habitat for the species in this area.

The project would result in some clearing of native vegetation however it will also involve substantial vegetation restoration which will offset this vegetation loss in the medium to long term.

3.11 Conclusion

Given the limited extent of disturbed habitat that will be affected by the development in relation to the larger areas of likely higher quality habitat that are located in the immediate locality, the impact to *Persoonia nutans* is unlikely to be significant.

D4. Grevillea parviflora subsp. parviflora

4.1 Description

Grevillea parviflora subsp. *parviflora*, family Proteaceae, is a low open to erect shrub usually 0.3−1 m high with narrow leaves and white flowers with rusty brown hairs (Benson & McDougall 2000; Royal Botanic Gardens 2011). The flowers are spider like, and are white or pinkish with rusty brown hairs. The fruiting capsule is 8-10 mm long with 1-2 seeds per capsule (NSW National Parks and Wildlife Service 2002c).

4.2 Conservation status

Grevillea parviflora subsp. *parviflora* is listed as Vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the NSW *Threatened Species Conservation Act 1995* (TSC Act).

4.3 Life history

Little is known of the life history of *Grevillea parviflora* subsp*. parviflora* and most knowledge on this species has arisen from general observation rather than direct scientific study (NSW National Parks and Wildlife Service 2002c). However, it is known that this species is relatively long lived with generation times between 25-60 years (Benson & McDougall 2000).

Flowers are produced between April and May and between July and December and are insect pollinated (Makinson 2000). One to two seeds are released at maturity, with short range (probably <2 m) seed dispersal most likely to be via gravity and ant dispersal (Benson & McDougall 2000; NSW National Parks and Wildlife Service 2002b). Little is known about the production and viability of seed, seed predation or germination rates and requirements (NSW National Parks and Wildlife Service 2002c).

Plants are capable of suckering or regenerating from a rootstock after disturbance (NSW National Parks and Wildlife Service 2002c). After fire or other disturbance, regeneration can occur from both the rhizomes and seed in the soil seed bank; however, after fire, adult plants are killed and seedling recruitment is uncommon (Benson & McDougall 2000). Most populations of *Grevillea parviflora* subsp. *parviflora* appear relatively large as a result of suckering.

4.4 Habitat requirements

Grevillea parviflora subsp. *parviflora* inhabits ridge crests, upper slopes, or flat plains in low-lying areas between 30–65 m above sea level (in the Lower Hunter Valley and Lake Macquarie) and on higher topography between 200–300 m above sea level south of Sydney (NSW National Parks and Wildlife Service 2002c). *Grevillea parviflora* subsp. *parviflora* prefers areas of shale/sandstone transition geology with sandy or light clay soils derived from Tertiary sands or alluvium that are deposited over thin shales, often with lateritic ironstone gravels that are infertile and poorly drained. Soils from the Mittagong Formation with alternating shale and fine-grained sandstones are also suitable (NSW National Parks and Wildlife Service 2002c).

This species has been recorded in a range of habitats, from heath and shrubby woodland to open forest and can often occur in exposed and disturbed sites such as beside tracks and roadways (NSW National Parks and Wildlife Service 2002c). Specifically, in the Sydney region, *Grevillea parviflora* subsp. *parviflora* is known to occur in the Shale Sandstone Transition Forest, Sydney Sandstone Ridgetop Woodland and Castlereagh Ironbark Forest (NSW National

Parks and Wildlife Service 2002c) and in Castlereagh Scribbly Gum Woodland (NSW Scientific Committee 2010).

4.4.1 Critical habitat

Critical habitat cannot be declared for *Grevillea parviflora* subsp. *parviflora* under the EPBC Act or TSC Act as it is a Vulnerable species. However, this does not mean that habitat critical for the survival of this species does not exist.

Habitat critical to the survival of a species may include areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts 2009).

According to the NSW National Parks and Wildlife service (2002b), until there is adequate protection of *Grevillea parviflora* subsp. *parviflora*, all sites where this species occurs are considered important and the habitat is considered significant. Sites of particular significance would include the following:

- sites with a population of >50 plants
- sites with a population that has a varied age structure including active recruitment of seedlings
- sites in an area of intact habitat away from high disturbance areas (NSW National Parks and Wildlife Service 2002b).

4.5 Distribution

4.5.1 Limits of known distribution

Grevillea parviflora subsp*. parviflora* is restricted to the Sydney Basin bioregion and occurs in scattered coastal locations in three disjunct populations, one in south-western Sydney (the focus of this assessment), one on the Central Coast and Lower Hunter Valley, and a northern population at Karuah and Tea Gardens (Makinson 2000; NSW National Parks and Wildlife Service 2002c)

Presently, the northern limit of *Grevillea parviflora* subsp*. parviflora* is at Heddon Greta in the Lower Hunter Valley. The southern and western limit is Bargo and the eastern limit is Awaba, near Newcastle (NSW National Parks and Wildlife Service 2002b).

4.5.2 Large and important populations

Grevillea parviflora subsp*. parviflora* occurs in substantial numbers in Werakata National Park to the south-west of Kurri Kurri (NSW National Parks and Wildlife Service 2002c). There are at least 21 known populations of *Grevillea parviflora subsp. parviflora* with several other older records requiring confirmation (NSW National Parks and Wildlife Service 2002c) (refer Table 3.1).

Table 4.1 Locality and number of plants in each known population

Locality	Number of plants (stems)
Appin, Wollondilly LGA	Unknown
Picton, Wollondilly LGA	Unknown
Bargo, Bargo Rd, Wollondilly LGA	Approximately 2,000
Wirrimbirra, Bargo, Wollondilly LGA	50
Kemps Creek, Liverpool LGA	1
Voyager Point, Liverpool LGA	Small
Tahmoor, Wollondilly LGA	Extinct
Thirlmere, Wollondilly LGA	Extinct
Prospect LGA	Extinct
Upper Georges River, Liverpool LGA	**Large**
Wedderburn, Campbelltown LGA	Unknown
Maldon, Wollondilly LGA	Unknown
Sydney Water	at least 2
Moss Vale, Wingecarribee LGA	To be confirmed
Kurri Kurri, Cessnock LGA	Unknown
Heddon Greta, Cessnock LGA	Unknown
Dooralong, Wyong LGA	Unknown
Cooranbong, Freemans Drive Macquarie LGA	Unknown
Awaba, Lake Macquarie LGA	Unknown
Karuah	Unknown
Wyong to Putty, Wyong LGA	Unknown
Werakata National Park (Kitchener area)	Substantial numbers
Cessnock LGA	At least 94
West Wallsend, Lake Macquarie LGA	Unknown

Due to the suckering nature of *Grevillea parviflora* subsp. *parviflora* it is often difficult to determine the number of plants at a site. All population estimates for this species are therefore a reflection of the number of suckers rather than individual plants and populations may be smaller than previously thought (Department of Sustainability Environment Water Population and Communities 2011a). The *Grevillea parviflora* subsp. *parviflora* subject to this assessment belong to the Upper Georges River population as highlighted in bold in the table.

Population sizes of *Grevillea parviflora* subsp*. parviflora* are variable but are mostly small (less than 20 plants) to medium size (50–100 plants) with few large populations (greater than 200 plants) (Department of Sustainability Environment Water Population and Communities 2011a; NSW National Parks and Wildlife Service 2002c). The largest known population occurs north of Bargo (refer Table 3.1) with an estimated 2,000 or more plants. The viable population size for *Grevillea parviflora* subsp*. parviflora* is unknown and until such information is available all populations should be assumed to be viable (NSW National Parks and Wildlife Service 2002b).

2.7 Conclusion

Castlereagh Swamp Woodland is listed as an Endangered Ecological Community under the TSC Act.

0.9 ha of this community will be affected. The area to be removed constitutes a small proportion of the occurrence of this community in the locality.

Given the limited extent of Castlereagh Swamp Woodland that will be affected by the development both directly and indirectly, the impact to the ecological community is unlikely to be significant.

4.6 Diseases and invasive species harmful to *Grevillea parviflora* subsp. *parviflora*

Soil-borne fungal diseases and oomycetes (water moulds) are perhaps the greatest disease threat to the family Proteaceae in Australia. The genus Grevillea, common with other members of the family Proteaceae, is generally considered susceptible to infection from *Phytophthora cinnamomi* which causes dieback. *Grevillea parviflora* subsp. *parviflora* is identified as a species that may be adversely affected by *P. cinnamomi* either because populations are threatened by direct infestation or by degradation of habitat (NSW Scientific Committee 2002).

Weed invasion is recognised as a threat to *Grevillea parviflora* subsp. *parviflora* (NSW National Parks and Wildlife Service 2002c). Aggressive native species such as *Imperata cylindrica* and *Kunzea ambigua* can reduce available habitat and create barriers for *Grevillea parviflora* subsp. *parviflora* (Department of Sustainability Environment Water Population and Communities 2011a; NSW National Parks and Wildlife Service 2002c).

Grevillea parviflora subsp. *parviflora* may also be affected by introduced animals including grazing by the feral European rabbit and disruption of reproduction due to competition between feral honey bees and the species' native pollinators.

4.7 Susceptibility of *Grevillea parviflora* subsp. *parviflora* to fragmentation

While direct habitat loss is the most important threat to *Grevillea parviflora* subsp. *parviflora*, fragmentation of populations and habitat are also an issue. The creation of barriers as a result of vegetation clearing and degradation of habitat due to weed invasion, frequent fires, dumping of fill or rubbish, and grazing by domestic animals may isolate populations of *Grevillea parviflora* subsp. *parviflora* resulting in a reduction in gene flow, lowering the genetic diversity of populations (NSW National Parks and Wildlife Service 2002b). The naturally limited seed dispersal range of *Grevillea parviflora* subsp. *parviflora* means that even minimal clearing may act as an effective barrier for this species (NSW National Parks and Wildlife Service 2002b).

Connectivity between populations of *Grevillea parviflora* subsp. *parviflora* is likely to be good in southern parts of its distribution (i.e. around Bargo) and in some areas in the Lower Hunter Valley (NSW National Parks and Wildlife Service 2002b). However, in more urbanised areas closer to Sydney (such as the study area), isolation of populations is likely to be increasing and presents more of an issue (NSW National Parks and Wildlife Service 2002b).

4.8 Key threatening processes relevant to *Grevillea parviflora* subsp. *parviflora*

The following key threatening processes listed under the EPBC Act and/or TSC Act are known or considered likely to affect *Grevillea parviflora* subsp. *parviflora*.

- Land clearance/Clearing of native vegetation.
- Competition and land degradation by rabbits / Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*).
- Competition from feral honey bees (*Apis mellifera*).
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

- Invasion of native plant communities by exotic perennial grasses.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) / Infection of native plants by *Phytophthora cinnamomi* (Department of Sustainability Environment Water Population and Communities 2011b; Office of Environment and Heritage 2011).

4.9 Recovery strategies for *Grevillea parviflora* subsp. *parviflora*

A recovery plan has not been developed for *Grevillea parviflora* subsp. *parviflora*, however, there are recovery strategies and actions recognised by the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for implementation at a regional and local scale. Regional priority actions include:

- Habitat Loss, Disturbance and Modification
  - Identify populations of high conservation priority.
  - Manage threats to areas of vegetation that contain populations/occurrences/remnants of *Grevillea parviflora* subsp. *parviflora*.
  - Ensure road widening and maintenance activities (or other infrastructure or development activities) in areas where the species occurs do not adversely impact on known populations.
  - Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on *Grevillea parviflora* subsp. *parviflora*.
  - Investigate formal conservation arrangements, such as the use of covenants, conservation agreements or inclusion in reserve tenure.
- Conservation Information
  - Raise awareness of *Grevillea parviflora* subsp. *parviflora* within the local community.
  - Liaise with land managers to encourage the preparation of site management plans and the implementation of appropriate threat abatement measures, particularly in fire management, bush regeneration, roadside management, weed control, fencing and signage.
  - Ensure this species is considered in all planning matters on land that contains or may contain populations of the species.
- Enable Recovery of Additional Sites and/or Populations
  - Investigate options for linking, enhancing or establishing additional populations.
  - Implement appropriate national translocation protocols if establishing additional populations is considered necessary and feasible.
  - Undertake seed collection and storage.

Local Priority Actions include:

- Habitat Loss, Disturbance and Modification
  - Monitor known populations to identify key threats.

- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
- Control access routes to suitably constrain public access to known sites on public land.
- Undertake survey work in suitable habitat and potential habitat to locate any additional populations.
- Minimise adverse impacts from land use at known sites.
- Mark and fence off sites during development/road maintenance activities.
- Ensure that personnel responsible for planning and undertaking maintenance activities are able to identify the species and are aware of its habitat.
- Avoid use of heavy machinery in areas of known populations.

- Invasive Weeds
  - Identify and remove weeds in the local area, which could become a threat to Small-flower Grevillea, using appropriate methods.
  - Manage sites to prevent introduction of invasive weeds, which could become a threat to *Grevillea parviflora* subsp. *parviflora*, using appropriate methods.
- Fire
  - Reinstate an appropriate fire regime for *Grevillea parviflora* subsp. *parviflora*; either restrict fire or undertake ecological burns as required.

4.10 Project specific impacts

The proposed action may result in the removal of 6.5 ha of habitat known to be occupied by *Grevillea parviflora* subsp. *parviflora* within the proposed project site and an additional 10.5 ha of degraded and apparently unoccupied habitat. This will result in the loss of at least 16 individuals of the species with many suckers; however, additional individuals may be represented in a soil seed bank.

It is estimated that at least 420 ha of potential habitat exists within the Holsworthy area to the south of the site. The areas to be cleared for the project which are occupied by the species therefore equate to approximately 1.5% of the local habitat for the species.

Whilst the precise Upper Georges River local population of the species is unknown, it is considered to be large; i.e. in excess of 200 plants (Department of Sustainability Environment Water Population and Communities 2011a).

It is estimated that approximately 420 ha of potential habitat for this species exists within the Holsworthy area to the south and lands to the west of the site (refer Figure D-1). Potential habitat for *Grevillea parviflora subsp. parviflora* is mapped in Figure D-1 and represents those areas that possess suitable soil types (Agnes Banks and Berkshire Park soil formations) and also support suitable vegetation communities. Recent records of the species from surveys conducted by Parsons Brinckerhoff in late 2012 are also shown on the figure.

Whilst the total population of the species in this area is unknown, in excess of 300 stems of the species were recently recorded during investigations by Parsons Brinckerhoff in late 2012 in vegetation to the east of the site (refer Figure D-1). It is hence considered likely that this habitat, and other habitat to the south, contains a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants within the subject site are therefore likely to make up a small proportion of this population.

The plants within the subject site are therefore likely to make up a small proportion of the local population.

4.11 Significance assessment

Section 5A of the EP&A Act requires the following factors, plus any assessment guidelines, to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The project is unlikely to create any barriers to cross-pollination or seed dispersal between patches of habitat within the distribution of the local population and is hence unlikely to significantly affect the life cycle of the local population.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The project will result in the clearing of approximately 6.5 ha of occupied habitat for the species. With the presence of large areas of suitable habitat for *Grevillea parviflora* subsp. *parviflora* in the locality (approximately 420 ha), particularly to the east of Moorebank Avenue, only a very small proportion of the available habitat for this species in the locality will be removed by the Project. The Project would result in the loss of approximately 1.5% of the currently available habitat for *Grevillea parviflora* subsp. *parviflora* in the locality. Therefore, it is unlikely that the Project would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the local population of *Grevillea parviflora* subsp. *parviflora* is likely to be at significantly increased risk of extinction.

The habitat of the local population of the species is already fragmented by existing roadways and cleared areas. In the context of this species' limited dispersal ability, minimal habitat fragmentation (i.e. the breaking apart of habitat into smaller pieces) will occur due to the Project as only functionally isolated areas of habitat will be removed.The clearing associated with the project is, therefore, unlikely to substantially increase the fragmentation or isolation of patches of habitat occupied by the local population of the species.

The habitat for *Grevillea parviflora subsp. parviflora* that would be removed, while in good to moderately degraded condition, is functionally isolated (for this species due to its limited seed dispersal) from other areas of *Grevillea parviflora subsp. parviflora* habitat in the locality. This habitat is in an area of high disturbance and based on the data collected during the field survey, the population is composed of approximately 16 mature plants with many suckers. Due to the suckering nature of *Grevillea parviflora subsp. parviflora* it is difficult to determine if active recruitment of seedlings is occurring as the smaller plants may have been suckers or seedlings.

The larger areas of potential habitat to the east of Moorebank Ave and further to the south that retain functional connectivity for this species are more likely to represent an area of habitat important to the survival of *Grevillea parviflora subsp. parviflora*.

Given the small proportion of this potential habitat (1.5%) that would be affected a significant adverse impact on critical habitat for the species is unlikely.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for this species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The recovery plans and strategies of relevance to these species are described in Section 3.9.

These strategies primarily relate to management of threats to known populations of the species, research and policy development and are of limited relevance to the project. The project is not considered likely to substantially contribute to or interfere with the implementation of these recovery plans and strategies.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project will constitute three key threatening processes (KTPs) under the *Threatened Species Conservation Act 1995*:

- Clearing of native vegetation.

- Invasion of native plant communities by exotic perennial grasses.

The habitat for *Grevillea parviflora subsp. parviflora* in the study area will be completely removed by the Project. Consequently, no invasive species harmful to *Grevillea parviflora subsp. parviflora* would become established in habitat for the species in this area.

The project would result in some clearing of native vegetation however it will also involve substantial vegetation restoration which will offset this vegetation loss in the medium to long term.

4.12 Conclusion

Given the limited extent of disturbed and functionally isolated habitat that will be affected by the development in relation to that located in the immediate locality, the impact to *Grevillea parviflora subsp. parviflora* is unlikely to be significant.

D5. Other threatened species of plant

5.1 Status and habitat description

The following species which are listed under the TSC Act are considered to have a moderate likelihood of occurring on the site:

- *Persoonia hirsuta*
- *Acacia pubescens*
- *Dillwynia tenuifolia*
- *Leucopogon exolasius*
- *Pultenaea parviflora.*

These species have been as a group as they are all shrubs which were not recorded on the site but are considered to have a moderate likelihood of occurrence on the site as isolated individuals and/or in the form of a soil-stored seed bank.

The habitat of these species is summarised in Table 5.1.

Table 5.1 Habitat of state listed Threatened species of plant

Species Name	Habitat
Acacia bynoeana	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with Corymbia gummifera, Eucalyptus haemastoma, E. gummifera, E. parramattensis, E. sclerophylla, Banksia serrata and Angophora bakeri (NSW National Parks and Wildlife Service 1999a). No historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
Acacia pubescens	Restricted to the Sydney Region from Bilpin to the Georges River and also at Woodford where it usually grows in open sclerophyll forest and woodland on clay soils. Typically it occurs at the intergrade between shales and sandstones in gravely soils often with ironstone (Harden 2002; NSW National Parks and Wildlife Service 2003b). Historic records of this species exist in the locality. Marginal habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
Dillwynia tenuifolia	Occurs on the Cumberland Plain from the Blue Mountains to Howes Valley area where it grows in dry sclerophyll woodland on sandstone, shale or laterite (Harden 2002). Specifically, occurs within Castlereagh woodlands, particularly in shale gravel transition forest. Associated species include Eucalyptus fibrosa, Eucalyptus sclerophylla, Melaleuca decora, Daviesia ulicifolia, Dillwynia juniperina and Allocasuarina littoralis (James 1997).
Leucopogon exolasius	Restricted chiefly to the Woronora and Grose Rivers and Stokes Creek, Sydney catchments and the Royal National Park. One old record from the Grose River. Grows in woodland on sandstone (Royal Botanic Gardens 2011). Marginal habitat for this species exists in the study area along the Georges River corridor. Three local records. Unlikely to occur elsewhere in study area.
Pultenaea parviflora	Restricted to the Cumberland Plain where it grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium (Harden 2002). Locally abundant within Castlereagh Ironbark Forest and Shale/Gravel Transition Forest on tertiary alluvium or laterised clays (James 1997; NSW National Parks and Wildlife Service 2002d). Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.

5.2 Specific impacts

Approximately 6.5 ha of high condition Castlereagh Scribbly Gum Woodland that is potential habitat for these species will be removed. A further 10.5 ha of low condition potential habitat would also be removed.

5.3 Threats

Recognised threats to these species include:

- Catastrophic, stochastic events that may lead to localised extinction due to the fragmented nature of the populations and their small size.
- Habitat disturbance during road, trail and powerline maintenance.
- Damage to plants on trail margins by recreational vehicles, horse riding and pedestrian use.
- Inappropriate fire regimes.
- Further clearing for urban and rural development, and the subsequent impacts from fragmentation.
- Weed invasion.
- Mowing, grazing or other types of habitat modification such as weed invasion, rubbish dumping or urban runoff.
- Disease
- Hybridisation (A. pubescens)
- Fill and rubbish dumping
- Partial clearance (e.g. removal or thinning of the canopy) which may have a significant impact upon vegetation structure resulting in dense monospecific regrowth which out competes smaller species.

Key threatening processes that may affect these species include:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- High frequency fire.

5.4 Recovery

An approved recovery plan has been prepared for *Acacia pubescens* (NSW National Parks and Wildlife Service 2003a).

Specific objectives of the plan are to:

- Ensure that a representative sample of *A. pubescens* populations occurring on public and private lands are protected from habitat loss and managed for conservation.

- Reduce the impacts of threats at sites across the species' range.
- Ensure that any planning and management decisions that are made which affect the species, are made in accordance with the recovery objectives of this plan.
- Understand the biology, ecology, health and distribution of the species including the range of genetic variation.
- Develop the awareness and involvement of the broader community in the species and its conservation.
- Re-assess the conservation status of the species (NSW National Parks and Wildlife Service 2003a).

None of these actions are relevant to the project.

A multi-entity recovery plan (Department of Environment Climate Change and Water 2010a) has been prepared for the threatened biodiversity of the Cumberland Plain which includes *Dillwynia tenuifolia* and *Pultenaea parvifolia*. No species-specific recovery actions are identified for these species in the plan. Recovery actions relevant to the project are shown in Table 5.2.

Table 5.2 Relevant Cumberland Plain Recovery Plan priority actions

Recovery action[1]	Relationship of action to the Project
1.5 In circumstances where impacts on the threatened biodiversity listed … are unavoidable, as part of any consent, approval or license that is issued, ensure that offset measures are undertaken within the priority conservation lands where practicable.	Offset locations will be identified in consultation with the Office of Environment and Heritage and located in priority conservation lands where practicable.
2.2 Support and promote the adoption of best practice standards for bushland management and restoration … on public and private lands within the Cumberland Plain.	The Conservation Zone within the site and external offset sites will be managed and restored in accordance with best practice guidelines.
2.5 State and Australian government agencies will manage, to best practice standards (as specified in Appendix 2), any lands which are under their ownership or for which they have care, control and management and: - contain any of the threatened biodiversity listed in Table 1 - are located within the priority conservation lands or, if located outside these lands, have conservation as a primary management objective	The Conservation Zone within the site and external offset sites will be managed and restored in accordance with best practice guidelines.

Previously, the TSC Act required the preparation of a recovery plan for each threat-listed species, population or ecological community and a threat abatement plan for each listed key threatening process (KTP). However, as the number of threat-listed species listed under the Act grew, this approach became increasingly unworkable (Department of Environment and Climate Change 2007b).

In November 2004, the NSW State Government reformed the State's threatened species legislation. One element of the reforms included a requirement for the Director-Generals of the NSW Department of Primary Industries (DPI) and Department of Environment, Climate Change and Water (DECCW) to prepare and adopt a Priorities Action Statement (PAS) (Department of Industry and Investment 2010).

Each PAS outlines the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of threat-listed species, populations and ecological communities and manage key threatening processes (Department of Environment Climate Change and Water 2010c; Department of Industry and Investment 2010).

The relevance of these actions to these species in the context of the project is summarised in Table 5.3.

Table 5.3 Recovery actions identified in the PAS

Recovery action[1]	*Acacia bynoeana*	*Leucopogon exolasius*	Does action relate to the Project?
Commission survey and status assessment.	Y		Not applicable
Complete priority State/National recovery plan in accordance with contractual obligation between DEC and DEH by 2007.	Y		Not applicable
Conduct surveys to determine the status of Southern Highlands and Upper Blue Mountains sites	Y		Not applicable
Ensure that council-managed land on which sites occur are appropriately classified and managed for conservation / Ensure that sites on crown land are appropriately managed for conservation of species.	Y		Weed management during and after construction is consistent with the intent of this action
Further research into fire regime is required.		Y	Not applicable
Identify and survey potential habitat to detect new populations / Identify and survey potential habitat / Identify, map and survey potential habitat.	Y		Not applicable
Incorporate best knowledge regarding appropriate fire regime into land management practices / Incorporate appropriate fire regime into land management practices.	Y		Not applicable
Incorporate site specific threat abatement measures for the species into Plan of Management for sites in council or crown reserves.	Y		Not applicable
Incorporate site specific threat abatement measures for the species into Plans of Management for on-park sites / DECCW reserves.	Y		Not applicable
Increase the level of legislative protection for sites through land-use planning mechanisms and conservation agreements. Retain vegetative linkages between sites where possible.	Y		Not applicable
Liaise with land managers to encourage the preparation of site management plans and the implementation of appropriate threat abatement measures, such as weed control/bush regeneration, site protection (fencing/signage) and fire management / Liaise with private and public land managers to facilitate the preparation and implementation of management plans that address threatening processes.	Y		Weed management during and after construction is consistent with the intent of this action

Recovery action[1]	*Acacia bynoeana*	*Leucopogon exolasius*	Does action relate to the Project?
Monitor the population for changes.		Y	Not applicable
Restrict vehicular and pedestrian access to sites, where necessary / Restrict access to sites, where necessary.	Y		Not applicable
Search likely habitat for other populations.		Y	Not applicable
Undertake management focussed biological and ecological research / Undertake management focussed ecological studies.	Y		Not applicable
Undertake targeted bush regeneration works, where required.	Y		Weed management during and after construction is consistent with the intent of this action
Update species profile and EIA guidelines.	Y		Not applicable

Source: Office of Environment and Heritage (2012b)

5.5 Significance assessment

As these species have similar habitat requirements and threatening processes and a similar likelihood of occurrence they are considered together for the purpose of this impact significance assessment.

Section 5A of the EP&A Act requires the following factors, plus any assessment guidelines, to be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The project is unlikely to significantly affect processes such as pollination, seed dispersal and recruitment which could affect the breeding of any population of any of these Threatened species of plant in the study area. It is unknown whether a viable population of any of these species exists within the study area. The presence of a substantial population of any of these species with potential for long-term viability is unlikely as these species were not recorded on the site. If present, these species would exist as small, isolated populations.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The project will result in the clearing of approximately 17 ha of potential habitat for these species.

The habitat affected is already fragmented by existing roadways and cleared areas.
The clearing associated with the project is unlikely to substantially increase the fragmentation or isolation of patches of this habitat in relation to other such habitat in the locality.

The lack of any records of these species within the study area and the modification and fragmentation that this habitat has undergone suggests that this habitat is unlikely to be important for the conservation of any of these species.

This loss of habitat is unlikely to significantly affect the long-term survival of any of these species in the locality.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for these species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The recovery plans and strategies of relevance to these species are described in Section 5.4 of this Appendix.

These strategies primarily relate to management of threats to known populations of the species, research and policy development and are of limited relevance to the project. The project is not considered likely to substantially contribute to or interfere with the implementation of these recovery plans and strategies.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project will constitute three key threatening processes (KTPs) under the *Threatened Species Conservation Act 1995*:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.

The project would result in some clearing of native vegetation and has potential to result in weed proliferation. The vegetation clearing protocols proposed and weed management during and after construction will however minimise these impacts.

5.6 Conclusion

Given the limited extent of habitat that will be affected by the development the impact to these species is unlikely to be significant.

D6. Squirrel Glider and Eastern Pygmy Possum

6.1 Status

The Eastern Pygmy-possum and Squirrel Glider are listed as a Vulnerable species under the TSC Act.

6.2 Eastern Pygmy-possum

Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Common Ringtail Possum dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks. Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares (Office of Environment and Heritage 2012b).

6.3 Squirrel Glider

The Squirrel Glider is sparsely distributed along the east coast and immediate inland districts from western Victoria to north Queensland. In NSW it is found in dry sclerophyll forest and woodland but not found in dense coastal ranges. It typically inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. It is associated with mixed tree species stands with a shrub or Acacia midstorey. It requires abundant tree hollows for refuge and nest sites and feeds on gum of acacias, eucalypt sap and invertebrates (NSW National Parks and Wildlife Service 1999b){NSW National Parks and Wildlife Service, 1999 #39}.

6.4 Specific impacts

The 27.4-35.7 ha of woodland affected is only likely to be used by the these on a sporadic basis, particularly by dispersing juveniles, as this vegetation type is marginal habitat for the species and is degraded with a lower than natural abundance of potential food plants. The core habitat of any Squirrel Glider or Eastern Pygmy Possum populations utilising the site is likely to be found in the more expansive woodlands to the south-east of the site which are of a floristic composition more suited to these species.

Some of the 46 hollow-bearing trees that would be lost may contain hollows suitable for den sites. Nest box installation will be conducted in the riparian zone which will offset some of this loss of potential den habitat.

6.5 Threats

The decline of these species is attributed to the following threats:

- loss and fragmentation of habitat
- loss of hollow-bearing trees
- loss of flowering understorey and midstorey shrubs abundance and diversity in forests
- Individuals can get caught in barbed wire fences while gliding (Squirrel Glider only)
- changed fire regimes that affect the abundance of flowering myrtaceous shrubs, particularly banksias
- predation from cats, dogs and foxes
- loss of hollow availability due to takeover by feral honeybees and exotic birds
- loss of nest sites due to removal of firewood(Department of Environment Climate Change and Water 2010c).

6.6 Recovery

No recovery plans have been developed for these species however recommended management actions have been identified for these species and are shown in Table 6.1 and table 6.2.

Table 6.1 Management actions for Squirrel Glider

Description of management action[1]	Does action relate to the Project?
Retain den trees and recruitment trees (future hollow-bearing trees).	Potential den trees for this species will be removed however, a large proportion of potential den trees and recruitment trees will be retained in the riparian zone of the Georges River. Revegetation, the installation of nest boxes and the implementation of the offset strategy will contribute to the availability of potential den sites for the species in the medium and long term.
Retain food resources, particularly sap-feeding trees and understorey feed species such as Acacias and banksias	Potential food resources for this species will be removed however, a large proportion of food resources will be retained in the riparian zone of the Georges River. Weed removal and revegetation of native shrub and sub-canopy layers will contribute to the availability of potential food sources for the species in the medium and long term.
Replace top one or two strands of barbed wire on fences with regular wire in and adjacent to habitat	The potential for gliding possums and bats to be injured will be considered in the design of fences bordering on areas of retained/restored habitat. Fences will be designed, where practicable, to minimise the risk of injury.
Retain and protect areas of habitat, particularly mature or oldgrowth forest containing hollow-bearing trees and sap-feeding trees	Potential habitat for this species will be removed however, a large proportion of habitat will be retained in the riparian zone of the Georges River. Weed removal and revegetation will contribute to the protection of remaining habitat from further degradation.
In urban and rural areas retain and rehabilitate habitat to maintain or increase the total area of habitat	Potential habitat for this species will be removed however, a large proportion of habitat will be retained in the riparian zone of the Georges River. Weed removal and revegetation will

Description of management action[1]	Does action relate to the Project?
available, reduce edge effects, minimise foraging distances and increase the types of resources available.	consolidate patches of habitat and reduce edge effects.

Source: (Office of Environment and Heritage 2012b)

Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

Table 6.2 Management actions for Eastern Pygmy-possum

Description of management action[1]	Does action relate to the Project?
Control feral predators and rabbits.	Not applicable
Avoid frequent burning of habitat.	Fire will be managed for biodiversity conservation in the retained and restored vegetation of the riparian zone of the Georges River.
Protect habitat in proposed development areas and retain linkages across the broader landscape.	Potential habitat for this species will be removed however, a large proportion of habitat will be retained in the riparian zone of the Georges River. Weed removal and revegetation will consolidate patches of habitat and reduce edge effects.
Avoid overgrazing by stock and fire wood collection in areas of heathy understorey vegetation.	Not applicable
Regenerate and replant local feed sources.	Potential food resources for this species will be removed however, a large proportion of food resources will be retained in the riparian zone of the Georges River. Weed removal and revegetation of native shrub and sub-canopy layers will contribute to the availability of potential food sources for the species in the medium and long term.

Source: (Office of Environment and Heritage 2012b)

Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

6.7 Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The habitat for these species in the study area is considered to be marginal and it is unlikely that a significant proportion of any local population breeds on the site.

The proposed nest box installation, hollow-relocation and vegetation restoration is likely to offset the loss of breeding habitat to the extent that local populations of these species are unlikely to be placed at significantly increased likelihood of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a. **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

b. **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

a. **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

b. **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

c. **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The approximately 27.4-35.7 ha of woodland affected is only likely to be used the these on a sporadic basis, particularly by dispersing juveniles, as this vegetation type is marginal habitat for the species and is degraded with a lower than natural abundance of potential food plants. The core habitat of any Squirrel Glider or Eastern Pygmy Possum populations utilising the site is likely to be found in the more expansive woodlands to the south-east of the site which are of a floristic composition more suited to these species. As these species are moderately mobile they are considered unlikely to be significantly affected by the minor additional habitat fragmentation that would occur as a result of the project.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for these species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plans have been developed for these species however priority actions have been identified for their recovery. While the project will result in loss of potential habitat, it also has potential to contribute to the implementation these actions (refer Table 6.2, Table 6.3) through the installation of nest boxes and the restoration of riparian vegetation in this location.
The project is unlikely to significantly interfere with the implementation of any recovery actions of relevance to these species.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The project would contribute to the following key threatening processes that may affect these species:

- Clearing of native vegetation.

- Loss of hollow-bearing trees.
- Removal of dead wood and trees (Office of Environment and Heritage 2012b).

With the implementation of the riparian vegetation and habitat restoration proposed, however, the project is unlikely to have a significant long-term contribution to these threatening processes.

6.8 Conclusion

Given the limited extent of habitat that will be affected by the development the impact to these species is unlikely to be significant.

D7. Cumberland Land Snail

7.1 Status

The Cumberland Land Snail is listed as an Endangered species under the TSC Act.

7.2 Description

The Cumberland Land Snail (*Meridolum corneovirens*) is a terrestrial species of snail that is generally tan to dark orange in colour ranging from 15-30 mm in size (National Parks and Wildlife Service 2000). The species can be confused with introduced and other native snails. Currently, there is little known about the biology, dispersal patterns and distance movement, however, current knowledge suggest the species is restricted to the Cumberland Plain and Castlereagh Woodlands of Western Sydney and also along the fringes of River Flat Forest, especially where it meets Cumberland Plain Woodland. Microhabitat features used by the species include the underparts of logs and other debris, leaf and bark accumulations around the bases of trees and sometimes under grass clumps. Loose soil is sometimes used by the species for burrowing, and *Meridolum corneovirens* is fungal feeder and is generally active at night. The bulk of the known populations are small, isolated and vulnerable to impacts from clearing and habitat modification such as the removal of ground cover as this removes shelter, breeding habitat and sources of food (National Parks and Wildlife Service 2000).

The species is known to be genetically structured over short distances. Population studies have shown that individuals from any one location (within a few metres of each other) are very likely to be genetically related and the genetic neighbourhood is limited to about 350 m (Clarke & Richardson 2002).

7.3 Specific impacts

This species is able to occupy disturbed woodland vegetation if suitable cover (fallen timber, rubbish and leaf litter) is available. In the study area, potential habitat for the species occurs in Alluvial Woodland where leaf litter, artificial debris and fallen branches provide food and shelter. Approximately 27.4-35.7 ha of this habitat, representing approximately 60% of potential habitat in the study area, would be removed.

Given the species' very limited dispersal ability (Clarke & Richardson 2002), the 2006 recordings of the species in the study area are likely, if the species is still extant, to represent a discrete sub-population with limited interaction between this and other sub-populations outside the study area due to habitat fragmentation.

Insufficient information about the population dynamics of the species or any extant population on the site is available to determine whether a viable population of the species exists. For the purpose of this assessment however, the sub-population in the study area is considered to be viable.

7.4 Threats

There is generally a poor understanding of other threats to this species however the main recognised threat is clearing and degradation of Cumberland Plain Woodland remnants (Office of Environment and Heritage 2012b).

Key threatening processes that may affect this species include:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- Invasion and establishment of exotic vines and scramblers.
- High frequency fire.
- Removal of dead wood and trees (Office of Environment and Heritage 2012b).

7.5 Recovery

No recovery plans have been developed for this species however nine priority actions have been identified for its recovery (Office of Environment and Heritage 2012b).

Table 7.1 Recovery actions for Cumberland Plain Land Snail

Description of priority action[1]	Does action relate to the project?
Approach priority private site landholders to negotiate implementing protective management regimes.	Not applicable
Review species' conservation status with consideration of data obtained since listing as endangered.	Not applicable
Implement appropriate fire regimes (ones that allow build up of grass and litter layers).	The species will be considered in the management plan for the Conservation Zone.
Reserve Fire Management Strategy to include operational guidelines to protect this species from fire	Not applicable
Ensure public land plans of management include appropriate actions for species' protection.	The species will be considered in the management plan for the Conservation Zone.
Install structures (where necessary) to prevent accidental slashing and removal of plant debris.	The species will be considered in the management plan for the Conservation Zone.
Implement weed control at sites where necessary.	Weed control would be implemented throughout the project which would minimise the potential for weed spread into retained areas of the species' habitat
Investigate population census techniques and responses to environmental conditions, with the aim of developing estimates of true population size based on numbers detected in standard surveys.	Not applicable
Identify priority sites for conservation actions on private land.	Not applicable.

Source: Office of Environment and Heritage (2012b)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

7.6 Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Insufficient information about the population dynamics of the species is available to determine whether any extant sub-population within the study area is likely to be viable. For the purpose of this assessment however any extant population in the study area is considered to be viable.

The size and geographic extent of any extant sub-population is unknown however given the small number of individuals recorded it is presumed to be small.

The proposed habitat removal may affect the life cycle of individuals within this sub-population however, it is unlikely to increase the likelihood of extinction of the broader population within the locality.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable

In relation to the habitat of a threatened species, population or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The project would include the clearing of up to approximately 27.4-35.7 ha of potential habitat for this species.

As any sub-population of this species in the study is likely to be small and somewhat isolated from other sub-populations in the locality due to intervening areas of unsuitable habitat such as roadways and areas with highly modified groundcover, the project is considered unlikely to substantially increase the present level of fragmentation of these groups.

The importance of any sub-population of this species in the study to the long-term survival of the species in the locality is unknown. Given the limited opportunity for genetic interaction between isolated groups, the contribution of each group to the viability of nearby groups (and the broader population) also appears limited. There may however be potential for currently isolated groups to contribute to one another's viability through the possible translocation of individuals to supplement nearby groups in the locality thereby increasing the genetic diversity of the recipient groups (sub-populations).

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for this species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plans have been developed for this species however nine priority actions have been identified for its recovery (Office of Environment and Heritage 2012b). Most of these actions (refer Table 7.1) are not applicable to the project. The proposed weed management and relocation of woody debris are however considered to be consistent with the objectives of these recovery actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The project may result in or contribute to the following key threatening processes that may affect this species:

- Clearing of native vegetation.
- Invasion of native plant communities by exotic perennial grasses.
- Invasion and establishment of exotic vines and scramblers.
- Removal of dead wood and trees (Office of Environment and Heritage 2012b).

The proposed vegetation clearing protocol, weed management and relocation of woody debris would minimise the impact of these processes.

7.7 Conclusion

The Cumberland Land Snail is an Endangered Species listed under the TSC Act.

Potential habitat for this species will be lost and mortality of individuals may occur however, substantial areas of potential habitat will be retained and individuals of the species uncovered during vegetation clearing will be relocated into adjacent retained habitat. The project is, therefore, unlikely to have a significant impact on the local occurrence of the species.

D8. Microchiropteran bats

None of these species were captured during harp trapping conducted during the field survey, however ultrasonic (Anabat) bat call recording and analysis revealed the possible presence of Eastern Freetail-bat Bat, Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bentwing-bat and Large-footed Myotis. Due to the poor quality of call recordings and/or overlap in the call characteristics with other bat species, the presence of these species on site has not been definitively determined. For the purposes of this assessment, all of these species have therefore been assumed to occur on site.

8.1 Status

The following microchiropteran bats (microbats) are each listed as Vulnerable under the TSC Act.

8.2 Eastern Freetail-bat Bat

This species lives in sclerophyll forest and woodland. Small colonies have been found in tree hollows or under loose bark. It feeds on insects above the forest canopy or in clearings at the forest edge (Churchill 2008).

This species has previously been recorded within one kilometres of the study area (Office of Environment and Heritage 2012a).

Possible threats for this species include forest harvesting and habitat clearance (Duncan *et al.* 1999a).

8.3 Greater Broad-nosed Bat

The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3-6 m but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Strahan 1995).

It is distributed along the east coast of Australia from the New South Wales/ Victorian border to the north coast of Queensland.

This species has previously been recorded within one kilometres of the study area (Office of Environment and Heritage 2012a) and a probable record of this species was made during the current survey using identification of echolocation calls (Anabat).

Possible threats for this species include forest harvesting and habitat clearance (Duncan et al. 1999b).

8.4 Eastern False Pipistrelle

This species usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. It prefers wet habitats where trees are more than 20 m high but Forages within the canopy of dry sclerophyll forest (Churchill 2008).

This species has previously been recorded within one kilometres of the study area (Office of Environment and Heritage 2012a) and a probable record of this species was made during the current survey using identification of echolocation calls (Anabat).

8.5 Yellow-bellied Sheathtail-bat

Yellow-bellied Sheathtail Bats occur in almost all habitats from wet and dry sclerophyll forest, open woodland, Acacia shrubland, and grasslands. This species roosts in hollows of live and dead hollow-bearing trees, the outside walls of buildings, under exfoliating bark, or in burrows of terrestrial mammals in treeless areas. They have also been found in the abandoned nests of Sugar Glider (*Petaurus breviceps*) or birds (Richards 1998b).

Yellow-bellied Sheathtail Bats forage above the tree canopy. Foraging height varies with the height of the canopy; they fly high and fast. In more open country they forage lower to the ground (Lumsden & Bennett 1995). This species eats a variety of prey mainly beetles (up to 90 per cent) but also long-horned grasshoppers, shield bugs and few flying ants (Churchill 2008).

Yellow-bellied Sheathtail Bats tend to be solitary for most of the year but may form small groups of up to six. Breeding has been recorded from December to mid-March, when a single young is born. Seasonal movements are unknown and there is speculation about a migration to southern Australia in late summer and autumn (Richards 1998b).

8.6 Eastern Bentwing-bat

This species is usually found in well-timbered valleys where it forages on small insects above the canopy. It roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill 2008).

Populations of this highly mobile and species are centred on maternity and hibernation caves. Outside of the breeding and hibernation seasons bats disperse over wider areas to forage and roost in a variety of natural caves and man-made structures (Churchill 2008). Local populations of these species therefore tend to cover large geographic areas and consist of many individuals.

This species has previously been recorded in the locality.

Possible threats for this species include disturbance of roost sites, introduced predators and pollutants (Duncan et al. 1999).

8.7 Large-footed Myotis

The Large-footed Myotis is a cave dwelling bat that also roosts in mine shafts, stormwater tunnels, under bridges and in buildings usually in small colonies of 10 -15 individuals.
This species occasionally roosts in tree hollows amongst vegetation, often in clumps of pandanus palms. The species usually select roosts close to water, often choosing caves that overhang pools. They have been caught in mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River red gum woodland along the east coast of Australia (Churchill 2008; Richards 1998a).

Colonies always occur close to bodies of water where this species feeds on aquatic invertebrates and small fish by trawling across the water surface and catching flying insects (Churchill 2008).

8.8 Specific impacts

The air spaces within and around all native vegetation and over water bodies within the study area provide foraging opportunities for these bat species. Larger woodland patches with more intact vegetation structure, particularly the riparian vegetation of the Georges River are however considered likely to be the most important foraging areas.

Potential breeding and roosting habitat is largely restricted to locations which contain mature hollow-bearing trees. Mature hollow-bearing trees within the study area are concentrated along the Georges River riparian corridor but also occur as remnant trees is disturbed vegetation elsewhere in the study area.

The project would include the clearing of up to approximately 27.4-35.7 ha of potential foraging habitat for these species. Approximately 46 hollow-bearing and potentially hollow-bearing trees, which provide potential roosting and breeding habitat for hollow-dependent species, would be removed.

Of the bat species likely to occur in the study area, the Eastern Bentwing-bat is not known to utilise tree hollows.

8.9 Threats

Recognised threats to these species include:

- Loss or disturbance of roosting sites and maternity caves.
- Disturbance to winter roosting sites and breeding sites.
- Clearing adjacent to foraging areas.
- Application of pesticides in or adjacent to foraging areas.
- Loss of vegetation for foraging and hollow-bearing trees for roosting.
- Application of pesticides in or adjacent to foraging areas (Office of Environment and Heritage 2012b).

Key threatening processes that may affect these species include:

- Clearing of native vegetation.
- Loss of hollow-bearing trees.
- Removal of dead wood and trees
- Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (Office of Environment and Heritage 2012b).

8.10 Recovery

No recovery plans have been developed for these species however priority actions have been identified for their recovery. Most of these actions relate to research, education and policy development and are of limited relevance to the project. The project has potential to contribute to the implementation of three of these actions (refer Table 8.1) through the installation of bat

Table 8.1 Recovery actions for Threatened species of microbat

Description of priority action[1]	Relevant to species or population						Does action relate to the project?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing-bat	Large-footed Myotis	
Assess the importance by survey of estuaries and other tidal waterways for the species across its range.						Y	Not applicable
Better define species distribution through survey in coastal lowlands on- and off-reserve.		Y					Not applicable
Better regulate pollution of waterways e.g. sewage and fertilizer run-off (eutrophication) and pesticide/herbicide leakage (chemical pollution) and thermal pollution.						Y	Not applicable
Compile register of all known roost sites in natural and artificial structures including current and historical data and identify significance of roost, e.g. maternity, hibernation, transient roost.					Y		Not applicable
Confirm species taxonomy of NSW populations, relative to other Australian populations.					Y		Not applicable
Confirm species taxonomy of NSW populations, relative to other Australian populations.					Y		Not applicable
Control foxes and feral cats around roosting sites, particularly maternity caves and hibernation sites.					Y		Not applicable
Determine susceptibility to logging.					Y	Y	Not applicable
Determine the effectiveness of PVP assessment, offsets and actions for bats.					Y		Not applicable
Determine the effectiveness of PVP assessment, offsets and actions for bats.					Y		Not applicable
Develop and promote State-wide bat awareness programs for schools, CMAs, landholders and industry groups etc.	Y	Y	Y	Y			Not applicable
Encourage recovery of natural hydrological regimes, including retention and rehabilitation of riparian vegetation.						Y	The proposed measures to minimise vegetation clearing and rehabilitate riparian vegetation are consistent with this

Description of priority action[1]	Relevant to species or population						Does action relate to the project?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing-bat	Large-footed Myotis	
							action.
Ensure protection of known roosts and forest within 10 km of roosts in PVP assessments (offsets should include nearby remnants in high productivity) and other environmental planning instruments.					Y		Not applicable
Ensure the Code of Practice for private native forestry includes adequate measures to protect large, hollow-bearing trees and viable numbers of recruit trees. .	Y	Y	Y	Y			Not applicable
Ensure the largest hollow bearing trees, inc. dead trees and paddock trees, are given highest priority for retention in PVP assessments. Offsets should include remnants in high productivity.	Y	Y	Y	Y		Y	Not applicable
Establish a gating design for disused mines across species range that will not adversely impact species. Consultation with cave bat specialist prior to any gating operations.					Y		Not applicable
Exclude prescription burns from 100m from cave entrance, ensure smoke/flames of fires do not enter caves/roosts in artificial structures.					Y		Not applicable
For roost caves vulnerable to human disturbance, monitor their visitation by people, particularly during winter and spring/summer maternity season and in school holidays.	Y						Not applicable
Identify and protect significant roost habitat in artificial structures (e.g. culverts, old buildings and derelict mines).					Y		Not applicable
Identify areas of private land that contain high densities of large hollow-bearing trees as areas of high conservation value planning instruments and land management negotiations e.g. LEP, CAPs, PVPs.	Y	Y	Y	Y			Not applicable
Identify important foraging range and key habitat components for this species.	Y	Y	Y				Not applicable
Identify the effects of fragmentation in a range of fragmented landscapes i.e. the farmland/forest interface and the urban/forest interface e.g. movement and persistence across a range of fragment sizes.	Y	Y	Y	Y			Not applicable
Identify the spatial population structure, including genetic isolation, movement and persistence across the species range.						Y	Not applicable
Identify the susceptibility of the species to pesticides.	Y	Y		Y	Y		Not applicable

Description of priority action[1]	Relevant to species or population						Does action relate to the project?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing-bat	Large-footed Myotis	
Identify, protect and enhance roost habitat beneath artificial structures (e.g. bridges), especially when due for replacement, and assess effectiveness of the actions.						Y	Not applicable
Investigate the effectiveness of logging prescriptions.	Y	Y	Y	Y		Y	Not applicable
Measure genetic population structure among cave roosts of maternity colonies to estimate dispersal and genetic isolation, and vulnerability to regional population extinction.					Y		Not applicable
Monitor the breeding success of a representative sample of maternity colonies in cave roosts over a number of years to determine the viability of regional populations.	Y						Not applicable
Prepare EIA guidelines which address the retention of hollow bearing trees maintaining diversity of age groups, species diversity, structural diversity. Give priority to largest hollow bearing trees.	Y	Y	Y	Y		Y	Not applicable
Prepare fire management plans for significant roost caves, disused mines, culverts, especially maternity and winter roosts.					Y		Not applicable
Prepare management plans for significant bat roosts especially all known maternity colonies and winter colonies.					Y		Not applicable
Promote bats throughout the rural community as ecologically interesting and important, but sensitive to disturbance at caves/disused mine tunnels.					Y		Not applicable
Promote roosting habitat in new artificial structures within the species range.						Y	Consideration will be given to fitting roost boxes to the bridge over the Georges River to provide roost sites for the Large-footed Myotis. This measure is consistent with this action.
Promote the conservation of HCV private land areas using measures such as incentive funding to landholders, off-setting and biobanking, acquisition for	Y	Y	Y	Y			Not applicable

Description of priority action[1]	Relevant to species or population						Does action relate to the project?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing-bat	Large-footed Myotis	
reserve establishment or other means.							
Promote the conservation of these key roost areas using measures such as incentive funding to landholders, offseting and biobanking, acquisition for reserve establishment or other means					Y		Not applicable
Quantify any benefits of local bat populations to reducing the impact of insect pests on commercial crops.	Y	Y	Y	Y			Not applicable
Raise awareness of the effects of pesticides.		Y		Y			Not applicable
Regular censuses of maternity colonies (Wee Jasper, Bungonia, Willi-Willi, Riverton) and other key roosts in network, especially where there are population estimates from banding in the 1960s.	Y						Not applicable
Research the degree of long-term fidelity to roost trees and roosting areas in order to assess their importance and the effects of their removal.	Y	Y	Y	Y			Not applicable
Research the effect of different burning regimes on cave disturbance and surrounding foraging habitat.					Y		Not applicable
Research the effect of different burning regimes.	Y	Y	Y	Y			Not applicable
Research the effectiveness of rehabilitation measures intended to increase bat populations in degraded landscapes, such as revegetating and installing bat boxes.	Y	Y	Y	Y			Not applicable
Research the potential for long distance/seasonal movement.				Y			Not applicable
Research the roosting ecology of tree-roosting bats. For example identifying the attributes of key roosts. .	Y	Y	Y	Y			Not applicable
Research to identify important foraging range and key habitat components around significant roosts.					Y		Not applicable
Research to identify important foraging range and key habitat components for this species. Identify the importance of riparian vegetation to the species.						Y	Not applicable
Resolve species taxonomy by morphology/genetics and reassess conservation status.						Y	Not applicable
Restrict access where possible to known maternity sites. (e.g.: signs; bat-friendly, preferably external gates at caves).					Y		Not applicable

Description of priority action[1]	Relevant to species or population						Does action relate to the project?
	Eastern Freetail-bat-bat	Greater Broad-nosed Bat	Eastern False Pipistrelle	Yellow-bellied Sheathtail Bat	Eastern Bentwing-bat	Large-footed Myotis	
Restrict caving activities at significant roosts during important stages of the annual bat life cycle (eg winter hibernation, summer maternity season).					Y		Not applicable
Restrict caving activity during critical times of year in important roosts used by species, particularly maternity and hibernation roosts.					Y		Not applicable
Search for significant roost sites and restrict access where possible (e.g. gating of caves). Significant includes maternity, hibernation and transient sites including in artificial structures. .					Y		Not applicable
Study the ecological requirements of maternity colonies and their environs and migratory patterns.					Y		Not applicable
Study the ecology, habitat requirements and susceptibility to logging and other forestry practices of this little-known species.	Y	Y	Y		Y	Y	Not applicable
Study the species biology such as reproductive capacity, longevity, mortality rate and life history, or thermal and energy requirements to better determine capacity to respond to changes in climate or recover from losses in the population.				Y			Not applicable
Study the susceptibility of this species to pesticide accumulation				Y			Not applicable
Survey large inland waterways for this species to determine distribution in Murray Darling Basin.	High					Y	Not applicable
Undertake a systematic survey of productive coastal river valleys to quantify the importance of private land relative to public lands.		Y					Not applicable
Undertake long-term monitoring of populations cross tenure in conjunction with other bat species to document changes.	Y	Y	Y	Y		Y	Not applicable
Undertake non-chemical removal of weeds (e.g. lantana, blackberry) to prevent obstruction of cave entrances.					Y		Not applicable
Use radio-tracking to identify important foraging range and help interpret density of records.				Y			Not applicable

Source: Office of Environment and Heritage (2012b)

1 Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

8.11 Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Eastern Bentwing-bat breeds in communal maternity caves migrating long distances between these and summer foraging habitat and is highly unlikely to breed in the study area.

Whilst additional potential breeding habitat is likely to be available to hollow-dependent microbat species in the locality, the loss of 46 hollows is considered likely to represent a significant proportion of the locally available breeding habitat for hollow-breeding bats. The proposed nest box installation, hollow-relocation and vegetation restoration is likely to offset this loss of breeding habitat to the extent that local populations of these species are unlikely to be placed at significantly increased likelihood of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a. **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

b. **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

a. **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

b. **(b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

c. **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The Eastern Bentwing-bat migrates over large distances between maternity and hibernation caves and summer foraging habitat where it uses a variety of natural caves and artificial structures for roosting.

The project would include the clearing of up to approximately 39.9 ha of potential foraging habitat for microbat species. Potential foraging habitat for these species is considered to be relatively abundant in the locality. The foraging habitat that the species would lose is considered to be of only moderate importance to local populations of these species.

As these species are highly mobile they are considered unlikely to be significantly affected by the minor additional habitat fragmentation that would occur as a result of the project.

Additional potential breeding habitat is likely to be available to hollow-dependent microbat species in the locality, and the loss of 46 hollows, chiefly located in moderately to highly modified habitat, is unlikely to cause a significant reduction in the locally available breeding habitat for hollow-breeding bats or place theses species or to significantly increase their likelihood of extinction.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for these species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plans have been developed for these species however priority actions have been identified for their recovery (refer Table 8.1). Most of these actions relate to research, education and policy development and are of limited relevance to the project. The project is unlikely to interfere with the implementation of any recovery actions of relevance to these species.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The project would contribute to the following key threatening processes that may affect these species:

- Clearing of native vegetation.
- Loss of hollow-bearing trees.
- Removal of dead wood and trees (Office of Environment and Heritage 2012b).

With the implementation of the riparian vegetation and habitat restoration proposed, however, the project is unlikely to have a significant long-term contribution to these threatening processes.

8.12 Conclusion

Impacts on these six microbat species areas are unlikely to be significant due to the relatively small amount of clearing of potential breeding habitat and proposed vegetation and habitat restoration activities.

D9. Grey-headed Flying-fox

9.1 Status

The Grey-headed Flying-fox is listed as Vulnerable under Schedule 2 of *the Threatened Species Conservation Act*.

9.2 Species and habitat description

The Grey-headed Flying-fox is found in a variety of habitats including subtropical and temperate rainforest, mangroves, paper bark swamps, heathland, sclerophyll forests, urban gardens and cultivated areas from South-east Queensland, through eastern NSW into south-eastern areas of Victoria with occasional occurrences in eastern South Australia. It forages on blossoms and fruits of over 80 species of plants (Parry-Jones & Augee 1991). The major foraging resource for Grey-headed Flying-fox includes the nectar and pollen of a variety of native plants including *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines, and native figs (*Ficus* spp.). They have also been found to chew leaves and appear to eat the salt glands from mangroves (Parry-Jones & Augee 1991).

Grey-headed Flying-foxes congregate in camps of up to 200,000 individuals with camp size influenced by the availability of the local blossom, with the camps being located close to water, in vegetation within a dense canopy. These bats have nightly feeding ranges of up to 20 to 50 km from their daytime camp (Eby 1991).

Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Annual mating commences in January and a single young is born each October or November. For the first three weeks females carry their young when they forage, after this, the young are left together in the camp when they forage (Churchill 2008).

Site fidelity to camps is high with some camps being used for over a century. Individuals are highly mobile and regularly move between camp sites in response to local food availability (Parry-Jones & Augee 1991; Parry-Jones & Augee 1992; Spencer *et al.* 1991).

9.3 Specific impacts

Grey-headed Flying-foxes have been previously recorded in the locality and a single individual was recorded flying over the investigation area during field surveys. No flying-fox colonies were recorded on the site.

Food resources for the Grey-headed Flying-fox (nectar and fruit) are generally varied and abundant in the summer months and scarce in winter (Department of Sustainability Environment Water Population and Communities 2012). Vegetation dominated by winter-flowering trees is, therefore, of particular importance as foraging habitat for the species.

The Castlereagh Scribbly Gum Woodland of the site may provide a foraging resource for the Grey-headed Flying-fox when the dominant eucalypts are in flower. The dominant trees in this community (*Eucalyptus sclerophylla* and *Melaleuca* spp.) are summer-flowering and do not provide a substantial winter food source for the species. *Eucalyptus tereticornis*, a winter-flowering species, is one of the dominant trees in the Alluvial Woodland and Riparian Forest communities.

Flying-foxes roost and breed in large colonies (camps) which are typically located in tall, at least moderately dense vegetation usually in close proximity to water bodies (reference). The only vegetation on the site with potential to provide suitable conditions for inhabitation of a flying-fox camp is the riparian vegetation along the Georges River. The nearest known camp is at Cabramatta, approximately 4.5km north-east of the subject site.

The approximately 17 ha of Castlereagh Scribbly Gum Woodland and Castlereagh Swamp Woodland to be removed is only likely to be used as a foraging habitat by this species in summer when the dominant tree species are flowering heavily and is unlikely to be significant habitat.

The approximately 27.4-35.7 ha of Alluvial Woodland and Riparian Forest to be removed is likely to be of high value winter foraging habitat for this species. As a substantial (>50m wide) area of riparian vegetation will be retained, potential roosting and breeding habitat for the species is unlikely to be significantly affected.

9.4 Threats

Recognised threats include:

- Loss of foraging habitat.
- Disturbance of roosting sites.
- Unregulated shooting.
- Electrocution on powerlines (Office of Environment and Heritage 2012b).

Key threatening processes that may affect the species include:

- clearing of native vegetation.

9.5 Recovery

No NSW plan has been developed for this species however thirty-one priority actions have been identified for its recovery (Office of Environment and Heritage 2012b).

These strategies primarily relate to research, education and policy development and are of limited relevance to the project. The project is not considered likely to substantially contribute to or interfere with the implementation of these recovery strategies

Table 9.1 Recovery actions for the Grey-headed Flying-fox

Description of priority action[1]	Does action relate to the project?
Provide educational resources to improve public attitudes toward Grey-headed Flying-foxes.	Not applicable
Develop materials for public education & provide them to land managers & local community groups working with controversial flying-fox camps, highlighting species status, reasons for being in urban areas, reasons for decline etc.	Not applicable
Monitor public attitudes towards flying-foxes.	Not applicable
Review & evaluate camp site management activities, summarising outcomes of past experiences at controversial camps. Noise impacts on	Not applicable

Description of priority action[1]	Does action relate to the project?
neighbours of camps to be considered. For use in managing future conflicts with humans at flying-fox camps.	
Conduct periodic range-wide assessments of the population size of Grey-headed Flying-foxes to monitor population trends.	Not applicable
Grey-headed Flying-fox National Recovery Team to undertake an annual review of the national recovery plan's implementation.	Not applicable
Enhance and sustain the vegetation of camps critical to the survival of Grey-headed Flying-foxes.	Not applicable
Protect and enhance priority foraging habitat for Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.	Not applicable. Habitat of the study area is not considered to be priority foraging habitat.
Protect roosting habitat critical to the survival of Grey-headed Flying-foxes, for example through management plans, local environmental plans and development assessments, and through volunteer conservation programs for privately owned land.	Not applicable
Increase the extent and viability of foraging habitat for Grey-headed Flying-foxes that is productive during winter and spring (generally times of food shortage); including habitat restoration/rehabilitation works.	Clearing of foraging habitat that is productive during winter has been minimised through retention of riparian vegetation. Restoration of vegetation in the riparian corridor will include planting of winter-flowering trees.
Develop and implement a grower-based program to monitor trends in damage to commercial fruit crops by flying-foxes, and use the results to monitor the performance of actions to reduce crop damage.	Not applicable
Systematically document the levels of flying-fox damage to the horticulture industry within the range of the Grey-headed Flying-fox.	Not applicable
Develop guidelines to assist land managers dealing with controversial flying-fox camps.	Not applicable
Complete national recovery plan in 2007.	Not applicable
Develop and promote incentives to reduce killing of flying-foxes in commercial fruit crops.	Not applicable
Develop methods for rapid estimates of flying-fox damage on commercial crops, allowing the long-term monitoring of industry-wide levels and patterns of flying-fox damage.	Not applicable
Review and improve methods used to assess population size of Grey-headed Flying-foxes.	Not applicable
Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts.	Not applicable
Describe the species, age structure & demographics of flying-foxes killed in fruit crops to improve the understanding of the impact by assessing trends in the species, sex, age & reproductive status of animals killed on crops.	Not applicable
Determine characteristics of roosting habitat for Grey-headed Flying-foxes, exploring the roles of floristic composition, vegetation structure, microclimate and landscape features, and assess the status of camps.	Not applicable
Investigate the age structure and longevity of Grey-headed Flying-foxes.	Not applicable
Assess the impacts Grey-headed Flying-fox camps have on water quality, and publish results in a peer-reviewed journal.	Not applicable

Description of priority action[1]	Does action relate to the project?
Develop methods to monitor landscape scale nectar availability trends, to explain/potentially predict crop damage trends where crop protection is absent, & promote importance of foraging habitat productive in seasons critical to the horticulture industry.	Not applicable
Investigate between-year fidelity of Grey-headed Flying-fox individuals to seasonal camps.	Not applicable
Investigate the differences in genetic relatedness, sex, age etc. between sedentary and transient Grey-headed Flying-foxes.	Not applicable
Investigate the genetic structure within Grey-headed Flying-fox camps, including levels of relatedness within and between members of adult groups, occupants of individual trees etc.	Not applicable
Investigate the patterns of juvenile Grey-headed Flying-fox dispersal and mortality, allowing identification of the specific habitat requirements of juveniles.	Not applicable
Identify the commercial fruit industries that are affected by Grey-headed Flying-foxes, to provide an information base for use by the various stakeholders.	Not applicable
Set priorities for protecting foraging habitat critical to the survival of Grey-headed Flying-foxes and generate maps of priority foraging habitat.	Not applicable
Establish & maintain a range-wide database of Grey-headed Flying-fox camps, including information on location, tenure, zoning & history of use, for distribution to land management/planning authorities, researchers & interested public.	Not applicable

Source: Office of Environment and Heritage (2012b)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

9.6 Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

No camp sites (roosting and breeding habitat) for the Grey-headed Flying-fox are located within or adjacent to the study area. Breeding habitat for the species is hence unlikely to be affected.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a. **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**

b. **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

a. **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

b. **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

c. **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,**

Approximately 40 ha of woodland will be cleared which is likely to be used as a foraging habitat by this species on a seasonal basis when the dominant eucalypt species are flowering heavily.

As this species is highly mobile it is considered unlikely to be significantly affected by the additional habitat fragmentation that would occur as a result of the project.

Potential summer foraging habitat for this species (all vegetation on site) is considered to be relatively abundant in the locality and is considered to be of only moderate importance to the local occurrence of this species.

The winter foraging habitat (Alluvial Woodland and Riparian Forest) to be removed (27.4-35.7 ha) is less abundant and of greater importance however a substantial area will be retained (22 ha) within the Conservation Zone along the Georges River.. The project is, therefore, unlikely to have a significant long-term impact on the availability of important habitat for the species in the locality.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for this species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The project is not considered likely to substantially contribute to or interfere with the implementation of recovery strategies for this species (refer Table 9.1).

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project would contribute to the clearing of native vegetation key threatening process that may affect this species. The increased impact of this KTP as a result of the project is not however considered likely to significantly impact the local population of this species.

9.7 Conclusion

The Grey-headed Flying-fox is listed as a Vulnerable species under the TSC Act. The Grey-headed Flying-fox is unlikely to be significantly affected by the project.

boxes under the bridge over the Georges River and the restoration of riparian vegetation in this location. The project is not considered likely to interfere with the implementation of any of the other recovery actions of relevance to these species.

D10. Migratory and nomadic nectarivorous birds

The following three bird species are all migratory or nomadic nectar-feeding species which are only likely to utilise the study area on a seasonal or sporadic basis in response to the flowering of the dominant eucalypt species.

10.1 Status

The Little Lorikeet and Black-chinned Honeyeater are listed as a Vulnerable species under the TSC Act. The Swift Parrot and Regent Honeyeater are listed as Endangered and Critically Endangered species respectively under the TSC Act.

10.2 Little Lorikeet

In NSW Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range (Royal Australian Ornithologists Union 2003). Little Lorikeets are generally considered to be nomadic with irregular large or small influxes of individuals occurring at any time of year, apparently related to food availability. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts (Higgins 1999).

The breeding biology of Little Lorikeets is little known with most breeding records from the western slopes. The major threats to Little Lorikeets are loss of breeding sites and food resources from ongoing land clearing (NSW Scientific Committee 2009).

10.3 Swift Parrot

Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, Swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coast's including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering *Acacia pycnantha*, is indicated. Sites used vary from year to year. (Garnett & Crowley 2000a),(Swift Parrot Recovery Team 2001).

10.4 Regent Honeyeater

Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with *Casuarina cunninghamiana* and *Amyema cambagei* are important for feeding and breeding. Important food trees include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), E. melliodora (Yellow Box) and *E. leucoxylon* (Yellow Gum) (Garnett & Crowley 2000a).

Regent Honeyeaters are highly mobile, rarely remaining long in one place unless breeding. Even then, they usually depart as soon as their young are independent. During winter, Regent Honeyeaters disperse widely in small groups. In spring they concentrate into the main breeding areas around Chiltern and Benalla in Victoria and Capertee Valley and Bundarra District in NSW. Other sites regularly visited include Canberra and the Warrumbungles, Mudgee and

Gosford areas in New South Wales (Garnett & Crowley 2000a). The species also utilises the woodland communities of the Cumberland Plain.

10.5 Black-chinned Honeyeater

Found in dry eucalypt woodland particularly those containing ironbark and box. Occurs within areas of annual rainfall between 400-700 mm. Feed on insects, nectar and lerps (Garnett & Crowley 2000b). It occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees. Feeding territories are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares (Office of Environment and Heritage 2012b).

10.6 Specific impacts

The approximately 27.4-35.7 ha of Alluvial Woodland and Riparian Forest affected may be used as a foraging habitat by these species on a seasonal or sporadic basis when the dominant eucalypt species are flowering heavily.

Some of the 46 hollow-bearing trees that would be lost may contain hollows suitable for nesting by the Little Lorikeet however most breeding records for the species are from the western slopes region and breeding by this species is infrequently recorded on the Cumberland Plain. The site is unlikely to contain significant breeding habitat. .

10.7 Threats

Recognised threats applicable to these species in NSW include:

- Loss of and degradation of habitat through vegetation clearing and grazing.
- Poor regeneration of open forest and woodland habitats because of intense grazing.
- May be excluded from smaller remnants by aggressive species such as the Noisy Miner (*Manorina melanocephala*).
- For swift parrots, collisions with wire netting fences, windows and cars, during the breeding season and winter migration (especially where such obstacles are in close proximity to suitable habitat) (Office of Environment and Heritage 2012b).

Key threatening processes that may affect the species include:

- Clearing of native vegetation.
- Loss of hollow-bearing trees (Little Lorikeet only).

10.8 Recovery

No NSW recovery plan has been developed for the Swift Parrot however management actions (refer Table 10.1) have been identified for its recovery (Office of Environment and Heritage 2012b).

A Regent Honeyeater recovery plan (Menkhorst *et al.* 1999) has been prepared however this plan was for 1999 to 2003 and the actions contained therein are of limited relevance to the current management of the species. The strategies in the plan primarily relate to research, education and policy development and are of limited relevance to the project. The project is not considered likely to substantially contribute to or interfere with the implementation of these recovery strategies. Management actions have, however, been developed for the species and are listed in Table 10.2.

No recovery plan has been prepared for the Little Lorikeet or Black-chinned Honeyeater however management actions have been identified (Office of Environment and Heritage 2012b) and are shown in Table 10.3 and Table 10.4.

Table 10.1 Management actions for the Swift Parrot

Description of management action[1]	Does action relate to the project?
Reduce collisions in areas where Swift Parrots are foraging by closing window blinds or letting windows get dirty. Alternatively hang wind chimes, mobiles etc in front of windows. Hang strips of fabric across wire mesh fences.	Bird-strike will be considered in the detailed design of buildings and infrastructure on the site.
Retain stands of winter-flowering feed-trees, particularly large mature individuals.	Clearing of foraging habitat that is productive during winter has been minimised through retention of riparian vegetation.
Revegetate with winter-flowering tree species where appropriate.	Clearing of foraging habitat that is productive during winter has been minimised through retention of riparian vegetation. Restoration of vegetation in the riparian corridor will include planting of winter-flowering trees.
Participate in biannual surveys to locate the winter foraging areas for this species.	Not applicable

Source: Office of Environment and Heritage (2012b)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

Table 10.2 Management actions for the Regent Honeyeater

Description of management action[1]	Does action relate to the project?
Maintain a captive population of Regent Honeyeaters.	Not applicable
Provide landholders and other community members with information on the ecology and conservation requirements of the Regent Honeyeater. Use incentives on private land to encourage landholders to manage key areas.	Not applicable
No loss of mature key nectar tree species. Minimise the removal of mistletoes at key sites.	Not applicable
Encourage landholders/agistees to remove stock from sensitive riparian breeding sites.	Not applicable
Protect and enhance key breeding and foraging habitats.	Not applicable
Encourage natural regeneration and increase the remnant size of known and potential Regent Honeyeater habitats.	Clearing of foraging habitat that is productive during winter has been minimised through retention of riparian vegetation. Restoration of vegetation in the riparian corridor will include planting of winter-flowering trees.

Description of management action[1]	Does action relate to the project?
Continue treeplanting programs at key breeding and foraging locations.	Not applicable
No further loss of known woodland and forest habitat throughout the range of the Regent Honeyeater from developments.	Not applicable
Conduct research into habitat selection in non-breeding season and long-distance movements.	Not applicable
Investigate impacts of interspecific competition for resources and nest predation by native birds.	Not applicable

Source: Office of Environment and Heritage (2012b)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

Table 10.3 Management actions for the Little Lorikeet

Management action	Does action relate to the project?
Retain large old trees, especially those that are hollow-bearing	Clearing of large old trees has been minimised through retention of tall mature riparian vegetation. Restoration of vegetation in the riparian corridor will include installation of nest boxes which will mitigate the potential impact of the loss of hollow-bearing trees.
Ensure recruitment of trees into the mature age class so that there is not a lag period of decades between the death of old trees and hollow formation in younger trees.	Restoration of vegetation in the riparian corridor will increase recruitment of trees through tree planting and the removal of weeds which suppress natural germination and establishment.
Protect large flowering Eucalyptus trees throughout the habitats frequented by this species. Manage remnant woodlands and forest for recovery of old-growth characteristics.	Clearing of large old trees has been minimised through retention of tall mature riparian vegetation.
Where natural tree recruitment is inadequate, replant local species to maintain foraging habitat and breeding sites.	Restoration of vegetation in the riparian corridor will increase recruitment of trees through tree planting and the removal of weeds which suppress natural germination and establishment.
Reduce the abundance of feral Honeybees and limit the exploitation of nectar by domestic bees where resources are spatially or temporally sparse (e.g. in years of drought).	Not applicable
Document nest sites and ensure their protection.	Not applicable

Source: Office of Environment and Heritage (2012b)

Table 10.4 Management actions for the Black-chinned Honeyeater

Management action	Does action relate to the project?
Retain suitable woodland habitats, particularly those with unimproved pasture and an intact native ground plant layer.	Clearing of higher quality potential habitat has been minimised through retention of mature riparian vegetation. Restoration of vegetation in the riparian corridor will include weed removal and reestablishment of a native ground plant layer which is likely to increase the suitability of the retained habitat for this species in the long term.
Increase the size and connectivity of existing remnants, planting trees and establishing buffer zones of unimproved uncultivated pasture around woodland remnants.	Restoration of currently cleared areas within the riparian corridor and weed removal will increase the width and condition of the vegetation remnant therefore its viability as a wildlife movement corridor.

Source: Office of Environment and Heritage (2012b)

10.9 Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Swift Parrot only breeds in Tasmania. The Regent Honeyeater chiefly breeds in several main breeding areas and is unlikely to breed in the disturbed habitat of the study area.

Most breeding records for the Little Lorikeet are from the South-west slopes region and it is unlikely that an ecologically significant proportion of any population of the species would breed in the study area.

Potential breeding habitat for the Black-chinned Honeyeater in the study area is only likely to exist in the riparian corridor of the Georges River due to the fragmentation and altered vegetation structure of remnants throughout the remainder of the site.

No significant impact on the lifecycle of these species is considered likely to occur as result of the project.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable

In relation to the habitat of a threatened species, population or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

Approximately 40 ha of woodland would be cleared which may be used as a foraging habitat by these species on a seasonal basis when the dominant eucalypt species are flowering heavily.

As these species are highly mobile it is considered unlikely that they would be significantly affected by the additional habitat fragmentation that would occur as a result of the project.

Potential foraging habitat for these species is considered to be moderately abundant in the locality. The foraging habitat that the species would lose is considered to be of only moderate importance to the local occurrence of these species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for these species in NSW.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The project is not considered likely to substantially contribute to or interfere with the implementation of recovery strategies for this species (refer Table 10.1, Table 10.2 and Table 10.3).

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project would contribute to the clearing of native vegetation key threatening process that may affect these species. The project would also contribute to the loss of hollow-bearing trees key threatening process that may affect the Little Lorikeet. The increased impact of these KTPs as a result of the project is not however considered likely to significantly impact the local occurrence of these species.

10.10 Conclusion

The Swift Parrot and Regent Honeyeater are listed as Endangered and Critically Endangered species respectively under the TSC Act. The Little Lorikeet and Black-chinned Honeyeater are listed as Vulnerable species under the TSC Act.

These migratory or nomadic nectar-feeding birds are unlikely to be significantly affected by the project.

D11. Wide-ranging predatory birds

11.1 Status

The Powerful Owl, Little Eagle and Spotted Harrier are listed as Vulnerable species under the TSC Act.

11.2 Powerful Owl

The Powerful Owl inhabits a range and mosaic of vegetation types, from woodland and open sclerophyll forest (on productive sites) to tall open wet forest and rainforest, with mesic gullies and permanent streams (Debus, S. J. S. & Chafer 1994). The owl requires large tracts of forest or woodland habitat but can also occur in fragmented landscapes. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species (Higgins 1999).

Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. (Kavanagh & Debus 1994). During the breeding season, the male Powerful Owl roosts in a "grove" of up to 20-30 trees, situated within 100-200 m of the nest tree where the female shelters (NSW National Parks and Wildlife Service 1998).

The main prey items are medium-sized arboreal marsupials, particularly the slow-moving Greater Glider, as well as Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls (Kavanagh *et al.* 1995).

Pairs of Powerful Owls are believed to have high fidelity to a small number of hollow-bearing nest trees and will defend a large home range of 400-1450 hectares (Debus, S. J. S. 1995).

11.3 Little Eagle

The Little Eagle occupies habitats rich in prey within open eucalypt forest, woodland or open woodland (Marchant & Higgins 1993); Aumann 2001a). For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring. Young fledge in early summer. Generation length has been estimated as 10 years (Debus, S. & Soderquist 2008). It eats birds, reptiles and mammals, occasionally adding large insects and carrion (Marchant & Higgins 1993); Aumann 2001b; Debus et al. 2007). It was formerly heavily dependent on rabbits, but following the spread of rabbit calicivirus disease, and consequent decline in rabbit numbers by 65-80% in the arid and semi-arid zones (Sharp et al. 2002), the Little Eagle is increasingly dependent on native prey.

11.4 Spotted Harrier

The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population.

The species occurs in grassy open woodland, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months. Preys on terrestrial mammals, birds and reptiles, occasionally insects and rarely carrion(Office of Environment and Heritage 2012b).

11.5 Square-tailed Kite

The Square-tailed Kite hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects and seems to prefer structurally diverse landscapes (Garnett & Crowley 2000a). The species shows a particular preference for timbered watercourses and appears to occupy large hunting ranges of more than 100km2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs (Office of Environment and Heritage 2012b).

11.6 Specific impacts

The approximately 27.4-35.7 ha of Alluvial woodland and Riparian forest affected may be used as a foraging habitat by these species on an occasional basis as part of a large home range.

The vegetation of the core of the study area, away from the riparian corridor of the Georges River is considered to be marginal as nesting habitat due to the location of large and hollow-bearing trees within areas that are subject to frequent disturbance due to activities such as mowing, vehicle movement on internal roadways and pedestrian movements.

The vegetation of the riparian corridor is more likely to provide suitable nesting habitat for these species. The project would involve removal of large and hollow-bearing trees at the edge of the riparian corridor and could thereby affect marginal potential breeding habitat for these species.

11.7 Threats

Recognised threats to the Powerful include:

- Historical loss and fragmentation of suitable forest and woodland habitat from land clearing for residential and agricultural development. This loss also affects the populations of arboreal prey species, particularly the Greater Glider which reduces food availability for the Powerful Owl.
- Inappropriate forest harvesting practices that have changed forest structure and removed old growth hollow-bearing trees. Loss of hollow-bearing trees reduces the availability of suitable nest sites and prey habitat.
- Can be extremely sensitive to disturbance around the nest site, particularly during pre-laying, laying and downy chick stages. Disturbance during the breeding period may affect breeding success.
- High frequency hazard reduction burning may also reduce the longevity of individuals by affecting prey availability.
- Road kills.
- Secondary poisoning.
- Predation of fledglings by foxes, dogs and cats Owl (Office of Environment and Heritage 2012b).

Recognised threats to the Spotted Harrier include:

- Clearing and degradation of foraging and breeding habitat, particularly that which affects prey densities.
- Secondary poisoning from rodenticides.
- Secondary poisoning from rabbit baiting (Office of Environment and Heritage 2012b).

Recognised threats to the Little Eagle include:

- Rural-residential subdivision and associated land uses (e.g. horse and goat grazing).
- Clearing and degradation of foraging and breeding habitat.
- Urban expansion.
- Secondary poisoning from rabbit baiting (Office of Environment and Heritage 2012b).

Key threatening processes that may affect these species include:

- Clearing of native vegetation.
- Loss of hollow-bearing trees (Powerful Owl only).

11.8 Recovery

A recovery plan has been prepared for the Threatened large forest owls of NSW which includes the Powerful Owl (Office of Environment and Heritage 2012b).

The recover actions identified in this plan are shown in Table 11.1.

Table 11.1 Recovery actions for the Powerful Owl

Description of recovery action[1]	Does action relate to the project?
Update and refine existing owl habitat models using the best available information.	Not applicable
Map the amount of modelled habitat across forested land in NSW.	Not applicable
Design a sampling strategy to test the modelled habitat for the presence of owls and locate identified sites.	Not applicable
Field validation of modelled habitat for the presence of owls.	Not applicable
Estimate the areal amount of mapped modelled habitat for each owl species that is occupied (based on the proportion of sample sites with owls in them) and use this estimate to further estimate the number of owl territories present within different land tenures (based on home range data).	Not applicable
Develop a sampling methodology stratified across different land tenures and disturbance histories, as well as a set of standardised regional monitoring protocols.	Not applicable
Seek cooperative involvement of other agencies, researchers and the community in the implementation of the regional monitoring program.	Not applicable
Implement a regional monitoring program.	Not applicable

Description of recovery action[1]	Does action relate to the project?
Investigate the implementation by DPI (Forests NSW) of the forestry TSL owl prescriptions by carrying out proactive audits targeting these prescriptions (DEC) and through IFOA monitoring and reporting DPI (Forests NSW).	Not applicable
Carry out post harvest surveys in locations where owls were detected prior to logging to determine if they are continuing to occupy the habitat.	Not applicable
Encourage post-graduate student radio tracking projects examining the use of logged and unlogged forest by the three owl species.	Not applicable
Make an assessment of the implementation and effectiveness of forestry owl prescriptions using data collected in this action and if necessary refine the prescriptions and negotiate changes to the forestry TSLs.	Not applicable
Prepare and disseminate environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess and mitigate the impacts of developments on the large forest owls and their habitats.	Not applicable
Monitor and report on the effectiveness of concurrence and licence conditions that have previously been applied to reduce the impacts of developments on the three large forest owl species or their habitats. This will involve keeping a record of such conditions, selecting case studies and then checking for the presence of owls at long intervals post development.	Not applicable
Use this information to develop a set of prescriptive guidelines that may be used to mitigate the impacts of developments on the three large forest owls.	Not applicable
Provide up-to-date and accurate large forest owl and habitat information in the 'PVP Developer – Threatened Species Tool'. This will ensure that broadscale clearing is only approved under the NV Act if the 'improve or maintain' test is met.	Not applicable
Facilitate the adequate consideration of large forest owls during biodiversity certification of environmental planning instruments. This may include ensuring that correct survey methods are used, informed habitat assessments are undertaken and adequate conservation measures are included in EPIs to assist the recovery of the owls.	Not applicable
Provide up to date information and data for the BioBanking assessment methodology.	Not applicable
Prepare guidelines addressing issues associated with habitat protection and management, and survey and assessment. The guidelines are to provide detailed information on the identification of significant habitat for owls, appropriate strategies for its protection, and for habitat creation as part of revegetation programs. The guidelines will be published on the DEC threatened species website and link to species profile information.	Not applicable
Encourage CMAs to invest in actions that actively manage and/or conserve large forest owl habitat as part of their Catchment Action Plans. In addition, seek other funding opportunities in partnership with community groups, to promote owl conservation on private lands.	Not applicable
Encourage private landholders to undertake management options to conserve and/or actively manage large forest owl habitat (and particularly nest sites) through incentive Property Vegetation Plans, Voluntary Conservation Agreements or other management initiatives.	Not applicable
Seek an Australian Research Council (ARC) Linkage grant or other joint funding opportunity to initiate research into identified key areas of the biology and ecology of the large forest owls.	Not applicable
Promote awareness and involvement of the research and management needs of the three large forest owls among the scientific and academic community.	Not applicable

Description of recovery action[1]	Does action relate to the project?
Seek scholarship funds for an aboriginal student to investigate the cultural and historic significance of the three species.	Not applicable
Encourage and coordinate the involvement of community-based groups (e.g. the Australian Bird and Bat Study Association) and animal care groups (e.g. WIRES) in the implementation of recovery actions.	Not applicable
Ensure the DEC threatened species website provides current information on owl identification (including photographs and samples of calls), habitat identification and protection, any current activities the community can be involved in, as well as information on how and where to report sightings and other relevant information. Ensure the site has links to other key internet sites such as the Australasian Raptor Association.	Not applicable
Coordinate implementation of actions.	Not applicable
Review plan and rewrite in final year.	Not applicable
Convene a threatened owl workshop with relevant experts and stakeholders to reassess the NSW conservation status of the three large forest owls. This action will be undertaken upon conclusion of the implementation of all of the above actions.	Not applicable

Source: Office of Environment and Heritage (2012b)

1. Actions may apply to one type of geographic area (CMA, LGA and DECC national park administration area) or to specific land managers only (i.e. Catchment Management Authority, Local Council, National Park or private landowners).

A draft recovery plan was prepared for the Barking Owl which includes an appendix of best practice guidelines for the management of the species containing the following broad landscape management recommendations:

- Focus on protecting from further clearing the more productive, lower lying areas of the landscape, (usually valley systems and along drainage lines).
- Ensure that substantial-sized blocks of mature forest and woodland are maintained and protected from clearing as well as smaller forest fragments within a few kilometres of such blocks.
- Protect all habitat within a 1 km wide buffer on both sides of major river systems.
- Protect from further clearing all mature forest remnant habitat on private land adjacent to forests, along road and track sides, along creeks and paddock boundaries.
- Protect from clearing all large old trees on both public and private land, including old paddock trees.
- Use tree planting and vegetation regeneration to connect existing remnants of vegetation.
- Prohibit removal of dead and fallen timber (especially large trees and logs) for firewood in forest and woodland areas that support Barking Owls (NSW National Parks and Wildlife Service 2003c).

No recovery plan has been developed for the Spotted Harrier or Little Eagle and to date, no priority actions have been identified their recovery however the following are identified in the Threatened species profiles for the species ads being necessary for these recovery of these species (Office of Environment and Heritage 2012b):

- Protect areas of habitat from overgrazing.
- Protect areas of habitat from development.
- Retain and protect nesting and foraging habitat.
- Buffer habitat areas from the impacts of other activities.
- Protect known populations and areas of potential habitat from clearing, fragmentation or disturbance.
- Rehabilitate known and potential habitat.
- Retain and protect nesting and foraging habitat.
- Report cases of illegal shooting to the DECCW.

Clearing of large old trees has been minimised through retention of tall mature riparian vegetation. Restoration of vegetation in the riparian corridor will include installation of nest boxes which will mitigate the potential impact of the loss of hollow-bearing trees which provide breeding opportunities for owls and their prey.

The project is not considered likely to substantially contribute to or interfere with the implementation of these recovery strategies.

11.9 Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

No nests of birds of prey were located in the study area. Trees of suitable size for nesting by birds of prey within the areas to be cleared for the project were primarily located in partially cleared vegetation in an open park-like setting. These trees are considered unlikely to be used as nesting habitat due to the disturbance associated with vehicular traffic and other human activity in these locations.

The approximately 27.4-35.7 ha of woodland/forest affected may be used as a foraging habitat by these species on an occasional basis as part of a large home range.

The vegetation of the core of the study area (away from the riparian corridor) of the Georges River is considered to be marginal as nesting habitat due to the location of large and hollow-bearing trees within areas that are subject to frequent disturbance due to activities such as mowing, vehicle movement on internal roadways and pedestrian movements.

The vegetation of the riparian corridor is more likely to provide suitable nesting habitat for these species. The project would involve removal of large and hollow-bearing trees at the edge of the riparian corridor and could thereby affect marginal potential breeding habitat for these species.

None of these species are considered likely to breed in the study area.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable

In relation to the habitat of a threatened species, population or ecological community:

a. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The 27.4-35.7 ha of woodland/forest habitat would be cleared which may be used as a foraging habitat would form only part of the home range of a single individual or breeding pair of these species. The home range of the Powerful Owl is 400-1450 ha (Office of Environment and Heritage 2012b) and that of the Barking Owl is likely to be in the range of 30-200 ha (NSW National Parks and Wildlife Service 2003c). The Little Eagle and Spotted Harrier are also likely to large home ranges of at least several hundred hectares, often inhabit sparsely forested habitats including grasslands and are highly mobile. They are hence unlikely to be significantly affected by the fragmentation of woodland that is likely to occur.

The Powerful Owl is likely to move along corridors of riparian vegetation in the locality and to forage in nearby woodland remnants. These riparian corridors are unlikely to be significantly fragmented by the project.

The foraging habitat that these species would lose is considered to be of only moderate importance to the local occurrence of the species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for these species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The project is not considered likely to substantially contribute to or interfere with the implementation of recovery strategies for these species (refer Section 8.7).

11.10 Conclusion

The Powerful Owl, Barking Owl, Little Eagle, Square-tailed Kite, and Spotted Harrier are listed as Vulnerable species under the TSC Act. These wide-ranging predatory birds are unlikely to be significantly affected by the project.

D12. Woodland birds

12.1 Status

The Scarlet Robin, Flame Robin and Varied Sittella are listed as Vulnerable species under the TSC Act.

12.2 Scarlet Robin

The Scarlet Robin is found in south-eastern Australia (extreme south-east Queensland to Tasmania, western Victoria and south-east South Australia) and south-west Western Australia. In NSW it occupies open forests and woodlands from the coast to the inland slopes (Higgins & Peter 2002). Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains. The Scarlet Robin breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. It forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris.
The Scarlet Robin builds an open cup nest of plant fibres and cobwebs, sited in the fork of tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 m above the ground (Higgins & Peter 2002).

12.3 Flame Robin

In NSW, the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats (Higgins & Peter 2002). The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank (Department of Environment Climate Change and Water 2010b)

12.4 Varied Sitella

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west (Higgins & Peter 2002; Royal Australian Ornithologists Union 2003). It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland and scrubby parks and gardens (Pizzey & Knight 1997). The Varied Sittella feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (Debus, S. & Soderquist 2008).

In north-eastern NSW Varied Sittellas occur in sedentary groups or clans holding weakly-defended territories of 13-20 ha (Noske 1998).

The Varied Sittella was found to be relatively common within the Greater Southern Sydney Region in which the study area is located and has a fair amount of habitat within protected areas however it is likely to have declined significantly on the Cumberland Plain (Department of Environment and Climate Change 2007c, 2007d).

12.5 Specific impacts

The 40 ha of woodland affected by the project may be used as a foraging habitat by the Scarlet Robin and Flame Robin on an occasional basis or seasonal basis but is unlikely to be used as breeding habitat by these species.

The Varied Sittella may both forage and breed in the riparian corridor of the Georges River but is unlikely to occur elsewhere in the study area. The project will result in the loss of approximately 27.4-35.7 ha of habitat for this species.

12.6 Threats

Recognised threats to the Scarlet Robin, Flame Robin and Varied Sittella include:

- Historical habitat clearing and degradation.
- Habitat modification due to overgrazing.
- Reduction of size of remnant patches.
- Reduction in the structural complexity of habitat, including reductions in canopy cover, shrub cover, ground cover, logs, fallen branches and leaf litter.
- Reduction of the native ground cover in favour of exotic grasses.
- Loss of nest sites, food sources and foraging sites, such as standing dead timber, logs and coarse woody debris from depletion by grazing, firewood collection and 'tidying up' of rough pasture.
- Predation by over-abundant populations of Pied Currawong (*Strepera graculina*) which are supported by planted exotic berry-producing shrubs; this pressure, is addition to that from other native and exotic predators, may be a potentially severe threat to the breeding success of Scarlet Robin populations.
- Predation by feral cats (*Felis cattus*).
- Dominance of Noisy Miners in woodland patches.
- Robbing of nests and predation of fledglings by rats.
- Isolation of patches of habitat, particularly where these patches are smaller than 30 ha, and in landscapes where clearing has been heavy or where remnants are surrounded by cropping or stock grazing.
- Habitat for the Scarlet Robin and Flame Robin may become unsuitable if dense regeneration occurs after bushfires or other disturbances (Office of Environment and Heritage 2012b).

12.7 Recovery

No recovery plans have been developed for these species, however, the following are identified in the Threatened species profiles for the Scarlet Robin, Flame Robin and Varied Sittella as being necessary for the recovery of the species (Office of Environment and Heritage 2012b):

- Retain existing forest, woodland and remnant grassland vegetation, including paddock trees.
- Retain dead timber on the ground in open forest and woodland areas.
- Enhance potential habitat through regeneration by reducing the intensity and duration of grazing.
- Fence remnants to protect from long-term, intense grazing.
- Increase the size of existing remnants, by planting trees and establishing buffer zones of un-modified, uncultivated pasture around woodland remnants.
- Keep domestic cats indoors at night; desex domestic cats; assess the appropriateness of cat ownership in new subdivisions adjacent to Scarlet Robin habitat.
- Avoid the use of exotic berry-producing shrubs in landscape and garden plantings in areas adjacent to Scarlet Robin habitats.

Measures designed to minimise clearing of vegetation and fauna habitat and revegetation activities are considered to be consistent with these strategies.

The project is not considered likely to substantially contribute to or interfere with the implementation of these management actions.

12.8 Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Scarlet Robin and Flame Robin usually breed in forest and woodland, often on ridges and slopes and migrate to more open country outside of the breeding season. The Scarlet Robin and Flame Robin are likely to occasionally forage in the study area outside the breeding season but are unlikely to breed there.

The Varied Sittella is a sedentary species which may breed in the locality. It builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (Debus, S. & Soderquist 2008). Within the study area, substantial occurrences of mature and rough-barked trees are almost exclusively found along the riparian corridor of the Georges River. This vegetation will largely be retained and substantial vegetation restoration will also be conducted to improve the condition of this retained habitat.

None of these species are likely to have their life cycles significantly affected by the project.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable

In relation to the habitat of a threatened species, population or ecological community:

a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

40 ha of woodland would be cleared which may be used as a foraging habitat by these species. 27.4-35.7 ha of this habitat may also be used as breeding habitat by the Varied Sittella.

The habitat of the study area is already fragmented and the minor additional fragmentation as a result of the project is unlikely to alter the value of the remaining habitat for these species in the study area.

The foraging habitat that the species would lose is considered to be of only moderate importance to the local occurrence of this species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No critical habitat has been listed for these species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The project is not considered likely to substantially contribute to or interfere with the implementation of recovery strategies for this species (refer Section 9.7).

12.9 Conclusion

The Varied Sittella, Flame Robin and Scarlet Robin are listed as Vulnerable species under the TSC Act.

The Project is unlikely to cause a significant impact on these species.

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Appendix E

Management Plan for Restoration of the Riparian Zone of the Georges River

Contents

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Glossary

Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ genetic diversity – the variety of genes (or units of heredity) in any population ▪ species diversity – the variety of species ▪ ecosystem diversity – the variety of communities or ecosystems.
Critical Habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered ecological community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* and both the State (DECCW) and Federal (DEWHA) Directors-General maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant State and Commonwealth legislation.
Department of Environment, Climate Change and Water (DECCW)	Broadly, the Department of Environment, Climate Change and Water works towards a healthy environment cared for and enjoyed by the whole NSW community; manages the state's natural resources, including biodiversity, soils and natural vegetation; manages natural and cultural heritage across the state's land and waters; acts to minimise the impacts of climate change; promotes sustainable consumption, resource use and waste management; regulates activities to protect the environment; and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making..
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
EPBC Act	Abbreviates the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
Habitat	An area or areas occupied, or periodically or occasionally occupied by a species, population or ecological community, including any biotic or abiotic components.
Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key Threatening Processes are listed under the *Threatened Species Conservation Act 1995,* the *Fisheries Management Act 1994* and the *Environment Protection and Biodiversity Conservation Act 1999.* Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant State and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004) .
Locality	The area within 10 km of the site.
Local population	The population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated (Department of Environment and Climate Change 2007).

Migratory species	Species protected as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999.* Listed migratory species are those listed in the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA). Listed migratory species also include any native species identified in an international agreement approved by the Minister (Department of the Environment Water Heritage and the Arts 2010). Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*.
Priorities action statements	In November 2004, the NSW State Government reformed the State's threatened species legislation (*Fisheries Management Act 1994* and the *Threatened Species Conservation Act 1995*). One element of the reforms included a requirement for the Director-Generals of the NSW Department of Primary Industries (DPI) and Department of Environment and Climate Change (DECC) to prepare and adopt a Priorities Action Statement (PAS). A separate PAS has been prepared by each agency (Department of Industry and Investment 2010). Each PAS outlines the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of threatened species, populations and ecological communities and manage key threatening processes (Department of Environment Climate Change and Water 2010) (Department of Industry and Investment 2010).
Protected species	Those species defined as protected under the *National Parks and Wildlife Act 1974*. Includes all native animals, and all native plants listed on Schedule 13 of the *National Parks and Wildlife Act 1974*.
Recovery plan	A plan prepared under the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1999* to assist the recovery of a Threatened species, population, or ecological community.
REF	Abbreviates Review of Environmental Factors
Region	A bioregion defined in a national system of bioregionalisation. For this study, this is the Sydney Basin bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
Significant	Important, weighty, or more than ordinary (as defined by the Department of Environment and Climate Change 2007).
Site	The specific area that is the, namely the construction footprint of the road upgrade.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*. Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant State and/or Commonwealth legislation.
TSC Act	Abbreviates the NSW *Threatened Species Conservation Act 1995.*
Viable local population	A population that has the capacity to live, develop, and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change 2007).
Weeds of National Significance	In 1998, Australian governments endorsed a framework to identify which weed species could be considered (WONS) within an agricultural, forestry and environmental context. Twenty WONS were identified through this process (Australian Government 2010).

1. Introduction

This management plan has been prepared for the riparian lands adjacent to the eastern bank of the Georges River within the location of the proposed Intermodal Facility at Moorebank IMT site) and a parcel of land opposite the IMT site on the western bank of the river at Casula. The purpose of this plan is to guide the restoration of the riparian landform, vegetation and fauna habitat of the site and to improve the quality of water entering the Georges River.

1.1 Site location

The site includes the eastern side of the River corridor from approximately 300 m south of the M5 Motorway for a length of approximately 2.5 km south to the East Hills Railway Line. The site also includes an area of land on the western bank of the river at Casula including approximately 750 m of riverbank within Lot 4 DP 1130937.

1.2 Requirement for a management plan

A plan for riparian zone management is required in order for the Department of Finance and Deregulation to implement best practice ecological management principles, with an aim of achieving improved ecological condition in this area.

The site has a long history of disturbance as a result of vegetation clearing as well as industrial development and military training exercises, which has resulted in significant alteration to ecological conditions, particularly with regard to native vegetation, hydrological conditions and weed invasion. Despite this disturbance, these areas retain value as habitat for threatened species and provide a movement corridor for both terrestrial and aquatic wildlife in a largely cleared and fragmented urban landscape.

These areas are of value for their biodiversity conservation values, aesthetics and the ecosystem services they provide.

1.3 Objectives and approach

Good ecological management must be guided by clear and achievable objectives, including short, medium and long-term actions to achieve these outcomes. Such objectives provide an overall vision for the future management of the site.

The objectives of the plan include:

- restoration and revegetation of the riparian zone of the site to be consistent with, and complementary to, areas of remnant indigenous vegetation within the Georges River Corridor
- long term eradication and suppression of the most detrimental weed species on the site including vine and woody weeds
- consolidation and widening of the existing vegetation corridor of Georges River where feasible
- improved habitat values for native animals and plants, particularly threatened species.

Development of priority actions involves careful consideration of their likely efficacy, cost-effectiveness and maintenance requirements to ensure that the available resources are effective in achieving the overall objectives of the plan. Priority actions are presented in Section 5.4.

The overall objectives and the priority actions have been developed within a framework that recognises that natural area restoration programs may be unsuccessful in achieving desired outcomes if insufficient consideration is given to the root causes of degradation and/or expectations of responses to management are unrealistic. A poorly designed vegetation management regime also poses a risk of causing further degradation due to factors such as erosion and water quality impacts.

An integrated approach to management is therefore required, recognising the interaction between the operational requirements of adjacent lands, stormwater issues, public amenity, weed proliferation and habitat for native species. Strategies must consider potential conflicts between objectives; such as the potential impact of weed removal on bank stability and fauna habitat.

Only through such an informed approach can a practical and effective plan be developed and implemented with minimal risk of adverse outcomes.

1.4 Timescale of the plan

This management plan has been developed to provide guidance in the short (1–5 years), medium (6–10 years) and long-term (11–20 years) however it is anticipated that the site will require monitoring and low intensity maintenance in perpetuity to prevent re-emergence of weed infestations. It is aimed to be an adaptive management program that includes review on an annual basis.

2. Relevant legislation and guidelines

National, state and local legislation, strategies and guidelines will influence the overall direction and approvals required for the management of vegetation within the site and are discussed below.

2.1 National legislation and plans

2.1.1 *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the primary piece of legislation that governs actions undertaken by the Commonwealth and actions undertaken on Commonwealth land. The EPBC Act provides for the protection and management of nationally and internationally important flora, fauna, and ecological communities through the listing of threatened species, endangered populations, and threatened ecological communities throughout Australia. These are defined in the EPBC Act as Matters of National Environmental Significance (NES). Other key functions of the EPBC Act include the listing of Key Threatening Processes and Critical Habitat.

The main NES Matter of relevance to the site is the presence of threatened species and threatened species' habitat which is a key consideration in the management of the site. The site is located on Commonwealth land and all impacts on the environment of the site are governed by the EPBC Act.

2.1.2 The Australian Weeds Strategy

The Australian Weeds Strategy replaces the National Weeds Strategy, providing a national framework for the reduction of the economic, environmental, and social impacts of weeds. Weed management is recognised as essential to the sustainable management of natural resources, the economy, the environment, human health and amenity. The Strategy addresses the prevention of new weed problems, abatement of existing weed problems, and the enhancement of capacity to combat weed problems.

The Strategy aims to compliment and guide the efforts of state, territory, regional, and local government strategies and initiatives by providing a national framework. Building on the National Weeds Strategy created in mid-1997, the Australian Weeds Strategy continues the core objective of the National Weeds Strategy by identifying Weeds of National Significance (WONS) and the resultant coordinated actions across Australia. Weeds of National Significance are determined by the following four criteria:

- level of invasiveness
- environmental impacts
- potential for spread
- socio-economic and environmental values (Natural Resource Management Ministerial Council 2006).

Of relevance to the site are the management guidelines for the WONS which occur on the site.

2.2 State legislation and plans

State legislation and plans are included here for completeness and in order to allow the Department of Finance and Deregulation to carry out the works following, where possible, state requirements. However there is no strict requirement for state legislations and plans to be followed on Commonwealth land.

2.2.1 *Threatened Species Conservation Act 1995*

The *Threatened Species Conservation Act 1995* (TSC Act) provides for the listing of threatened species, endangered populations, and endangered ecological communities in NSW. Another key function of the TSC Act is the listing of Key Threatening Processes (KTPs). Key Threatening Processes are defined as those which have been identified as having a significant impact on the conservation of native flora and fauna. The following KTPs of most relevance to weed control and vegetation restoration are currently acting on or have the potential to act on the vegetation of the study site:

- invasion, establishment and spread of *Lantana camara*
- invasion and establishment of exotic vines and scramblers
- invasion of plant communities by exotic perennial grasses
- infection of native plants by *Phytophthora cinnamomi*
- invasion and establishment of escaped exotic garden plants.

Strategies designed to ameliorate the threats listed under the TSC Act are outlined in the Priorities Action Statements (PAS). These include the preparation of Threat Abatement Plans (TAPs) and lists detailed actions which aim to protect threatened species. The TSC Act also requires the preparation of recovery plans for listed endangered ecological communities.

2.2.2 *National Parks and Wildlife Act 1974*

Under the *National Parks and Wildlife Act 1974* (NPW Act), the care, control, and management of National Parks, nature reserves, historic sites, and Aboriginal areas is vested to the Director-General of the NSW National Parks and Wildlife Service (NPWS). The NPW Act also provides for the protection of native plants and animals and sets the penalties for affecting listed protected species without approval.

2.2.3 *Noxious Weeds Act 1993*

The legislation which regulates weed management in NSW is the *Noxious Weeds Act 1993*. The Act defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds and sets up categorisation and control actions.
The Act also imposes penalties for various offences relating to noxious weeds. Specifically, the objectives of the Act include identifying noxious weeds, specifying control measures and the responsibilities for weed control of public and private land holders and providing a framework for state-wide control.

The Act imposes obligations on occupiers of land to control noxious weeds declared for their area. The amendments to the *Noxious Weeds Act* in 2005 introduced a new system of classification with noxious weeds now categorised into control classes according to the type of activity required to control their spread. The control classes are as follows:

- Control Class 1 – State Prohibited Weeds.
- Control Class 2 – Regionally Prohibited Weeds.
- Control Class 3 – Regionally Controlled Weeds.
- Control Class 4 – Locally Controlled Weeds.
- Control Class 5 – Restricted Plants.

Control class 1, 2, and 5 weeds are notifiable weeds under this classification system. Twelve of the weed species present on the site are classed as noxious under the *Noxious Weeds Act 1993* and should be controlled according to the provisions of the Act by the landowner, in this case the Department of Finance and Deregulation.

2.2.4 *Pesticides Act 1999*

The *Pesticides Act 1999* and the Pesticides Regulation 1995 regulate the use of all pesticides in NSW after the point of sale. Specific provisions for record keeping, required training, and notification of use are made. Pesticide users in NSW are required to:

- only use pesticides registered or permitted by the Australian Pesticides and Veterinary medicines Authority (AVPMA)
- obtain an AVPMA permit to use a pesticide in a way not covered by the label
- strictly follow label directions or directions specified in an AVPMA permit
- prevent injury to people, damage to property, or harm to non-target plants and animals
- keep records on the use pesticides for occupational purposes
- be trained in pesticide use if using pesticides as part of their occupation
- notify the public of pesticide applications in public places if applied by a public authority.

Herbicides are included as pesticides under the Act and these requirements need to be adhered to in the implementation of the plan.

2.2.5 New South Wales Weed Strategy

The goal of the NSW Weed Strategy is the sustainable reduction of the negative impact of weeds on the economy, community, industries, and environment of NSW. Recognising the environmental and economic burden that weeds place on the state of NSW, a set of priorities have been developed depending on land use objectives. In the context of the site, the priorities of the Strategy relating to reducing the adverse impacts of weeds and increasing the aesthetic and recreational value of public lands are the most relevant to this plan.

A major objective of the Strategy is to continue the exclusion of serious weeds which are not already present in NSW. For weeds that are present, their negative effects are to be reduced by reducing their distribution and developing strategies to minimise their impact (NSW department of Primary Industries 2008).

The following outlines the key objectives of the Strategy:

- Prevention of new weed problems in New South Wales.
- Discouraging environmental changes which favour weed invasion.
- Development and implementation of programs to reduce environmental degradation and the loss of biodiversity through weed invasion.
- Control of weeds that affect community health.
- Development and promotion of sustainable, cost-effective management systems for the control of weeds in crops, pasture and forestry.
- Implementation of effective weed control programs on public, State-owned and Crown land.
- An effective and efficient system for delivery of noxious weed control and the enforcement of weeds legislation.
- Ongoing planning and monitoring of weed control programs to ensure that objectives are achieved in an efficient and cost-effective manner.
- Appropriate legislation to support weed control activities and to ensure that weed control programs achieve desired production, environmental and health objectives.

3. Existing environment

The following is a description of the existing conditions of the site which guided the development of management objectives and strategies.

3.1 Land use context

The site is located in a highly developed landscape. Railway lines, a landfill site and parklands are located adjacent to the western portion of the site and a golf course and Defence lands line the eastern portion.

3.2 Landform

The bank profile of the site is natural through most of the site with the exception several defence training areas which have been modified through soil excavation, levelling and construction of hardstand areas. The largest of these areas is a Defence training area referred to as 'the dust bowl' which is entirely clear of vegetation. For the purposes of the management plan the site is described in terms of the zones described in Table 3.1 below.

Table 3.1 Management zones

Zone	Description
River edge	A narrow to broad area of flat to gently sloped area of land only slightly elevated above the level of the river
Bank	The moderately to steeply sloped area between the river terrace and the floodplain
Floodplain	The gently sloped to flat upper edge of the upper bank and adjacent areas of relatively flat land subject to very infrequent inundation.

3.3 Aquatic environment

3.3.1 Water quality

Water quality within Georges River is poor as a result of a long history of vegetation clearing, industrial activity and residential development within the catchment.

3.3.2 Aquatic ecology

Due to the poor water quality within the river, altered hydrological conditions and the introduction of exotic fish (e.g. Plague Minnow) disturbance-sensitive fish, frog and aquatic invertebrate species are likely to be reduced in abundance or locally extinct. The aquatic environment is however likely to provide habitat for a variety of more resilient native fish species (e.g. Long-finned Eel, Short-finned Eel), frogs (e.g. Striped Marsh Frog) and the Eastern Snake-necked Tortoise. The river and fringing vegetation provide habitat for a variety of waterbirds such as ducks, herons and cormorants.

3.4 Soil conditions

3.4.1 River edge

Immediately surrounding the Georges River are terraces of soil likely composed of soft mud and organic matter derived from the accumulation of alluvial silt and decaying vegetation material.

3.4.2 Bank

Above the river terrace the river bank within the site appears to relatively intact native soil except in areas subject to previous earthworks and construction of hardstand areas.

3.4.3 Floodplain

The relatively flat floodplain of the site has been subject to partial to full vegetation clearing. The soil in these areas is likely to be largely natural with the possible exception of elevated nutrient levels from fertiliser application.

3.4.4 Noxious and nationally significant weeds

Twelve noxious weeds and nine weeds of national significance have been recorded on the site and adjacent lands as detailed in Table 3.2.

Table 3.2 Noxious and nationally significant weeds in the locality

Scientific Name	Common Name	*Noxious Weeds Act 1993* control class[1]	Weeds of National Significance.
Chrysanthemoides monilifera ssp. monilifera	Boneseed	2	Yes
Salvinia molesta	-	2	Yes
Alternanthera philoxeroides	Alligator Weed	3	Yes
Chrysanthemoides monilifera ssp. rotundata	Bitou Bush	3	Yes
Asparagus asparagoides	Bridal Creeper	4	Yes
Ligustrum lucidum	Large-leaved Privet	4	-
Ligustrum sinense	Small-leaved Privet	4	-
Olea europaea ssp. cuspidata	African Olive	4	-
Ludwigia peruviana	-	4	-
Asparagus aethiopicus	Ground asparagus	-	Yes
Sagittaria platyphylla	-	-	Yes
**Rubus fruiticosus*	Blackberry complex	4	Yes
**Lantana camara*	Lantana	4	Yes
**Sagittaria platyphylla*		5	-

Notes 1) Control Categories under the *Noxious Weeds Act 1993*: Class 2: The plant must be eradicated from the land and the land must be kept free of the plant. Class 3: The plant must be fully and continuously suppressed and destroyed. Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. Class 5: The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

3.4.5 Vegetation

The existing vegetation of the site is summarised in Table 3.3.

Table 3.3 Summary of existing vegetation

Zone and vegetation community	Canopy species	Understorey species	Ground cover species
River edge and Bank (Riparian Forest)	*Eucalyptus bosistoana*, *Eucalyptus botryoides* x *saligna*, *Angophora floribunda*, *Casuarina cunninghamiana*	*Tristaniopsis laurina*, *Backhousia myrtifolia*, *Stenocarpus salignus*, *Jacksonia scoparia*, *Polyscias sambucifolia*, *Westringia longifolia*, *Santalum obtusifolium*, *Acacia binervia*, *Acacia decurrens*, *Callistemon salignus*, **Arundo donax*, *Melia azedarach*, **Ligustrum sinense*, *Phebalium squamulosum*	*Microlaena stipoides*, **Eragrostis curvula*, **Cardiospermum grandiflorum*, *Leucopogon juniperinus*, *Morinda jasminoides*, *Pteridium esculentum*, **Araujia sericifera*, **Verbena bonariensis*, **Asparagus* spp., *Gahnia aspera*, *Pratia purpurascens*, *Austrostipa ramosissima*
Floodplain (Alluvial Woodland)	*Eucalyptus tereticornis*, *Eucalyptus botryoides* x *saligna, Eucalyptus baueriana,* *Angophora floribunda*	*Acacia decurrens*, *Acacia binervia*, *Ozothamnus diosmifolius*, *Kunzea ambigua*, **Lantana camara*	*Microlaena stipoides*, **Eragrostis curvula*, **Senecio madagascariensis*, **Conyza bonariensis*, *Tricoryne elatior*, *Pratia purpurascens*, **Bidens pilosa*, **Sida rhombifolia*, *Cynodon dactylon*
Floodplain (exotic grassland)	N/A	N/A	**Pennisetum clandestinum*, *Cynodon dactylon,* **Eragrostis curvula*, **Senecio madagascariensis*, * *Microlaena stipoides*

3.4.6 Wildlife corridor value

Upstream (south) of the site, substantial areas of wildlife habitat exist in vegetation communities along the lower reaches of Georges River and surrounding lands which are linked via the site and narrow bands of riparian vegetation to larger areas of vegetation in parklands and reserves along the downstream section of the river.

The site thus forms part of an important wildlife corridor linking these habitats, the value of which may be improved through the implementation of this plan.

4. Risk and constraint assessment

The following sections provide an assessment of the risks and constraints associated with management activities and recommended measures to avoid or mitigate potential adverse outcomes.

4.1 Biodiversity

The vegetation of the site consists of River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner, an endangered ecological community which is listed under the TSC Act. This vegetation is also potential habitat for variety of species. Restoration of the site is considered to pose a risk to these species, through habitat modification if the potential adverse impacts of weed removal activities are not adequately considered and mitigated.

With appropriate restoration methods and timing, however, the implementation of the plan should result in improved vegetation and habitat conditions in the medium to long term.

4.2 Soil conditions

The highly disturbed soils in the cleared areas of the site are likely to have a number of characteristics that may constrain rehabilitation of the site. The possible presence of elevated levels of plant nutrients such as phosphorus and nitrogen creates conditions that give a competitive advantage to exotic species. Exotic species are generally adapted to rapid growth under high nutrient conditions to the detriment of native species that are adapted to low nutrient availability and are less responsive to greater nutrient availability.

The possible presence of these nutrients in the superficial soil layers of the site is a constraint to the establishment and maintenance of a native groundcover as it is likely to results in substantial ongoing weed control requirements. While these nutrients may be slowly reduced in concentration as they are absorbed into the biomass of perennial plants and leached by rainfall, this process is likely to take years or decades to reduce the nutrient concentration to a level at which native species have a competitive advantage over weeds.

The likely presence of a substantial and persistent weed seed-bank in the soils of the site is also likely to constrain the rehabilitation of the site due to the maintenance requirements associated with the ongoing germination of weeds.

These potential constraints may be avoided by either stripping of superficial soil layers or by capping these areas with imported soil as described in Section 5.2.1. This approach will require substantial initial costs however it will require less weed control after planting and is likely to be the most cost-effective and sustainable in the long term solution to the restoration of these areas.

4.2.1 Contamination

Defence heavy vehicle training areas may contain contaminants and planting in this zone may pose potential hazards to bushland restoration personnel.

It is therefore recommended that the soil in this zone is stabilised using machinery and capped with clean soil such that planting and later weeding will not disturb any potentially contaminated material. Safety measures such as dust suppression and the use of dust masks are likely to be required during these earthworks.

4.2.2 Erosion

Due to the erosive potential of the steep sections of the bank and the intermittent inundation of this zone, it is recommended that soil disturbance here is minimized. Where new stormwater channels and outlets are proposed, stabilisation using a combination of hard (e.g. rock armouring) and soft (e.g. geotextile fabric and vegetation) erosion protection is recommended.

4.3 Infrastructure

The site is generally non-operational with the exception of the proposed rail bridge and stormwater infrastructure. It is recommended that erosion control measures are implemented at major stormwater outlets within the site (refer Section 5.5). The rail bridge is likely to constrain the choice of plant species for revegetation within this area as tree planting may not be appropriate due to the required clearance distances and only a limited selection of naturally-occurring species are likely to be able to grow in low light conditions under the bridge.

5. Management and restoration strategies

Management and restoration strategies for the site include:

- weed management
- vegetation restoration
- habitat management and restoration
- stormwater management.

Each of these strategies includes a number of specific actions designed to meet the objectives of the plan, namely to:

- restore and revegetate the riparian zone to be consistent with and complementary to areas of remnant indigenous vegetation within the Georges River Corridor
- eradicate in the long term the most detrimental weed species on the site including vine and woody weeds
- consolidate and widen the existing vegetation corridor of Georges River where feasible
- improve habitat for aquatic fauna as well as terrestrial species
- protect and enhance the habitat for threat-listed species.

5.1 Weed management strategy

The main objective of the weed management strategy is:

- long term eradication of the most detrimental weed species on the site including vine and woody weeds.

The strategy will also contribute to the other objectives of the plan by enabling the restoration of native vegetation and protecting existing fauna habitat values during restoration.

The weed management strategy for the site involves the continual suppression of vine and woody shrub and thicket-forming weeds with the aim of eventual eradication of these groups from the entire site. Introduced trees are to be selectively culled to provide space for the planting of native trees and shrubs with most mature introduced trees retained until native plantings mature to a suitable size.

Herb and grass weeds are to be removed from the cleared areas of the floodplain and soil conditions in these areas are to be modified to create conditions that facilitate the establishment of native species and the maintenance of a low cover of weeds.

Given the wind, water and animal-assisted dispersal abilities of many of the weed species present on the site, continual re-invasion of the site is inevitable and ongoing maintenance will be required. Once the vegetation restoration phase of the plan is complete however maintenance of low densities of vine and woody weeds will require only regular monitoring and spot-treatment of vine and woody weed infestations.

5.1.1 Vine weeds

Vine weeds, particularly Balloon Vine (*Cardiospermum grandiflorum*) have the potential to inhibit the restoration of the site due to their ability to smother other vegetation, often shading out and eventually killing shrubs, small trees and groundcover vegetation.

The following actions in Table 5.1 are recommended for the control of vine weeds.

Table 5.1 Vine weed management actions

Action	Description	Reasoning	Priority	Timing
Primary vine weed control	Spray broad areas of vine weeds with an approved herbicide targeting vines at the base of native trees as a priority. In areas containing the native species at low density, either cut these species back to ground level or utilise a selective herbicide to target vine weeds. Hand weed/scrape and paint vine weeds in areas containing moderate to high density of native understorey/groundcover.	Kills vines without causing major soil disturbance Quick and cost-effective Retains soil covering to minimise erosion	Medium	Medium term
Vine weed skirting	Cut back vines from all trees on the site leaving aerial stems to decompose in canopy.	Relieves impact of vines on native trees, reduces the wind-dispersal ability of Balloon Vine and retains bird habitat	High	Short term
Slashing and raking	Slash dead (sprayed) vine weeds in planting locations on the river banks using a brush-cutter, rake and remove weed debris from planting areas.	Removes debris allowing sunlight to stimulate weed seed-bank germination so weed seed-bank can be reduced over time. Creates clear conditions for revegetation	Medium	Short term
Secondary vine weed control	Hand remove or spray newly germinated weed seedlings and regrowth with an approved herbicide.	Removes weed regeneration in preparation for revegetation Prevents weed regrowth from affecting regenerating native plants.	Medium	Medium term

Action	Description	Reasoning	Priority	Timing
Maintenance weeding	Hand removal, scrape and paint weeds in replanted and regenerating vegetation with approved herbicide and spot-spray.	Removes residual and newly invading weeds whilst minimising off-target damage to plantings	Medium	Long term

5.1.2 Woody shrub/thicket weeds

Woody weeds, particularly Lantana (*Lantana camara*) are the most abundant and problematic weeds on the site. Blackberry (*Rubus fruticosus* aggregate species) is also problematic in several small patches and a variety of other woody weeds occur at low density.

Table 5.2 Woody weed management actions

Action	Description	Reasoning	Priority	Timing
Selective woody weed removal	In areas with a mixture of native shrubs and woody weeds, selectively remove woody weeds in a staged program as native regeneration matures to ensure sufficient vegetation cover for bank stabilisation and bird habitat. Treat according to the chemical control methods. Remove all Blackberry using the chemical control methods. Cut/scrape and paint woody weeds in areas containing native understorey / groundcover using the methods.	Kills woody weeds without causing major soil disturbance Maintains bank stabilising properties of weeds until native tree and shrub plantings mature Retains bird habitat until native shrub plantings mature Creates space for regeneration and planting of native shrubs	High	Short term
Staged woody weed removal	Mechanically remove dense infestations of Lantana in a staged process by removing a band (up to 20 m width) along the landward edge of the riparian zone. Monitor for native plant regeneration for one year. If native regeneration is sufficient, conduct secondary and maintenance weeding to prevent weed re-establishment. Plant indigenous shrubs and groundcover to provide fauna habitat if natural regeneration is insufficient to provide a near-natural understorey/groundcover. Repeat process in new areas once regeneration/revegetation areas have reached near-natural density and height (~1.5-2m).	Removes source of weed seeds, allows sunlight to stimulate weed and native seed-bank germination and reduces shading of plantings while retaining fauna habitat properties of woody weeds until native plants are sufficiently mature.	High	Short term to Medium term

Action	Description	Reasoning	Priority	Timing
Secondary woody weed control	Hand remove, foliar-spray or cut and paint woody weed seedlings prior to and after initial control/revegetation using techniques.	Removes weed seedlings at an early stage when control is more easily achieved with minimal use of herbicides and minimal soil disturbance	Medium	Medium term
Maintenance weeding	Hand removal, scrape and paint weeds in replanted and regenerating vegetation with approved herbicide and spot-spray in accordance with the chemical control methods.	Removes residual and newly invading weeds whilst minimising off-target damage to plantings	Medium	Long term

5.1.3 Herb and grass weeds

A variety of herb weeds and grass weeds occur on the site in locations where there is an incomplete cover of vine and woody weeds.

Table 5.3 Herb and grass weed management actions

Action	Description	Reasoning	Priority	Timing
Selective herb and grass weed control on banks	Hand remove, cut and paint and/or spot-spray (using a selective herbicide) herb and grass weeds located in areas of native vegetation on ongoing basis using techniques. Herbicide spraying should be phased out as native cover increases in favour of hand-seeding.	Ongoing maintenance of low densities of herb and grass weeds will be required due to likely re-infestation of the site from seeds or stem material carried by wind and water	Medium	Long term

5.2 Vegetation restoration strategy

The main objectives of the vegetation restoration strategy are to:

- restore and revegetate the riparian zone to be consistent with and complementary to areas of higher condition remnant indigenous vegetation within the Georges River Corridor
- establish a riparian environment that is complementary to the aquatic ecological community of the Georges River
- to consolidate and widen the existing vegetation corridor of Georges River where feasible
- to improve habitat for native flora and fauna, particularly threatened species.

The soils of the restoration zone are likely to be moderately to highly disturbed through the addition of plant nutrients, compaction and altered surface conditions (e.g. imported soil, gravel and concreted surfaces)

These areas thus have little or no potential for natural regeneration of native vegetation and require a reconstructive approach.

The importation of weed-free, low nutrient soil is recommended as it will:

- minimise potential safety hazards to restoration staff from contaminants and steep, loosely aggregated soils
- bury weed seedbanks to a depth from which they are unlikely to germinate
- create soil conditions conducive to the establishment of native vegetation and the cost-effective long-term suppression of weeds.

Table 5.4 Vegetation restoration management actions

Action	Description	Reasoning	Priority	Timing
Weed removal	Bulky weeds (e.g. woody weeds and robust herbs) present within the restoration zone should be removed by cut/paint herbicide application and/or herbicide spraying followed by slashing. Occasional native trees and small shrubs that may be present in these areas should be retained where practicable.	Removal of weed material will allow for more even spreading of soil and will minimise weed regeneration.	High	Short term to Medium term
Soil spreading	Spread imported soil over planting areas to a depth of at least 300 mm. This will cap any potentially contaminated soils, provide a barrier to weed germination and provide a substrate for plant growth. The depth of soil will have a gradual transition to the existing ground level around the base of existing trees	Cleared areas of the site may contain contaminants and are likely to have persistent weed soil-seedbanks. By capping the weed seedbank through installing low-nutrient soil and mulch, post-planting weed issues can be minimised. Investment in soil preparation at this stage in the restoration process is likely to be more cost-effective in the long-term due to reduced revegetation and maintenance requirements.	High	Short term to Medium term

Action	Description	Reasoning	Priority	Timing
Hydro-mulching	Hydro-mulching/hydro-seeding using native grass seeds.	Hydromulching/hydroseeding will provide both initial erosion control and weed suppression on cleared areas and long-term control as a continuous cover of native grasses is established.	High	Short term to Medium term
Planting of steep areas	Planting of steep slopes will be conducted by planting species with high erosion protection capability and a spreading habit at high density.	Planting of hardy, deep-rooted native shrub and groundcover species will further improve bank stability and biodiversity outcomes. Planting will aim to replicate vegetation structure and composition of naturally occurring communities.	High	Short term to Medium term
General planting	Planting of cleared areas will be conducted. The outer 2 m on the edges of these zones, where they at the interface of the riparian zone and the adjacent intermodal facility site will be planted with a high density of native groundcover species (e.g. *Lomandra longifolia, Dianella caerulea, D. longifolia, D. revoluta, Imperata cylindrica*).	Planting at the outer edges of these zones will aim to act as a buffer between these areas and adjacent landscaped areas. Planting of the remaining area will aim to replicate vegetation structure and composition of naturally occurring communities.	High	Short term to Medium term
Watering	Plantings and hydro-mulched/hydro-seeded areas will be watered as required depending on rainfall conditions to provide optimum conditions for the establishment of vegetation.	It is essential that plantings establish quickly to provide appropriate soil stabilisation before mulch decomposes.	High	Short term to Medium term

5.3 General habitat management and restoration

The objective of the habitat management and restoration strategy is:

- to improve habitat for native animals, particularly threatened species.

5.3.1 Retaining existing habitat

Existing fauna habitat on the site consists chiefly of patches of native forest with varying understorey density including areas with native canopy over woody weed thickets.

The following measure is designed to minimise the disturbance to fauna habitat as a result of the project by adapting a staged weed removal and revegetation approach.

Table 5.5 Management actions for retaining existing fauna habitat

Action	Description	Reasoning	Priority	Timing
Maintaining tree and shrub cover	Limit weed removal to retain fauna habitat until native shrub and tree plantings mature (refer actions 6 and 7).	Maintains fauna habitat value of site between weed treatment and native vegetation establishment.	High	Short term to Long term

5.3.2 Habitat enhancement and restoration

Opportunities exist to enhance the quality of the site as habitat for threatened species through implementation of a planting scheme which maximises the density and diversity of habitats available on the site. Habitat can also be created through the installation of artificial nesting/roosting boxes and large woody debris. The management actions in Table 5.6 are recommended for habitat enhancement and restoration on the site.

Table 5.6 Management actions for habitat enhancement and restoration

Action	Description	Reasoning	Priority	Timing
Create structurally diverse vegetation	The layout of revegetated areas will provide a varied structure with open areas, shrub thickets and connected tree canopy to maximise the structural complexity and connectivity of the habitat provided.	A complex habitat structure emulates natural vegetation and provides habitat for a wider variety of native species than a more homogenous design and maximises the wildlife corridor value of the site	High	Medium term
Chose plant species to maximise fauna habitat	The planting palette chosen for revegetation will include species with characteristics which provide habitat resources for native fauna. Species should be chosen with the characteristics specific to the site.	There is limited space for providing fauna habitat on the site and as a wildlife corridor it is important that a wide variety and high density of habitat is available	High	Short term
Installing nest boxes for hollow-dependent native animals	Nest boxes would be installed in existing native trees on the site to provide potential nest sites for animal (e.g. birds and bats). Care needs to be taken to ensure any nest boxes installed do not encourage breeding by introduced fauna species such as Indian Mynas and Feral Honeybees.	A variety of hollow-nesting fauna species, particularly hollow-dependent microbats, owls and parrots may benefit from the installation of nest boxes.	Medium	Medium to Long term
Create frog habitat during construction of storm-water outlets	New stormwater outlets may, if practicable, be designed to include pond areas with fringing and emergent native sedges to create frog habitat. Ponds would be at least $25m^2$ and would be designed to have internal variation in depth between 5mm and 500mm during average rainfall conditions. Where feasible ponds would be located such that they are elevated above the average river water level to minimise the likelihood of them becoming infested with Plague Minnow through inundation by the river and allow them to dry out intermittently.	The main stream of Georges River is unlikely to provide a suitable breeding habitat for many species of frogs due to the presence of introduced fish species and poor water quality. Accumulated stormwater at outlets is likely to provide breeding habitat for hardy frog species such as Striped Marsh Frogs, Emerald-spotted Tree Frog and Common Eastern Froglets which have been recorded in the vicinity.	Medium	Medium to Long term
Create rocky habitat	Wherever rocks are used to stabilise stormwater outlets, lay rocks down in such a way that cavities suitable as hiding places for animals (e.g. reptiles and frogs) are created.	Rock armouring provides an opportunity to surface cover suitable as hiding places for terrestrial fauna.	Medium	Medium to Long term

5.4 Management of undesirable animal species

Animal species which may be detrimental to the biodiversity of the site include both introduced species and native species which have increased in abundance in the region due to habitat modification as a result of human activity.

Introduced animal species which are known or considered likely to occupy the site include:

- mammals (e.g. Black Rat, European Rabbit, fox)
- birds (e.g. Common Mynah, Spotted Turtledove, Red-whiskered Bulbul)
- fish (e.g. Plague Minnow)
- insects (e.g. European Honeybee).

Australian native animals which are known or considered likely to occupy the site which may be detrimental to biodiversity include the following birds:

- Noisy Miner, Bell Miner
- Pied Currawong
- cockatoos (Sulphur-crested Cockatoo, Galah, Long-billed Corella, Little Corella).

These species may affect the native species diversity through:

- Predation (e.g. Fox, Plague Minnow, Black Rat, Pied Currawong)
- Competition for habitat resources such as tree hollows (e.g. European Honeybee, Common Mynah, cockatoos) or food resources (e.g. Red-whiskered Bulbul, Noisy Miner)
- Competitive exclusion and resultant ecological imbalances (e.g. Bell Miner, Noisy Miner)
- Modification of habitat through damage to vegetation and spreading of weeds (e.g. European Rabbit, Red-whiskered Bulbul).

Successful management of undesirable animal species requires an integrated approach including habitat manipulation and/or culling programs. Culling of undesirable species over a small spatial area is likely to result in constant re-invasion from adjacent lands and is unlikely to be effective in substantially reducing the impact of these species. Culling programs need to be co-ordinated and conducted at a regional scale if they are to be effective.

The management actions in Table 5.7 are recommended for the management of undesirable animal species on the site.

Table 5.7 Management actions for undesirable animal species

Action	Description	Reasoning	Priority	Timing
Monitoring of undesirable animal species	Monitor the site for the presence of introduced and undesirable animal species as part of fauna monitoring (refer Action 69)	Determines the nature of the existing situation with regard to undesirable animals to inform potential involvement in regional management programs and determine whether habitat modification may be required.	Medium	Short term to Medium term
Co-operate with government bodies, interest groups and adjacent landowners in regional pest management programs	Consult the NSW Department of Industry and Investment (Primary Industries – Agriculture), the NSW Department of Environment Climate Change and Water, the Invasive Animal Cooperative Research Centre interest groups (e.g. Australasian Pest Bird Network and local landowners. Include the site in any pest management programs planned for the region during the life of the plan.	Effective management of undesirable species is dependent on a carefully-planned regional approach.	Medium	Short term to Medium term
Manage the use of nest boxes by undesirable species	Remove the eggs and/or young of introduced animals (e.g. Black Rat, Common Myna) found utilising nest boxes under appropriate permit conditions. Remove any insect colonies (bees, wasps, termites, ants found in nest boxes). Modify or move nest boxes to discourage use by undesirable species.	While nest boxes have potential to increase the habitat value of the site for native fauna, they also have potential to provide habitat for undesirable species.	Medium	Medium to Long term

5.5 Detailed planning, monitoring and adaptive management

While this plan provides a framework for the restoration and ongoing management of the site, detailed planning is required to ensure the successful implementation of the recommended actions.

A variety of issues may arise in the implementation of the plan which would require actions to be modified or additional actions to be implemented. A monitoring program is thus required to detect issues at an early stage such that appropriate adaptations may be made to strategies to ensure that the relevant objectives can be met.

Issues are most likely to arise due to uncertainty with regard to the biophysical characteristics of the soil of the site such as soil conditions, weed persistence and native vegetation regeneration potential.

5.5.1 Detailed planning

Detailed planning for the implementation of the plan will require the following actions in Table 5.8.

Table 5.8 Management actions for detailed planning

Action	Description	Reasoning	Priority	Timing
Project management	A suitably qualified contractor with experience in the restoration of native vegetation will be engaged at commencement to co-ordinate and supervise the implementation of the plan including activities such as the organising of materials, implementation of environmental safeguards (e.g. stormwater and dust management) during construction), staffing, occupational health and safety and monitoring arrangements.	The implementation of the plan requires careful planning by experienced personnel to ensure its success.	High	Short to Long term
Sourcing of soil	A source of appropriate soil for the rehabilitation of the site will need to be identified. Soil will be obtained from land development sites in western Sydney and will be tested by a soil scientist to ensure that the characteristics of the soil are suitable for the rehabilitation of the site.	The choice of soil to cap the fill batters is a key consideration for the plan as it will be a very important factor in the effectiveness of vegetation establishment and the level of weed infestation likely to affect revegetated areas.	High	Short to Long term
Obtaining plants and seeds	The collection of seeds and propagation of plants will commence as soon as possible to ensure that a sufficient supply of plants is available to commence planting in the first year of the plan.	Due to variability between years in flowering and seed production, the collection of seeds and plant propagation is likely to take several years to achieve the required diversity and abundance of plants.	High	Short to Long term

5.5.2 Monitoring and performance indicators

The following monitoring actions, for specific performance indicators, will be conducted to determine whether the actions are successful in achieving the desired outcomes. Management actions for monitoring and performance indicators are provided in Table 5.9.

Table 5.9 Management actions for monitoring and performance indicators

Action	Description	Performance indicator	Priority	Timing
Weed monitoring	Monitor the cover and diversity of weeds targeting key weed species (e.g. *Cardiospermum grandiflorum*, *Lantana camara*).	The cover of key weed species is decreasing steadily. The diversity of key weed species is stable or decreasing.	High	Short to Long term
Native cover monitoring	Monitor the cover and diversity of native canopy, shrub and groundcover plants.	The cover and diversity of native trees and shrubs is increasing or has reached the desired end point for the site. Native groundcover is increasing or has stabilised at least 80% cover in restoration zones. The cover and diversity of naturally-occurring native groundcover patches is stable or increasing.	High	Short to Long term
Fauna and nest box monitoring	Monitor the diversity and abundance of bird species utilising the site through timed counts in specified locations as an indicator of fauna habitat condition; keep a tally of all other vertebrate animals opportunistically recorded on the site; monitor nest boxes for use by native and introduced species.	The diversity and abundance of sedentary native bird species is stable or increasing when compared to the average for the monitoring point.	Moderate	Short to Medium term
Erosion monitoring	Monitor stormwater outlet locations, riverbanks and edges of the river terrace to determine if any areas of substantial erosion are apparent.	The extent of erosion apparent on the site is stable or decreasing.	High	Short to Long term

5.5.3 Adaptive management

The proposed management actions are considered to be the most reliable and cost-effective means of achieving the long-term objectives of the plan. Due to inherent uncertainties in the characteristics of the site and its response to the proposed treatments, an adaptive management principle including the actions listed in Table 5.10 is required.

Table 5.10 Adaptive management actions

Action	Description	Reasoning	Priority	Timing
Trial treatments	Trial weed-control, soil stabilisation and revegetation treatments at a small spatial scale. Monitor and compare results with key performance indicators prior to broad-scale implementation.	Small scale trails of treatments are prudent to ensure that they are effective prior to more substantial investment of time and resources	High	Short to Long term
Modify and/or substitute actions	If monitoring of trial treatments shows that the actions are not achieving the performance indicators, seek expert advice and modify actions accordingly. Trial the modified or substituted actions as described in Action 53.	Alternative methods may exist for the achievement of the outcomes which will be considered if the proposed actions are unsuccessful.	High	Short to Long term

6. Staging of actions

A summary of the sequence of the commencement of management actions in terms of project stages is shown in Table 6.1. Many of the management actions will be implemented incrementally over several stages with precise timing dependent on the outcome of trial treatments and the availability of soil and plants.

Table 6.1 Description of sequence

Stage	Summary of actions
1	▪ detailed planning ▪ protection of environmental values ▪ protection of the safety of staff ▪ baseline monitoring
2	▪ trialling of weed control and revegetation ▪ monitoring of the effectiveness of actions in trial locations
3	▪ modification of actions in response to the findings of monitoring ▪ expansion of actions to the remainder of the site ▪ ongoing monitoring
4	▪ ongoing monitoring ▪ secondary and maintenance weed control

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Appendix F

Biodiversity Offsets Strategy

Moorebank Intermodal Terminal - Biodiversity Offsets Strategy

September 2014

Moorebank Intermodal Company

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A+ GRI Rating: Sustainability Report 2010

2103829A-PR_6144 Rev_H

Revision	Details	Date	Amended By
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01	Rev A	02 November 2012	Tanya Bangel, Paul Rossington
02	Rev B	12 November 2012	Martin Predavec
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06	Rev E	16 April 2013	Paul Rossington
07	Rev F	25 June 2013	Paul Rossington
08	Rev G	2 July 2014	Alex Cockerill
09	Rev H	11 September 2014	Alex Cockerill

Author: Lukas Clews, Tanya Bangel, Paul Rossington

Signed:

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1. Introduction

The Moorebank Intermodal Terminal (IMT) Project (the Project) involves the development of approximately 220 hectares (ha) of land at the IMT site for the construction and operation of an IMT and associated infrastructure, facilities and warehousing. The Project includes a rail link connecting the IMT site to the Southern Sydney Freight Line (SSFL) and road entry and exit points from Moorebank Avenue.

An Environmental Impact Statement (EIS) and biodiversity Technical Paper (EA) are being prepared to allow assessment and to seek approval for the Project under the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act), as a Stage 1 State Significant Development (SSD).

The Department of Environment (DoE), EIS Guidelines and the Draft Revised Secretary's Environmental Assessment Requirements (SEARs) for environmental assessment of the Project, issued 2 July 2014 and 4 June 2014 respectively, include issues relating to biodiversity. The DGRs outline the need for a strategy to offset ecological impacts and native vegetation clearance, consistent with the ‘improve and maintain’ principle.

The proposed strategy must also demonstrate how it will achieve long term conservation outcomes; and taking into account the *Environment Protection and Biodiversity Conservation Act 1999 – Environmental Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012),the *Principles for the use of biodiversity offsets in NSW* (Department of Environment and Climate Change 2008) and the NSW Biodiversity Offsets Policy for Major Projects (Offset Policy 2014).

This report identifies a strategy to offset the residual biodiversity impacts of the Project. Three offset areas, suitable to partially offset the biodiversity impacts of the Project, are described and a detailed method of identifying additional offsets is proposed.

This includes offsets for Threatened species listed under the EPBC Act and NSW *Threatened Species Conservation Act 1995* (TSC Act) and Threatened ecological communities listed under the TSC Act.

The development of the offset strategy for the Moorebank IMT Project has been guided by the *Environment Protection and Biodiversity Conservation Act 1999 – Environmental Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012), the *Principles for the use of biodiversity offsets in NSW* (Department of Environment and Climate Change 2008) and Offset Policy 2014.

This report outlines the residual biodiversity impacts to be offset, identifies a proposed offset strategy specific to the Project, identifies the ecological values of the proposed offset areas, and outlines the compliance of the offset strategy with Commonwealth and state offsetting principles.

2. Avoidance of impacts

This section outlines the consideration and ability of the Project to avoid and minimise the direct and indirect impacts of a development proposal on biodiversity values as required by the NSW Offset Policy 2014.

Given the location and nature of the Project and its context with regard to existing road and rail infrastructure, there is limited scope for using alternative locations to entirely avoid impacts on biodiversity. Given the scale and type of development, there are only limited possibilities for the incorporation of small isolated patches of vegetation into the design of a large industrial and warehouse development. The EIS is for a Stage 1 SSD development approval of a concept design and future avoidance of vegetation will be investigated during detailed design and Stage 2 SSD development approvals. It is acknowledged that the current proposal will clear approximately 44–52 ha of TEC, however the majority of this vegetation is made up of small, highly fragmented and disturbed patches of vegetation in low condition. The retention of these isolated patches within an industrial development precinct would provide little long term conservation benefit to the TEC species.

Avoidance of vegetation was initially considered in the planning phase of the Project and was supported through the ecological integrity classification (Section 2.7 of the EA) which ‘classification of ecological values was used in the identification of constraints and evaluation of potential design options for the Project’. This assessment considered the full build development scenario and ensured the high conservation lands were considered for avoidance along with the range of other factors.

Reduction of impacts on areas of high ecological value was considered in the analysis and evaluation of design options for the Project, resulting in the retention of substantial areas of vegetation and habitat contiguous with the riparian vegetation of the Georges River (refer Section 6.4.4 of the EIS).

The areas of high ecological integrity to be impacted by the proposal (classed as high only because of the presence of threatened flora species and TEC) are restricted to narrow linear remnant adjoining Moorebank Avenue and the SIMTA facility that are considered of limited viability for conservation when considering the small fragmented size, high edge to area ratio, and surrounding land uses.

2.1 Mitigation

The mitigation measures specific to the ecological impacts of the Project are provided in Section 4 of the EA. Many of the general impact mitigation measures (e.g. dust suppression, sedimentation controls) would also contribute to the mitigation of construction and operation phase impacts on the ecological values of the Project site during all Project development phases. Implementation of the offsets strategy would address the remaining (residual) impacts that cannot be mitigated through the proposed management measures alone. The offset strategy as outlined in section 6.3.3 has been developed to relate specifically to the impact of each individual rail access option.

3. Residual biodiversity impacts to be offset

The Project will have direct and indirect impacts on biodiversity during the construction and operation phases. Construction of the Project will require the clearing of vegetation and habitats and this has been identified as the key residual impact in the EIS and biodiversity Technical Paper.

While a phased development approach is proposed for the Project, the offset strategy has been developed with the intent to meet the ‘worst-case’ scenario in terms of the Full Build footprint, including the associated construction compounds. This is the combined development area for all Project development phases.

As previously identified in the EIS and biodiversity Technical Paper the final layout and footprint of the IMT will depend on the location of the selected rail access option and therefore there are three IMT layouts proposed in this EIS. The residual impacts of each of the three options on threatened biodiversity recorded or considered likely to occur within the study area, are listed in Table 3.1, along with an estimate of residual impacts associated with habitat removal for each of the rail connection options. Full details of the existing environment and biodiversity impacts will be outlined in the EIS and biodiversity Technical Paper.

Table 3.1 Residual vegetation and habitat removal

Vegetation community/habitat/ threatened species	Approx. extent (ha) within Project site	Full Build clearing (ha)		
		Northern Rail Access Option	Central Rail Access Option	Southern Rail Access Option
Vegetation				
Castlereagh Swamp Woodland[1]	0.9	0.9	0.9	0.9
Castlereagh Scribbly Gum Woodland[2]	16.1	16.1	16.1	16.1
Riparian Forest (River-Flat Eucalypt Forest)[1]	16.2	2.2	4.7	5.3
Alluvial Woodland (River-Flat Eucalypt Forest)[1]	35.6	25.2	26.7	30.4
Total River-Flat Eucalypt Forest[3]	51.8	27.4	31.4	35.7
Total vegetation	**68.8**	**44.4**	**48.4**	**52.7**
Fauna habitat				
Shrubby eucalypt woodland	17.0	17.0	17.0	17.0
Tall eucalypt forest	51.8	27.4	31.4	35.6
Waterbodies	2.0	2.0	2.0	2.0
Cleared land	130.1	n/a	n/a	n/a

Notes: 1 - Endangered Ecological Community as listed under the TSC Act;
2 - Vulnerable Ecological Community as listed under the TSC Act;
3 - River flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney basin and South East Corner bioregions.

Threatened biodiversity recorded or considered likely to occur within the study area is listed in Table 3.2 along with an estimate of residual impacts associated with habitat removal. Two EPBC Act listed flora species *Grevillea parviflora* subsp. *parviflora* (Vulnerable) and *Persoonia nutans* (Endangered) will be directly affected by the Project. Approximately 16 *Grevillea parviflora* subsp. *parviflora* and 10 *Persoonia nutans* individuals will be removed. Additionally, the soil seed bank will also be removed.

Table 3.2 Residual impacts to Threatened biodiversity

Threatened biodiversity	Status		Extent (community and habitat) to be removed by the Project (ha) Estimated number of individuals (where applicable)
	EPBC Act[1]	TSC Act[2]	
Threatened ecological communities			
Castlereagh Swamp Woodland	-	E	0.9
Castlereagh Scribbly Gum Woodland	-	V	16.1
River-Flat Eucalypt Forest	-	E	27.4–35.7
Threatened flora			
Acacia bynoeana	V	E	17.0
Acacia pubescens	V	V	17.0
Dillwynia tenuifolia	V	V	17.0
Grevillea parviflora* subsp. *parviflora	**V**	**V**	17.0 (≈16 individuals ≈50 stems)
Leucopogon exolasius	V	V	17.0
Persoonia hirsuta	E	E	17.0
Persoonia nutans	**E**	**E**	17.0 (≈10 individuals)
Pultenaea parviflora	V	E	17.0
Threatened fauna			
Barking Owl	-	V	27.4–35.7
Black-chinned Honeyeater	-	V	44.4–52.7
Eastern Bent-wing Bat	-	V	44.4–52.7
Eastern False Pipistrelle	-	V	27.4–35.7
Eastern Free-tail bat	-	V	44.4–52.7
Eastern Pygmy-possum	-	V	44.4–52.7
Flame Robin	-	V	44.4–52.7
Gang-gang Cockatoo	-	V	44.4–52.7
Greater Broad-nosed Bat	-	V	44.4–52.7
Grey-headed Flying-fox	V	V	44.4–52.7
Koala	V	V	27.4–35.7
Large-footed Myotis	-	V	27.4–35.7
Little Eagle	-	V	44.4–52.7
Little Lorikeet	-	V	44.4–52.7
Powerful Owl	-	V	27.4–35.7
Regent Honeyeater	E	CE	44.4–52.7
Scarlet Robin	-	V	44.4–52.7
Spotted Harrier	-	V	44.4–52.7
Spotted-tailed Quoll	E	V	44.4–52.7
Square-tailed Kite	-	V	44.4–52.7

Threatened biodiversity	Status		Extent (community and habitat) to be removed by the Project (ha) Estimated number of individuals (where applicable)
	EPBC Act[1]	TSC Act[2]	
Squirrel Glider	-	V	44.4–52.7
Swift Parrot	E	E	44.4–52.7
Varied Sittella	-	V	44.4–52.7
Yellow-bellied Sheathtail Bat	-	V	44.4–52.7

Notes: 1 – V = Vulnerable, E = Endangered (EPBC Act).
2- – V= Vulnerable, E = Endangered, CE = Critically Endangered (TSC Act). Species in bold were recorded in the study area during the ecological assessment.

4. Proposed offset package

Offset strategies may include both on and off site or local area schemes that contribute to the long term conservation of Threatened species and communities. The offset strategies chosen for the Project include a combination of:

- on-site offsets – securely conserving and improving the condition of existing riparian habitat or providing a buffer to an area of existing habitat within the Project site; and
- off-site offsets – securing and improving the condition of existing habitats at other sites in the immediate locality of the Project site.

The currently proposed offset areas that have been identified as part of the offset strategy are on land owned by the Australian Government and therefore, State and local legislative obligations do not apply to these lands.

4.1 Identification of off-site offset areas

The offset strategy has identified the need for off-site offsets to supplement the existing on site offset. These areas will be identified and secured before clearing on the Project site commences. In identifying these offsets the following criteria have been considered:

4.1.1 Biodiversity and landscape characteristics

The following biodiversity and landscape characteristics will be important considerations in the identification of additional offsets:

- presence of relevant Threatened biodiversity
- distance from the Project
- current condition and potential for improvement
- connectivity.

These criteria are described in further detail below.

4.1.1.1 Presence of relevant Threatened biodiversity

When determining offsets, they must be targeted and offset the impacts on a ‘like for like or better’ basis. Given that the Project includes clearing of Threatened ecological communities, and threated species the offsets should where possible include these species and communities.

4.1.1.2 Distance from the Project

Biodiversity offsets should be located appropriately and offset the impact in the same region. Ideally, offset habitat areas should be located within the region of the Project.

Choosing offsets within the region of the Project is also consistent with the need to provide compensatory habitat of similar type and quality to that being removed. The integrity of the habitat network and biodiversity values of the locality are retained and habitat is secured and existing corridors consolidated for local flora and fauna populations.

In addition to the ecological benefits, by choosing offsets located within the region of the Project, conservation planning can be integrated with development planning and this is also likely to benefit the reputation of the proponent, particularly with local stakeholders.

4.1.1.3 Current condition and potential for improvement

Habitat condition gives an indication of its quality for flora and fauna habitat and long-term viability. The condition of a remnant is a result of a number of factors including weed invasion, fragmentation, pollution and disturbances including clearing, fire and grazing. The condition provides an index of a site's potential to support Threatened species, populations and communities. Although it is preferable that the condition/habitat quality of offset areas exceeds or matches that of habitat removed, this is not always achievable. Where the condition or quality of the offset is not equivalent to that of the area being cleared, a greater area of offset may be required.

Where the condition of habitats can be improved through changes in management (for example cessation of grazing, weed control), this improvement in condition can be used to offset a development.

4.1.1.4 Connectivity

Connectivity of habitats is essential to the long-term survival of many species because it facilitates movement on a local scale, for foraging and sheltering, as well as on a regional or even national scale as a wildlife corridor for dispersal and migration. Remnants with habitat linkages are more likely to maintain their biodiversity in the long-term because wildlife corridors:

- provide increased foraging area for wide-ranging species
- provide cover for movement between habitat patches, particularly for cover-dependent species and species with poor dispersal ability and enhance the movement of animals through sub-optimal habitats
- reduce genetic isolation
- facilitate access to a mix of habitats and successional stages to those species which require them for different activities (for example, foraging or breeding)
- provide refuge from disturbances such as fire
- provide habitat in itself

- link wildlife populations and maintain immigration and re-colonisation between otherwise isolated patches. This in turn may help reduce the risk of population extinction (Wilson & Lindenmayer 1995).

Connectivity of habitats creates larger remnants that are likely to be of higher quality and support higher biodiversity.

Offsets are likely to be of greater biodiversity value where they are located adjacent to remnant vegetation creating a larger remnant or where they provide linkages within otherwise fragmented landscapes. Compensatory habitat should act to consolidate existing corridors or, occur adjacent to existing areas of native vegetation in order to maintain or increase their habitat quality and long-term viability.

4.1.2 Preliminary desktop identification of possible sites

The first step in identifying potential offsets is to undertake a desktop assessment. This includes a review of readily available information for the western Sydney region including but not limited to:

- vegetation mapping; e.g. *The native vegetation of the Cumberland Plain, western Sydney* (Tozer 2003)
- land use zone mapping
- other relevant mapping; e.g. Cumberland Plain priority conservation lands mapping (Department of Environment Climate Change and Water 2010)
- regional land management plans and policies
- broad-scale biodiversity survey reports; e.g. *Threatened and pest animals of Greater Southern Sydney*, (Department of Environment and Climate Change 2007b), *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region* (Department of Environment and Climate Change 2007a)
- wildlife databases; e.g. Bionet Atlas of NSW Wildlife (Office of Environment and Heritage 2013).

These data sources would be used to locate areas that:

- contain the biodiversity values to be offset i.e.:
  - known occurrences of *Persoonia nutans* and *Grevillea parviflora* subsp. *parviflora*
  - potential habitat for the other Threatened species of animals and plants considered likely to occur in the Project area (refer Table 4.3)
  - the same Threatened ecological communities affected by the Project
- are not currently protected from development by existing legislation or binding conservation arrangements.
- exhibit appropriate biodiversity and landscape characteristics (refer section 2).

Consultation with the NSW Office of Environment and Heritage (OEH) and relevant local councils would also be used to identify priority lands for conservation and potential use as offsets.

- These sites would require further refinement, as described below, to identify a short list of potential offset sites.

4.1.3 Assessment and ranking of potential sites

The sites identified during the desktop review would require refinement based on more detailed investigation of issues including:

- tenure and zoning of the potential offset sites
- current land ownership and availability of land for purchase
- likelihood of loss without protection as an offset; considering factors such as physical constraints on land use and proposed developments
- potential interaction with adjacent land uses; e.g. required fire regimes with regard to bushfire hazard reduction and biodiversity conservation
- size, shape and connectivity with other vegetation/habitat.

The outcome of the refinement process would be a short list of potential offset sites for detailed investigation ranked in terms of their suitability based on the above criteria.

4.1.4 Site inspection and identification of preferred site/s

Preliminary field investigations of short-listed sites would be required to verify their suitability as offsets with regard to:

- *population estimates of Persoonia nutans and Grevillea* parviflora subsp. *parviflora*
- habitat suitability for the other Threatened species of animals and plants considered likely to occur in the Project area
- presence and distribution of the Threatened ecological communities affected by the Project
- current vegetation/habitat condition and potential for improvement
- long-term management issues
- the results of the inspection would be used to further refine the offset sites and identify a preferred site or sites for adequacy assessment (refer section 4.1).

4.1.5 Assessment against offsetting principles

- The sites will also need to be assessed against the *Principles for the use of environmental offsets under the EPBC Act* and *Principles for the use of biodiversity offsets in NSW* to determine their suitability for offsetting the impacts of the Project.

4.1.6 Indirect offset options

If any shortfall in the availability of direct offsets is identified, options for the implementation of other compensatory measures as indirect offset measures will be explored. Options considered would include, but not be limited to, funding for:

- research programs into the ecology and management of relevant Threatened species
- public education programs aimed at reducing impacts associated with human behaviour (e.g. rubbish dumping, horse riding)
- conservation of relevant Threatened species in other regions.

4.2 Proposed offset sites

Three areas are currently proposed for offsets (refer Figures 4.1–4.3). These areas are described below.

4.2.1 Moorebank Conservation area

Moorebank offset area – Georges River riparian zone: restoration and management of the Georges River riparian zone (approximately 32.3–38.6 ha) including the eastern side of the river corridor from approximately 300 m south of the M5 Motorway for a length of approximately 2.5 km south to the East Hills Railway Line (refer Figure 4.4). This offset conserves a corridor extending from the Georges River to the 1 in 1% annual exceedance probability flood line; however it is possible this corridor will be extended beyond the boundary subject to future development stages not the subject of this EIS. Restoration and management of this zone is proposed. This area is currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure - Defence) under the *Liverpool Local Environmental Plan 2008*. As such, this land is zoned and reserved for Defence development.

4.2.2 Casula Offset area

Management and restoration of vegetation within Lot 4 DP 1130937 (Casula Offset Area) is proposed (refer Figure 4.4). The Casula Offset Area (also referred to as the ‘hourglass land’) is an irregular shaped allotment of approximately 3.2 ha on the western side of the Georges River opposite the Project site.

This area is currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure – Defence) under the Liverpool Local Environmental Plan 2008. As such, this land is zoned and reserved for Defence development.

The site contains native vegetation that would require active management, including weed removal and supplementary planting with native species, in order to improve the condition of the vegetation and habitats contained therein. It also contains a large patch of vegetation dominated by weeds which would require clearing and revegetation with native species.

4.2.3 Wattle Grove Offset area

Part of the eastern portion of Lot 3001 DP 1125930 (east of Moorebank Avenue) contains native vegetation that is proposed to be used to offset vegetation to be cleared for the Project (refer Figure 4.5).This area of approximately 78.3 ha of vegetation adjoins the East Hills Railway Line to the south, land owned by the SIMTA consortium to the northwest, and the residential area of the suburb of Wattle Grove to the east. This area is currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure - Defence) under the Liverpool Local Environmental Plan 2008. This land would need to be actively managed in order to maintain or improve the condition of the vegetation and habitats.

In regards to the proposed on-site offsets, the final size of both the Moorebank offset area – Georges River riparian zone and Casula offset area (as identified above) will depend on the location of the selected rail access option. Therefore, there are three potential IMT offset layouts proposed in this EIS (refer to Figure 4.1 to Figure 4.3).

PROPOSED MOOREBANK INTERMODAL TERMINAL
BIODIVERSITY OFFSET STRATEGY

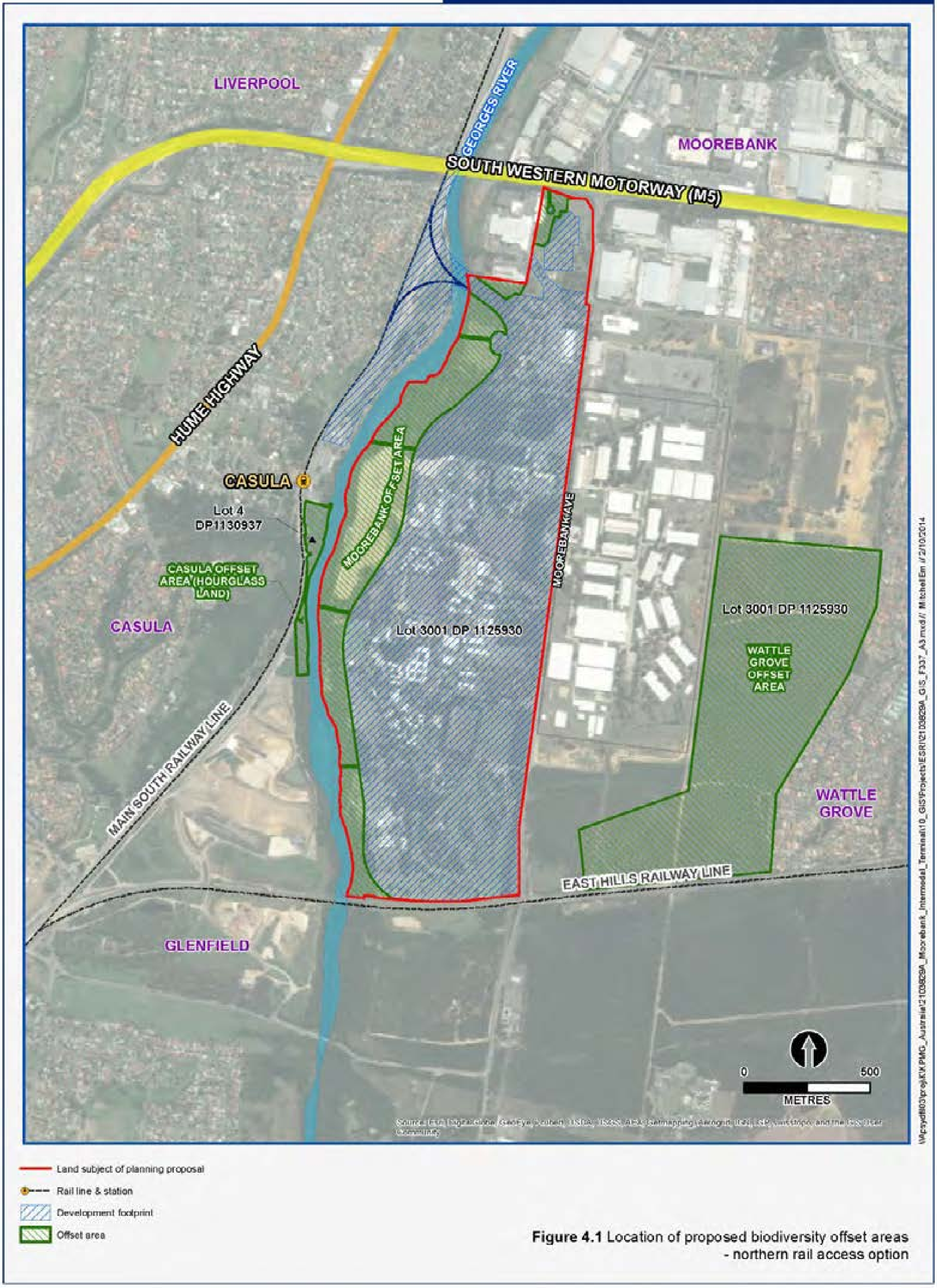

Figure 4.1 Location of proposed biodiversity offset areas - northern rail access option

PROPOSED MOOREBANK INTERMODAL TERMINAL
BIODIVERSITY OFFSET STRATEGY

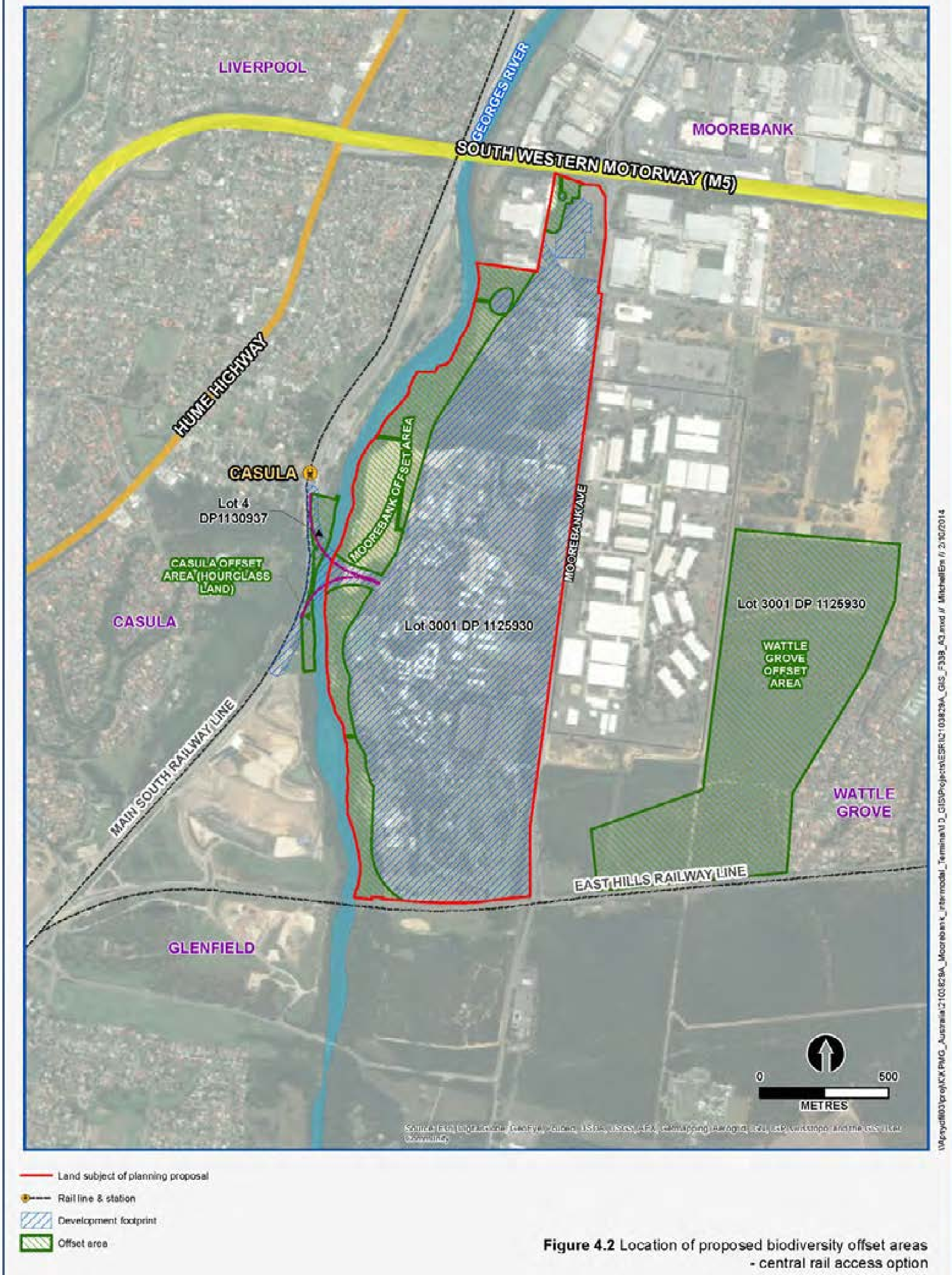

Figure 4.2 Location of proposed biodiversity offset areas - central rail access option

PROPOSED MOOREBANK INTERMODAL TERMINAL
BIODIVERSITY OFFSET STRATEGY

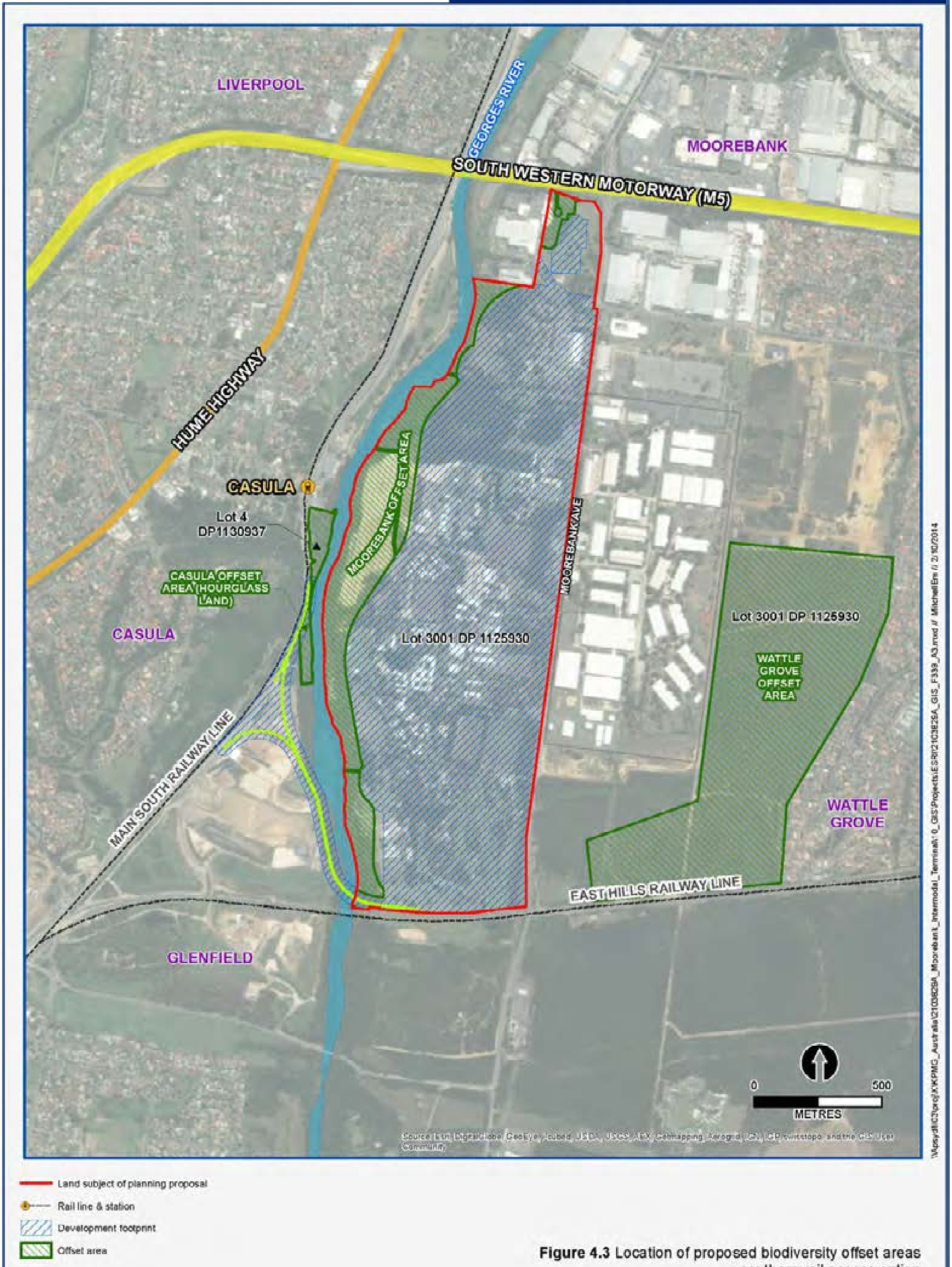

Figure 4.3 Location of proposed biodiversity offset areas - southern rail access option

4.3 Ecological values of the proposed offset areas

The ecological values of the proposed offset areas are outlined in terms of known occurrence of threatened species of plant, fauna habitat potential and vegetation condition.

Detailed ecological surveys and assessments of these offset sites have been undertaken in accordance with the NSW BioBanking Assessment Methodology (BBAM). These surveys included ecological vegetation mapping and preliminary threatened flora surveys and built on previous ecological surveys within the Casula offset area and Wattle Grove Offset Area (GHD 2014). The general conditions, fauna habitats and vegetation communities of the proposed offset areas are summarised in Table 4.1 below.

Table 4.1 Summary of general conditions, fauna habitat and vegetation communities of the offset areas

Offset areas	General condition of offset sites	Fauna habitat	Vegetation communities	Threatened biodiversity
Moorebank offset area	The mapped vegetation of the site varies from patches with native species dominant in all vegetation layers to patches with the understory and ground layer dominated by introduced vines and shrubs (e.g. *Lantana camara*). Under present conditions there is little light pollution affecting the vegetation along the Georges River. Light pollution is likely to be substantially higher during the construction and operation of the Project due to fixed lighting within the facility and lighting from trucks and trains. The proposed vegetation restoration within the riparian corridor and landscape planting in the interior of the site is, is likely to mitigate light pollution through the screening effects of increased vegetation.	The fauna habitat of the Georges River riparian corridor consists of a tall eucalypt forest with an understory varying in its structure and composition including areas with dense weed thickets, diverse native shrubbery and sparse understory consisting mainly of grasses, leaf litter and scattered shrubs (refer to Figure 4.4). Large mature hollow-bearing trees, potentially hollow-bearing trees and fallen woody debris are moderately abundant in this area. Habitat in this area is connected via the riverbank underneath the East Hills railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve. Overall, the fauna habitat in the site is in moderate condition.	Riparian Forest Alluvial Woodland (For list of dominant species refer to Table 4.2).	TSC Act listed Endangered ecological community: ▪ River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
Casula offset area	The vegetation of the site is mapped as Riparian Forest (Tozer 2003). Field verification of the site on 18 February 2013 revealed that most of the site is covered by disturbed Riparian Forest with the exception of an area in the north which is dominated by the woody weeds *Ligustrum lucidum*, *Ligustrum sinense* and *Lantana camara*. The Riparian Forest of the site has a largely intact canopy layer with an understory varying from a mixture of native species (e.g. *Breynia oblongifolia*) to areas dominated by *Lantana camara*. Overall, the native vegetation mapped in the site is in moderate condition. Existing ecological light pollution is likely to affect the Casula Offset Area due to its location immediately adjacent to the Southern Sydney Freight Line. The light conditions here may limit the suitability of the site for some nocturnal animal species, however, some nocturnal species are likely to be habituated to increased light levels and to persist in utilizing this habitat.	The fauna habitat of the Casula Offset Area (refer Figure 4.4) consists of a tall eucalypt forest with an understory varying in its structure and composition including areas with dense weed thickets and native shrubbery. Hollow-bearing trees and fallen woody debris are present in these areas which provide potential microhabitat features for a variety of species of animal. Habitat in this area is connected via the riverbank underneath the East Hills railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve. Connectivity to substantial areas of fauna habitat to the north is less pronounced due to the presence of intervening areas with only very narrow bands of riparian vegetation.	Riparian Forest (For list of dominant species refer to Table 4.2).	TSC Act listed Endangered ecological community: ▪ River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Offset areas	General condition of offset sites	Fauna habitat	Vegetation communities	Threatened biodiversity
Wattle Grove Offset Area	Mapped areas of native vegetation in this site are generally dominated by native species with only minor weed invasion. Areas of more intense weed invasion, where introduced species are dominant in the ground layer, are limited to the periphery of the site and patches of regrowth vegetation in the south-west of the site (refer areas with no vegetation mapped in Figure 4.5). Sporadic weed occurrences also exist along track edges in the core of the site. The site is subject to periodic hazard reduction burning for the protection of the adjacent suburban area of Wattle Grove. The frequency and intensity of burning of the vegetation on the site is likely to influence its suitability as habitat for threatened species. Overall, the native vegetation mapped in the site is in moderate to good condition. Areas with no vegetation mapped generally consist of regrowth native trees and large shrubs with an understory dominated by introduced species.	The fauna habitat of the Wattle Grove Offset Area consists of eucalypt woodland with an understory varying in its structure and composition including areas with dense thickets of native shrubbery and areas of sparse understory consisting mainly of grasses, leaf litter and scattered shrubs. Large mature hollow-bearing and potentially hollow-bearing trees occur at low. Fallen woody debris generally occurs at low density, likely as a result of fuel reduction burning activities. *Habitat in this area is separated by a fenced rail corridor limiting connectivity for terrestrial and arboreal fauna. Due to its size (73.81 ha), it is likely to have potential to support viable populations of a variety of fauna species under appropriate management. If populations of less mobile animal species (i.e. non-flying species) are lost, there is limited scope for natural repopulation of this habitat due to its limited connectivity. Overall, the fauna habitat in the site is in moderate to good condition.	Riparian Forest Alluvial Woodland Shale/Gravel Transition Forest Castlereagh Swamp Woodland Castlereagh Scribbly Gum Woodland (For list of dominant species refer to Table 4.3).	TSC Act listed Vulnerable ecological community: ▪ *Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion.* TSC Act listed Endangered ecological community: ▪ *Castlereagh Swamp Woodland Community* ▪ *Cooks River Castlereagh Ironbark Forest* ▪ *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* ▪ *Shale Gravel Transition Forest in the Sydney Basin Bioregion* EPBC Act listed Critically endangered ecological community ▪ *Shale Gravel Transition Forest in the Sydney Basin Bioregion* EPBC Act listed species ▪ *Acacia pubescens* ▪ *Persoonia nutans* ▪ *Grevillea parviflora subsp. parviflora*

4.3.1 General condition of offset sites

4.3.1.1 Moorebank Offset area

The mapped vegetation of the site varies from patches with native species dominant in all vegetation layers to patches with the understory and ground layer dominated by introduced vines and shrubs (e.g. **Lantana camara*). Dirt/gravel vehicle paths, small patches of bare ground with minimal vegetation and concrete pads are also found here. Larger areas of bare ground and introduced grassland are included in the site but are not included in native vegetation mapping (refer Figure 4.4). Overall, the vegetation of the site is considered to be in moderate condition.

Without intervention, it is likely that the condition of vegetation and fauna habitats would continue to decline due to the ongoing reduction of the native shrub layer and lack of tree recruitment due competition with woody weeds, particularly **Lantana camara*. Under present conditions there is little light pollution affecting the vegetation along the Georges River. Light pollution is likely to be substantially higher during the construction and operation of the Project due to fixed lighting within the facility and lighting from trucks and trains. The proposed vegetation restoration within the riparian corridor and landscape planting in the interior of the site is, however, likely to mitigate light pollution through the screening effects of increased vegetation. The proposed lighting for the site would also be designed to minimise light spill (as explained in the main EIS document), thereby minimising ecological light pollution impacts. With the proposed vegetation restoration, significant ecological light pollution impacts on the offset site are unlikely.

4.3.1.2 Casula Offset area

The vegetation of the site is mapped as Riparian Forest (Tozer 2003). Field verification of the site on 18 February 2013 revealed that most of the site is covered by disturbed Riparian Forest with the exception of an area in the north which is dominated by the woody weeds **Ligustrum lucidum*, **Ligustrum sinense* and **Lantana camara*. The Riparian Forest of the site has a largely intact canopy layer with an understory varying from a mixture of native species (e.g. *Breynia oblongifolia*) to areas dominated by **Lantana camara*. Overall, the native vegetation mapped in the site is in moderate condition.

Without intervention, it is likely that the condition of vegetation and fauna habitats would continue to decline due to the ongoing reduction of the native shrub layer and lack of tree recruitment due competition with woody weeds, particularly **Lantana camara*.

Existing ecological light pollution is likely to affect the Casula Offset Area due to its location immediately adjacent to the Southern Freight Rail Line. The light conditions here may limit the suitability of the site for some nocturnal animal species; however, some nocturnal species are likely to be habituated to increased light levels and to persist in utilizing this habitat.

4.3.1.3 Wattle Grove Offset area

Mapped areas of native vegetation in this site are generally dominated by native species with only minor weed invasion. Areas of more intense weed invasion, where introduced species are dominant in the ground layer, are limited to the periphery of the site and patches of regrowth vegetation in the south-west of the site (refer areas with no vegetation mapped in Figure 3.5). Sporadic weed occurrences also occur along track edges in the core of the site.

The site is subject to periodic hazard reduction burning for the protection of the adjacent suburban area of Wattle Grove. The frequency and intensity of burning of the vegetation on the site is likely to influence its suitability as habitat for threatened species.

Overall, the native vegetation mapped in the site is in moderate to good condition. Areas with no vegetation mapped generally consist of regrowth native trees and large shrubs with an understory dominated by introduced species.

4.3.2 Vegetation community composition and condition

Vegetation community composition and condition in the offset areas is described in Table 4.2–4.3. Figures 4.4–4.5 outline the distribution of vegetation communities in each offset area.

Table 4.2 Moorebank Conservation Area and Casula Offset area vegetation composition and condition

Vegetation community	Canopy height	Dominant species			Conservation significance	Ecological integrity[2]
		Canopy	Understorey[1]	Ground cover[1]		
Riparian Forest	25–30 m	*Eucalyptus bosistoana*, *Eucalyptus botryoides* x *saligna*, *Angophora floribunda*, *Casuarina cunninghamiana*	*Tristaniopsis laurina*, *Backhousia myrtifolia*, *Stenocarpus salignus*, *Jacksonia scoparia*, *Polyscias sambucifolia*, *Westringia longifolia*, *Santalum obtusifolium*, *Acacia binervia*, *Acacia decurrens*, *Callistemon salignus*, **Arundo donax*, *Melia azedarach*, **Ligustrum sinense*, *Phebalium squamulosum*	*Microlaena stipoides*, **Eragrostis curvula*, **Cardiospermum grandiflorum*, *Leucopogon juniperinus*, *Morinda jasminoides*, *Pteridium esculentum*, **Araujia sericifera*, **Verbena bonariensis*, **Asparagus* spp., *Gahnia aspera*, *Pratia purpurascens*, *Austrostipa ramosissima*	TSC Act listed Endangered ecological community *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*	Moderate to High
Alluvial Woodland	20–25 m	*Eucalyptus tereticornis*, *Eucalyptus botryoides* x *saligna, Eucalyptus baueriana, Angophora floribunda*	*Acacia decurrens*, *Acacia binervia*, *Ozothamnus diosmifolius*, *Kunzea ambigua*, **Lantana camara*	*Microlaena stipoides*, **Eragrostis curvula*, **Senecio madagascariensis*, **Conyza bonariensis*, *Tricoryne elatior*, *Pratia purpurascens*, **Bidens pilosa*, **Sida rhombifolia*, *Cynodon dactylon*	TSC Act listed Endangered ecological community *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*	Moderate to High

Notes: 1. Asterisk (*) denotes an introduced species.

2. Refer to Section 2.4.2 of the *Moorebank Intermodal Freight Terminal - Ecological Impact Assessment* for Ecological Integrity definitions

Table 4.2 Wattle Grove Offset area – eastern bushland area vegetation community composition and condition

Vegetation community	Canopy height	Dominant species			Conservation significance	Ecological integrity
		Canopy	Understorey	Ground cover		
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland	8–12 m	*Eucalyptus sclerophylla, Angophora bakeri* *Eucalyptus globoidea, Eucalyptus parramattensis* subsp. *parramattensis, Melaleuca decora*	*Kunzea capitata, Melaleuca nodosa*, *Acacia brownei*, *Banksia spinulosa*, *Banksia oblongifolia, Hakea sericea, Astroloma humifusum, Daviesia acicularis, Petrophile sessilis, Hakea dactyloides, Acacia linifolia, Isopogon anethifolius, Leptospermum polygalifolium, Dillwynia parvifolium, Leptospermum parvifolium, Leptospermum trinervium, Pimelea linifolia, Pultenaea villosa, Callistemon linearis, Pultenaea elliptica*, and *Acacia falcata.*	*Lomandra multiflora, Cyathochaeta diandra, Dianella revoluta, Cheilanthes sieberi, Themeda australis, Laxmannia gracilis, Billardiera scandens, Pratia purpurascens, Eragrostis brownei, Goodenia hederacea var, hederacea, Aristida vagans, Trachymene incisa, Entolasia stricta, Xanthorrhoea minor, Stylidium graminifolium, Microlaena stipoides, Panicum simile, Dampiera stricta, Lepyrodia scariosa, Leptocarpus tenax, Cassytha pubescens* and *Hardenbergia violaceae.*	TSC Act listed Vulnerable ecological community *Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion.*	High
Parramatta Red Gum woodland	8–10 m	*Eucalyptus parramattensis* subsp. *parramattensis,* *Angophora floribunda, Melaleuca linariifolia, Melaleuca decora, Angophora bakeri, Eucalyptus sclerophylla*	*Melaleuca thymifolia, Melaleuca erubescens, Leptospermum polygalifolium, Callistemon linearis* and *Pultenaea villosa.*	*Lomandra longifolia, Hakea sericea, Gahnia sp., Pteridium esculatum, Dianella revoluta, Juncus usitatus, Aristida vagans, Pratia purpurascens, Ranunculus inundatus, Imperata cylindrica, Centella asiatica, Goodenia paniculata, Lepidosperma quadrangulatum, Lepyrodia muelleri, Carex appressa Typha orientalis, Leptocarpus tenax. Isolepis inundata, Isolepis cernua, Schoenus brevifolius, Baumea articulata,* and *Chorizandra cymbaria.*	TSC Act listed Endangered ecological community *Castlereagh Swamp Woodland Community.*	High

Vegetation community	Canopy height	Dominant species			Conservation significance	Ecological integrity
		Canopy	Understorey	Ground cover		
Broad-leaved Ironbark - Melaleuca decora grassy open forest	16–20 m	*Eucalyptus fibrosa, Eucalyptus tereticornis, Melaleuca decora, Allocasuarina littoralis, Exocarpus cupressiformis* and *Acacia decurrens.*	*Ozothamnus diosmifolium, Bursaria spinosa, Acacia falcata, Pultenaea villosa, Daviesia ulicifolia, Olearia microphylla, Lissanthe strigosa, Hakea sericea, Dillwynia parvifolia, Melaleuca nodosa, Leucopogon juniperinus, Persoonia linearis,* and *Pomax umbellata.*	*Lissanthe strigosa, Entolasia stricta, Themeda australis Aristida vagans, Austrodanthonia tenuior, Lomandra longifolia, Lomandra multiflora, Dianella revoluta, Hibbertia obtusifolia, Lepidosperma laterale, Cheilanthes sieberi, Gonocarpus tetragynus, Dichondra repens, Centella asiatica, Einadia hastata, Billardiera scandens, Hardenbergia violaceae* and *Glycine clandestina.*	TSC Act listed Endangered ecological community. *Shale Gravel Transition Forest in the Sydney Basin Bioregion.* EPBC Act listed Critically endangered ecological community.	High
Broad-leaved Ironbark - Melaleuca decora shrubby open forest	16–20 m	*Eucalyptus fibrosa, Eucalyptus tereticornis, Melaleuca decora, and Melaleuca nodosa.*	*Melaleuca nodosa, Bursaria spinosa, Acacia falcata, Pultenaea villosa, Notelaea longifolia, Daviesia ulicifolia, Lissanthe strigosa, Lissanthe strigosa, Leucopogon juniperinus, Persoonia linearis,* and *Pomax umbellata.*	*Lomandra filiformis, Lissanthe strigosa, Themeda australis, Entolasia stricta, Aristida vagans, Lomandra longifolia, Lomandra multiflora, Dianella revoluta, Lepidosperma laterale, Pratia purpurascens, Einadia hastata, Hardenbergia violaceae* and *Glycine clandestina.*	TSC Act listed Endangered ecological community *Cooks River/ Castlereagh Ironbark Forest in the Sydney Basin Bioregion.*	High

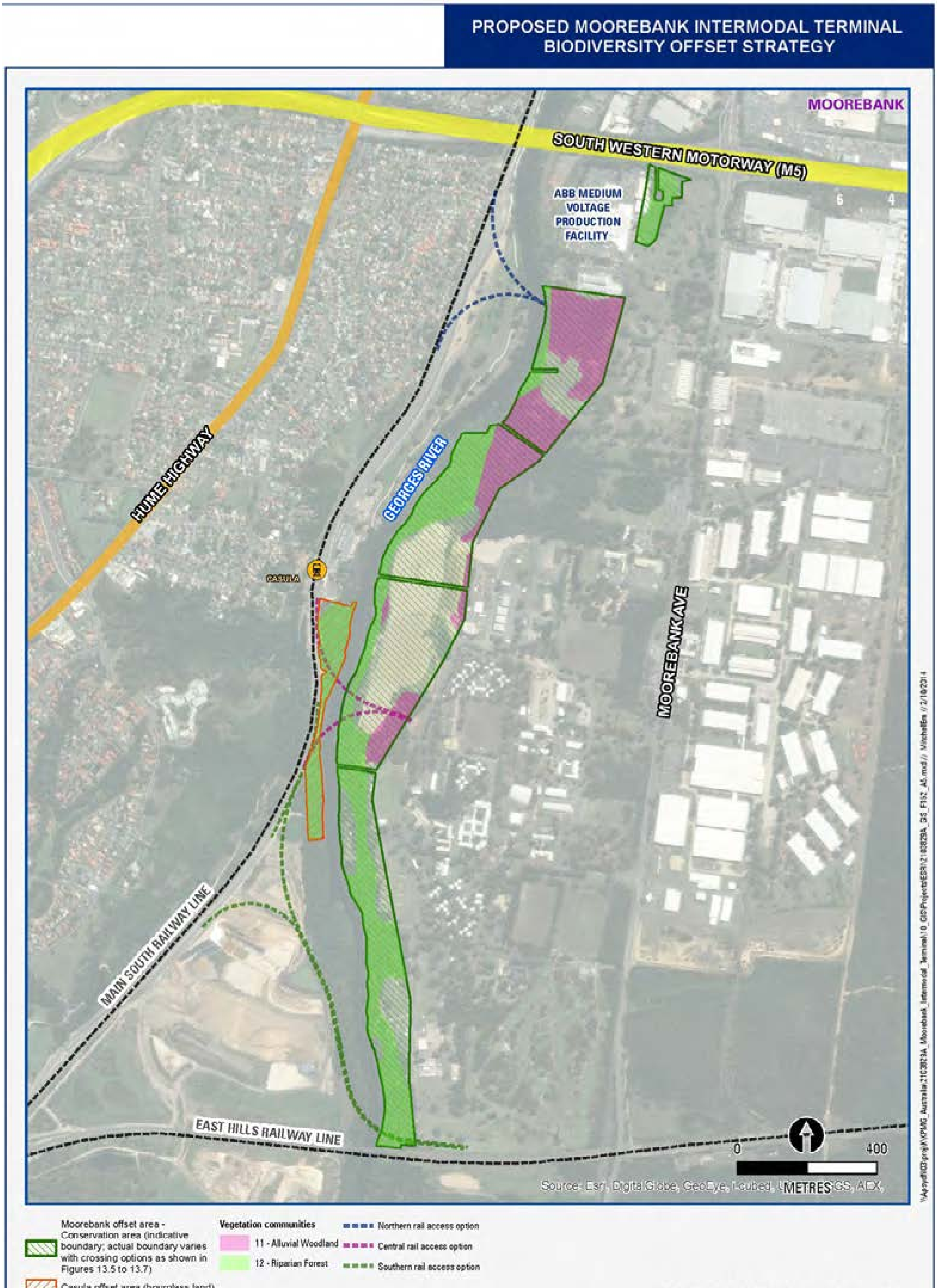

Figure 4.4 Moorebank offset area - Conservation area and Casula offset area - vegetation communities

PROPOSED MOOREBANK INTERMODAL TERMINAL
BIODIVERSITY OFFSET STRATEGY

Figure 4.5 Moorebank offset area - Wattle Grove offset area - vegetation communities and threatened plants

4.3.3 Fauna habitat of offset sites

4.3.3.1 Moorebank Offset area

The fauna habitat of the Moorebank Offset Area consists of a tall eucalypt forest with an understory varying in its structure and composition including areas with dense weed thickets, diverse native shrubbery and sparse understory consisting mainly of grasses, leaf litter and scattered shrubs. Large mature hollow-bearing, potentially hollow-bearing trees and fallen woody debris are moderately abundant in this area.

Habitat in this area is connected via the riverbank below the railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve. Connectivity to substantial areas of fauna habitat to the north is less pronounced due to the presence of intervening areas with only very narrow bands of riparian vegetation.

Overall, the fauna habitat in the site is in moderate condition.

4.3.3.2 Casula Offset area

The fauna habitat of the Casula Offset Area consists of a tall eucalypt forest with an understory varying in its structure and composition including areas with dense weed thickets and native shrubbery. Hollow-bearing trees and fallen woody debris are present in these areas which provide potential microhabitat features for a variety of species of animal.

Habitat in this area is connected via the riverbank underneath the railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve. Connectivity to substantial areas of fauna habitat to the north is less pronounced due to the presence of intervening areas with only very narrow bands of riparian vegetation. Recent weed removal and replanting with indigenous species in Riparian Forest areas immediately to the north of the site is likely, however to result in a minor improvement in connectivity to the north in the medium term.

4.3.3.3 Wattle Grove Offset area

The fauna habitat of the Wattle Grove Offset Area consists of eucalypt woodland with an understory varying in its structure and composition including areas with dense thickets of native shrubbery and areas of sparse understory consisting mainly of grasses, leaf litter and scattered shrubs. Large mature hollow-bearing and potentially hollow-bearing trees occur at low density in this site. Fallen woody debris generally occurs at low density, likely as a result of fuel reduction burning activities in the northern portion of the site. The southern area of the site contained a moderate density of fallen timber debris providing habitat for reptiles and small terrestrial mammals.

Swamp Forest in the form of Parramatta Red Gum Woodland contained sedges and small areas of aquatic habitat such as small wetlands and areas of open water. This contained habitat for reptiles, amphibians and birds.

The site is fenced on the north, east and south of the site, and maintains connectivity to a small area of native bushland to the west. A rail corridor and the fence separates this area from a large area of habitat to the south limiting connectivity for terrestrial and arboreal fauna. Due to its size (73.81 ha), it is likely to have potential to support viable populations of a variety of fauna species under appropriate management. If populations of less mobile animal species (i.e. non-flying species) are lost, however, there is limited scope for natural repopulation of this habitat due to its limited connectivity. Overall, the fauna habitat in the site is in moderate to good condition.

4.3.4 Threatened species of plant

Targeted surveys for *Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans* were conducted on the Wattle Grove offset area on 29 November 2012 and May 2014 and to provide further detail regarding the population size and distribution of these species in the offset area. Results of the survey are shown in Table 4.4.

Table 4.4 Threatened flora populations recorded within the offsets

Offset area	Threatened species population information		
	Grevillea parviflora* subsp. *parviflora	***Persoonia nutans***	**Other species**
Wattle Grove offset area	A minimum population of 325 stems recorded but total number likely to be substantially higher as surveys did not cover entire site and stems count estimates were conservative. Larger concentrations (>50 stems) mostly in the southern half of the site and scattered individuals elsewhere.	51 individuals recorded within the offset area. The largest concentration was recorded along the boundary of the offset area between Anzac Creek and the southern boundary of the Defence National Storage and Distribution Centre site (refer Figure 3.3). Scattered individuals recorded elsewhere. A further four individuals were recorded within the perimeter fence but outside the mapped offset boundary.	Three clumps comprising > 300 stems of *Acacia pubescens* recorded.

4.4 Management of currently proposed offset areas

The existing management of the currently proposed offset areas and proposed management are outlined below.

4.4.1 Existing management

The proposed offset sites are currently managed by the Department of Defence (Defence). A Weed Management Plan (WMP) has been prepared for Defence Maintenance Management Pty Ltd (DMM) on behalf of the Defence (AECOM Australia 2010). The scope of the plan was to develop and implement all works related to the management and control of weeds on Liverpool Military Area (LMA) for a period of three years (from 1 February 2010–31 January 2013) (AECOM Australia 2010). The WMP also included an Annual Works Schedule (AWS) providing a framework against which specialist sub-contractors, DMM and Defence personnel, can identify the target weeds, define their priority for control, and implement a cost effective and environmentally sustainable program of control aligned to the implementation of the required Defence activities at each site (AECOM Australia 2010). The goal of the WMP is to effectively manage weeds so that the site can be fully utilised within legislative responsibilities and sustain the Defence training activities over the long term (AECOM Australia 2010). Current and proposed management of biodiversity values on Defence lands in the LMA primarily involves weed management, with a focus on minimising the spread of environmental weeds (AECOM Australia 2010). The primary goal of weed management in the LMA is to manage the African Lovegrass (**Eragrostis curvula*) population as part of the ongoing management of Threatened flora species and native vegetation. Priority has been given to control of African Lovegrass on access routes to the less disturbed sections of the LMA (AECOM Australia 2010).The control of other environmental and noxious weeds such as Blackberry (**Rubus* spp.) and Green Cestrum (**Cestrum parqui*) is also a key consideration (AECOM Australia 2010).

African Lovegrass is also present at low density in the Moorebank Conservation Area and Casula Offset Area.

The current management regime appears to be focussed on containing the further spread of weeds rather than large scale reduction in existing weed infestation. While possibly sufficient to maintain the current condition of native vegetation and associated Threatened species habitat, current management is unlikely to result in a long-term improvement in biodiversity values without a substantially higher resource investment.

The proposed management described below includes an intensification of weed management and other measures to actively improve the biodiversity values of the offset sites.

4.4.2 Proposed management

4.4.2.1 Restoration and management of the Moorebank Offset area and Casula Offset area

The Moorebank Offset Area restoration site that forms an integral part of the Project site includes the eastern side of the River corridor from approximately 300 m south of the M5 Motorway for a length of approximately 2.5 km south to the East Hills Railway Line. The Casula Offset Area is located on the western side of the Georges River opposite the Project site (refer Figure 4.1 and Figure 4.2).

A riparian restoration plan for this area has been developed (refer Appendix E of the Project biodiversity technical paper). The purpose of this restoration plan is to guide the restoration of the riparian landform, vegetation and fauna habitat of the site and to improve the quality of water entering the Georges River. The objectives of the plan include:

- restoration and revegetation of the riparian zone of the site to be consistent with, and complementary to, areas of remnant indigenous vegetation within the Georges River Corridor (approximately 16.7 ha of land to be revegetated);
- long-term eradication and suppression of the most detrimental weed species on the site including vine and woody weeds (approximately 20.0 ha of land to undergo a weed control program);
- consolidation and widening of the existing vegetation corridor of Georges River where feasible. It is currently proposed to revegetate and conserve a corridor extending from the riverbank to the 1 in 100 year flood line, however opportunities will be explored during detailed design to extend the conservation area beyond the 1 in 100 year flood line. This opportunity will be subject to future development approval (DA) stages and is not the subject of this EIS;

- improved habitat values for native animals and plants, particularly threatened species; and
- management of undesirable animal species including introduced animal species and some Australian native animals which may be detrimental to the biodiversity of the Project site.

Successful implementation of this strategy would require detailed planning, monitoring and adaptive management.

The detailed planning stage may include management actions involving project management, sourcing of soil and obtaining plants and seeds. A variety of issues may arise in the implementation of the plan which would require actions to be modified or additional actions to be implemented. A monitoring program is thus required to detect issues at an early stage such that appropriate adaptations may be made to strategies to ensure that the relevant objectives can be met. Adaptive management actions may include trial treatments (such as trial weed-control) and subsequent modified and/or substitute actions to find alternative methods to achieve the same outcomes if the proposed actions are unsuccessful.

4.4.2.2 Management of undesirable animal species

- Successful management of undesirable animal species requires an integrated approach including habitat manipulation and/or culling programs. Culling of undesirable species over a small spatial area is likely to result in constant re-invasion from adjacent lands and is unlikely to be effective in substantially reducing the impact of these species. Proposed measures to manage undesirable animal species include:
  - Monitoring of undesirable animal species. Monitor the site for the presence of introduced and undesirable animal species as part of fauna monitoring;
  - Co-operate with government bodies, interest groups and adjacent landowners in regional pest management programs including the NSW Department of Primary Industries, the OEH, and the Invasive Animal Cooperative Research Centre interest groups (e.g. Australasian Pest Bird Network and local landowners);
  - Manage the use of nest boxes by undesirable species by removing the eggs and/or young of introduced animals (e.g. Black Rat and Common Myna) found utilising nest boxes under appropriate permit conditions;
  - Remove any insect colonies (bees, wasps, termites, ants found in nest boxes); and
  - Modify or move nest boxes to discourage use by undesirable species.

4.5 Security of offset lands

Offsets sites need to demonstrate ongoing conservation of land in perpetuity for the benefit of future generations. Offset sites must be enduring and must offset the impact of the development for at least the period that the impact occurs. The security of land tenure and ongoing management of offset site(s) is critical to the long-term viability of offsets and must be carefully considered:

- To ensure the conservation of lands in-perpetuity, the offset strategy will require the dedication of any identified offset sites under a secure conservation arrangement. The most suitable conservation arrangement for land should be explored and identified in consultation with the relevant stakeholders and in accordance with the FBA. The preferred options is through the establishment of a BioBanking agreement.

If not conserved under a BioBanking agreement or National Park Estate however, the offset sites may be subject to discounting. If public use of offset lands was proposed, this could also reduce the offset credits generated by the offset lands subject to public use. Such issues would increase the total area of land required to be conserved. This issue should be further considered when formulating the final offset package.

4.6 Comparison of vegetation and habitat removal to the extent provided in currently proposed offset areas

A comparison is provided in Table 4.5 between the extent of vegetation and habitat removal with that provided in the currently proposed offset areas. A comparison of the extent of habitat for Threatened biodiversity to be cleared with the extent of habitat provided in the currently proposed offset areas is provided in Table 4.6. The comparison assessment and following offset calculations for the quantification of offset requirements against Commonwealth and State policy's provide a range of values, reflecting the differences between the impacts of the central, northern and southern rail access options.

Offsets must be proportionate to the impact, in terms of size, scale and habitat type (SEWPaC 2012). The proposed biodiversity offset strategy is based around a dual direct offset approach to achieve an improved conservation outcome by combining the long-term protection of existing habitat in good condition at the IMT site with the restoration, rehabilitation and re-establishment of habitat in poor condition along the Georges River riparian corridor. A ratio (offset: clearing) of 2.0–2.6:1 would be achieved through the securing of the currently proposed offsets.

In addition, a comparison of the extent of habitat for threatened biodiversity to be cleared with the extent of habitat provided in the currently proposed offset areas is provided in Table 4.5. For the majority of threatened biodiversity, the ratio of offsets to clearing is 1–2.3:1.

Table 4.5 Comparison of vegetation and habitat removal (as a range to reflect variation between the northern, central and southern rail access options) to the extent provided in offset areas

Vegetation community/ habitat type	Extent to be removed by the Project (ha)[1]	Extent provided in offset areas (ha)						Ratio (offset: clearing)
		Moorebank Offset Area – Georges River Riparian Zone		Casula Offset area		Wattle Grove Offset	Combined offset areas	
		Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Area	
Vegetation								
Castlereagh Swamp Woodland[1]	0.9	-	-	-	-	19.77	**19.77**	21:1
Castlereagh Scribbly Gum Woodland[2]	16.1	-	-	-	-	27.46	**27.46**	1.7:1
Riparian Forest (River-Flat Eucalypt Forest)[1]	2.2–5.3	13.1–13.5	-	0.5–3.0	1.1	-	**14.7–17.6**	3.5–9.8:1
Alluvial woodland (River-Flat Eucalypt Forest)[1]	25.2–30.4	2.5–6.5	16.7	-	-	-	**19.2–23.2**	0.6–0.9:1
Shale/Gravel Transition Forest	-	-	-	-	-	13.35	**13.35**	13.35:1
Cooks River Castlereagh Ironbark Forest	-	-	-	-	-	13.23	**13.23**	13.23:1
Total area	**44.4–52.7**	**15.6–20.0**	**16.7**	**0.5–3.0**	**1.1**	**73.81**	107.71–114.61	2.-0–2.6:1

<table>
<tr><th rowspan="3">Vegetation community/ habitat type</th><th rowspan="3">Extent to be removed by the Project (ha)[1]</th><th colspan="6">Extent provided in offset areas (ha)</th><th rowspan="3">Ratio (offset: clearing)</th></tr>
<tr><th colspan="2">Moorebank Offset Area – Georges River Riparian Zone</th><th colspan="2">Casula Offset area</th><th>Wattle Grove Offset</th><th>Combined offset areas</th></tr>
<tr><th>Weed control – habitat restoration</th><th>Revegetation</th><th>Weed control – habitat restoration</th><th>Revegetation</th><th>Weed control – habitat restoration</th><th>Area</th></tr>
<tr><td>Shrubby eucalypt woodland</td><td>17.0</td><td>-</td><td>-</td><td>-</td><td>-</td><td>73.81</td><td>73.81</td><td>4.3:1</td></tr>
<tr><td>Tall eucalypt forest</td><td>27.4–35.7</td><td>20.0</td><td>16.7</td><td>3.0</td><td>1.1</td><td>-</td><td>33.9–40.8</td><td>0.9–1.5 : 1</td></tr>
<tr><td>Total area</td><td>44.4–52.7</td><td>15.6–20.0</td><td>16.7</td><td>0.5–3.0</td><td>1.1</td><td>73.81</td><td>107.71–114.61</td><td>2.-0–2.6:1</td></tr>
</table>

Notes: 1 - Endangered Ecological Communities as listed under the NSW *Threatened Species Conservation Act 1995*;
2 – Vulnerable Ecological Community as listed under the TSC Act. 3) Critically Endangered ecological community as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Table 4.6 Comparison of impacts to Threatened biodiversity to extent of habitat provided in offset areas (range presented to address all access options)

Threatened biodiversity	Status		Extent of known or potential habitat to be removed by the Project (ha) Population estimate (where applicable)	Extent provided in offset areas (ha) and population estimate (where applicable)						Ratio offset: clearing
				Moorebank Offset Area – Georges River Riparian Zone		Casula Offset area		Wattle Grove Offset	Combined offset areas	
	EPBC Act[1]	TSC Act[2]		Weed control – habitat restoration	Revege-tation	Weed control – habitat restoration	Revege-tation			
Threatened ecological communities										
Castlereagh Swamp Woodland	-	E	0.9	-	-	-	-	19.77	**19.77**	21:1
Castlereagh Scribbly Gum Woodland	-	V	16.1	-	-	-	-	27.46	**27.46**	1.7:1
River-Flat Eucalypt Forest	-	E	27.4–35.7	15.6–20.0	16.7	0.5–3.0	1.1	-	**33.9–40.8**	1.0–1.5 : 1
Shale/Gravel Transition Forest	CE	E	-	-	-	-	-	13.35	**13.35**	13.35:1
Cooks River Castlereagh Ironbark Forest		E	-	-	-	-	-	13.23	**13.23**	13.23:1
Total TEC	-	-	**44.4–52.7**	**15.6–20.0**	**16.7**	**0.5–3.0**	**1.1**	**73.81**	**107.71–114.61**	**2.-0–2.6:1**

Threatened biodiversity	Status		Extent of known or potential habitat to be removed by the Project (ha) Population estimate (where applicable)	Extent provided in offset areas (ha) and population estimate (where applicable)						Ratio offset: clearing
				Moorebank Offset Area – Georges River Riparian Zone		Casula Offset area		Wattle Grove Offset	Combined offset areas	
	EPBC Act[1]	TSC Act[2]		Weed control – habitat restoration	Revege-tation	Weed control – habitat restoration	Revege-tation			
Threatened flora										
Acacia bynoeana	V	E1	17.0	-	-	-	-	73.81	73.81	**4.3:1**
Acacia pubescens	V	V	17.0	-	-	-	-	73.81	73.81 (>250 individuals)	**4.3:1**
Dillwynia tenuifolia	V	V	17.0	-	-	-	-	73.81	73.81	**4.3:1**
Grevillea parviflora subsp. *parviflora*	V	V	17.0 (≈16 individuals ≈50 stems)	-	-	-	-	73.81	73.81 (>200 individuals)	**4.3:1**
Leucopogon exolasius	V	V	17.0	-	-	-	-	73.81	73.81	**4.3:1**
Persoonia hirsuta	E	E1	17.0	-	-	-	-	73.81	73.81	**4.3:1**
Persoonia nutans	E	E1	17.0 (≈10 individuals)	-	-	-	-	73.81	73.81 (>2 individuals)	**4.3:1**
Pultenaea parviflora	V	E1	17.0	-	-	-	-	73.81	73.81	**4.3:1**

Threatened biodiversity	Status		Extent of known or potential habitat to be removed by the Project (ha) Population estimate (where applicable)	Extent provided in offset areas (ha) and population estimate (where applicable)						Ratio offset: clearing
				Moorebank Offset Area – Georges River Riparian Zone		Casula Offset area		Wattle Grove Offset	Combined offset areas	
	EPBC Act[1]	TSC Act[2]		Weed control – habitat restoration	Revege-tation	Weed control – habitat restoration	Revege-tation			
Threatened fauna										
Barking Owl	-	V	27.4–35.7	20.0	16.7	3.0	1.1		33.9–40.8	**1.0–1.5 : 1**
Black-chinned Honeyeater	-	V	44.4–52.7	20.0	16.7	3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Eastern Bent-wing Bat	-	V	44.4–52.7	20.0	16.7	3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Eastern False Pipistrelle	-	V	27.4-35.7	15.6–20.0	16.7	0.5–3.0	1.1	-	33.9–40.8	**1.0–1.5 : 1**
Eastern Free-tail bat	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Eastern Pygmy-possum	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Flame Robin	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Gang-gang Cockatoo	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Greater Broad-nosed Bat	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Grey-headed Flying-fox	V	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Koala	V	V	27.4–35.7	15.6–20.0	16.7	0.5–3.0	1.1	-	33.9–40.8	**1.0–1.5 : 1**
Large-footed Myotis	-	V	27.4–35.7	15.6–20.0	16.7	0.5–3.0	1.1	-	33.9–40.8	**1.0–1.5 : 1**

Threatened biodiversity	Status		Extent of known or potential habitat to be removed by the Project (ha) Population estimate (where applicable)	Extent provided in offset areas (ha) and population estimate (where applicable)						Ratio offset: clearing
				Moorebank Offset Area – Georges River Riparian Zone		Casula Offset area		Wattle Grove Offset	Combined offset areas	
	EPBC Act[1]	TSC Act[2]		Weed control – habitat restoration	Revege-tation	Weed control – habitat restoration	Revege-tation			
Little Eagle	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Little Lorikeet	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Powerful Owl	-	V	27.4–35.7	15.6–20.0	16.7	0.5–3.0	1.1	-	33.9–40.8	**1.0–1.5 : 1**
Regent Honeyeater	E	CE	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Scarlet Robin	-	V	44.4–52.7	15.6-–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Spotted Harrier	-	V	44.4–52.7	15.6-–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Spotted-tailed Quoll	E	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Square-tailed Kite	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Squirrel Glider	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Swift Parrot	E	E	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Varied Sittella	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1
Yellow-bellied Sheathtail Bat	-	V	44.4–52.7	15.6–20.0	16.7	0.5–3.0	1.1	**73.81**	107.71–114.61	2.-0–2.6:1

Source: Table 3.3 in Appendix F, Ecological Impact Assessment (Volume 2, Part B)

Notes: 1) - V = Vulnerable, E = Endangered, CE = Critically Endangered (Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*) (EPBC Act).
2) V= Vulnerable, E1 = Endangered (Threatened Species Conservation Act 1995).

5. Compliance with offsetting principles

This section provides a comparison of the Projects biodiversity offset strategy against the principles for the use of environmental offsets under the EPBC Act, as outlined in the current *Environment Protection and Biodiversity Conservation Act 1999 Environmental Biodiversity Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012), the *Principles for the use of biodiversity offsets in NSW* (Department of Environment and Climate Change 2008) and the Draft NSW Biodiversity Offsets Policy for Major Projects.

5.1 Principles for the use of environmental offsets under the EPBC Act

DoE has developed principles for the use of environmental offsets under the EPBC Act which assess any proposed environmental offsets for matters of National Environmental Significance (including Threatened species and communities). This is done to ensure consistency, transparency and equity under the EPBC Act. The applicable principles are as follows:

- suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter;
- suitable offsets must be built around direct offsets but may include other compensatory measures;
- suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter;
- suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter;
- suitable offsets must effectively account for and manage the risks of the offset not succeeding;
- suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs;
- suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable; and
- suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

The eight principles are addressed below in relation to the potential impacts of the Project and the proposed offsets.

1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed development

Offsets must deliver an overall conservation outcome that *improves or maintains* the viability of the aspect of the environment that is protected by national environment law and affected by the proposed development (Department of Sustainability Environment Water Population and Communities 2012). As the Project involves the Commonwealth and actions that affect Commonwealth areas, offsets must be targeted to the aspect of the environment that is being impacted. An improved conservation outcome may be achieved by:

- improving existing habitat for the protected matter
- creating new habitat for the protected matter
- reducing threats to the protected matter
- increasing the values of a heritage place, and/or
- averting the loss of a protected matter or its habitat that is under threat (Department of Sustainability Environment Water Population and Communities 2012).

The proposed offset strategy consists of a dual direct offset approach, including offsets both within and outside of the Project site, to achieve an improved conservation outcome combining the long-term protection and/or enhancement of existing habitat in moderate to good condition with the restoration, rehabilitation and re-establishment of habitat in poor condition.

2. Be built around direct offsets but may include other compensatory measures

The proposed offset strategy consists of a dual direct offset approach by combining the long-term protection of existing habitat at the IMT site and two other locations in the locality with restoration, rehabilitation and re-establishment of the degraded habitats along the Georges River riparian corridor. The offset strategy also provides for the conversation of a large area of existing habitat with locally important populations of the threatened plants species impacted by the project.

3. Be in proportion to the level of statutory protection that applies to the protected matter

Offsets required for protected matters with higher conservation (threat) status must be greater than those with a lower status (Department of Sustainability Environment Water Population and Communities 2012).

4. Be of a scale and size proportionate to the residual impacts on the protected matter

Offsets must be proportionate to the impact, in both size and scale (Department of Sustainability Environment Water Population and Communities 2012). The proposed offset strategy is based around a dual direct offset approach to achieve an improved conservation outcome by combining the long-term protection of existing habitat in good condition at the Wattle Grove and Casula offsets with the restoration, rehabilitation and re-establishment of habitat in moderate condition along the Georges River riparian corridor. The offsets are proportionate to the impact in both size and scale, providing between 90% and 209% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.0-2.6:1 has been secured under the currently proposed offsets with additional offsets still yet to be determined. No clearing will take place until the additional offsets have been secured.

5. Effectively manage the risks of the offset not succeeding

The proposed offset strategy addresses risk by directly accounting for the residual biodiversity impacts associated with the Project. Direct replacement and management of the same vegetation and habitat types that are to be impacted will occur. The proposed offset areas identified to date are located directly adjacent to the impact site. Using direct offsets to account for the residual biodiversity impacts of the Project in a positive ratio situated, at least in part, adjacent to the Project area should minimise the risks of the offset not succeeding. The biodiversity offset strategy will be implemented as part of the EIS process which minimises the risks of the strategy not being implemented.

Perverse outcomes (environmental, social or economic) are unlikely to occur with the implementation of the proposed offset strategy.

6. Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or projects (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action)

The current planning controls for the Project biodiversity offset areas have been investigated. This investigation concluded that the lands are currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure - Defence) under the *Liverpool Local Environmental Plan 2008*. As this land is zoned and reserved for Defence infrastructure, it is not currently protected from development. The proposed offset areas are not agreed to under any other schemes or Projects.

7. Be efficient, effective, timely, transparent, scientifically robust and reasonable

The proposed offset strategy is as follows:

- efficient – the proposed offset areas are close to the development site and are capable of achieving the desired result with the minimum use of resources, time, and effort
- effective – will result in the intended result (i.e. an improved conservation outcome)
- timely – will be secured and functional prior to vegetation clearing within the Project area
- transparent – clearly recognisable as to what the offset strategy is trying to achieve

- scientifically robust – the proposed offset strategy is straightforward and conforms to current thinking in conservation science and ecological restoration
- reasonable – the proposed offset strategy does not promise more than is possible or achievable.

8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced

The proponent or its contractors will report on the success of the offsets to ensure that the offsets are delivering an improved conservation outcome. Annual reports on the success of the offset strategy will be provided to the DoE and the DP&E and will be made publicly available.

All establishment costs of the proposed offsets will be borne by MIC or a future developer under contractual requirements specified by MIC

5.1.1 Adequacy assessment of Biodiversity offsets under the EPBC Act

The *Offsets Assessment Guide* (Department of Sustainability Environment Water Populations and Communities 2012) provides the biodiversity offset requirements and decision-making framework for DoE to assess the suitability of biodiversity offsets. The guide assesses the appropriateness and adequacy of the proposed offsets, in alignment to the principles and offset requirements under the EPBC Act, for Threatened species and ecological communities (Department of Sustainability Environment Water Population and Communities 2012).

The key steps in the process under this policy (once impacts have been avoided as far as practicable) are to:

- identify the residual impacts to threatened species, their habitats or threatened ecological communities;
- determine likely offsets required via use of the Offsets Assessment Guide calculator; and
- develop an offset strategy and subsequent offset package to formalise appropriate offsets in consultation with DoE.

The Projects biodiversity offsets areas identified to date, has been assessed using the *Offsets Assessment Guide.* The assessment is based on habitat of Threatened biodiversity known and predicted to occur within the Project area. The areas and condition of habitat within the Project will be based on the habitat assessments completed during field surveys for the EIS.

For the Project the following approach was taken:

- current known direct impacts of the northern rail option to threatened species, habitats and ecological communities were confirmed; and
- a flora offset calculation and a fauna habitat calculation were undertaken to determine sufficient offset areas in hectares.

Assumptions for the calculation included:

- The impacts of the project (that will require offsetting) are assumed to be those as identified in Technical Paper 3 - *Ecological Impact Assessment*).
- The flora offset calculation was based on habitat for the endangered *Persoonia nutans* and the vulnerable *Grevillea parviflora*, as the endangered status for *Persoonia* results in the maximum offset requirement for threatened flora overall.
- The fauna offset calculation was based on fauna habitat for recorded species such as the Grey-headed Flying Fox, which is listed as vulnerable under the EPBC Act and potential habitat for endangered species like the Regent Honeyeater and Swift Parrot. These species would utilise any of the forested habitats on the site for potential foraging. The calculation was based on these species likely presence and the assumption that all native forested habitats formed habitat for this fauna species.
- No threatened vegetation communities listed under the EPBC Act were recorded on the site, although the use of fauna habitat for all native forested vegetation impacts ensures that all vegetation impacts are considered for offsetting, whether they are listed as threatened under the EPBC Act or not.

These assessments will also account for the value of habitat to to State-listed Threatened species, populations and ecological communities.

During the assessment a conservative approach will be adopted to ensure adequacy due to information limitations. The assumptions listed in Table 5.1 have been made when assessing offsets.

Table 5.1 Assumptions of protected matter attributes when assessing adequacy of biodiversity offsets

Protected matter attributes	Assumption	Score
EPBC Act status	The highest status of EPBC Act Threatened species considered likely to occur within the Project area will be used in determining the annual probability of extinction. Three separate assessment have been completed for the Project (refer to Attachment A): ▪ vulnerable plant species ▪ endangered plant species ▪ vulnerable fauna species.	▪ Vulnerable plant species ▪ Endangered plant species ▪ Vulnerable fauna species
Protected matter attributes	While detailed counts of the two recorded threatened flora species exists for the projects impacts, given the potential for a soil seed bank for the species and absence of viable population data within the project for the threatened fauna, a precautionary approach was taken and the presence of habitat was used as the key attribute for assessment.	Habitat
Quality of site habitat	The condition of the sites habitats has been assessed through detailed surveys and assessment in accordance with the NSW Biobanking methodology. These surveys collected data on a range of site condition variables specifically relevant to the ecological requirements of a threatened species or ecological community. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features. **site condition** The site specific date identified condition scores for the vegetation to be impacted between 36–44/100. **site context** The Project is situated on land in the suburb of Moorebank in a locality that includes the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Department of Defence land. Much of the vegetation of the Project site has been cleared and replaced with roads, buildings, playing fields and exotic grassland, or substantially thinned, leaving only scattered remnant trees. Substantial areas of vegetation remain, however, in the west of the site within the riparian zone of the Georges River and in patches along the eastern boundary of the site adjacent to Moorebank Avenue. **Species stocking rate** The two threatened flora species, *Persoonia nutans* and *Grevillea parviflora* were recorded in relatively low numbers within the development site (10 and 16 respectively) when compared to the significant number (40 and 360 respectively) recorded from the adjoining better quality habitats associated with the Wattle Grove Offset area immediately to the south east of the development.	5
Time over which loss is adverted	It is assumed that the offset areas will be secured for at least 20 years for conservation purposes. It is likely that the offset would be secured in perpetuity, however, the *Offsets Assessment Guide* allows for a maximum of 20 year for offset assessment purposes.	20 years

Protected matter attributes	Assumption	Score
Time until ecological benefit	The proposed biodiversity strategy involves the restoration and rehabilitation of the disturbed areas of the Casula Offset Area and Georges River Riparian Zone as part of the Projects early works program well before any proposed vegetation clearing activities with the Project site (refer to Attachment E of the Biodiversity Technical report). The Wattle Grove Offset area is a large area of relatively undisturbed vegetation and habitats and as such will require very little time before the ecological benefit is made.	2
Risk of loss (%)	The risk of the habitat within the proposed offset sites being completely lost will be assessed based on the following aspects: ▪ Physical constraints – topography and flooding ▪ Land use zoning ▪ Surrounding Infrastructure ▪ Existing development applications. The Casula Offset Area and Georges River Riparian Zone are currently disturbed and subject to significant development pressures from the neighbours industrial, urban development and transport land uses. It is considered these areas are likely to be subject to >50% risk of loss. The Wattle Grove Offset area is currently impacted by only periodic defence developments and edge effects from the adjoining transport corridors. It is considered these areas are likely to be subject to <20% risk of loss. A precautionary approach has been taken to the combined weighting and while the Casula Offset Area and Georges River Riparian Zone are considered to be significantly greater risk of loss a combined weighting of 25% has been applied.	25%
Start quality of offset	The condition of the sites habitats has been assessed through detailed surveys and assessment in accordance with the NSW Biobanking methodology. These surveys collected data on a range of site condition variables specifically relevant to the ecological requirements of a threatened species or ecological community. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features. **Site condition** The site specific date identified condition scores for the vegetation to be impacted between 56–84/100. **Site context** The Wattle grove offset consolidated a large are of remnant vegetation on the urban fringe with adjoining large areas of quality habitat associated with defence land. The Casula Offset Area and Georges River Offset area will consolidate an important riparian a corridor through the urban and industrial land use. **Species stocking rate** The two threatened flora species, *Persoonia nutans* and *Grevillea parviflora* were recorded in relatively significant number (40 and 360 respectively) from the Wattle Grove Offset area immediately to the south east of the development. This area and its habitats are considered important local population of these species.	8

Protected matter attributes	Assumption	Score
Future quality without offset	The future quality of the proposed offset areas will be predicted based on observed threatening processes (e.g. weed invasion) affecting the offset areas and the likely continuation of these processes in the absence of more intense management for conservation.	7
Future quality with offset	The future quality of the proposed offset areas will be predicted based on proposed management (e.g. weed control, assisted natural regeneration and revegetation of disturbed vegetation) within offset areas. **Site condition** The site specific date identified condition scores for the vegetation to be impacted between 85–100/100.	9
Confidence in result (%)	The level of certainty about the success of the proposed offset areas will be estimated by taking into consideration the potential change in habitat quality and adverted loss over time. This includes the degree to which the proposed offset actions can be achieved to benefit the protected matters and the strength and effectiveness of risk-mitigation measures. The relatively minor requirements for the substantial area of the Wattle grove offset and relatively small area of rehabilitation required in the Georges River offset area suggest a high confidence result is likely.	75

A summary of the adequacy of the Projects offsets generated by the calculations using the Commonwealth Offset Guide is provided below in Table 5.2.

Table 5.2 Commonwealth offset requirement balance

Vegetation community or species	Area to be Impacted (ha)	Area to be impacted (adjusted hectares)	Estimated offset area required (ha) using Offset Guide	Proposed Offset Area (ha)	% of impact offset
Persoonia nutans habitat (Endangered)	17	8.5	40	73.8	209%
Grevillea parviflora habitat (Vulnerable)	17	8.5	35	73.8	187.7%
Grey-headed Flying Fox habitat (Vulnerable)	44.4–52.7	22–26.3	92–107	107.1–114.6.	99.5–124%
Potential Habitat for Swift Parrot and Regent Honeyeater (Endangered)	44.4–52.7	22-26	103-121	107.1–114.6.	88.9-104%
Total*	**44.4–52.7**		**147***[*]	**107.1–114.6**	**N/A**

Note: * indicates that the total equates to the total cumulative requirement of the fauna and flora, however the proposed offsets fauna habitat includes the flora habitat requirement.

To compensate for the impact upon threatened flora, a minimum area of suitable habitat of 40 ha is required. The current offsets would provide 73.8 ha of suitable habitat with demonstrated occurrence of *Persoonia nutans* and *Grevillea parviflora* subsp. *parviflora* and would fulfil this requirement.

In terms of native forest fauna habitat impacts of the project, the calculations have identified that a total offset area of approximately 92–121 ha needs to be provided. Of this, the current offsets would provide 107–114.6 ha of similar suitable habitat and would fulfil this requirement.

In summary, the proposed biodiversity offset strategy consists of a dual direct offset approach including offsets both within and outside the Project site to achieve an improved conservation outcome combining the long-term protection and/or enhancement of existing habitat in moderate to good condition with the restoration, rehabilitation and re-establishment of habitat in moderate condition. The offsets are proportionate to the impact in both size and scale, providing between 90% and 209% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.0 - 2.6:1 has been secured under the currently proposed offsets.

5.2 Principles for the use of biodiversity offsets in NSW

The NSW Secretary's Environmental Assessment Requirements (SEARs) for the Project suggest the offsets strategy must demonstrate how it achieves the overarching principles of current policy. In March 2014, the Draft NSW Biodiversity Offsets Policy for Major Projects (Draft Policy) was released for public exhibition. The Draft Policy has now been finalised (Offset Policy 2014) and will be implemented from 1 October 2014 when it will be mandatory for all SSD and SSI projects.

The Offset Policy 2014 reduced the number of offset principles to six and introduced the use of a new assessment methodology, the Framework for Biodiversity Assessment (FBA).

The principles outlined in this policy are as follows:

- Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.

  Given the location and nature of the Project and its context with regard to existing road and rail infrastructure, there is limited scope for using alternative locations to entirely avoid impacts on biodiversity. Reduction of impacts on areas of high ecological value was considered in the analysis and evaluation of design options for the Project, resulting in the retention of substantial areas of vegetation and habitat contiguous with the riparian vegetation of the Georges River (refer Section 6.4.4 of the EIS).

- Offset requirements should be based on a reliable and transparent assessment of losses and gains.

  The offsets proposed in this biodiversity offsets strategy will be based on comparison of offset site values with the residual impacts on biodiversity identified in the Environmental Impact Statement.

  The Projects biodiversity offsets areas identified to date, have been assessed for adeqaucy using the Comenwealth *Offsets Assessment Guide.* The offsets are likely to result in a net improvement over time in both size and scale, providing between 90% and 209% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.0-2.6:1 has been securely conserved.

- The maximum offset requirements of the Project under the current *Offset Policy 2014* has been quantified using FBA calculator as up to 1324 ecosystem credits or approximately 134 ha. The residual offset requirement for the Project in accordance with the FBA is between 22-224 ecosystem credits (2.2 and 22.4 ha) of Alluvial woodland. MIC are commitment to providing a BOS that adequately meets quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offset for Alluvial Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.

  The proposed offset areas have been targeted to contain the specific species, habitat and vegetation requirements as impacted by the Project. The proposed offset sites generally contain vegetation types of similar or greater conservation value, located in the same IBRA subregion, contain similar habitat values for threatened species and threatened ecological communities listed on the TSC Act.

Offsets must be additional to other legal requirements.

The *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012) outlines the Commonwealth Government requirements for offsets for matters of national environmental significance. This biodiversity offsets strategy has been designed to conform to the seven principles outlined in this policy.

- Offsets must be enduring, enforceable and auditable.

  The currently proposed offset areas and additional offset areas identified (as described in section 3.5) will be protected by an agreement that will place legal restrictions on the future use and management of the land that would exist within the title for the land in perpetuity. This will ensure that the offsets are enduring and that they will offset the impact of the development for the period that the impact occurs.

- Supplementary measures can be used in lieu of offsets.

  The offset strategies chosen for the Project include a combination of:

  - on-site offsets – securely conserving and improving the condition of existing riparian habitat or providing a buffer to an area of existing habitat within the Project site; and

  - off-site offsets – securing and improving the condition of existing habitats at other sites in the immediate locality of the Project site.

The currently proposed offset areas meet 99% and 209% of the direct offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.0–2.6:1 has been securely conserved.

The Projects biodiversity offsets areas, have been assessed for adequacy using the Commonwealth Offsets Assessment Guide. The offsets are likely to result in a net improvement over time in both size and scale, providing between 90% and 209% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.0-2.6:1 has been securely conserved.

The maximum offset requirements of the Project under the current *Offset Policy 2014* has been quantified using FBA calculator as up to 1324 ecosystem credits or approximately 134 ha. The residual offset requirement for the Project in accordance with the FBA is between 22–224 ecosystem credits (2.2 and 22.4 ha) of Alluvial woodland.

MIC are commitment to providing a offsets strategy that adequately meets quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offset for Alluvial Woodland.

5.3 Adequacy assessment of the biodiversity offsets under the FBA (Offset Policy 2014)

The FBA Methodology provides a transparent and repeatable methodology for assessing impacts on biodiversity through a modified credit calculator, similar to the existing credit calculator used under the Biobanking Assessment methodology (BBAM).

The key steps in the process under this policy (once impacts have been avoided as far as practicable) are to:

- Identify the residual impacts (once all avoidance and other mitigation measures have been applied) to threatened species, their habitats or threatened ecological communities.
- Determine likely offsets required via use of the FBA calculator
- Develop an offset strategy and subsequent offset package to formalise appropriate offsets in consultation with Office of Environment and Heritage (OEH).

The maximum offset requirements of the Project under the current *Offset Policy 2014* has been quantified using FBA calculator as up to 1324 ecosystem credits or approximately 134 ha (refer to Table 5.3).

Table 5.3 Summary of vegetation and plants to be impacted and FBA ecosystem credits required to offset the impacts

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation (Cleared estimate)	Area or number to be Impacted (ha)	Red Flag	Conservation Status	Estimated credits required	Area (ha)	Estimated credits Provided	Proposed Offset Area (ha)	Balance Credits	Balance Area
Alluvial Woodland	ME018 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Coastal Valley Grassy Woodlands (95)16.1	25.2-30.4	Yes	TSC Act E	571-690	63.3-69	183	19.2–23.2	-388-507	-38.8-50.7
Riparian Forest	ME044 Sydney Blue GumXBangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin[1]	Wet Sclerophyll Forests (45)	2.2-5.3	Yes[2]	TSC Act E	53-129	5.3-12.9	149	14.7- 17.6	20-96	2-9.6
Castlereagh Swamp Woodland	ME005 Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (45)	0.9	Yes	TSC Act E	30	3	180	19.77	177	17.7

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation (Cleared estimate)	Area or number to be Impacted (ha)	Red Flag	Conservation Status	Estimated credits required	Area (ha)	Estimated credits Provided	Proposed Offset Area (ha)	Balance Credits	Balance Area
Castlereagh Scribbly Gum Woodland	ME003 Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (50)	16.1	Yes[2]	TSC Act V	485	48.5	260	27.46	-225	-22.5
Shale/Gravel Transition Forest	ME004 Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (75)	-	Yes	TSC Act CE EPBC Act CE	-	-	152	13.35	152	13.35
Cooks River Castlereagh Ironbark Forest	ME002 Broad-leaved Ironbark - *Melaleuca decora* shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (95)	-	Yes	TSC Act E	-	-	156	13.23	156	13.23
TOTAL			**44.4-52.7**			**1139-1334**	**113-133.4**	**1080**	**107.7-114.6**	**-59-254**	**-5.9-25.4**

Note: [1] indicates closest available similar vegetation type in the BBAM calculator.
[2] indicates that a threatened ecological community could not be selected in the calculator despite the observed communities being threatened ecological communities.

5.3.1 Variation of the offset rules and supplementary measures for part of residual required ecosystem credits

A key objective of the *Offset policy* (Objective 3) is to provide major projects some flexibility in the application of the FBA, particularly around variation criteria for the like for like offset requirements.

These criteria allow the consent authority to approve a variation of the offset rules for ecosystem credits where a proponent can demonstrate:

a) All reasonable steps have been taken to secure the number and type of ecosystem credits impacted on the development site, and

No ecosystem credits currently exist within the CMA, however a number of credits are currently available on the register for the Alluvial woodland:

b) The vegetation of which the ecosystem credit relates is not associated with an ecological community that is listed on the EPBC Act or listed as critically endangered community on the TSC Act.

There are no vegetation types associated with an ecological community that is listed on the EPBC Act or listed as critically endangered community on the TSC Act within the Project site.

Subject to the offset rules set out above the consent authority may approve:

(a) *a variation of the offset rules for matching ecosystem credits, by allowing ecosystem credits created for a PCT from the same vegetation formation as the PCT to which the required ecosystem credit relates to be proposed as an offset, or*

(b) a supplementary measure to be proposed as an offset for the PCT where the PCT is associated with an EEC or a CEEC.

A summary of the variation and supplementary measures rules are provided below in sections 5.2.1.1-2.

5.3.1.1 Variation of the offset rules for ecosystem credits

The consent authority may approve a variation of the offset rules for matching ecosystem credits, by allowing ecosystem credits created for a PCT from the same vegetation formation as the required ecosystem credit to be proposed as part of the Biodiversity Offset Strategy (BOS), where in the consent authority's opinion the BOS demonstrates that:

(a*) all reasonable steps to secure a matching ecosystem credit have been taken by the proponent, and*

(b) the required ecosystem credit is not for a PCT associated with a CEEC listed on the TSC Act or an ecological community listed on the EPBC Act, and

(c) the PCT from the same vegetation formation has a percent cleared value of the PCT in the major catchment area equal to or greater than the percent

cleared of the PCT to which the required ecosystem credit relates, or

(d) *where the required ecosystem credit is for a PCT that is associated with a CEEC/EEC, the PCT from the same formation is also associated with an CEEC/EEC.*

5.3.1.2 Use of supplementary measures for ecosystem credits

The consent authority may approve supplementary measures to be proposed as part of the BOS for a PCT impacted at the development site, where in the consent authority's opinion the BOS demonstrates that:

(a) *all reasonable steps have been taken by the proponent to secure a matching ecosystem credit, and*

(b) *the PCT to which a required ecosystem credit relates is associated with a CEEC/EEC or for which the impact of development does not require further consideration according to Subsection 9.2.4 of the FBA, and*

(c) *the supplementary measure applies to that CEEC/EEC, and*

(d) *the supplementary measure is carried out in accordance with the rules governing supplementary measures, including calculating the financial contribution of the supplementary measures in accordance with Appendix B of the Offsets Policy.*

5.3.2 Proposed use of Variation of offset rules

The proposed offsets do not currently meet the entire quantum of ecosystem credit requirements for the Projects development impacts under the FBA methodology. The short fall in ecosystem credits provided by the proposed offsets is associated with the Alluvial Woodland and Castlereagh Scribbly Gum Woodland vegetation communities, a summary of which is provided below in Table 5.4.

Table 5.4 Summary of shortfall of ecosystem credits and vegetation types to be impacted

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation	Percent cleared in CMA	Conservation Status	Deficit credits required
Alluvial Woodland	ME018 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Coastal Valley Grassy Woodlands	95	TSC Act E	-388-507
Castlereagh Scribbly Gum Woodland	ME003 Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests	50	TSC Act V	-225

The proposed offsets do provide a surplus of ecosystem credits to the requirements of the Projects development impacts for four vegetation communities (refer to Table 5.5 below).

Table 5.5 Summary of surplus of ecosystem credits and vegetation types within the proposed offsets

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation (Cleared estimate)	Percent cleared in CMA	Conservation Status	Area (ha)	Surplus credits provided
Riparian Forest	ME044 Sydney Blue GumXBangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin[1]	Wet Sclerophyll Forests	45	TSC Act E	2-9.6	20-96
Castlereagh Swamp Woodland	ME005 Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests	45	TSC Act E	17.7	180
Shale/Gravel Transition Forest	ME004 Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests	75	TSC Act CE EPBC Act CE	13.35	152
Cooks River Castlereagh Ironbark Forest	ME002 Broad-leaved Ironbark - *Melaleuca decora* shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests	95	TSC Act E	13.23	156

The BOS proposes to uses the surplus ecosystem credits (refer to Table 5.5) within the proposed offsets in accordance with the Variation rules identified in Section 5.2.1 to contribute to the short fall in the Alluvial Woodland and Castlereagh Scribbly Gum Woodland ecosystem credits provided by the proposed offsets. A summary of these ecosystem trades for both Alluvial Woodland and Castlereagh Scribbly Gum Woodland is provided in the following sections.

5.3.2.1 Castlereagh Scribbly Gum Woodland alterative ecosystem credits

The proposed surplus offset credits can provide the residual 225 Castlereagh Scribbly Gum Woodland by substituting with the following alternative vegetation types generally in accordance with the Variation criteria of the FBA (refer to Table 5.6 below).

Table 5.6 Summary of vegetation and plants to be impacted and FBA credits required to offset impacts

Vegetation community or species	Assigned Biometric vegetation type	Veg Formation	Percent cleared in CMA	Residual offset requirement (ha)	Residual offset requirement (credits)	Alternative vegetation of equal or greater conservation value (ha)				Final Residual offsets (ha)
						The Riparian Forest	Cooks River Castlereagh Ironbark Forest	Shale/Gravel Transition Forest	Castlereagh Swamp Woodland	
Castlereagh Scribbly Gum Woodland	ME003 Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests	50	-22.5	-225	-	-	45 (4.5)	180 (16.57)	0

5.3.2.2 Alluvial Woodland alterative ecosystem credits and residual offset requirements

Riparian Forest, Cooks River Castlereagh Ironbark Forest, Shale Gravel Transition Forest and Castlereagh Swamp Woodland), classified under different vegetation formations and vegetation classes to the Alluvial Woodland vegetation and therefore do not strictly meet the requirements of the alternative vegetation types under the Variation criteria of the FBA. However, these vegetation types are of similar or greater conservation value located in the same IBRA subregion, contain similar habitat values for threatened species and in the case of the Riparian Woodland are representative of the same threatened ecological community, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions as listed on the TSC Act.

The Riparian Forest ecosystem credits are also considered to meet the broad principles of the FBAs 'supplementary measures for ecosystem credits' as the reservation will provide for direct conservation outcomes for the same EEC, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions as listed on the TSC Act.

The other communities also meet the criteria identified in the core objectives of the *Offset Policy 2014* as they are '*targeted to relevant higher conservation priorities'.* Therefore considering the transitional nature of the *Offset Policy 2014* and that the proposed offset sites were originally identified on the basis of meeting the Commonwealth offset requirements and NSW previous offsets policy's, (NSW Department of Environment and Climate Change 2008), it is proposed that the surplus areas of the vegetation within the offsets are considered suitable alternative vegetation types for the projects short fall of Alluvial Woodland ecosystem credits. A summary of the alternative Alluvial Woodland types and final residual offset requirement is provided in Table 5.7 below.

Table 5.7 Summary of alternative ecosystem credits proposed for Alluvial Woodland

Vegetation community or species	Assigned Biometric vegetation type	Veg Formation	Veg Class	Percent cleared in CMA	Residual offset requirement (ha)	Residual offset requirement (credits)	Alternative vegetation of equal or greater conservation value (ha)				Final Residual offsets (ha)
							The Riparian Forest	Cooks River Castlereagh Ironbark Forest	Shale/Gravel Transition Forest	Castlereagh Swamp Woodland	
Alluvial Woodland	ME018 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Grassy Woodlands	Coastal Valley Grassy Woodlands	95	-388-507	-38.8-50.7	20-96 (2-9.6)	156 (13.23)	107 (8.85)	-	-29- 224 (-2.9-22.4)

The final residual offset requirement for the Project are between 22–224 ecosystem credits (2.2 and 22.4 ha) of Alluvial woodland. MIC is committed to meeting the total quantum of the projects offset requirements in accordance with the FBA and Offset Policy 2014. This will include commitments to source additional offsets requirements not currently met by the proposed offsets.

5.3.1 Proposed process for securing residual offsets requirements

The BOS has identified that the despite the currently proposed biodiversity offsets, the Project has a residual offset requirement for Alluvial Woodland in accordance with The FBA and NSW Offset Policy 2014.

The Project is currently in concept design, and will require further assessment and regulatory approval at the detailed design stage of the Project. MIC commit to undertaking a revised FBA calculation to quantify the projects final impacts at the detailed design. Any residual offset requirements identified at detailed design will be sourced using the following steps, in order of preference;

1. As search of the NSW Biobanking credit register for suitable 'Like for Like' ecosystem credits meeting the Projects residual offset requirements

2. Search of potentially suitable offset sites to be established as a Biobanking Agreement containing the Projects residual offset requirements. In identifying these offsets the following criteria will be considered:

- Presence of relevant threatened biodiversity, vegetation types in accordance with the FBA credit profile requirements (Attribute 1): when determining offsets, threatened biodiversity must be targeted and the impacts should be offset on a 'like for like or better' basis. As the Project includes clearing of threatened ecological communities, and threated species, the offsets should include these species and communities.

- Distance from the Project and bioregional requirements in accordance with the FBA credit profile requirements (Attribute 2: biodiversity offsets should be located within the same IBRA subregion and as close to the Project site as possible.

- Current condition and potential for improvement: the condition provides an indication of a site's potential to support threatened species.

- Habitat connectivity: this is essential to the long-term survival of many species because it enables species to move from one habitat into another.

Where MIC can demonstrate that the residual offset requirements cannot be found under Option 1 or 2 above and where the consent authority's opinion "*all reasonable steps to secure a matching ecosystem credit have been taken by the proponent* " , then alternatives offset arrangements in accordance with the FBA and in consultation with the consent authority's will be provided. These may include;

- a variation of the offset rules for matching ecosystem credits, by allowing ecosystem credits created for a PCT from the same vegetation formation as the PCT to which the required ecosystem credit relates to be proposed as an offset, or

  a supplementary measure to be proposed as an offset for the PCT where the PCT is associated with an EEC or a CEEC.

6. Conclusion

The proposed biodiversity offset strategy consists of a dual direct offset approach including offsets both within and outside the Project site to achieve an improved conservation outcome combining the long-term protection and/or enhancement of existing habitat in moderate to good condition with the restoration, rehabilitation and re-establishment of habitat in moderate condition.

Three offset sites have been identified which provide 107.7–114.6 ha of land suitable for use as offsets for the EPBC Act and TSC Act listed Threatened species and endangered ecological communities.

The offsets are proportionate to the impact in both size and scale, providing between 99% and 209% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.0-2.6 has been secured under the currently proposed offsets.

The proposed offsets meet the majority of the proposal ecosystem credits requirements in accordance with the FBA and NSW Offset Policy 2014. Short falls in the required ecosystem credits for the Alluvial Woodland and Castlereagh Scribbly Gum Woodland vegetation communities are partially provided by the proposed offsets through the use of the FBA variation and supplementary measures rules. A residual offset of between 22–224 ecosystem credits (2.2 and 22.4 ha) of Alluvial woodland is required. MIC are commitment to providing a offset strategy that adequately meets quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offset for Alluvial Woodland.

The proposed offsets strategy is underpinned by sound ecological principles to improve or maintain the existing biodiversity values of the local area.

The Moorebank Intermodal Company (MIC) have made a commitment that no clearing will be undertaken unless and until an appropriate offset package is secured. This strategy outlines the process to identify and assess the adequacy of the additional site/sites and the overall offset package.

7. References

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