# Technical Paper 2

Biodiversity

# South West Rail Link Environmental Assessment Biodiversity Technical Paper

May, 2010

Transport Infrastructure Development Corporation

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# Glossary

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| **Biodiversity** | The biological diversity of life is commonly regarded as being made up of the following three components:<br>▪ genetic diversity – the variety of genes (or units of heredity) in any population<br>▪ species diversity – the variety of species<br>▪ 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 (see Department of Environment and Conservation 2004c). 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 (Department of Environment, Climate Change and Water) and Federal (Department of the Environment, Water, Heritage and the Arts) 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 and Climate Change** | The former name of the NSW Department of Environment, Climate Change and Water. |
| **Department of the Environment, Water, Heritage and the Arts** | The Commonwealth Department of the Environment, Water, Heritage and the Arts changed their name twice in 2007 from the Department of the Environment and Heritage to Department of the Environment and Water Resources and then to the current name.<br>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*. |
| **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. |
| **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 2004c). 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 2004c). |
| **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 (as defined by the Department of Environment and Climate Change 2007a). |
| **Migratory species** | Species protected as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999.* Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*. |

| | |
|---|---|
| **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. |
| **Significant** | Important, weighty or more than ordinary (as defined by the Department of Environment and Climate Change 2007a). |
| **Threatened biodiversity** | Threatened species, populations or ecological communities, or their habitats as listed under either the *Threatened Species Conservation Act 1995, Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*.<br><br>Capitalisation of the terms 'Threatened' in this report refers to listing under the relevant state and/or Commonwealth legislation. |
| **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*.<br><br>Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation. |
| **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 (as defined by the Department of Environment and Climate Change 2007a). |

# 1. Introduction

## 1.1 Background

In December 2004, the New South Wales (NSW) Government announced a new land release plan for Sydney's South West and North West Sectors. Known as the Growth Centres it is part of the Government's s strategy to respond to Sydney's growing population. The release of this land was underpinned by a NSW Government commitment to ensure that the required infrastructure is put in place early in the development of these areas. In the South West Growth Centre, the required infrastructure includes a new rail line from the existing Glenfield Station to Leppington known as the South West Rail Link. The South West Rail Link was identified in the Structure Plan for the South West Growth Centre (Department of Planning 2005) and later in the Metropolitan Rail Expansion Program and Sydney Link.

In April 2006, the Minister for Planning declared the South West Rail Link to be a state significant project subject to Part 3A of the *Environmental Planning and Assessment Act 1979.* The Transport Infrastructure Development Corporation (TIDC) subsequently commissioned Parsons Brinkerhoff (PB) to prepare an Environmental Assessment and Concept Plan for the South West Rail Link corridor alignment that included, amongst other matters of consideration, a biodiversity assessment (Parsons Brinckerhoff 2006b). The South West Rail Link corridor alignment and concept plan was approved in August 2007. The Concept Plan comprised two components (refer Figure 1-1):

- Stage A:
  - The full construction and operation of the Glenfield North Flyover (and associated track reconfigurations) independent of Stage B projects.
  - The partial construction of the Glenfield South Flyover, consisting of piles, pile caps and substructures.
  - The establishment of temporary construction sites including the establishment of access tracks, located at Glenfield (excluding the construction site along Railway Parade) and the James Meehan Estate. These work sites are also required for the completion of Stage B.
- Stage B:
  - Glenfield Junction and Transport Interchange ('Glenfield Junction').
  - South West Rail Link Rail Corridor.

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GLENFIELD JUNCTION WORKS APPROVED

STAGE B2 WORKS (SWRL CORRIDOR) ENVIRONMENT ASSESSMENT

STAGE B1 WORKS(GLENFIELD STATION UPGRADE AND INTERCHANGE) REVIEW OF ENVIRONMENTAL FACTORS)

KEMPS CREEK
SOUTH WEST GROWTH CENTRE
CECIL PARK
HINCHINBROOK
GLENFIELD
AUSTRAL
WEST HOXTON
HOXTON PARK
ROSSMORE
PRESTONS
HORNINGSEA PARK
LEPPINGTON
DENHAM COURT
INGLEBURN
EDMONDSON PARK
MACQUARIE LINKS
MACQUARIE FIELDS
CASULA
MOOREBANK
WATTLE GROVE
HOLSWORTHY
CATHERINE FIELD
VARROVILLE

Glenfield Rd
Glenfield Ck
Anzac Ck
South Line
East Hills Line
Campbelltown Rd
Commuter car park
Cambridge Av
Glenfield Junction North flyover
GLENFIELD STATION
Canterbury Rd
Glenfield Junction South flyover
Bunbury Curran ck
Hoxton Park Rd
M7 Motorway
Cowpasture Rd
Kemps Ck
Western Sydney Regional Parklands
Non-certified area
Bringelly Rd
NEW LEPPINGTON STATION
NEW TRAIN STABLING FACILITY
Non-certified area
Camden Valley Wy
Forest Lawn Memorial Garden Cemetery
Non-certified area (Landcom Lands)
NEW EDMONDSON PARK STATION
Ingleburn Defence Site
LIVERPOOL LGA
CAMDEN LGA
CAMPBELLTOWN LGA
South Western Mwy
Hume Hwy
Williamson Rd
Brooks Rd
Harold St
Rileys Ck

0 2
KILOMETRES

Potential Substations
Approved Site Compounds
Potential Site Compounds
Potential Stockpile
Existing Rail
Motorways
Local roads
South West Growth Centre
Non-certifed areas subject to condition 12 of the Biodiversity certification report
Non-certifed areas subject to condition 14 of the Biodiversity certification report
Other non-certifed areas
Certified areas
Edmondson Park Conservation Agreement

**Figure 1-1** South West Rail Link Key Components

J:\A243-ENV\PROJ\21116808A_EIA_SWRL_Approl\10_GIS\Projects\21116808A_2036_EIA_Location_of_the_project_site_Fig1_1RevA.mxd SE 26.02.2010 // vb - 14.04.2010

On 29 August 2007, the NSW Minister for Planning granted concept approval for the Stage B works and project approval for Stage A works, meaning that no further assessment or approval is required for the Stage A works. Stage B of the South West Rail Link was determined to require further assessment under Part 3A and Part 5 the *Environmental Planning and Assessment Act 1979*. Based on the Minister's assessment requirements, Stage B would comprise two components:

- Stage B1 – Glenfield Junction and Transport Interchange, for which assessment and approval under Part 5 of the *Environmental Planning and Assessment Act 1979* would be required.
- Stage B2 – South West Rail Link Rail Corridor, for which assessment and approval under Part 3A of the *Environmental Planning and Assessment Act 1979* would be required.

A separate Review of Environmental Factors and associated biodiversity assessment has been prepared for Glenfield Station (Stage B1) for assessment under Part 5 of the *Environmental Planning and Assessment Act 1979*). The South West Rail Link-Glenfield Transport Interchange, Stage 1 of the project encompassing the Glenfield works (Stage A and B1), was approved by TIDC in April 2009.

Stage 2 of the project (Stage B2 in the concept plan), is the South West Rail Link – Glenfield to Leppington Rail Line. The proposed opening of the South West Rail Link is 2016. In accordance with the assessment and approval procedure under Part 3A of the *Environmental Planning and Assessment Act 1979,* an Environmental Assessment has subsequently been prepared for the project. The purpose of the Environmental Assessment is to:

- Assist with seeking the Minister's approval for Stage 2 of the South West Rail Link, pursuant to section 75P(1)(a) of the *Environmental Planning and Assessment Act 1979*.
- Demonstrate that the requirements set out in the Ministers Conditions of Approval (MCoA) for the Concept Plan relating to further assessment have been addressed.
- Demonstrate that the Statement of Commitments relating to the South West Rail Link have been addressed.

This biodiversity assessment has been prepared to support the Environmental Assessment for Stage 2 of the South West Rail link. Stage 2 of the South West Rail Link will be referred to as "the project" for the remainder of this document.

### 1.1.1 Project location and context

The project is located between Glenfield and Leppington in south-western Sydney (refer Figure 1-1). The proposed rail corridor passes through three local government areas (LGAs): Liverpool, Campbelltown and Camden.

The project is proposed to extend as a dual track, electrified railway line, for approximately 11 kilometres (km) from the existing junction of the East Hills and Main South Lines in Sydney's south-west to a new stabling facility to the west of the planned Leppington town centre. The project will also incorporate a reconfiguration and upgrade of Glenfield Station (subject to separate assessment under Part 5 of the *Environmental Planning and*

*Assessment Act 1979*), and two new stations located at Edmondson Park and Leppington. A further extension beyond Leppington is also under consideration, but does not form part of this project.

A large proportion of the project will be located within the South West Growth Centre of Sydney (also known as the South West Sector), which is an area of land release and significant growth identified in the Department of Planning (2005a) Sydney Metropolitan Strategy *(City of Cities – A Plan for Sydney's Future*).

## 1.2 Consultation

Consultation was undertaken with representatives of the Department of Environment, Climate Change and Water including Ray Giddins, Regional Biodiversity Conservation Officer, in relation to biodiversity prior to the commencement of the biodiversity assessment with regard to the following issues:

- Survey effort expectation and assessment of impacts in the biodiversity certified area of the South West Growth Centre.
- Calculation of biodiversity offsets for the project.
- Threatened species, populations or ecological communities of likely relevance to the project.

## 1.3 Scope of the report

The Director-General's Environmental Assessment Report (Department of Planning 2007) recommended the Environmental Assessment consider the following matters relating to biodiversity for Stage 2 of the further assessment:

- Confirmation of the footprint of the proposal and identification of impacts to threatened species, populations and ecological communities, utilising existing information (Growth Centres Conservation Plan) or undertaking additional surveys using appropriately rigorous and justified survey methodology.
- Assessment of impacts to riparian and instream ecology and impacts to existing or planned biodiversity corridors (including the regional corridors identified in the Edmondson Park Ecological Assessment 2003 prepared by Eco Logical Australia Pty Ltd). This includes opportunities for developing a buffer zone between the rail line and Denham Court as a biodiversity corridor.
- Address as relevant, the requirement of the Growth Centres State Environmental Planning Policy in relation to 'Flood Prone and Major Creek Land' in relation to habitat connectivity and non-certified area of Biodiversity Certification.
- Demonstrate that unavoidable impacts will be appropriately offset.

The draft *Guidelines for Threatened Species Assessment* (2005a) state that the objective of the biodiversity assessment process under Part 3A is to provide information to enable decision-makers to ensure that developments deliver the following environmental outcomes:

1. Maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation).
2. Conserve biological diversity and promote ecologically sustainable development.

3. Protect areas of high conservation value (including areas of critical habitat).
4. Prevent the extinction of threatened species.
5. Protect the long-term viability of local populations of a species, population or ecological community.
6. Protect aspects of the environment that are Matters of National Environmental Significance.

With these objectives in mind, the aims of this technical paper are to:

- Determine and describe the characteristics and condition of the vegetation communities and terrestrial and aquatic flora and fauna habitats within the study area.
- Determine the occurrence, or likelihood of occurrence, of Threatened species, populations and communities (biodiversity) or other significant features listed under the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* and *Environment Protection and Biodiversity Conservation Act 1999* within the study area.
- Assess the significance of impacts to Threatened biodiversity that occur or have potential habitat within the study area.
- Propose amelioration measures to avoid or mitigate impacts on the ecological values of the study area.
- Demonstrate that unavoidable impacts will be appropriately offset.

## 1.4 Structure of the technical paper

The structure and content of this technical paper is described below:

- Section 1 - an introduction including background on the project.
- Section 2 - the state and Commonwealth legislation and statutory framework relevant to the assessment of biodiversity for the project.
- Section 3 - the methods used to complete the biodiversity assessment.
- Section 4 - the findings of the desk-based assessments and field studies.
- Section 5 - the Threatened biodiversity, other species of conservation concern and other significant ecological features recorded or likely to occur in the study area.
- Section 6 - the potential impacts of the project on biodiversity, including Threatened biodiversity recorded or likely to occur in the study area.
- Section 7 - the impact mitigation measures and offsets strategy proposed for the project.
- Section 8 - the conclusions of significance assessments that were undertaken for species listed under the *Threatened Species Conservation Act 1995* and/or *Environment Protection and Biodiversity Conservation Act 1999* that are likely to be affected by the project including addressing the heads of consideration for assessment of impacts to Threatened biodiversity under Part 3A of the *Environmental Planning and Assessment Act 1979*.

- Section 9 - a summary and conclusions of the biodiversity assessment.

# 2. Legislative and statutory framework

This section outlines the state and Commonwealth legislation and statutory framework relevant to the assessment of biodiversity for the project.

## 2.1 State assessment framework

The project will be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A), which is the principle strategic planning and approval instrument in NSW. Part 3A outlines the approval framework for major infrastructure, or other development that in the opinion of the Minister for Planning, is of state or regional environmental planning significance.

Legislation relevant to biodiversity and the project is summarised in Table 2-1.

**Table 2-1 Legislation and guidelines relevant to biodiversity**

| Legislation (governing authority) | Objectives | Relevance to current project |
|---|---|---|
| **State** | | |
| *Environmental Planning and Assessment Act 1979*<br>(Department of Planning) | To encourage the proper management, development and conservation of natural and artificial resources for the purpose of promoting the social and economic welfare of the community and a better environment. | As the principle planning instrument in NSW, this Act dictates the assessment and approval pathway for the proposal and thereby the factors for consideration for assessment of the significance to biodiversity, and the requirements to consider or seek authorization under other NSW legislation and planning policies. |
| *National Parks and Wildlife Act 1974*<br>(Department of the Environment, Climate Change and Water) | The objects of this Act are the conservation of nature and objectives, places or features of cultural value.<br>This Act contains provisions that relate to the protection of native terrestrial fauna and some flora and endangered ecological communities in addition to indigenous cultural heritage. | Penalties relating to causing harm to native flora and fauna (including Threatened species, populations and communities) are outlined in this Act.<br>Actions approved under Part 3A of the *Environmental Planning and Assessment Act 1979* are exempt from prosecution as long as the impact is within the levels approved. |

| Legislation (governing authority) | Objectives | Relevance to current project |
|---|---|---|
| *Threatened Species Conservation Act 1995*<br><br>(Department of the Environment, Climate Change and Water) | To conserve biological diversity and prevent the extinction and promote the recovery of threatened species, populations and ecological communities.<br><br>To ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed. | Threatened biodiversity are listed under this Act. These lists provide a trigger of an assessment of threatened species that are known or likely to occur and are likely to be directly or indirectly affected by the proposal.<br><br>Significance assessments for projects assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* are completed in accordance with the heads of consideration outlined in Draft guidelines for threatened species assessment (Department of Environment and Conservation 2005a).<br>This Act also puts in place biodiversity certification and BioBanking (see section 2.1.1 for more detail regarding biodiversity certification and *The Threatened Species Conservation Amendment (Special Provisions) Act 2008*). |
| *Fisheries Management Act 1994*<br><br>(Industry and Investment NSW) | The objectives of this Act are to conserve, develop and share the fishery resources of the state for the benefit of present and future generations.<br><br>Included in this objective is to conserve Threatened species, populations and ecological communities of fish and marine vegetation. | Threatened aquatic biodiversity are listed under this Act. Significance assessments must be completed for all Threatened ecological communities, populations and species listed under this Act that are recorded in the study area, or likely to occur, and which will be directly or indirectly affected by the proposal. Significance assessments for projects assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* are completed in accordance with the heads of consideration outlined in Draft guidelines for threatened species assessment (Department of Environment and Conservation 2005a).<br><br>Under s.205 of this Act, a permit is required to harm any harm marine vegetation, including mangroves or seagrasses. However, an action approved under Part 3A of the *Environmental Planning and Assessment Act 1979* is exempt from requiring a s.205 permit. |

Part 3A makes provisions for the streamlining of the assessment and carrying out of actions to which it applies (refer section 75U and 75V of the Act). Under this NSW approval pathway, the project is therefore afforded the following exemptions that relate to biodiversity:

- A permit under Sections 201 (dredging or reclamation work), 205 (Marine vegetation—regulation of harm) or 219 (Passage of fish not to be blocked) of the *Fisheries Management Act 1994.*
- Approvals under sections 89 (water use approvals), 90 (water management work approvals) and 91 (activity approvals) under the *Water Management Act 2000.*

Furthermore, only the Minister or the Director General can issue enforcement orders under the *Environmental Planning and Assessment Act 1979* to actions approved under Part 3A of the Act.

Section 75R of the *Environmental Planning and Assessment Act 1979* also provides that environmental planning instruments, other than State Environmental Planning Policies, do not apply to or in respect of a Part 3A project (including Local Environment Plans). Under Section 75J however, the Minister may (but is not required to) take into account the provisions of any environmental planning instrument that would not (because of Section 75R) apply to the project if approved.

### 2.1.1 Sydney Regional Growth Centres and Biodiversity certification

The project is located predominantly within the South West Growth Centre identified in the State Environmental Planning Policy (Sydney Regional Growth Centres) 2006. The South West Growth Centre is approximately 17,000 ha and includes suburbs in three council areas: Liverpool, Camden and Campbelltown. The aims of this policy are to:

- Co-ordinate the release of land for residential, employment and other urban development in the North West and South West growth centres of the Sydney Region.
- Provide for comprehensive planning for those growth centres.
- Provide controls for the sustainability of land in those growth centres that has conservation value.
- Provide for the orderly and economic provision of infrastructure in and to those growth centres.
- Provide development controls in order to protect the health of the waterways in those growth centres.
- Protect and enhance land with natural and cultural heritage value.
- Provide land use and development controls that will contribute to the conservation of biodiversity.

The State Environmental Planning Policy (Sydney Regional Growth Centres) 2006 includes identification of environmentally sensitive areas including flood prone lands, including lands around Kemps Creek (refer Figure 2-1). The policy indicates that consent is not to be granted to the carrying out of development in flood prone lands unless consideration has been given to, among other things, whether or not the development will detrimentally affect the floodplain environment or cause avoidable erosion, siltation, salinity, destruction of riparian vegetation or a reduction in the stability of the riverbank/watercourse.

In order to streamline assessment and approval in the Growth Centres, an order to confer biodiversity certification on the State Environmental Planning Policy (Sydney Regional Growth Centres) 2006 was issued on the 11 December 2007 by the Minister for Climate Change Environment and Water. Biodiversity certification (under Section 126G of the *Threatened Species Conservation Act 1995*) may be conferred on an Environmental Planning Instrument if the Minister is satisfied that the instrument, in addition to any other relevant measures to be taken will lead to the overall improvement or maintenance of biodiversity values.

*The Threatened Species Conservation Amendment (Special Provisions) Act 2008* was passed on 25 June and amends the *Threatened Species Conservation Act 1995* by inserting a new part to Schedule 7 (Savings, transitional and other provisions) of the Act. The new Part 7, Schedule 7 of the Act confers biodiversity certification on the Growth Centres State Environmental Planning Policy. The amendment largely replicates the order to confer biodiversity certification on the Growth Centres State Environmental Planning Policy that was issued by the Minister for the Environment on 11 December 2007 and resolves any uncertainty about the certification granted on the Growth Centres State Environmental Planning Policy in accordance with Section 126G.

In order to demonstrate how biodiversity certification of the State Environmental Planning Policy (Sydney Regional Growth Centres) 2006 would lead to the overall improvement or maintenance of biodiversity values, a draft conservation plan (Eco Logical Australia 2007) was prepared. The draft conservation plan identified biodiversity values within the Growth Centres and proposed mechanisms to achieve positive conservation outcomes through the development assessment process. In addition to the mechanisms outlined in the draft conservation plan, the Minister's order (Minister for Climate Change Environment and Water 2007) outlines the conditions of the biodiversity certification.

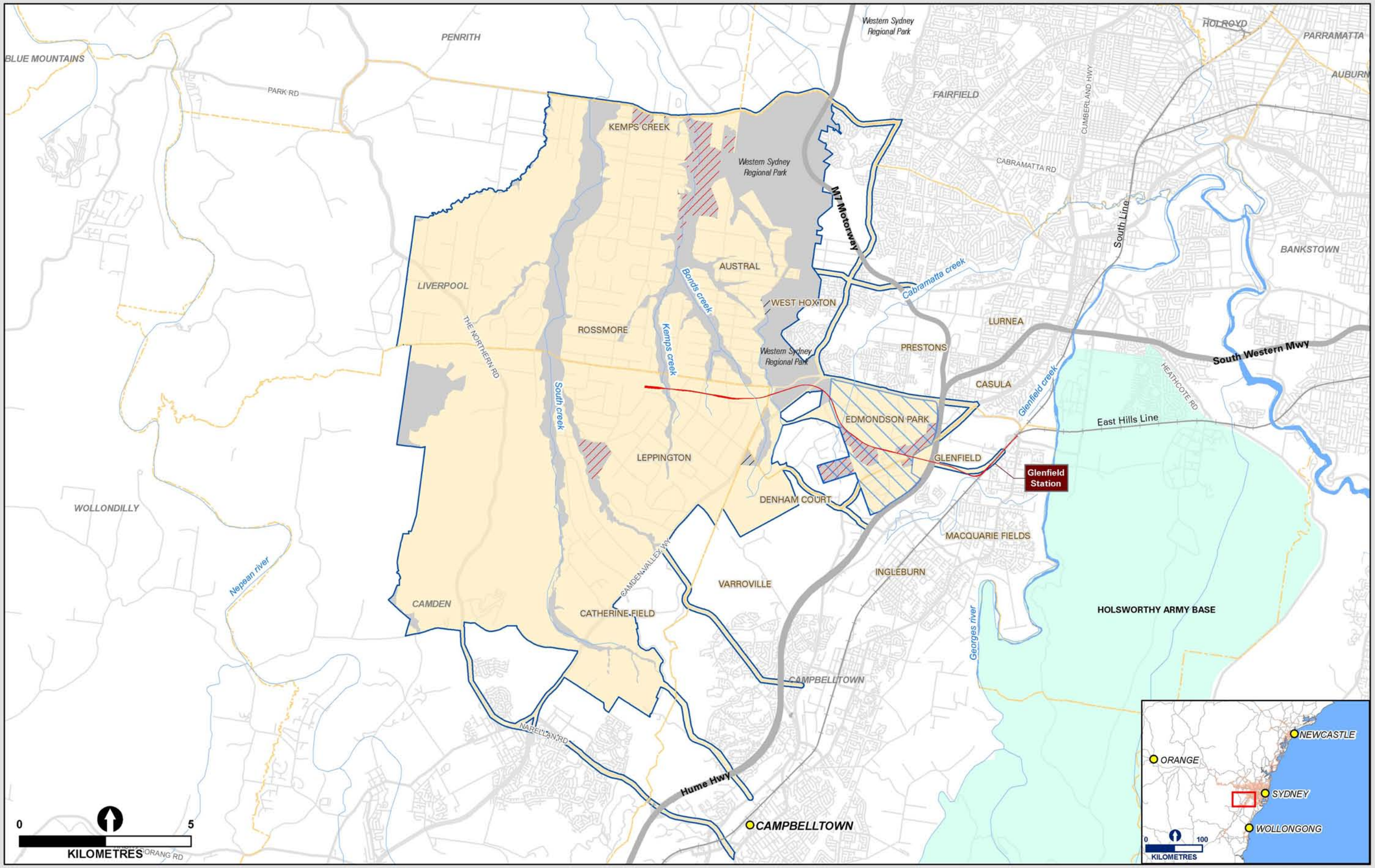


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**Figure 2-1** Biodiversity certification areas in the South West Growth Centre

Biodiversity certification identified areas within the Growth Centres as either 'certified' or 'non-certified' (refer Figure 2-1). Certified areas relate to areas that are likely to be of lower conservation value. Non-certified areas generally correspond with areas of higher conservation value (such as known locations of Threatened species habitat), flood prone and transitional land. Flood prone lands have been identified by the biodiversity certification in order to retain and protect existing native vegetation along important creek and riparian corridors. Transitional areas are areas in which further assessment of the significance of impacts will be required.

Biodiversity certification switches off the need to assess the significance of impacts for threatened species (in this case following the Department of Environment, Climate Change and Water Guidelines for Threatened Species Assessment under Part 3A). In these areas, it is taken that development is not likely to significantly affect any Threatened species, population or ecological community, or its habitat. In non-certified areas, there is no change to the approval process and Threatened species assessments are required as normal under the *Environmental Planning and Assessment Act 1979*.

Offsets are however required for impacts to biodiversity resulting from the project in non-certified areas (under condition 11 of the certification order, Minister for Climate Change Environment and Water 2007). Biodiversity offsets for the project are discussed further in Section 7.5.

## 2.2 Commonwealth assessment framework

Approval of an action under the NSW *Environmental Planning and Assessment Act 1979* does not negate the requirement to consider the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.* This Act is triggered by actions that are likely to have a significant impact on Matters of National Environmental Significance including World Heritage Areas, internationally significant (Ramsar) wetlands, Commonwealth marine areas, nationally Threatened species and communities, Migratory birds and National heritage places. The Act also considers the environmental impacts from actions undertaken on Commonwealth land or by Commonwealth agencies.

Under the *Environment Protection and Biodiversity Conservation Act 1999*, actions that are likely to have a significant impact on a Matter of National Environmental Significance or Commonwealth land should be referred to Commonwealth Department of the Environment, Water, Heritage and the Arts for consideration of whether or not the action requires approval from the Commonwealth Environment Minister.

Actions that are likely to have a significant impact on Matters of National Environmental Significance or Commonwealth land may be deemed 'controlled actions' and an environmental assessment must be carried out.

### 2.2.1 Edmondson Park Conservation Agreement

A Conservation Agreement has been signed between the Department of the Environment, Water, Heritage and the Arts, Department of Planning and Department of Environment, Climate Change and Water relating to the planning and the long term conservation of the Edmondson Park precinct of the South West Growth Centre (Figure 2-1). This agreement identifies the project corridor within the Edmondson Park precinct. The Conservation Agreement declares that a project approved under Part 3A of the *Environmental Planning and Assessment Act 1979* within the precinct is not likely to have a significant impact on threatened biodiversity as long as it follows the agreement. The agreement also puts in place an offsetting arrangement funded through the infrastructure contributions of the growth centres.

### 2.2.2 Strategic Assessment

Department of Planning (Strategic Lands) in consultation with the Department of the Environment, Water, Heritage and the Arts is currently undertaking a Strategic Assessment under the *Environment Protection and Biodiversity Conservation Act 1999* of the Growth Centres (North-west and South-west). The purpose of the strategic assessment is to review and potentially approve the growth centres State Environmental Planning Policy. The exhibition period for the Draft Terms of Reference for the Strategic Assessment closed in December 2009. Once signed off by the Federal Environment Minister, a Strategic Assessment will be prepared addressing the Terms of Reference. The strategic assessment will address potential impacts associated with the development of the growth centres as outlined in the growth centres State Environmental Planning Policy. If as part of the assessment the Minister agrees to endorse the State Environmental Planning Policy, it does not automatically constitute approval under the Act for the taking of action for which approval is required. However, the Minister may then decide to approve an action or class of action in accordance with the program. If the Minister as part of the strategic assessment does not approve an action, the proponent still has the option of submitting a project under the normal approval pathway.

# 3. Methods

This Section outlines the methods used to complete the biodiversity assessment.

The biodiversity assessment completed for this Technical Paper has been done to address the relevant state and Commonwealth statutory requirements in relation to the assessment of biodiversity and the matters outlined in TIDC's Statement of Commitments and the Minister's Conditions of Approval for the Concept Plan (see Section 2). In addition, the assessment has followed the *Draft Guidelines for Threatened Species Assessment under Part 3A of the Environmental Planning and Assessment Act 1979* (Department of Environment and Conservation 2005a) and included both desk-based searches of databases and historical records, as well as field surveys along the entire project corridor alignment.

Field surveys were completed in July 2006 as part of the concept approval process (Parsons Brinckerhoff 2006b), and in October 2006 and between March and June 2008. The description of the existing environment and conclusions of this report are based on a combination of field surveys and desktop review. Due to the delay in the final report, database searches were updated.

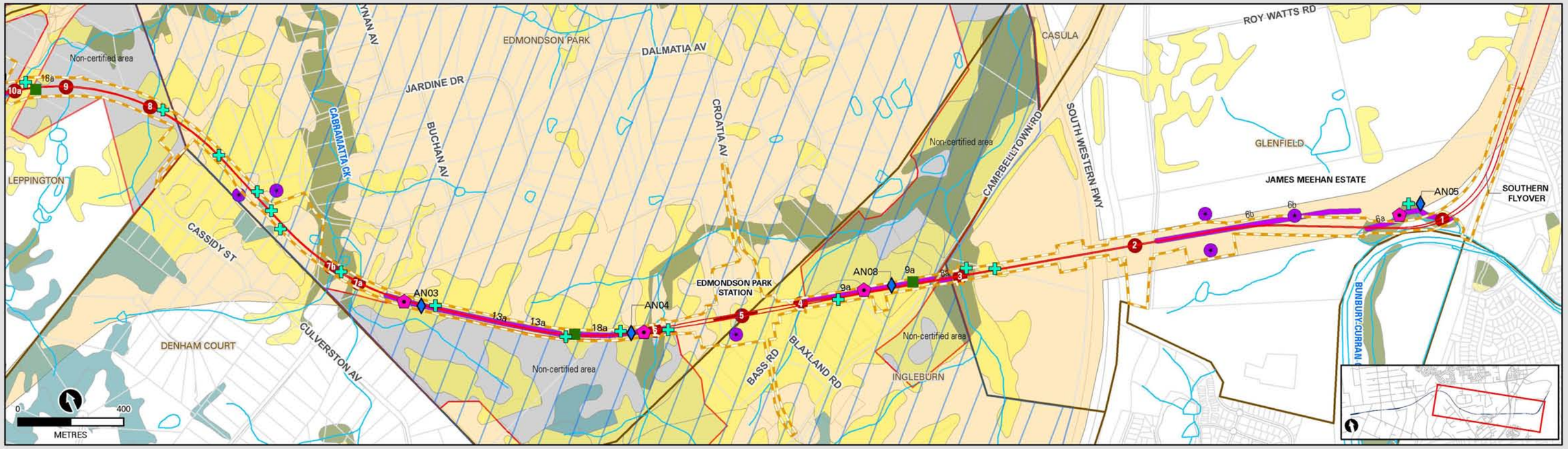
Survey effort and design was based on the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (Department of Environment and Conservation 2004c) and Department of Environment and Conservation Environmental Impact Assessment Guidelines for Threatened species including:

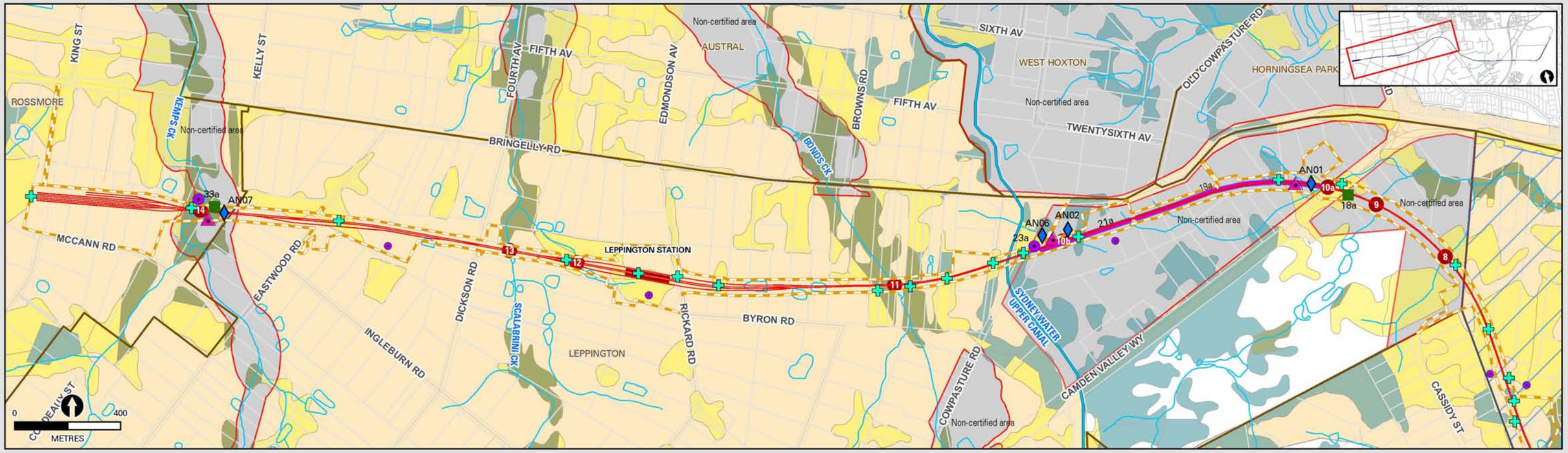
- *Acacia pubescens* (NSW National Parks and Wildlife Service 2003a)
- *Pimelea spicata* (NSW National Parks and Wildlife Service 2004)
- *Pultenaea pedunculata* (NSW National Parks and Wildlife Service 2002f)
- Cumberland Land Snail (*Meridolum corneovirens*) (National Parks and Wildlife Service 2000)
- Green and Golden Bell Frog (*Litoria aurea*) (Department of Environment and Conservation 2004a).

## 3.1 Definitions

For the purpose of this report, the following definitions apply:

- **Subject site:** the specific area that will be covered by the project. This includes the project corridor and additional ancillary work areas (refer Figure 3-1).
- **Study area:** the subject site and any additional areas that are likely to be affected by the project, either directly or indirectly. For the purpose of this project this is defined as the subject site and the concept proposal corridor.
- **Locality:** the area within a 10 kilometre radius of the study area.

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- Waterway crossing
- Cadastre
- Suburbs
- Drainage
- Proposed track
- Clearing footprint
- Non-certified areas
- Certified areas
- Edmondson Park Conservation Agreement

**Cumberland Plain Woodland**
- Shale Hills Woodland
- Shale Plains Woodland

**Sydney Coastal River-flat Forest**
- Alluvial Woodland

- Anabat (2008)
- Spotlight and call playback (2008)
- Flora quadrat (2008)
- Flora, habitat and Cumberland Land Snails search (2008)
- Flora, habitat and Cumberland Land Snails traverse (2008)
- Flora, habitat and Cumberland Land Snail surveys (2006)

**Figure 3-1** Location of flora and fauna survey effort

- **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).

Definitions of other technical terms are provided in the report glossary.

## 3.2 Contributors, qualifications and licences

The contributors to the preparation of this Technical Paper, their qualifications and roles are listed in Table 3-1.

**Table 3-1 Contributors and their roles**

| Name | Qualification | Role |
|---|---|---|
| Peter Monsted | BSc | Senior Botanist – field surveys and report preparation |
| Andrew McMillan | BSc (Hons) | Zoologist – 2008 field surveys and report preparation |
| Selga Harrington | BSc (Hons) | Senior Ecologist – 2006 targeted flora surveys |
| Alex Fraser | BAppSc (Hons) | Zoologist- 2006 field surveys |
| Rob Gration | MWldMgt (Habitat) | Senior Zoologist – bat call analysis |
| Dr. Martin Predavec | BSc (Hons), PhD | Principal Ecologist – ecology lead and review |

All work was carried out under the appropriate licences, including scientific licences as required under Clause 22 of the National Parks and Wildlife Regulations 2002, Section 132C of the *National Parks and Wildlife Act 1974,* as well as animal research authorities issued by the Department of Industry and Investment (Agriculture).

## 3.3 Nomenclature

Names of plants used in this document follow the Flora of NSW (Harden 1992, 1993, 2000, 2002) with updates from PlantNet (Royal Botanic Gardens 2010). Scientific names are used in this report for species of plant. Scientific and common names (where available) of plants are provided in the species lists in Appendices A and C.

The names of fungi follow those used by Young (1999) as used by the Department of Environment, Climate Change and Water in their determinations of Threatened species and ecological communities of fungi.

Names of vegetation communities in this report are based on the dominant species and structure of the community. Where practical, names follow those used in the Final Native Vegetation Mapping of the Cumberland Plain (NSW National Parks and Wildlife Service 2002b) and the names of Threatened ecological community listed under the *Threatened Species Conservation Act 1995* and/or *the Environment Protection and Biodiversity Conservation Act 1999.*

The names of vertebrates follow the Census of Australian Vertebrates (CAVS) database maintained by the Department of the Environment, Water, Heritage and the Arts (2010a) and as used by the Department of Environment, Climate Change and Water in the *Atlas of NSW Wildlife* (Department of Environment Climate Change and Water 2010). Common names are used in the report for species of animal. Scientific names of animals are included

the first time that the species is mentioned and are also used in species lists found in Appendices B and D.

## 3.4 Database searches and literature review

Records of Threatened biodiversity recorded previously in the project locality, or predicted to occur, were obtained from various databases to identify those species and communities likely to occur in the study area. Databases searched included:

- The Department of Environment, Climate Change and Water's Threatened species, populations and ecological communities website (2008) for Threatened biodiversity known or predicted to occur in the Cumberland subregion of the Hawkesbury Nepean Catchment Management Area.
- Atlas of NSW Wildlife (Department of Environment Climate Change and Water 2010).
- The Royal Botanic Gardens' PlantNet (2008) for records of Threatened and ROTAP (Rare or Threatened Australian Plant) species of plant based on records of the Hawkesbury Nepean catchment management area.
- Protected Matters Search Tool (Department of the Environment Water Heritage and the Arts 2010b) (refer to Appendix A for the accuracy of these databases).

Registers of critical habitat maintained by the Department of Environment, Climate Change and Water (2010) and the Department of the Environment, Water, Heritage and the Arts (2008) were reviewed to identify critical habitat in the locality (reviewed 19 August 2008).

Existing biodiversity studies and strategic biodiversity plans that relate to the project were reviewed including:

- Managing Sydney's Urban Growth: Ecological Assessment South West Sector Study Area (Eco Logical Australia Pty Ltd 2003a).
- Growth Centres Conservation Plan, Exhibition Draft (Eco Logical Australia 2007).
- Western Sydney Growth Centres: An assessment of the proposal to confer biodiversity certification on State Environmental Planning Policy (Sydney Region Growth Centres) 2006 under section 126G of the *Threatened Species Conservation Act 1995* (Department of Environment and Climate Change 2007b).
- Order to confer biodiversity certification on the State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (Minister for Climate Change Environment and Water 2007).
- Campbelltown Biodiversity Study (Eco Logical Australia Pty Ltd 2004).
- Liverpool Council Biodiversity Strategy (Eco Logical Australia Pty Ltd 2003c).
- South West Rail Link Environmental Issues Study. Working paper No 2 Flora and Fauna (Connell Wagner 2003).
- South West Rail Link Project Application Technical Report - Biodiversity Assessment (Parsons Brinckerhoff 2006b).

- Edmondson Park conservation agreement.

## 3.5 Terrestrial flora

A combination of quadrat and random meander flora surveys were used to: ground truth vegetation communities; assess floral diversity and dominant species; and search for Threatened species within the study area. Surveys were completed in all patches of remnant vegetation identified from broad scale vegetation mapping (NSW National Parks and Wildlife Service 2002b) and aerial photography, and each quadrat and random meander survey point was allocated a unique survey reference number (refer Figure 3-1).

The terrestrial flora survey effort ensured that a random meander survey was done in every patch of remnant vegetation in the study area and at least one quadrat survey was completed in each vegetation community (these techniques are described below). Cleared areas containing unclassified vegetation or no native vegetation overstorey were also traversed to search for Threatened species or their habitat and assess potential derived native grasslands.

### 3.5.1 Ground truthing of existing vegetation mapping

Vegetation in the locality has been mapped at a broad scale (1:25,000) in the Final Native Vegetation Mapping of the Cumberland Plain (NSW National Parks and Wildlife Service 2002b). This map was generated through aerial photographic interpretation, floristic surveys and statistical classification and modelling. The Final Native Vegetation Mapping of the Cumberland Plain identifies, describes and maps 18 vegetation communities across the Cumberland Plain (NSW National Parks and Wildlife Service 2002b).

The broad-scale vegetation mapping (NSW National Parks and Wildlife Service 2002b) was ground-truthed in July 2006 to verify the vegetation community type and conservation significance class of remnant vegetation along the entire project corridor. Ground-truthing involved confirming the occurrence, distribution and classification of vegetation remnants in the study area using random meander surveys within all patches of woodland vegetation traversed by the concept corridor (see Parsons Brinckerhoff 2006b).

### 3.5.2 Conservation significance of Cumberland Plain vegetation

Conservation significance classes have been assigned to each remnant by the Final Native Vegetation Mapping of the Cumberland Plain, Western Sydney (NSW National Parks and Wildlife Service 2002b, 2002c). The following four conservation significance classes have been described:

- **Core Habitat:** areas that constitute the backbone of a viable conservation and include all remnants of 10 ha or more of the mapped vegetation category with canopy cover of less than 10%.

- **Support for Core Habitat:** areas that provide a range of support values to the Core Habitat, including increasing remnant size, buffering from edge effects, and providing corridor connections. The focus of these areas is to identify priority areas for conservation and restoration in order to enhance the biodiversity values in the region.

- **Urban Remnant Trees (Critically Endangered Communities)**: areas of critically endangered ecological communities that remain as remnant trees in an urban landscape (mapped as Canopy Cover less than 10% (Urban Areas)). As there were no critically endangered communities identified in the study area, no areas of this category were identified in the study area.

- **Other Remnant Vegetation:** all native vegetation that does not fall within the above conservation significance classes (NSW National Parks and Wildlife Service 2002c).

The EPBC listing of Cumberland Plain Shale Woodlands and Shale-gravel Transition Forest is based on preservation of larger, good quality remnants and does not include derived grassland or degraded woodland. The area of EPBC listed community within the study area is based on Department of Environment, Climate Change and Water mapping and supported by our field data. Condition thresholds have been identified for the *Environment Protection and Biodiversity Conservation Act 1999* listed community:

A- Core – greater than 0.5 ha, and greater than 50% of the perennial understorey vegetation cover is made up of native species.

B- Larger patches- these are valuable due to their size. Patches are greater than 5 ha and greater than 30% of the perennial understorey vegetation cover is made up of native species.

C- Connected patches- patch size is greater than 0.5 ha and, greater than 30% of the perennial understorey vegetation cover is made up of native species, and the patch is contiguous with native vegetation remnant that is greater than 5 ha.

D- Contain hollow bearing trees- patch is greater than 0.5 ha, 30% of the perennial understorey vegetation cover is made up of native species. And the patch has atleast one hollow bearing tree or one larger tree (greater then 80cm diameter at breast height) per hectare.

### 3.5.3 Condition of vegetation communities

The quality of vegetation was assessed using parameters such as intactness, diversity, history of disturbance, weed invasion and health. Three categories were used to describe the condition of vegetation communities (refer Table 3-2).

**Table 3-2 Vegetation condition classes**

| Condition Class | Criteria |
|---|---|
| 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. |
| Moderate | Vegetation generally still retains its structural integrity. |
| Poor | Vegetation that has lost most of its species and is significantly modified structurally. Often such areas now have a discontinuous canopy of the original tree cover and very few shrubs. |

### 3.5.4 Random meander surveys

Due to the linear nature of the proposal, random meander surveys were completed along the entire length of the proposal. Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random manner throughout the site recording all species observed. The survey is continued until no additional species are observed within a patch. Random meander surveys also allow the boundaries between various vegetation communities and condition of vegetation to be recorded and are valuable for recording species that may not occur within quadrats including, including Threatened species (Department of Environment and Conservation 2004c).

Individual random meander surveys were separated whenever there was a significant change in vegetation community type or condition. For each random meander survey, the vegetation community was determined based on the dominant canopy species and the structure formation in accordance with Specht (1981) with reference to existing mapped vegetation communities.

### 3.5.5 Quadrat surveys

Quadrat surveys were completed to provide a quantitative examination of species abundance in each vegetation community. Quadrat surveys are also likely to detect inconspicuous species that may be missed by random meander or transect surveys (Department of Environment and Conservation 2004c).

Vegetation quadrats were 400 $m^2$ (20 x 20 m) within which all floral species were identified and assigned a vegetative cover abundance rating based on the following modified Braun-Blanquet scale:

1 = <5% cover, rare, few individuals

2 = <5% cover, uncommon

3 = <5% cover, common

4a = <5% cover, very abundant

4b = 5 - 25% cover

5 = 26 – 50% cover

6 = 51 – 75% cover

7 = >75% cover.

At each site, the vegetation community was also determined based on the dominant canopy species and the structure formation in accordance with Specht (1981).

### 3.5.6 Targeted searches for Threatened species

Targeted searches were conducted in the study area for three Threatened species and one Threatened population of plant considered likely to occur based database searches and habitat associated with broad scale mapped vegetation communities (NSW National Parks and Wildlife Service 2002b). These were *Pimelea spicata, Pultenaea pedunculata, Acacia pubescens* and the *Marsdenia viridiflora* subsp. *Viridiflora* population.

### *Pimelea spicata*

*Pimelea spicata* is a small decumbent herb that is difficult to detect when not in flower and has also been recorded previously in highly degraded areas that no longer contain native woodland vegetation (Department of Environment and Conservation 2004b). As such, the *Pimelea spicata* Environmental Impact Assessment Guidelines (NSW National Parks and Wildlife Service 2004) recommend that targeted surveys are completed when a known population of the species in the region is flowering.

The species flowers sporadically in response to rain, however the peak is generally March–April (Benson & McDougall 2002; Fairley 2004; NSW National Parks and Wildlife Service 2004; Robinson 2003). A population of *Pimelea spicata* within the Cumberland Plain area near Prospect Reservoir in the Holroyd City Council local government area was used as a reference population for this project.

Four targeted surveys were done for *Pimelea spicata* (refer Table 3-3 and Figure 3-1).

**Table 3-3 Target surveys for *Pimelea spicata***

| Date | Location | Flowering status of reference population |
|---|---|---|
| June 2006 | Project corridor west of the M5 | Not flowering |
| October 2006 | M5 motorway to southern flyover (James Meade Estate) | Flowering |
| March / April 2008 | Non-certified sites within the South West Growth Centre | Flowering |
| May 2008 | Southern flyover | Not flowering |

### *Pultenaea pedunculata*

*Pultenaea pedunculata* is a prostate shrub with populations scattered over a large geographic area in a range of habitats, however it is only known from three sites in western Sydney, two of which are relatively close to the study area (at Villawood and Prestons, NSW National Parks and Wildlife Service 2002g). As such the species local distribution is extremely restricted and any additional sites would be considered important (NSW National Parks and Wildlife Service 2002f).

*Pultenaea pedunculata* is also liable to be confused with other species of prostrate shrubs, particularly young *Kunzea ambigua,* and is best surveyed during flowering period of August to December (NSW National Parks and Wildlife Service 2002f). However, the Environmental Impact Assessment Guidelines note that with experience this species can be identified from vegetative features if not in flower.

In order to increase the likelihood of observing and correctly identifying the species, the Villawood and Prestons populations were visited prior to the March / April 2008 surveys with Ray Giddins, Regional Biodiversity Conservation Officer, Department of Environment, Climate Change and Water. Searches for this species were completed as part of the general floral surveys.

### *Acacia pubescens*

*Acacia pubescens* is an inconspicuous shrub that can be distinguished from other bipinnate wattles in the region by its conspicuously hairy branchlets. As such, surveys for the species may be conducted at any time of year (NSW National Parks and Wildlife Service 2003a). Targeted surveys for this species were completed as part of the general floral surveys.

***Marsdenia viridiflora* subsp. *viridiflora***

*Marsdenia viridiflora* subsp. *viridiflora* is widely distributed and common in sub-coastal and southern Queensland. Its southern range is on the Australian East Coast in northern NSW however, a disjunct population of the species also occurs in western Sydney on the Cumberland Plain as very scattered plants in areas of remnant vegetation (Forster 1995; NSW Scientific Committee 2000). The species is a distinctive and relatively conspicuous twining climber with stems up to 4 metres (m) long, narrow leaves 2 to 12 centimetres (cm) long and 1 - 18 millimetres (mm) wide) and large, pear-shaped fruit up to 80 mm long (Department of Environment and Conservation 2006). Targeted surveys for this species were completed as part of the general floral surveys.

## 3.6 Terrestrial fauna

### 3.6.1 Fauna habitats

The assessment of terrestrial fauna of the site was based primarily on the habitats present. While recording Threatened species as part of survey results can confirm their presence in an area, a lack of Threatened species records cannot necessarily be used to argue for the absence of the species from the site when suitable habitat is present. By the very nature of their rarity, Threatened species are often difficult to detect. Suitable habitat is, therefore, the most important factor to consider when determining the potential presence of Threatened species.

Fauna habitats were assessed generally by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation, the structure and composition of the litter layer, and other habitat attributes important for feeding, roosting and breeding. The following criteria were used to evaluate habitat values:

- **Good:** full range of fauna habitat components usually present (e.g. old-growth trees, fallen timber, feeding and roosting resources) and habitat links to other remnant ecosystems in the landscape are intact.
- **Moderate:** some fauna habitat components are missing (e.g. old-growth trees and fallen timber), links 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 (e.g. due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat links with other remnant ecosystems in the landscape are usually severely compromised by extensive past clearing.

In addition to the general evaluation of fauna habitats in the study area, fauna feature traverses were also completed. These surveys involve traversing through various habitat types on foot to detect and collect information on the likelihood of Threatened species occurring in the study area. This technique involved assessment of the presence and abundance of hollow bearing trees, identification of feeding signs by Glossy Black-cockatoos (*Calyptorhynchus lathami*), nest/roost sites of large forest owls and bats, presence of leaf litter and other habitat features for Cumberland Land Snail (*Meridolum corneovirens*) and identifying faunal scats and other indirect evidence.

### 3.6.2 Fauna survey

Fauna surveys were completed to detect species that were considered likely to occur within the study area following the fauna habitat assessment completed for the South West Rail Link concept plan (Parsons Brinckerhoff 2006a), including the following Threatened species:

- Cumberland Land Snail (*Meridolum corneovirens*)
- Common (Eastern) Bentwing Bat (*Miniopterus schreibersii*)
- Large-footed Myotis (*Myotis adversus*)
- Eastern Freetail Bat (*Micronomus norfolkensis*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)
- Grey-headed Flying Fox (*Pteropus poliocephalus*)
- Barking Owl (Ninox connivens) and Masked Owl (*Tyto novaehollandiae*)
- Green and Golden Bell Frog (*Litoria aurea*).

The following census techniques were used to detect these Threatened species as well as more common species of animal. Survey effort is described in Section 3-7 and the location of surveys is shown in Figure 3-1.

***Diurnal bird census***

Diurnal birds were recorded in various fauna habitat types within the study area during 30 minutes census periods. Birds were identified either from sightings or characteristic calls. The number of each species and the activity at the time of sighting (foraging, breeding, or flying) was also recorded. Birds were also opportunistically recorded throughout the study area while undertaking habitat assessments and other fauna survey techniques.

***Call playback***

Forest Owls (Barking Owl, *Ninox connivens* and Masked Owl, *Tyto novaehollandiae*) and Green and Golden Bell Frog (*Litoria aurea*) were surveyed using a call broadcast method, where recordings of their calls are broadcast in order to elicit a response, either vocal or behavioural. Call playback surveys were undertaken using the methods of Kavanagh and Peake (1993) and Debus (1994). An initial listening period of 10-15 minutes was undertaken, followed by a spotlight search for 10 minutes to detect any animals in the immediate vicinity. The calls of the target species were then played intermittently for 5 minutes followed by a 10 minute listening period. Another 10 minutes of spotlighting and listening was conducted in the vicinity to check for bird and mammals attracted by the calls but not vocalising. Calls were broadcast using a portable compact disc player and amplified through a megaphone. All species responding to calls, including non-target species, were recorded.

***Spotlighting***

Spotlighting was used to target nocturnal frogs and arboreal, flying and large ground-dwelling mammals. Each spotlighting session was undertaken for a minimum period of 30 minutes by two ecologists on foot using two handheld 100 watt vari-beam spotlights. The speed of the spotlighting surveys was approximately 1 km per hour. Surveys concentrated on areas that contained suitable habitat for target species including larger patches woodland and waterbodies for frogs. All observations were identified to the species level and recorded.

***Anabat bat detection***

Ultrasonic Anabat Bat detection (either with a CF Storage ZCAIM or a SD1 unit, Titley Electronics Ballina) was used to record the echolocation calls of microchiropteran bats. Calls of echo-locating bats were interpreted by Rob Gration (Parsons Brinckerhoff).

In accordance with *Reporting Standards for bat detector use in Insectivorous Bat Survey* (Australasian Bat Society Inc 2007) a sample of 'frequency vs. time' graph for each species used as a reference library in the identification process has been provided in Appendix G. This appendix also provides an indication of the number of calls processed and the percentage of these that were identified.

***Cumberland Land Snail searches***

Searches for Cumberland Land Snail were done in all major woodland remnants in the study area in accordance with the Department of Environment, Climate Change and Water Environmental Impact Assessment Guidelines (National Parks and Wildlife Service 2000). Surveys involved active searches under logs and debris (including rubbish), amongst leaf and bark accumulations around the base of trees and within grass clumps.

An assessment of potential habitat was also done based on:

- the presence of Cumberland Land Snail or their shells
- the presence of Cumberland Plain Woodland
- the amount of groundcover present
- whether the habitat was at the edge or within the known expansion range of the species.

Snail shell specimens from woodland remnants were collected for verification by Martyn Robinson of the Australian Museum, Sydney.

***Herpetofauna surveys***

Herpetofauna (frogs and reptiles) census involved 1 ha diurnal searches. Species were recorded by sightings, characteristic calls (for frogs) and by searching under logs and leaf litter. Incidental sightings outside of standardised searches were recorded and the location described.

Species of frog were also targeted during diurnal searches and identified by their characteristic calls. These searches were completed in conjunction with call playback and spotlighting surveys for the Green and Golden Bell Frog (*Litoria aurea*).

## 3.7 Aquatic habitat assessment

The aquatic habitat assessment of each waterway crossing followed the relevant NSW Fisheries Policy and Guidelines (Fairfull & Witheridge 2003) and involved a description of the following habitat features:

- type and condition of vegetation in the riparian zone
- type and condition of in-stream vegetation
- presence of fish habitat, including large woody debris
- bank undercuts and scouring
- presence of barriers to fish passage into and beyond the site.

Based on these features, the fish habitat potential of each waterway crossing was classified in accordance with the relevant NSW Fisheries Policy and Guidelines (Fairfull & Witheridge 2003).

**Table 3-4 Waterway fish habitat classification**

| Classification | Characteristics of Waterway Type |
|---|---|
| Class 1<br>Major fish habitat | Major permanently or intermittently flowing waterway (e.g. river or major creek), habitat of a threatened fish species. |
| Class 2<br>Moderate fish habitat | Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi - permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area. |
| Class 3<br>Minimal fish habitat | Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi - permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats. |
| Class 4<br>Unlikely fish habitat | Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present). |

Based on Fairfull & Witheridge (2003).

## 3.8 Faunal survey effort

Table 3-5 provides a summary of the fauna survey effort for this assessment.

**Table 3-5 Fauna survey effort within the study area**

| Date | Survey type | Survey effort | Location description (Survey area/Fauna habitat type) |
|---|---|---|---|
| 04/03/2008 | Diurnal bird census | 90 minutes<br>(3 x 30 minute census) | Non-certified lands between Camden Valley Way and Cowpasture Road<br>Open Woodland to cleared areas (paddocks) |
| 05/03/2008 | Diurnal bird census | 30 minutes | Non-certified lands between Camden Valley Way and Cowpasture Road<br>Open Woodland to cleared areas (paddocks) |
| 05/03/2008 | Diurnal bird census | 30 minutes | Edmondson Park East. Remnant Woodland |
| 05/03/2008 | Diurnal bird census | 30 minutes | Edmondson Park West. Remnant Woodland |
| 06/03/2008 | Diurnal bird census | 30 minutes | James Meehan Estate. Open paddock/cleared grassland |
| 16/04/2008 | Diurnal bird census | 30 minutes | Kemps Creek |
| 17/04/2008 | Diurnal bird census | 30 minutes | Ingleburn Defence Site |

| Date | Survey type | Survey effort | Location description (Survey area/Fauna habitat type) |
|---|---|---|---|
| 04/03/2008 | Anabat | 15 hours | Non-certified lands between Camden Valley Way and Cowpasture Road<br>Farm dam surrounded by open woodland |
| 04/03/2008 | Anabat | 13 hours | Non-certified lands between Camden Valley Way and Cowpasture Road<br>Farm dam surrounded by open woodland |
| 05/03/2008 | Anabat | 18 hours | Edmondson Park. Remnant Woodland |
| 05/03/2008 | Anabat | 15 hours | Edmondson Park. Remnant Woodland surrounding drainage line |
| 06/03/2008 | Anabat | 16 hours | Non-certified lands between Camden Valley Way and Cowpasture Road<br>Farm dam surrounded by open woodland |
| 15/04/08 | Anabat | 12 hours | Non-certified lands surrounding Kemps Creek |
| 16/04/08 | Anabat | 12 hours | Non-certified lands surrounding Kemps Creek |
| 16/04/08 | Anabat | 12 hours | Non-certified lands on south side of Campbelltown Road |
| 17/04/08 | Anabat | 12 hours | Non-certified lands on Ingleburn Defence Site |
| 17/04/08 | Anabat | 12 hours | Non-certified lands on Ingleburn Defence Site |
| 27/05/2008 | Anabat | 12 hours | James Meehan estate (southern flyover) |
| 5/03/2008 | Spotlighting and call playback (Green and Golden Bell Frog, Barking Owl, Masked Owl) | 2 hours | Edmondson Park |
| 6/03/2008 | Spotlighting and call playback (Green and Golden Bell Frog, Barking Owl, Masked Owl) | 4 hours | Non-certified lands between Camden Valley Way and Cowpasture Road<br>Farm dam surrounded by open woodland |
| 16/04/08 | Spotlighting and call playback (Green and Golden Bell Frog, Barking Owl, Masked Owl) | 3 hours | Non-certified lands surrounding Kemps Creek |
| 17/04/08 | Spotlighting and call playback (Green and Golden Bell Frog, Barking Owl, Masked Owl) | 3 hours | Non-certified lands on the Ingleburn Defence Site |

| Date | Survey type | Survey effort | Location description (Survey area/Fauna habitat type) |
|---|---|---|---|
| 27/05/2008 | Spotlighting | 2 hours | James Meehan estate (southern flyover) |
| 4/03/2008 | Cumberland Land Snail search | 4 x 0.5 hours searches | Non-certified lands between Camden Valley Way and Cowpasture Road |
| 4/03/2008 | Cumberland Land Snail search | 2 x 0.5 hours searches | Non-certified lands south east of Camden Valley Way |
| 5/03/08 | Cumberland Land Snail search | 4 x 0.5 hours searches | Landcom lands at Edmondson Park |
| 15/04/2008 | Cumberland Land Snail search | 1 hour | Non-certified lands surrounding Kemps Creek |
| 16/04/08 | Cumberland Land Snail search | 1 hour | Non-certified lands on the Ingleburn Defence Site, eastern side of Campbelltown Road |
| 17/04/2008 | Cumberland Land Snail search | 2 hour | Non-certified lands on the Ingleburn Defence Site, western side of Campbelltown Road |
| 30/07/2008 | Cumberland Land Snail search | 1 hour | Site of proposed stockpile C |
| | | | |
| 30/07/2008 | Cumberland Land Snail search | 1 hour | Site of proposed stockpile F |
| 30/07/2008 | Cumberland Land Snail search | 1 hour | Site of proposed stockpile G |

## 3.9 Conservation significance

Assessment of the conservation significance of native flora and fauna is undertaken according to the following hierarchy:

1. national
2. state
3. regional
4. local.

Meaningful comparisons of significance or value at a variety of scales rely on widely accepted criteria (International Union for the Conservation of Nature 2001). The following criteria were used to assign an appropriate conservation significance category.

***National:*** remnant ecosystems containing populations of plant or animal species considered nationally vulnerable or endangered and listed on the *Environment Protection and Biodiversity Conservation Act 1999.* Also includes:

- Flora listed as threatened or rare in *Rare or Threatened Australian Plants* (Briggs & Leigh 1996).
- Species listed as endangered, vulnerable or rare in Australia in an Action Plan (published by Environment Australia) (Cogger *et al.* 1993; Duncan *et al.* 1999; Garnett & Crowley 2000; Maxwell 1996).

- Important habitat for Migratory species.

***State:*** remnant ecosystems containing populations of plant or animal species, or vegetation or animal communities considered Threatened in NSW, including species and communities listed under the *Threatened Species Conservation Act 1995*. This category also includes flora listed as poorly known in Australia in Rare or Threatened Australian Plants (Briggs & Leigh 1996).

***Regional:*** there are no widely accepted criteria for regional significance in NSW. The state is divided into bioregions (Thackway & Cresswell 1995) and much of the listing of Endangered Ecological Communities under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* are based around these regions. The NSW Government has set up Catchment Management Authorities to direct natural resource management in 13 general catchments. These authorities will incorporate earlier Regional Vegetation Management Plans that were required under the *Native Vegetation Conservation Act 1999*. In addition, numerous published studies and vegetation mapping projects have indicated the importance of vegetation and species at various spatial scales (NSW National Parks and Wildlife Service 2002d).

***Local:*** all remnant native vegetation and fauna habitat that does not fall into the categories above is considered to be of at least local significance, as most such areas have been reduced in extent since European settlement. The overall significance of the site on a local scale can take into consideration factors such as the size of fragments, degree of intactness and connectivity.

***Potentially significant:*** often, time constraints, the limitations of field methods or seasonal factors make it impossible to confirm the presence of significant flora or fauna species or populations. However, the habitat of an area being investigated may closely match that used by the significant species in areas nearby where it is known to occur. In these circumstances, the level of significance that would otherwise apply is qualified by 'potential'. In addition, some species or communities may possess characteristics that make them eligible for listing as threatened at either the State or National levels, although the listing has not yet taken place. Again, the level of significance for these species and communities is qualified by the term potential.

## 3.10 Impact significance assessment

### 3.10.1 Commonwealth listed biodiversity

The impact assessments followed the definitions given in Section 3.1. Tests for significance were completed for Threatened ecological communities, populations and species that were either:

- recorded in the study area, or
- recorded in the locality, with potential to occur in the study area.

For species and communities listed under the *Environment Protection and Biodiversity Conservation Act 1999,* significance assessments were undertaken in accordance with the administrative guidelines of the Department of the Environment, Water, Heritage and the Arts (Department of the Environment and Heritage 2006; Department of the Environment Heritage Water and the Arts 2009).

A Conservation Agreement for the Edmondson Park precinct has been signed between the Department of the Environment, Water, Heritage and the Arts, Department of Planning and Department of Environment, Climate Change and Water. This Conservation Agreement declares that a project approved under Part 3A of the *Environmental Planning and Assessment Act 1979* within the precinct is not likely to have a significant impact on threatened biodiversity and puts in place an offsetting arrangement funded through the infrastructure contributions of the growth centres. The assessment of impacts to biodiversity listed under the *Environment Protection and Biodiversity Conservation Act 1999* should therefore focus on impacts outside the Edmondson park precinct.

### 3.10.2 State listed biodiversity

The majority of the study area is within the South West Growth Centre certified area. Biodiversity certification switches off the need to undertake further significance assessments for Threatened species (under Section 5A of the *Environmental Planning and Assessment Act 1979*, the Seven Part Test). For species, populations and communities listed under the *Threatened Species Conservation Act 1995* or the *Fisheries Management Act 1994* that occur within non-certified areas, or outside the growth centre, significance assessments were carried out as required under the *Environmental Planning and Assessment Act 1979*. These followed the methods set by the Department of Environment, Climate Change and Water's *Draft guidelines for Threatened species assessment under Part 3A* (Department of Environment and Conservation 2005a).

## 3.11 Limitations

On all sites, varying degrees of non-uniformity of flora and fauna habitats are encountered. Hence no sampling technique can entirely eliminate the possibility that a species is present on a site (e.g. species of plant present in the seed bank). The conclusions in this report are based upon data acquired for the site and the environmental field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of survey, including the presence or otherwise of species. It should also be recognised that site conditions, including the presence of Threatened species, can change with time.

Where survey was undertaken outside the optimal time for detecting species, a precautionary approach was taken and it was assumed that the species was present if suitable habitat was observed.

# 4. Existing environment

This Section presents the findings of the desk-based assessments and field studies for the proposal. It describes the existing environment within the study area and the broader local environment. Specific reference to Threatened biodiversity or other significant features are presented in Section 5.

## 4.1 Landscape context

The study area traverses numerous lots with a variety of land uses, including rural residential properties (5 acre lots) with market gardens and/or light intensity grazing; land owned by the NSW Government (LandCom) that is rezoned for future residential development (Edmondson Park); housing and land owned by the Department of Defence; roads; and an existing railway corridor (at Glenfield). The remnant vegetation and fauna habitats along the study area have, therefore, been exposed to a range of past impacts and levels of disturbance and are located within an area of significant proposed development.

### 4.1.1 Bioregion

The study area lies within the Sydney Basin bioregion and the Cumberland subregion (Thackway & Cresswell 1995). This region lies on the central East Coast of NSW and covers 3,624,008 ha. As well as Sydney itself, the Sydney Basin Bioregion encompasses the towns of Wollongong, Nowra, Newcastle, Cessnock and Muswellbrook, and Blue Mountains towns such as Katoomba and Mt Victoria (NSW National Parks and Wildlife Service 2003b).

The region includes a significant proportion of the catchments of the Hawkesbury-Nepean, Hunter and Shoalhaven River systems; all of the smaller catchments of Lake Macquarie, Lake Illawarra, and the Hacking, Georges and Parramatta Rivers; and smaller portions of the headwaters of the Clyde and Macquarie Rivers. It consists of a geological basin filled with near horizontal sandstones and shales of Permian to Triassic age that overlie older basement rocks of the Lachlan Fold Belt. The sedimentary rocks have been subject to uplift with gentle folding and minor faulting during the formation of the Great Dividing Range (NSW National Parks and Wildlife Service 2003b). The Sydney Basin Bioregion is one of the most species diverse in Australia as a result of the variety of rock types, topography and climates.

The Sydney Basin Bioregion has the third highest area of conservation-oriented tenures of the NSW bioregions. Together, they occupy about 1,384,418 ha or 38.2% of the bioregion (NSW National Parks and Wildlife Service 2003b). The study area however does not contain, nor is it close to, any estate managed by the Department of Environment, Climate Change and Water. However, certified areas in the South West Growth Centre at Ingleburn Defence Site and Edmondson Park are subject to Condition 12 of the Biodiversity Certification order (refer Figure 2-1). The protection of native vegetation in these areas is considered essential to improve or maintain biodiversity values in the western Sydney and any impacts to these areas must be approved by the Department of Environment, Climate Change and Water. The study area also traverses the southern end of the Western Sydney Regional Parklands.

### 4.1.2 Mitchell landscapes

*Landscapes (Mitchell) of NSW* (NSW National Parks and Wildlife Service 2002e) outlines a system of ecosystem classification mapped at the 1:250,000 scale, based on a combination of soils, topography and vegetation. The study area is located within the Cumberland Plain landscape, which consists of low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast. The geology is characterised by Triassic shales, sandstones with Quaternary alluvium along the mains streams.

This landscape has been 91% cleared. Under the *Environmental Outcomes Methods of the Native Vegetation Ac*t (NSW Department of Natural Resources 2005), a landscape that is greater than 70% cleared is considered to be over-cleared.

### 4.1.3 The Cumberland Plain

The Cumberland Plain comprises gently undulating plains and low hills, rising gradually from the flat, low lying areas just above sea level in the north to an altitude of around 350 m on the rolling hills of the Razorback Range in the south (Tozer 2003). The dominant geological feature of the Cumberland Plain is Wianamatta shales comprising claystone, siltstone, laminite and fine to medium grained lithic sandstone that have weathered to form low fertility soils (Chapman & Murphy 1989). Significant areas of the shale are overlaid by Quaternary alluvium, derived from deposition and reworking of silty-clayey sands and gravels along watercourses and constitute some of the most fertile soils on the Cumberland Plain (Hazelton *et al.* 1989).

The Cumberland Plain has a long history of clearing and disturbance. The gentle slopes and fertile soils had much higher capacity to support agricultural and urban development than the surrounding sandstone regions (Department of Environment and Conservation 2005b) and by the middle of the nineteenth century most of the Cumberland Plain was either being grazed or cultivated. Urban, commercial and industrial land uses since the second half of the twenty first-century contributed further to clearing of the Cumberland Plain (NSW National Parks and Wildlife Service 2002d; Tozer 2003). It is estimated that only 13% of the pre-European extent of native vegetation communities on the Cumberland Plain remain (Tozer 2003).

Broad scale mapping of the vegetation communities of the Cumberland Plain identified 18 vegetation communities (NSW National Parks and Wildlife Service 2002b), however there are three main communities (Table 4-1).

**Table 4-1 Main ecological communities within the study area**

| Vegetation Community | Description | Status | |
|---|---|---|---|
| | | TSC Act[1] | EPBC Act[1] |
| Shale Hills and Shale Plains Woodlands[2] | Typical on heavy clay soils, derived from both shale and alluvium. | Critically Endangered - listed as Cumberland Plain Woodland | Critically Endangered- listed as Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest |
| Shale Sandstone Transition Forest | Occurs at the edges of the Cumberland Plain where the shale-influenced soils gradually change to sandstone and includes the sub-communities with Low Sandstone Influence and High Sandstone Influence. | Endangered | Endangered |
| Alluvial Woodland and Riparian Forest | Found on the moister and the more fertile deposits along creeks and rivers (Department of Environment and Conservation 2005b). | Endangered- included in the listing of River-Flat Eucalypt Forest on Coastal Floodplains | - |

1 This is a summary of likely status of vegetation communities based on vegetation descriptions based in the broad scale mapping report. Individual patches of these communities may not conform to the legislative listing.

2 Although there is significant overlap in these communities, not all occurrences conform to both *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999* listings. The TSC listing includes Shale Plains Woodland, Shale Hills Woodland and derived grassland. The *Environment Protection and Biodiversity Conservation Act 1999* listing is based on preservation of larger, good quality remnants and does not include derived grassland or degraded woodland. The area calculations of *Environment Protection and Biodiversity Conservation Act 1999* listed community is based on Department of Environment, Climate Change and Water mapping and supported by our field data. Condition thresholds are used to identify remnants that conform to the *Environment Protection and Biodiversity Conservation Act 1999* listed community (see Section 3.5.3).

### 4.1.4 Corridors and connectivity

Wildlife corridors can be defined as 'retained and/or restored systems of (linear) habitat which, at a minimum enhances connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation' (Wilson & Lindenmayer 1995). Corridors can provide ecological functions at a variety of spatial and temporal scales, from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions.

Corridors serve a number of different functions in terms of conservation including:

- Providing increased foraging area for wide-ranging species.
- Providing cover for movement between habitat patches, and enhancing the movement of animals through sub-optimal habitats.

- Reducing genetic isolation.
- Facilitating access to a mix of habitats and successional stages to those species which require them for different activities (for example, foraging or breeding).
- Providing refuge from disturbances such as fire.
- Providing habitat in itself.
- Linking wildlife populations and maintaining immigration and recolonisation between otherwise isolated patches, which in turn may help reduce the risk of population extinction (Wilson & Lindenmayer 1995).

At a regional scale, habitats surrounding the study area on the Cumberland Plain have been over-cleared. Extensive areas of core habitat are located however to the east associated with the Woronora Plateau and to the west associated with the Greater Blue Mountains.

Regional connectivity models were mapped for the *Campbelltown Biodiversity Study* (Eco Logical Australia Pty Ltd 2004), the *Liverpool Biodiversity Study* (Eco Logical Australia Pty Ltd 2003c), using a buffer zone of 100 m. The 100 m buffer was identified as the minimum size needed to identify linkages that would be meaningful at a regional scale, and 'capture' enough existing patches to form a suitable backbone of the connectivity system. These corridors generally include riparian areas as well as larger remnant patches of vegetation. A regional habitat corridor was identified between Camden Valley Way (Cabramatta Creek) and Campbelltown Road, which includes some patches of remnant vegetation (refer Figure 4-1).

At the local scale, riparian habitats and associated alluvial woodland traversed by the study area represent important connectivity within the surrounding over-cleared landscape that not only provide specialised habitat, but are often used by more mobile species as movement corridors (Bennett 1990). These riparian areas include habitat along Kemps Creek and Cabramatta Creek (refer Figure 4-2). Within Edmondson Park, these riparian corridors have been mapped (along with large vegetation patches) as part of the Edmondson Park Ecological Assessment (Eco Logical Australia Pty Ltd 2003b).

Remnant trees in paddocks can be important in agricultural landscapes for the conservation of fauna in the region, as they can provide habitat to a range of fauna and help to maintain connectivity between larger patches of vegetation. This, in turn, contributes to the viability of faunal populations (Gibbons & Boak 2002). Vegetation within the locality however, is highly fragmented. Although this vegetation may function as part of a wider local and regional corridor system, the vegetation along the project alignment does not form part of a clearly defined wildlife corridor between larger areas of wildlife habitat.

The study area also traverses the southern end of the Western Sydney Regional Parklands which forms the foundation of a 27 km north south corridor between Blacktown and Liverpool Local Government Areas along Eastern Creek and the hills of Hoxton Park. The parklands include existing core conservation areas and nature reserves such as Sydney Catchment Authority managed lands around Prospect Reservoir and the open space between Prospect Reservoir and the South West Growth Centre.

## 4.2 Vegetation communities and fauna habitat types

Three native vegetation communities have been mapped (NSW National Parks and Wildlife Service 2002b) in the study area (refer Figure 4-1), these are:

- Shale Hills Woodland
- Shale Plains Woodland
- Alluvial Woodland.

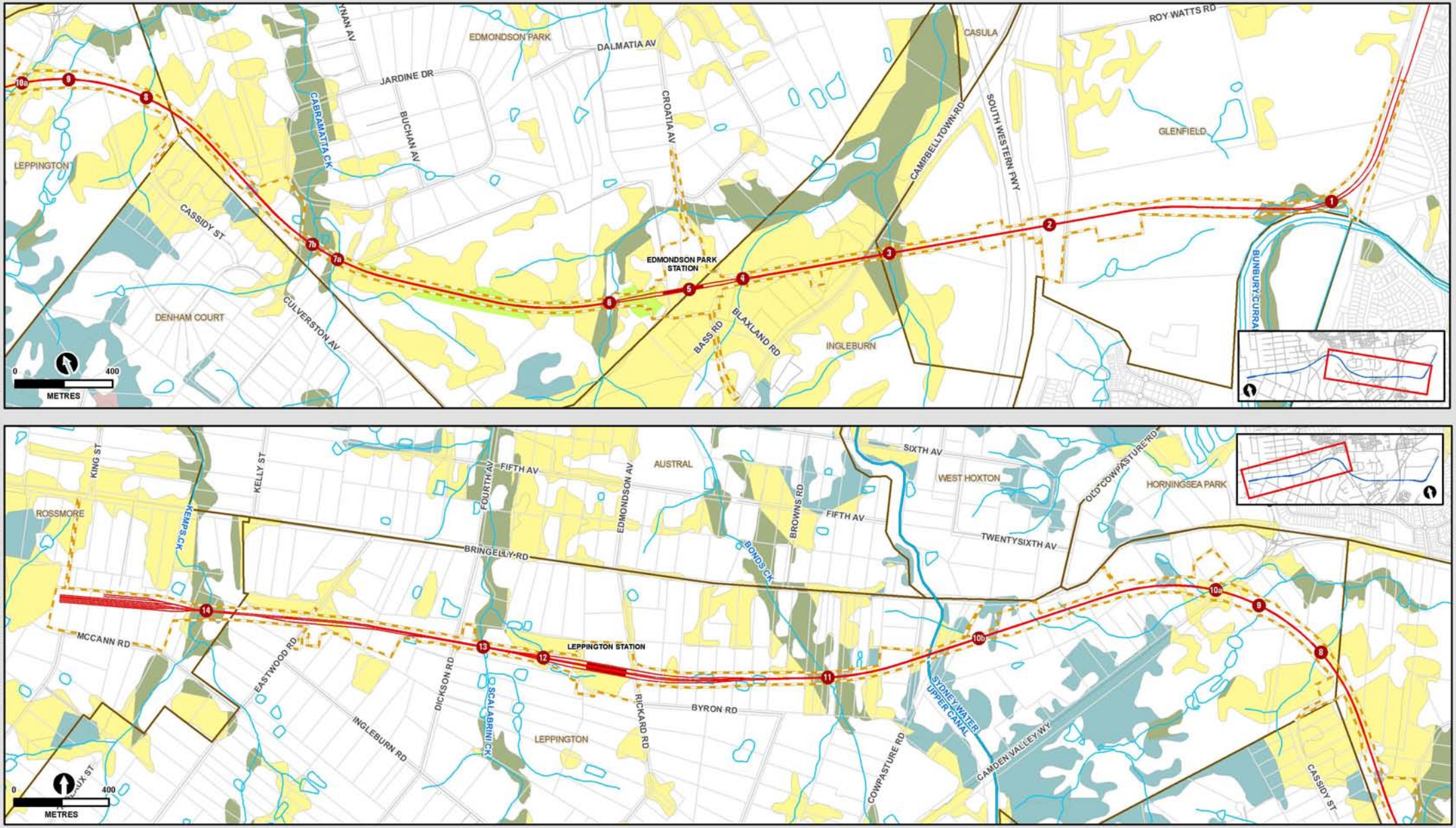
These communities occur as core habitat, support for core habitat and other remnant vegetation within the study area (refer Figure 4-2).

The remaining areas traversed by the project are areas mapped as 'No native vegetation overstorey' ((NSW National Parks and Wildlife Service 2002b). These areas comprise areas of grassland dominated by native and or exotic species, cleared paddocks, market gardens, roads, and industrial and residential areas.

### 4.2.1 Shale Hills Woodland

Shale Hills Woodland occurs on soils derived from Wianamatta Shale and occasionally on alluvium and is typically dominated by *Eucalyptus moluccana* and *E. tereticornis* (refer Photograph 4-1). The shrub layer is typically dominated by *Bursaria spinosa* and the ground cover has a high floral diversity (refer Table 4-2 for dominant species and structure of Shale Hills Woodland in the study area). Shale Hills Woodland is closely associated with Shale Plains Woodland and the communities may intergrade; however, Shale Hills Woodland occurs at higher elevations and on steeper slopes than Shale Plains Woodland.

Shale Hills Woodland occurred in fragmented patches within the Western Sydney Regional Parklands between Camden Valley Way and Cowpastures Road (refer Figure 4-1). The condition of the community in these patches was generally poor (refer Table 4-3).




1 Waterway crossing

Cadastre

Suburbs

Drainage

Proposed track

Clearing footprint*

**Cumberland Plain Woodland** [1]

Shale Hills Woodland

Shale Plains Woodland

**Sydney Coastal River-flat Forest** [1]

Alluvial Woodland

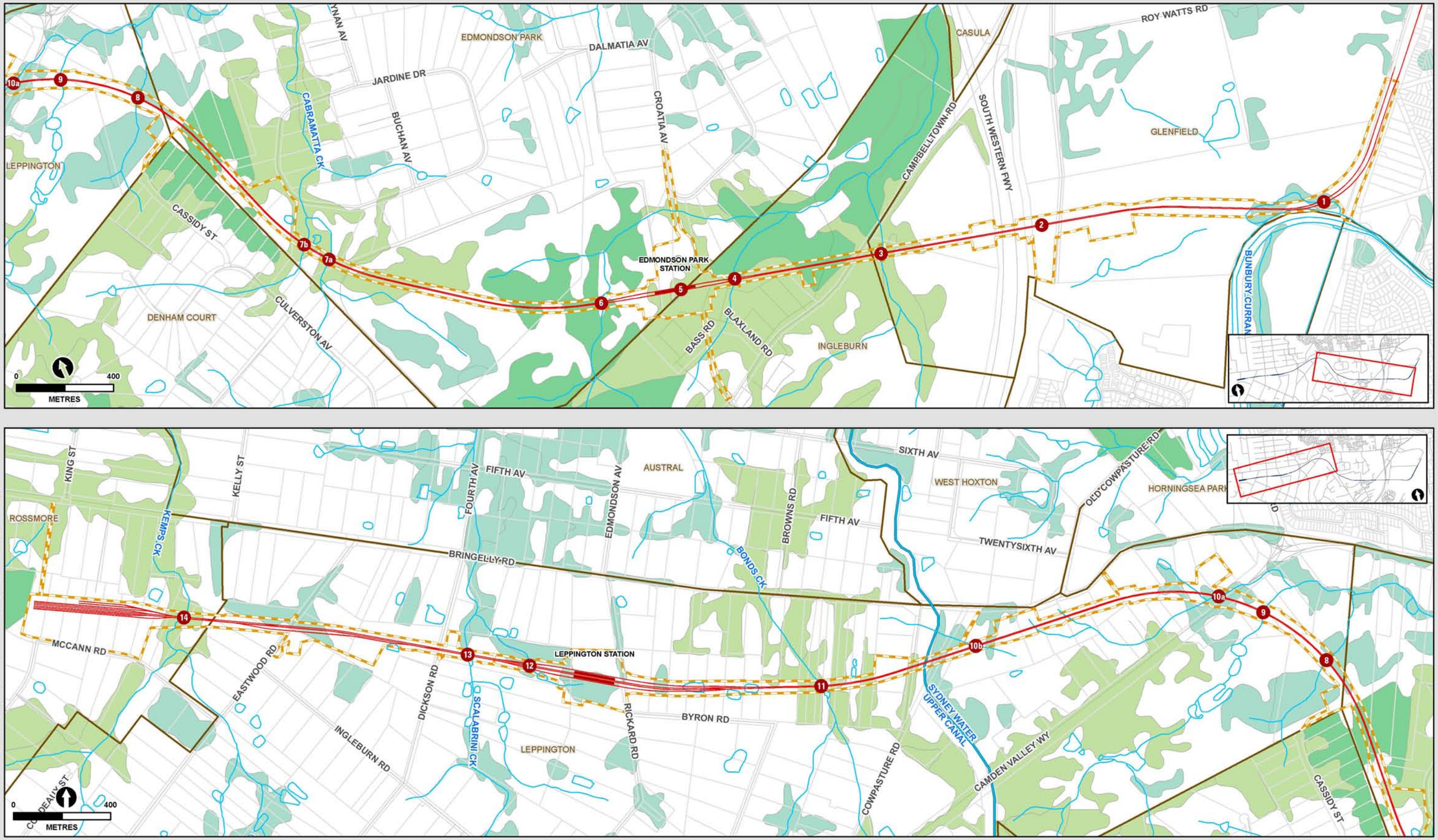
Derived native grasslands

1 - NSW National Parks and Wildlife Service (2002) *Native Vegetation of the Cumberland Plain.* NSW NPWS, Hurstville

***Note:** Clearing footprint includes likely stockpiles and construction compounds*

**Figure 4-1** Vegetation communities

PARSONS BRINCKERHOFF

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1 Waterway crossing
Cadastre
Suburbs
Drainage
Proposed track
Clearing footprint

**Conservation Significance Assessment Classes** [1]

Core Habitat
Support to Core Habitat
Other Remnant Vegetation

1 - NSW National Parks and Wildlife Service (2002) *Native Vegetation of the Cumberland Plain*. NSW NPWS, Hurstville

**Figure 4-2** Conservation significance of Cumberland Plain vegetation

**Table 4-2 Dominant species in the Shale Hills Woodland**

| Strata | Height range and % foliage cover | Dominant species |
|---|---|---|
| **Canopy** | 8 - 14 m<br>10 -30 % | *Eucalyptus moluccana* and *Eucalyptus tereticornis* regrowth with *Melaleuca styphelioides* and *Exocarpos cupressiformis* occurring in the sub-canopy. |
| **Shrub stratum** | 1 - 4 m<br>10 -80% | The presence and composition of the shrub stratum was variable depending on the disturbance history and condition of the patch and was absent or dominated by exotic species at 60% of sites within the study area. Where present, a native shrub stratum was dominated by *Bursaria spinosa* with *Daviesia ulicifolia*, *Acacia decurrens* and *Acacia falcate.*<br><br>Dominant exotic species at modified sites included *Olea europaea* ssp. *Africana, Lycium ferocissimum, Gomphocarpus fruticosus, Lantana camara* and *Rubus fruticosus.* |
| **Ground cover** | 0.2 -1.0 m<br>55 - 100 % | The ground cover was the most diverse stratum in this community including 47 native and 44 exotic ground cover species. The composition of the ground cover generally dominated by exotic species including *Cynodon dactylon, Eragrostis curvula, Pennisetum clandestinum, Setaria verticillata, Paspalum dilatatum, Chloris gayana, Setaria gracilis, Ehrharta erecta, Stenotaphrum secundatum and Sporobolus africanus*; with other herbaceous weeds including *Senecio madagascariensis, Plantago lanceolata, Verbena bonariensis, Sida rhombifolia, Bidens pilosa, Bidens subalternans*, *Cirsium vulgare*, *Hypochaeris radicata*.<br><br>Common native species included *Themeda australis, Chloris truncata, Cymbopogon refractus, Aristida* sp. and *Microlaena stipoides*; with forbs such *Lomandra multiflora, Lomandra filiformis, Juncus usitatus* and *Dianella revoluta*; and other herbs including *Cheilanthes sieberi, Dichondra repens, Goodenia hederacea ssp. hederacea, Centella asiatica, Eremophila debilis, Einadia hastate, Hardenbergia violacea, Brunoniella australis* and *Wahlenbergia gracilis.* |

**Table 4-3 Shale Hills Woodland within the study area**

| Location | Condition | Conservation significance class[1] |
|---|---|---|
| Western Sydney Regional Parklands | Poor,<br>highly fragmented and weed dominated | Other remnant vegetation |

1. Conservation significance class as per the *Guidelines for the conservation significance assessment of the native vegetation of the Cumberland Plain, Western Sydney* (NSW National Parks and Wildlife Service 2002c).

**Photograph 4-1 Shale Hills Woodland in Western Sydney Regional Parklands (moderate condition)**

### 4.2.2 Shale Plains Woodland

Shale Plains Woodland occurs on gently undulating soils derived from Wianamatta Shale and is typically dominated by *Eucalyptus moluccana* and *E. tereticornis* with *E. crebra, Corymbia maculata* and *E. eugenioides* occurring less frequently (refer Photograph 4-2). A small tree stratum is commonly present consisting of the canopy species (*Eucalyptus* spp.) with other small tree species such as *Exocarpos cupressiformis*, *Acacia parramattensis* subsp. *parramattensis* or *Acacia decurrens*. The shrub layer is typically dominated by *Bursaria spinosa* and the ground cover may include a high diversity of grasses, forbs and herbs (refer Table 4-4 for dominant species and structure of Shale Plains Woodland in the study area).

**Table 4-4 Dominant species in the Shale Plains Woodland**

| Strata | Height range and % foliage cover | Dominant species |
|---|---|---|
| **Canopy** | 8 - 22 m<br>10 -40 % | *Eucalyptus moluccana* and *Eucalyptus tereticornis* with *Eucalyptus eugenioides*, *Eucalyptus fibrosa, Melaleuca styphelioides*, *Casuarina cunninghamiana* and *Eucalyptus amplifolia* also recorded in some patches. |
| **Shrub stratum** | 1 - 4 m<br>10 -80% | The presence and composition of the shrub stratum was variable depending on the disturbance history and condition of the patch and was absent or dominated by exotic species at 50% of sites within the study area.<br>Where present, a native shrub stratum was dominated by *Bursaria spinosa* with *Dillwynia sieberi, Acacia decurrens, Acacia implexa, Allocasuarina littoralis* and *Dodonaea viscosa* ssp. *cuneata*. Dominant exotic species at modified sites included *Olea europaea* ssp. *Africana* and *Lycium ferocissimum.* |

| Strata | Height range and % foliage cover | Dominant species |
|---|---|---|
| **Ground cover** | 0.2 -1.0 m<br>55 - 100 % | The ground cover was the most diverse stratum in this community including 85 native and 50 exotic ground cover species. The composition of the ground cover was variable depending on the disturbance history and condition of the patch.<br><br>Patches in good condition were dominated by native species of grass including *Themeda australis, Chloris truncata, Cymbopogon refractus, Aristida* sp., *Microlaena stipoides*; with forbs such as *Lomandra multiflora, Lomandra filiformis, Juncus usitatus, Dianella revolute,*; and other herbs including *Cheilanthes sieberi, Dichondra repens, Goodenia hederacea* ssp. *hederacea*, *Eremophila debilis*, *Hardenbergia violacea*, *Einadia hastate, Desmodium varians, Glycine tabacina* and *Brunoniella australis*.<br><br>Patches in poor condition were dominated by exotic grasses including *Paspalum dilatatum, Cynodon dactylon, Eragrostis curvula, Chloris gayana, Pennisetum clandestinum, Setaria verticillata, Sporobolus africanus* and *Axonopus fissifolius*; with other herbaceous weeds including *Senecio madagascariensis, Plantago lanceolata, Verbena bonariensis, Sida rhombifolia, Bidens pilosa, Bryophyllum tubiflorum, Cirsium vulgare* and *Hypochaeris radicata.* |

**Photograph 4-2** **Shale Plains Woodland in moderate condition at Landcom lands in the Edmondson Park precinct**

Shale Plains Woodland occurred at six locations in the study area and the condition ranged from poor to good, comprising areas of 'core habitat', 'support for core habitat' and 'other remnant vegetation' (refer Table 4-5). All Shale Plains Woodland sites in the study area had evidence of historical clearing (partial or complete) and most sites were dominated by regrowth. Mature habitat trees were only recorded at two locations, the Ingleburn Defence Site and the Landcom lands in the Edmondson Park precinct.

**Table 4-5 Shale Plains Woodland within the study area**

| Location | Condition | Conservation significance class |
|---|---|---|
| Ingleburn Defence Site west of the former housing areas | Good | Core habitat |
| Ingleburn Defence Site amongst the former housing areas | Poor | Support for core habitat |
| Landcom lands in the Edmondson Park precinct | Good and moderate | Core habitat and Support for core habitat |
| West of Jardine Road, Edmondson Park | Moderate | Core habitat and Support for core habitat |
| Western Sydney Regional Parklands | Poor | Other remnant vegetation |
| Cowpasture Road to Leppington (western limit of project) | Moderate and poor | Support for core habitat and Other remnant vegetation |

1. Conservation significance class as per the *Guidelines for the conservation significance assessment of the native vegetation of the Cumberland Plain, Western Sydney* (NSW National Parks and Wildlife Service 2002c).

### 4.2.3 Alluvial woodland

Alluvial Woodland is associated with drainage lines traversing Wianamatta Shale soils and is a diverse vegetation community that can be dominated by a range of different species (NSW National Parks and Wildlife Service 2002b). Within the study area this community occurred as one of two broad forms: *Eucalyptus tereticornis* or *E. amplifolia* with *Angophora floribunda, Angophora subvelutina* and / or *Melaleuca linearifolia* (refer Photograph 4-3); or dominated by *Casuarina cunninghamiana* (refer Photograph 4-4).

Despite the variability in the composition of Alluvial woodland, overall flora diversity was generally lower than in Shale Hills and Shale Plains Woodland with only 69 native species recorded in the community in the study area (refer Table 4-6 for dominant species and structure of Alluvial Woodland in the study area).

Alluvial Woodland occurred at six locations in the study area associated with drainage lines (refer Table 4-7). The condition of the Alluvial Woodland at these locations ranged from moderate to poor and comprised areas of 'core habitat', 'support for core habitat' and 'other remnant vegetation'.

**Photograph 4-3** **Alluvial Woodland dominated by *Eucalyptus tereticornis* at James Meehan Estate**

**Photograph 4-4** **Alluvial Woodland dominated by *Casuarina cunninghamiana* at Kemps Creek**

**Table 4-6 Dominant species in the Shale Plains Woodland**

| Strata | Height range and % foliage cover | Dominant species |
|---|---|---|
| **Canopy** | 10-22 m<br>10-30% | The canopy was variable between locations and included *Casuarina cunninghamiana, Eucalyptus amplifolia, Eucalyptus tereticornis, Eucalyptus moluccana, Eucalyptus crebra, Eucalyptus fibrosa, Angophora subvelutina Melaleuca decora, Melaleuca styphelioides* and *Melaleuca sieberi.* |
| **Shrub stratum** | 2-8 m<br>15-80 % | The presence and composition of the shrub stratum was variable depending on the disturbance history and condition of the patch and was absent or dominated by exotic species at 50% of sites within the study area.<br>The shrub stratum in patches dominated by Myrtaceous species was dominated by exotic species including *Olea europaea* ssp. *africana*, *Lycium ferocissimum, Ligustrum lucidum* and *Rubus fruticosus.* In patches dominated by *Casuarina cunninghamiana* the shrub stratum was largely absent or dominated by *Casuarina cunninghamiana* regrowth. Native shrub species that were recorded in this community included *Acacia decurrens, Leucopogon juniperinus, Bursaria spinosa, Exocarpos cupressiformis, Ozothamnus diosmifolius, Dillwynia sieberi, Acacia parramattensis, Rubus parvifolius* and *Dodonaea viscosa* ssp. *cuneata*. |
| **Ground cover** | 0.1-0.2<br>10-75 % | The ground cover at all Alluvial Woodland sites however was dominated by exotic species including *Cynodon dactylon, Asparagus asparagoides, Sida rhombifolia, Plantago lanceolata, Pennisetum clandestinum, Foeniculum vulgare, Bidens pilosa, Cirsium vulgare, Senecio madagascariensis, Cyperus Eragrostis, Chloris gayana* and *Paspalum dilatatum.*<br>Native ground cover species that were present in the Alluvial Woodland were generally species tolerant of poor draining soils such as *Einadia hastate, Dichondra repens, Carex appressa*, *Cynodon dactylon, Ajuga australis, Brunoniella australis, Cheilanthes sieberi, Commelina cyanea, Eriochloa pseudoacrotricha, Panicum simile, Tetragonia tetragonioides, Plectranthus parviflorus, Pratia purpurascens, Eremophila debilis, Microlaena stipoides* and *Alternanthera denticulate.* |

**Table 4-7 Alluvial woodland within the study area**

| Crossing[1] | Location | Dominant canopy species | Condition | Conservation significance class[2] |
|---|---|---|---|---|
| 1 | Bunburry Curran Creek | *Eucalyptus tereticornis* | Moderate | Other remnant vegetation |
| 3 | Unnamed tributary of Maxwells Creek South east of Campbelltown Rd | *Casuarina cunninghamiana* | Moderate | Support for core habitat |
| 6 | Tributary of Maxwells Creek, Edmondson Park, 300m west of station | *Melaleuca styphelioides* and *Angophora floribunda* | Moderate | Core habitat |
| 7a | Cabramatta Creek, Edmondson Park | *Casuarina cunninghamiana* | Moderate | Support for core habitat |

| Crossing[1] | Location | Dominant canopy species | Condition | Conservation significance class[2] |
|---|---|---|---|---|
| 11 | Bonds Creek, West of Cowpasture Rd, Leppington | *Eucalyptus moluccana* and *Eucalyptus tereticornis* | Poor | Support for core habitat |
| 14 | Kemps Creek, North of McCann Rd | *Casuarina cunninghamiana* | Poor | Support for core habitat |

1. Crossing numbers refer the waterway crossing numbers described in Section 4.5.2 and 6.7

2. Conservation significance class as per the *Guidelines for the conservation significance assessment of the native vegetation of the Cumberland Plain, Western Sydney* (NSW National Parks and Wildlife Service 2002c)

### 4.2.4 No native vegetation overstorey

The remaining areas traversed by the study area are mapped as 'No native vegetation overstorey' (NSW National Parks and Wildlife Service 2002b). These areas comprise a range of land uses and conditions that lack a native vegetation overstorey, including areas of derived grassland (exotic and native dominated). A total of 169 species of plant were recorded in areas of 'No native vegetation overstorey' including 93 native species and 76 exotic species.

Areas of No native vegetation overstorey include patches of derived native dominated grassland in the Edmondson Park Release Area (refer Figure 4-1). Areas of native dominated grassland are formed (derived) when the trees and shrub stratum is removed (cleared) in a manner that allows a native dominated ground cover to persist. Derived grasslands are not distinguished by broad scale vegetation mapping (NSW National Parks and Wildlife Service 2002b) as they cannot be distinguished from exotic dominated grasslands (paddocks) through aerial photograph interpretation.

Native groundcover species that occur in derived grasslands are a good indicator of an areas resilience (regeneration potential) (Department of Environment and Conservation 2005b). Some derived grasslands therefore, given suitable management such as exclusion of grazing or mowing, have potential to be regenerated to their former vegetation structure — within the study area this is likely to be Shale Hills or Shale Plains Woodland. An areas of derived grassland may therefore be consistent with the *Final determination to list Cumberland Plain Woodland as an endangered ecological community* (NSW Scientific Committee 1997) as a 'seral stage towards that [natural] structure'. ('Seral stage' refers to an intermediate stage of an ecological succession in an ecosystem advancing towards its climax community or structure).

The *Environment Protection and Biodiversity Conservation Act 1999* listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest community does not include derived grasslands or shrublands (Threatened Species Scientific Committee 2008a, 2008b), as such none of these areas would be consistent with this listed community.

Derived native dominated grassland may also provide potential habitat for disturbance tolerant Threatened species such as *Pimelea spicata*, *Pultenaea peduncularis* and Cumberland Land Snail.

**Photograph 4-5 Derived native grassland at Edmondson Park**

## 4.3 Species of plant

A total of 282 species of plant, representing 80 families, were recorded within the study area of which 113 (40%) were native (refer to Appendix B). No Threatened species of plant was recorded. The number of species of plant recorded in each community is summarised in terms of the number of species recorded in the study area and in each community (refer Table 4-8).

**Table 4-8 Number of species of plant recorded in the study area**

| Community | Total Number of species | Number of native species (% of total) | Number of introduced species | Number of sample sites |
|---|---|---|---|---|
| Shale Hills Woodland | 125 | 63 (50%) | 62 | 5 |
| Shale Plains Woodland | 198 | 129 (65%) | 69 | 19 |
| Alluvial Woodland | 120 | 69 (58%) | 51 | 6 |
| No native canopy overstorey / unclassified vegetation | 168 | 93 (55%) | 75 | 4 |
| **All communities** | **282** | **113 (40%)** | **169** | **34** |

Floral diversity was highest in the ground cover stratum for both natives and exotic species with grasses and other ground cover (forbs, ferns, herbs, training vines and prostrate shrubs) growth forms accounting for 60% of native species and 71% of exotic and non-endemic species (refer Figure 4-3).

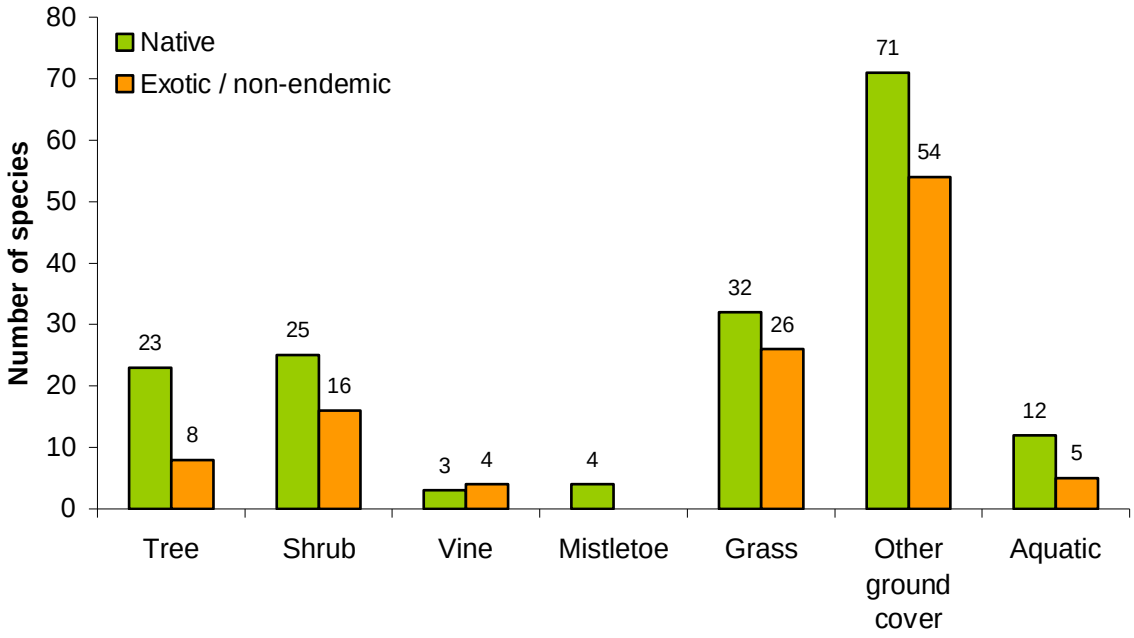


**Figure 4-3 Distribution of plant diversity by of growth form**

### 4.3.1 Weeds

One hundred and sixty-nine weeds (non-endemic or exotic species of plant) were recorded within the study area with weed diversity highest in the ground cover stratum (refer Figure 4-3).

The diversity and dominance of groundcover weeds was used as an indicator of disturbance history and condition. In modified areas (areas of no native canopy overstorey, unclassified vegetation and patches of remnant vegetation in poor condition) the ground cover was generally dominated by a combination of exotic grasses including *Pennisetum clandestinum, Axonopus fissifolius, Chloris gayana, Cynodon dactylon, Dactylis glomerata, Echinochloa crus-galli, Eleusine tristachya, Eragrostis curvula, Paspalum dilatatum, Setaria gracilis,* and *Sporobolus africanus.* A shrub stratum dominated by *Olea europaea* ssp. *africana, Lycium ferocissimum, Rubus fruticosus, Lantana camara, Ligustrum lucidum* or *Ligustrum sinense* was also an indicator of past disturbance and poor condition.

Fifteen species of plant recorded in the study area are listed under the *Noxious Weeds Act 1993* for the Camden Council, Campbelltown City Council or Liverpool City Council control areas and six are also listed as Weeds of National Significance (Thorp & Lynch 2000) (see Table 4-9). Of these species, *Myrsiphyllum asparagoides* was common in the patches of all remnant vegetation communities, *Lycium ferocissimum* was common in the Alluvial Woodland and *Lantana camara* and *Rubus fruticosus* were locally abundant in cleared areas such as in the Western Sydney Regional Parklands. The remaining species were generally sparse throughout the study area.

**Table 4-9 Weeds recorded in the study area**

| Family name | Botanical Name | Common name | NW Act control category[1] | WONS[2] |
|---|---|---|---|---|
| Amaranthaceae | *Alternanthera philoxeroides* | Alligator Weed | 3 | Y |
| Asparagaceae | *Myrsiphyllum asparagoides* | Bridal creeper | 5 | Y |
| Asteraceae | *Xanthium spinosum* | Bathurst Burr | 4 | |
| Cactaceae | *Opuntia* sp. | Prickly Pear | 4 | |
| Crassulaceae | *Bryophyllum tubiflora* | Mother-of-millions | 3 | |
| Oleaceae | *Ligustrum lucidum* | Large-leaved Privet | 4 | |
| | *Ligustrum sinense* | Small-leaved Privet | 4 | |
| Oxalidaceae | *Oxalis* sp. | | 5 | |
| Poaceae | *Sorghum halepense* | Johnson Grass | 4 | |
| | *Nassella neesiana* | Chilean needle grass | 4 | Y |
| Rosaceae | *Rubus fruticosus* | Blackberry complex | 4 | Y |
| Salicaceae | *Salix* sp. | Willow | 5 | Y |
| Solanaceae | *Cestrum parqui* | Green Cestrum | 3 | |
| | *Lycium ferocissimum* | African Boxthorn | 4 | |
| Verbenaceae | *Lantana camara* | Lantana | 5 | Y |

Notes: 1. *Noxious Weeds Act 1993*: 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.

2. Weeds of National Significance (Thorp & Lynch 2000).

## 4.4 Fauna habitats

The suitability, size and configuration of fauna habitat types correlated broadly with the structure, floristics, connectivity and condition of the vegetation communities described above (refer Table 4-10 and Figure 4-4).

**Table 4-10 Fauna habitats and their associated vegetation communities in the study area**

| Fauna habitat type | Vegetation community or location |
|---|---|
| Woodlands | ▪ Shale Hills Woodland<br>▪ Shale Plains Woodland<br>▪ Alluvial Woodland |
| Derived grasslands | ▪ No Native Canopy Overstorey / Unclassified vegetation |
| Developed areas | ▪ No Native Canopy Overstorey / Unclassified vegetation |
| Riparian and other aquatic habitat | ▪ Drainage lines within Alluvial woodland<br>▪ Minor drainage lines in Shale Hills Woodland and Shale Plains Woodland<br>▪ Drainage lines and other waterbodies in areas of No Native Canopy Overstorey / Unclassified vegetation |

### 4.4.1 Woodlands

Woodland fauna habitats consisted of the patches of remnant woodland vegetation communities including Shale Hills Woodland, Shale Plains Woodland and Alluvial Woodland. These woodland fauna habitats were interspersed with cleared areas of land including derived grasslands and developed areas.

Woodland habitats provide a range of fauna microhabitat resources. Eucalypts that dominate the woodlands provide an abundance of blossoms seasonally that are important feeding resources for nectivorous birds, arboreal mammals and the Threatened Grey-headed Flying-foxes. The presence of multiple *Eucalyptus* species across the woodland communities increases the likelihood that different species will be flowering throughout the year.

*Casuarina*, the other dominant genus in the Alluvial Woodlands, and to a lesser extent *Eucalyptus* spp., store seeds in nuts on the plant, providing a reliable resources base for many species of bird. High floral diversity in the shrub and groundcover stratum of woodlands also provide blossoms, fruit, seed and sap feeding resources across all seasons that support sedentary populations. Woodlands also support diverse communities of invertebrates, which in-turn provide an additional foraging resource for insectivorous fauna.

Mature eucalypts also develop hollows that are important roosting and nesting sites for obligate and opportunistic hollow using fauna including native birds, mammals (microbats, arboreal and scansorial), reptiles and frogs. The majority of the woodlands in the study area were however dominated by *Eucalyptus* regrowth that possessed few or no hollows. Mature eucalypts with hollows were however recorded at James Meehan Estate (the southern flyover), the Ingleburn Defence Site and within the Landcom lands at Edmondson Park.

Dense understorey and shrub vegetation, fallen timber, bark and leaf litter and dense ground cover vegetation also contribute to shelter and protection provided in woodlands. Structural diversity of the ground cover diversity was highest in the woodland patches with a native dominated understorey including sections of the Ingleburn Defence Site and within the Landcom lands at Edmondson Park. The Threatened Cumberland Land Snails was recorded at these locations.

No woodland fauna habitats in the study area were identified in an undisturbed state, however those in the Ingleburn Defence Site (excluding the areas amongst the former housing areas) and Landcom Lands in the Edmondson Park precinct were generally in good condition. The mosaic of woodland patches through these locations have local scale connectivity to other woodland habitats including Shale Plains Woodland in Edmondson Park, Alluvial Woodland along Cabramatta Creek and Shale Hills Woodland at Denham Court.

Woodland habitats in association with the Alluvial Woodland at James Meehan Estate and Kemps Creek were in moderate condition. Woodland habitat at James Meehan Estate is dominated by mature *Eucalyptus tereticornis* with numerous tree-hollows, however the understorey was dominated by weeds. This patch also has limited connectivity to Bunburry Curran Creek only. Woodland habitat in the study area at Kemps Creek has moderate connectivity to habitats along Kemps Creek, however is dominated by *Casuarina* regrowth that lacks hollow-bearing trees or a diverse native understory.

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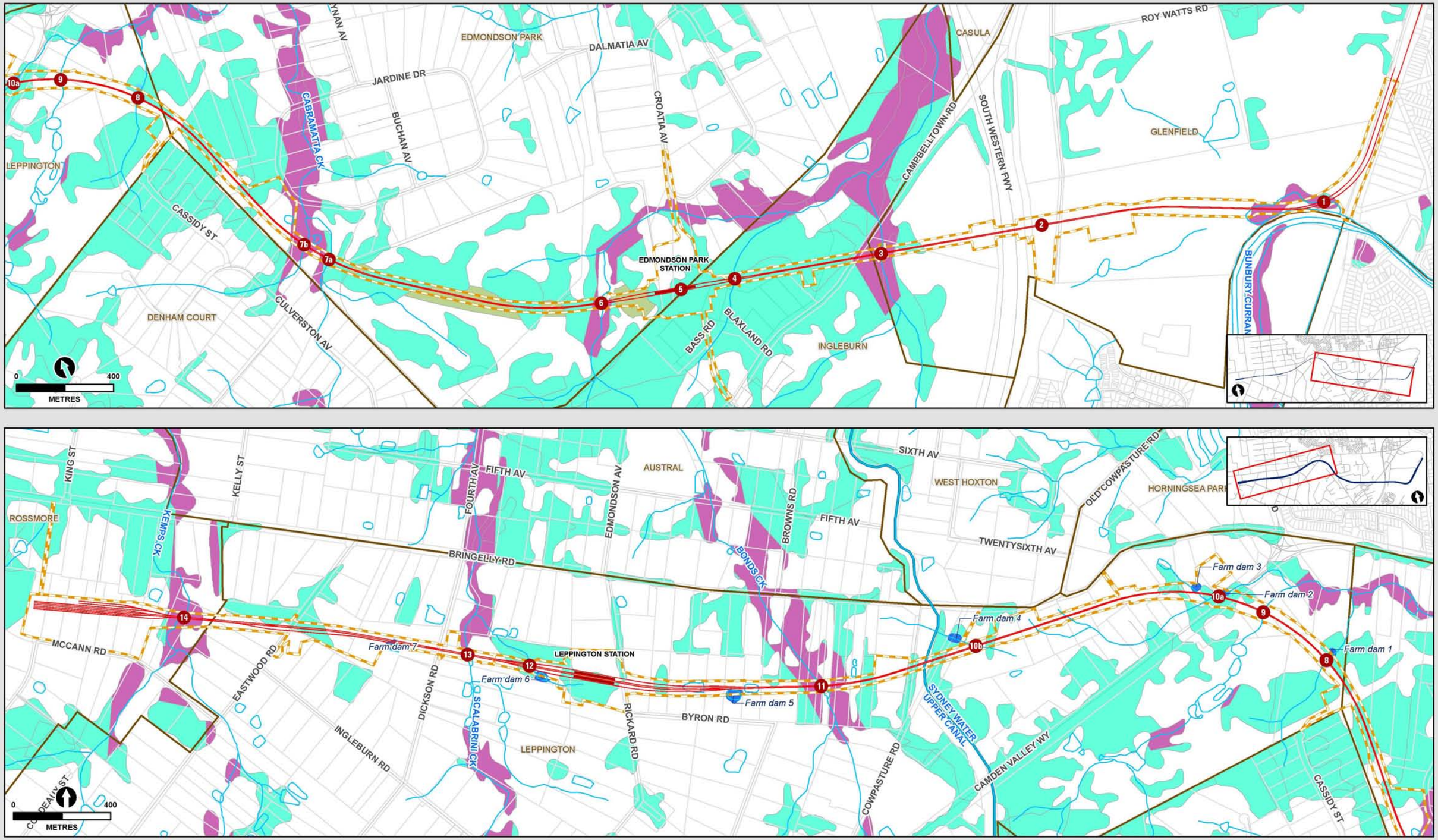


**Figure 4-4** Fauna habitat types

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The remaining woodland habitat in the study area consisted of small isolated patches of woodland commonly on properties used for grazing of livestock that were in poor condition. These patches were generally dominated by *Eucalyptus* or *Casuarina* regrowth, highly fragmented and lacked microhabitat elements such as tree–hollows, a diverse native shrub or ground cover, leaf litter or fallen timber. These isolated patches of woodland fauna habitat are however likely to act as stepping stones for the movement of fauna species between large fragments of habitat (Bennett 1990; Wilson & Lindenmayer 1995).

### 4.4.2 Derived grasslands

Derived grasslands are those areas where the native woodland vegetation has been cleared that are now dominated by a range of native and / or exotic grass and herb species. These areas generally corresponded with areas of No Native Canopy Overstorey (refer section 4.2.4) however may include some isolated mature (paddock) trees. Natural grasslands are not a naturally occurring vegetation community or fauna habitat type in the locality and represent highly modified woodlands. However, derived grasslands provide a range of fauna habitat elements that are limited or absent in woodland habitats thus increasing the overall fauna habitat diversity in the study area. The high floral diversity (native and exotic) and abundance of grasses provide a reliable and abundant source of seed throughout the seasons for species of bird that forage in open areas. The absence of canopy or shrub stratum also allows increased levels of light to reach the ground layer thus making them preferred reptile habitat during the cooler months. The absence of trees also provides good visibility for aerial hunting by raptors and preferred foraging habitat for some species of microbat that forage over cleared areas or along woodland edges.

Derived grasslands in good fauna habitat condition were dominated by native species, had high flora diversity (which may include native and exotic species) and had a high density of ground cover vegetation. Derived grasslands in this condition occurred in interspersed between the woodland habitats in the Landcom Lands in Edmondson Park which were dominated by *Themeda australis.*

Derived grasslands in moderate fauna habitat condition were those with a high floral diversity and a high density of ground cover vegetation dominated by exotic species. Derived grasslands in this condition occurred across much of the James Meehan Estate and Western Sydney Regional Parklands.

Derived grasslands in poor fauna habitat condition were those with a low flora diversity and low density of ground cover vegetation. Derived grasslands in this condition occurred in most of the remaining areas of No Native Canopy Overstorey throughout the study area.

### 4.4.3 Riparian and aquatic habitat

Riparian habitats provided optimal habitat for a range of vertebrate (particularly amphibians and reptiles) and invertebrate species. Riparian and aquatic habitats were associated with 11 of the 16 drainage lines and stormwater crossings and seven man-made waterbodies (farm dams) in the study area (refer Figure 4-4 and Table 4-11). In addition to the waterbodies listed in Table 4-11, there are three proposed roads that cross existing waterways, north and south of the proposed Edmondson Park station, These crossing are located upstream of Crossing 4, downstream of Crossing 6 and upstream of Crossing 10b. These additional crossings would need to be assessed as part of the detailed design for the project.

**Table 4-11 Riparian and other aquatic habitats**

| Crossing as per Figure 4-4 | Waterway / dam | Condition of riparian habitats | Fish habitat classification (Fairfull & Witheridge 2003)[1] |
|---|---|---|---|
| 1 | Bunbury Curran Creek | Poor - highly modified and dominated by weeds | Class 3 Minimal Fish Habitat |
| 2 | Unnamed stormwater drain at Quarter Session Road, Glenfield | Poor – no riparian habitat | Class 4 Unlikely Fish Habitat |
| 3 | Tributary of Maxwells Creek (south east of Campbelltown Rd) | Moderate - limited standing water however native dominated vegetation | Class 4 Unlikely Fish Habitat |
| 4 | Tributary of Maxwells Creek (in Ingleburn Defence site) | Moderate – minor ephemeral drainage line with limited riparian habitat | Class 4 Unlikely Fish Habitat |
| 5 | Tributary of Maxwells Creek (in Landcom lands in Edmondson Park) | Poor – undefined channel and no riparian habitat | Class 4 Unlikely Fish Habitat |
| 6 | Tributary of Maxwells Creek (in Landcom lands in Edmondson Park) | Moderate to good – small drainage line with semi-permanent pools, native dominated vegetation and large vegetated buffers | Class 3 Minimal Fish Habitat |
| 7a | Cabramatta Creek, Edmondson Park | Moderate - ephemeral drainage line with limited riparian habitat | Class 4 Unlikely Fish Habitat |
| 7b | Cabramatta Creek | Poor- drainage depression rather than a creek. Highly modified. | Class 4 Unlikely Fish Habitat |
| - | Farm dam 1 | Poor – no associated emergent aquatic vegetation | Class 4 Unlikely Fish Habitat |
| 8 | Unnamed tributaries of Cabramatta Creek 500m east of Camden Valley Way | Poor – minor depression channel across paddock | Class 4 Unlikely Fish Habitat |
| 9 | Unnamed tributary of Cabramatta Creek 150m east of Camden Valley Way | Poor – minor depression channel across paddock | Class 4 Unlikely Fish Habitat |
| 10a | Unnamed tributary of 100m west east of Camden Valley Way | Poor – minor depression channel across paddock | Class 4 Unlikely Fish Habitat |
| 10b | Unnamed drainage line | Poor- drainage depression rather than a creek. Highly modified. | Class 4 Unlikely Fish Habitat |
| - | Farm dam 2 | Poor – no associated emergent aquatic vegetation | Class 4 Unlikely Fish Habitat |
| - | Farm dam 3 | Poor – no associated emergent aquatic vegetation | Class 4 Unlikely Fish Habitat |
| - | Farm dam 4 | Moderate – some associated emergent aquatic vegetation | Class 4 Unlikely Fish Habitat |

| Crossing as per Figure 4-4 | Waterway / dam | Condition of riparian habitats | Fish habitat classification (Fairfull & Witheridge 2003)[1] |
|---|---|---|---|
| - | Sydney Water Canal | Poor – trapezoidal concrete channel | Class 4 Unlikely Fish Habitat |
| 11 | Bonds Creek | Poor - high density weeds and eroded banks | Class 4 Unlikely Fish Habitat |
| - | Farm dam 5 | Poor – no associated emergent aquatic vegetation, surrounded by market gardens | Class 4 Unlikely Fish Habitat |
| - | Farm dam 6 | Poor – no associated emergent aquatic vegetation, surrounded by market gardens | Class 4 Unlikely Fish Habitat |
| 12 | Unnamed stormwater drain | Poor – no riparian habitat | Class 4 Unlikely Fish Habitat |
| 13 | Scalabrini Creek | Poor - high density weeds and eroded banks | Class 4 Unlikely Fish Habitat |
| - | Farm dam 7 | Poor – no associated emergent aquatic vegetation, surrounded by market gardens | Class 4 Unlikely Fish Habitat |
| 14 | Kemps Creek | Moderate - ephemeral drainage line with limited riparian habitat | Class 3 Minimal Fish Habitat |

1. Fish habitat classification (Fairfull & Witheridge 2003) (refer Table 3-4): Minimal Fish Habitat (class 3): Permanent creek with clearly defined bed and banks and semi-permanent to permanent waters in pools. Freshwater aquatic vegetation is present. This creek supports potential fish habitat. Unlikely Fish Habitat (class 4): Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or freestanding water or pools after rain events.

Riparian habitats along the main drainage lines in the study area (Bunbury Curran Creek, tributaries of Maxwells Creek, Cabramatta Creek, Bonds Creek and Kemps Creek) were generally in moderate condition. Riparian habitats at these locations generally link into landscape scale fauna habitat corridors and are associated with remnant woodland vegetation (Alluvial Woodland). Bunbury Curran Creek and the tributaries of Maxwells Creek provided the best riparian habitats in the study area with semi-permanent pools and surrounding native vegetation. Cabramatta Creek, Bonds Creek, Scalabrini Creek and Kemps Creek provided lower quality riparian habitat for native fauna as they were smaller drainage lines dominated by *Casuarina cunninghamiana* with more intensive surrounding land uses.

Bunbury Curran Creek, one of the tributaries of Maxwells Creek, Scalabrini Creek and Kemps Creek also have potential to provide minimal fish habitat (permanent creek with clearly defined bed and banks and semi-permanent to permanent waters in pools, Fairfull & Witheridge 2003). The remaining drainage lines and farm dams in the study area provide unlikely fish habitat as they are ephemeral, only flow in response to localised rainfall and generally lack semi-permanent pools.

Farm dams in the study area also provided additional aquatic habitat, particularly for frogs and water birds. Farm dams in the study area however were generally in poor habitat condition with limited to no emergent aquatic vegetation and poor terrestrial vegetative

buffers. These dams are likely to support common species of frog only, as supported by the findings of the fauna surveys.

### 4.4.4 Developed areas

Developed areas included existing infrastructure, housing and industrial development and market gardens that have removed woodland or derived grassland habitat types. These areas generally do not provide habitat for native animals, except those species adapted to urbanised environments like parklands, bridges, roads, culverts and buildings. The fauna habitats of the highly modified areas were in poor condition.

## 4.5 Species of animal

Ninety-five species of animal were recorded in the study area during surveys carried out for this assessment comprising 84 native species and 11 introduced species (refer Appendix C). The most abundant and diverse group was birds, followed by mammals, reptiles and frogs (refer Figure 4-5).

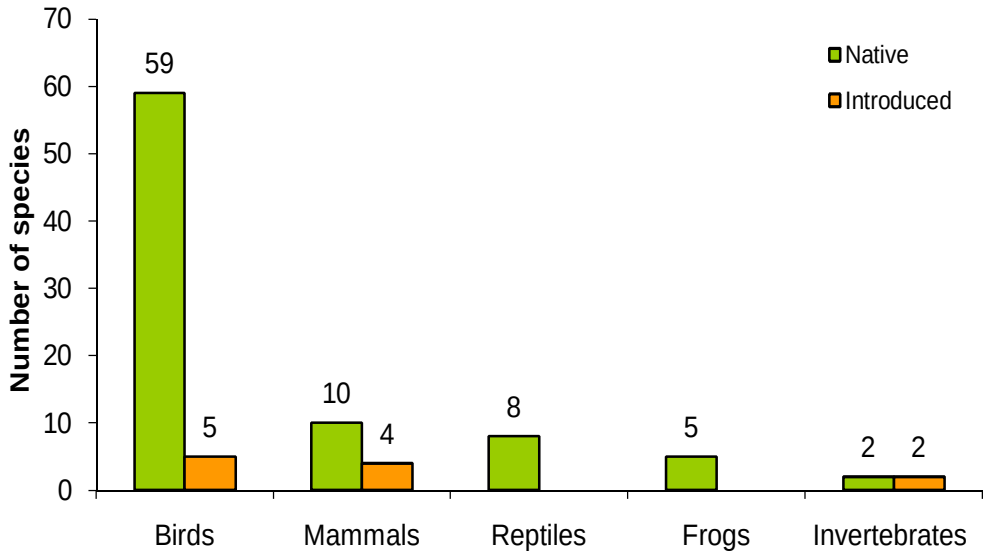


**Figure 4-5 Distribution of animal diversity by taxon**

### 4.5.1 Birds

Birds were the most diverse faunal group recorded in the study area and included 59 native species and five introduced species. The majority of the species of bird recorded are generalist species that are disturbance tolerant and relatively common in derived grasslands or fragmented landscapes. No Threatened species of birds was recorded in the study area.

Perching birds (including Passeriformes and Coraciiformes) were the most diverse group of birds in the study area with 37 species, including 3 introduced species. Perching birds included many common disturbance tolerant species that readily move across f the landscape (derived grassland and developed areas) such as Australian Raven (*Corvus coronoides*), Magpie (*Gymnorhina tibicen*), Magpie Lark (*Grallina cyanoleuca*), Laughing Kookaburra (*Dacelo novaeguineae*), Noisy Miner (*Manorina melanocephala*), Willie Wagtail (*Rhipidura leucophrys*), Welcome Swallow (*Hirundo neoxena*) and Tree

Martin (*Hirundo nigricans*). This group however also includes many woodland dependent species (disturbance sensitive) that are reliant on the remaining remnant vegetation in the locality for foraging and protection, such as Honeyeaters, Cuckoos, Mistletoebird, Robins and Thornbills. The perching bird group also included two migratory species: Rufous Songlark (*Cincloramphus mathewsi*) and Welcome Swallow.

Eight species of aquatic birds (Anseriformes, Ciconiiformes, Pelecaniformes, Gruiformes) were recorded in the study area. These species were generally recorded in, or close to, the drainage lines or farm dams (riparian and aquatic habitats).

The remaining species of bird consisted of 8 species of parrot, 4 species of dove and pigeons and 4 species of raptors and 1 species of wildfowl.

### 4.5.2 Mammals

Fifteen species of mammal were recorded in the study area consisting of 10 native species and 4 introduced species. Native species of mammal consisted of Common Brushtail Possum (*Trichosurus vulpecula*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and eight species of microbat.

Grey-headed Flying-fox were recorded flying over the study area and foraging in the Ingleburn Defence Site and the Alluvial Woodland at the James Meehan Estate. Grey-headed Flying-fox are also likely forage in all remnant vegetation in the locality as resources become available. No Grey-headed Flying-fox camps are known in the study area and the individuals recorded are likely to be from the Cabramatta Creek camp.

The Grey-headed Flying-fox and four of the species of microbat (Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*), Eastern Freetail-bat (*Micronomus norfolkensis*), Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*)) are Threatened species listed under the *Threatened Species Conservation Act 1995*. The Grey-headed Flying-fox is the only recorded Threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999* within the study area.

Introduced species of mammal (naturalised pests) recorded in the study area were fox, cat, rabbit and mouse. Introduced species of mammal did not include domesticated animals.

### 4.5.3 Frogs

Five common species of frogs were recorded in the study area. Common Eastern Froglet (*Crinia signifera*) was the most common species of frog recorded and occurred in most of aquatic habitats. None of the species of frog recorded within the study area are Threatened species listed under the *Threatened Species Conservation Act 1995* or *Environment Protection and Biodiversity Conservation Act 1999*.

### 4.5.4 Reptiles

Nine common species of reptile were recorded in the study area. The majority of reptiles in the study area were recorded in association with the woodland habitats where leaf litter and fallen timber provides suitable habitat. None of the species of reptile recorded within the study area are Threatened species listed under the *Threatened Species Conservation Act 1995* or *Environment Protection and Biodiversity Conservation Act 1999*.

### 4.5.5 Invertebrates

Invertebrate surveys targeted the Cumberland Land Snail and as such the results of this assessment are by no means representative of the total invertebrate diversity in the study area. Four species of snail were identified: two introduced species and two native, including the Threatened Cumberland Land Snail. The Cumberland Land Snail is listed as Vulnerable under the *Threatened Species Conservation Act 1995*.

# 5. Threatened biodiversity and other significant features

Threatened species, populations and ecological communities are key elements of biodiversity that are used as surrogates to assess the significance of impacts on biodiversity resulting from an action, or measure the ability of mitigation measures and offsets to improve or maintain biodiversity values.

This section details the Threatened biodiversity, other species of conservation concern and other significant features recorded or likely to occur in the study area, based on those recorded or predicted to occur within the locality and the nature of the habitats observed within the existing environment (refer to Section 4). The results presented in this section are based on assessment across the entire study area including both certified and non-certified areas.

Matters listed under the relevant state and Commonwealth legislation have been addressed separately. For those species and communities either recorder or considered likely to occur, assessment of the significance of impacts have been completed (refer Section 8).

## 5.1 State listed biodiversity and other significant features

### 5.1.1 Threatened ecological communities

Two Threatened ecological communities listed under the *Threatened Species Conservation Act 1995* were identified in the study area (refer Table 5-1). These ecological communities correspond with the broad scale mapping of vegetation communities in the study area (NSW National Parks and Wildlife Service 2002b, refer Figure 5-1).

**Table 5-1 Threatened ecological communities**

| Threatened Ecological Community | Corresponding vegetation communities in broad scale vegetation mapping[1] | Conservation status[2] |
|---|---|---|
| Cumberland Plain Woodland | Shale Plains Woodland<br>Shale Hills Woodland | Critically endangered |
| River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions | Alluvial woodland | Endangered |

1. Based on broad scale mapping of vegetation communities in the study area (NSW National Parks and Wildlife Service 2002b, refer Figure 5-1)

2. Conservation status as listed under the *Threatened Species Conservation Act 1995*

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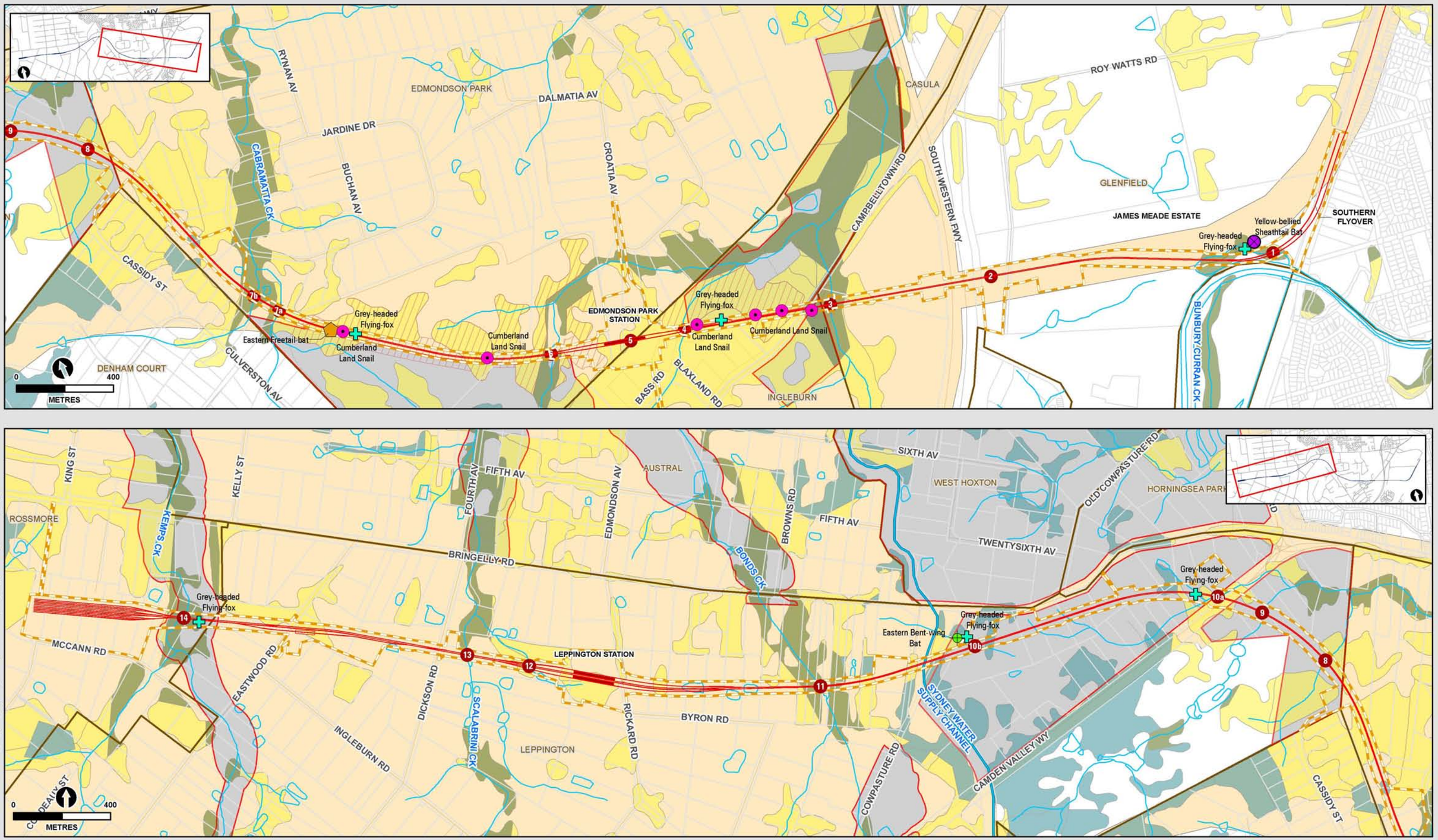


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1 Waterway crossing
Cadastre
Suburbs
Drainage
Proposed track
Clearing footprint

Non-certified areas
Certified areas
Cumberland Land Snail habitat

**Cumberland Plain Woodland**
Shale Hills Woodland
Shale Plains Woodland

**Sydney Coastal River-flat Forest**
Alluvial Woodland

**Threatened species recorded**
Cumberland Land Snail *(Meridolum corneovirens)*
Eastern Bent-wing Bat *(Miniopterus schreibersii oceanensis)*
Eastern Freetail-bat *(Mormopterus norfolkensis)*
Grey-headed Flying-fox *(Pteropus poliocephalus)*
Yellow-bellied Sheathtail Bat *(Saccolaimus flaviventris)*

**Figure 5-1** Threatened biodiversity recorded in the study area

### 5.1.2 Endangered populations

Two Threatened populations are listed in the Local Government Areas traversed by the project (Liverpool, Campbelltown and Camden).

The Endangered *Dillwynia tenuifolia* population at Kemps Creek has a distinct distribution (NSW National Parks and Wildlife Service 2002a), which is not located within the study area, as such it will not be affected by the proposal.

The Endangered *Marsdenia viridiflora* subsp. *viridiflora* population in Western Sydney occurs in moist shale, shale hills and shale plains woodland which correspond with Shale Plains Woodland, Shale Hills Woodland or Alluvial Woodland in the study area. This species was not recorded in the study area despite being detectable during survey at all times of the year. It is therefore considered unlikely to be present despite the presence of suitable habitat.

### 5.1.3 Threatened species of plant

Forty-one Threatened species of plant listed under the *Threatened Species Conservation Act 1995* are known or predicted to occur in the locality (refer Appendix D). No Threatened species of plant was detected during the surveys done for this assessment.

Potential habitat was detected for three Threatened species of plant during surveys undertaken for the concept plan (Parsons Brinckerhoff 2006b): *Acacia pubescens*, *Pimelea spicata* and *Pultenaea pedunculata*. Targeted searches for these species were subsequently undertaken in patches of potential habitat for these species and none were detected. As such, these species have been considered unlikely to occur.

### 5.1.4 Threatened species of fungi

Nine Threatened species of fungus are known to occur in the Cumberland Catchment Management Authority sub-region (refer Table 5-2).

**Table 5-2 Threatened species of fungi in the Cumberland Catchment Management Authority sub-region**

| Species | Conservation status [1] |
|---|---|
| *Camarophyllopsis kearneyi* | E |
| *Hygrocybe anomala* var. *ianthinomarginata* | V |
| *Hygrocybe aurantipes* | V |
| *Hygrocybe austropratensis* | E |
| *Hygrocybe collucera* | E |
| *Hygrocybe griseoramosa* | E |
| *Hygrocybe lanecovensis* | E |
| *Hygrocybe reesiae* | V |
| *Hygrocybe rubronivea* | V |

1. Conservation status as listed under the *Threatened Species Conservation Act 1995*. E = endangered. V = vulnerable.

These species are all major components of the *Hygrocybeae* community of Lane Cove Bushland Park, a Threatened ecological community listed under the *Threatened Species Conservation Act 1995.* This community occurs in warm temperate forests within the Lane Cover Bushland Park on unfertile and erodible Hawkesbury sandstone soils. Surveys for these species beyond the known Lane Cove location have recorded *Hygrocybe reeiae* and *Hygrocybe aurantipes* in the Hazelwood area and Mt Wilson in the Blue Mountains National Park, and *Hygrocybe anomala* var. *ianthinomarginata* from the Royal National Park and Blue Mountains National Park (Department of Environment and Climate Change 2008). These species are considered unlikely to occur in the study area due to lack of suitable habitat.

### 5.1.5 Threatened species of animal

Forty-eight Threatened species of animal listed under the *Threatened Species Conservation Act 1995* are known or predicted to occur in the locality comprising 14 mammals, 25 birds, 2 reptiles, 6 frogs and 1 invertebrate (refer Appendix E). Six Threatened species of animal were recorded in the study area, with one additional species not recorded but considered to have the potential to occur based on the presence of suitable habitat (refer Table 5-3).

**Table 5-3 Threatened species of animal recorded or likely to occur in the study area**

| Name | Conservation status [1] | Recorded |
|---|---|---|
| Cumberland Land Snail (*Meridolum corneovirens*) | E | Yes |
| Grey-headed Flying-fox (*Pteropus poliocephalus*) | V | Yes |
| Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) | V | Yes |
| Eastern Freetail-bat (*Micronomus norfolkensis*) | V | Yes |
| Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) | V | Yes |
| Greater Broad-nosed Bat (*Scoteanax rueppellii*) | V | Yes |
| Eastern False Pipistrelle *(Falsistrellus tasmaniensis)* | V | No |

1. Conservation status as listed under the *Threatened Species Conservation Act 1995*. E = endangered. V = vulnerable

### 5.1.6 Threatened species of fish

Two Threatened species of fish and one invertebrate listed under the *Fisheries Management Act 1994* are known or predicted to occur in the locality: Trout Cod (*Maccullochella macquariensis*), Macquarie Perch *(Macquaria australasica)* and Adam's Emerald Dragonfly (*Archaeophya adamsi*). No suitable habitat was identified for the Threatened species listed under the *Fisheries Management Act 1994* (refer Appendix E).

### 5.1.7 Critical habitat

Critical habitat is 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.

No declared critical habitat listed under the *Threatened Species Conservation Act 1995* occurs within the study area or locality.

## 5.2 Matters of National Environmental Significance

Matters of National Environmental Significance are listed and protected under the *Environment Protection and Biodiversity Conservation Act 1999*. The Act identifies eight Matters of National Environmental Significance:

- world heritage properties
- national heritage places
- wetlands of international importance (Ramsar wetlands)
- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mining).

Matters of National Environmental Significance relating to biodiversity are discussed below in relation to the project.

### 5.2.1 World heritage areas

World heritage properties include sites of both cultural and/or environmental heritage that are either an Australian property on the World Heritage List kept under the World Heritage Convention, or a property declared to be a World Heritage property by the Commonwealth Environment Minister.

No records of world heritage properties listed under the *Environment Protection and Biodiversity Conservation Act 1999* were identified from the Protected Matters Search Tool in the project locality.

The Greater Blue Mountains Area is the closest World Heritage Property to the proposed action. Given the distance from the project it is unlikely that this area would be affected either directly or indirectly.

### 5.2.2 Ramsar wetlands

No Ramsar Wetlands listed and protected under the *Environment Protection and Biodiversity Conservation Act 1999* occur in the study locality. Towra Point Nature Reserve (Ramsar Wetland) is located approximately 40 km to the south of the study area however, is unlikely to be affected by the proposal either directly or indirectly.

### 5.2.3 Threatened ecological communities

Three Threatened ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* were identified or predicted to occur in the study area (refer Table 5-4). Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest was the only ecological community listed under the *Environment Protection and Biodiversity Conservation Act 1999* identified in the study area (Figure 5-2). This listing includes the Shale Plains Woodland and Shale Hills Woodland vegetation communities that occur within the study area, although the definition of the listed community differs under both state and Commonwealth legislation.

Although there is significant overlap in the TSC and EPBC listed communities not all occurrences conform to both *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999* listings. The *Threatened Species Conservation Act 1995* listing includes Shale Plains Woodland, Shale Hills Woodland and derived grassland.

The *Environment Protection and Biodiversity Conservation Act 1999* listing is based on preservation of larger, good quality remnants and does not include derived grassland or degraded woodland. Condition thresholds are used to identify remnants that conform to this listing (see Section 3.5.3). The area calculations of *Environment Protection and Biodiversity Conservation Act 1999* listed community in this report are based on Department of Environment, Climate Change and Water mapping and supported by our field data.

**Table 5-4 Summary of Threatened ecological communities that are Matters of National Environmental Significance**

| Name | Conservation Status[1] | Recorded in study area |
|---|---|---|
| Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (includes Shale Plains and Hills Woodlands) | CE | yes |
| Shale/Sandstone Transition Forest | E | no |
| Turpentine-Ironbark Forest in the Sydney Basin Bioregion | CE | no |

1. E = Endangered, CE = Critically Endangered (*Environment Protection and Biodiversity Conservation Act 1999*).

### 5.2.4 Threatened species

Twelve Threatened species of plant and 20 Threatened species of animal listed under the *Environment Protection and Biodiversity Conservation Act 1999* have habitat in the locality (refer Table 5-5 and Appendices D and E). Of these species only one was recorded (Grey-headed Flying-fox). No other Threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999* was considered likely to occur in the study area.

Critical habitat may be listed for Threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999* if it is habitat critical to the survival of a species or ecological community. This refers to 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
- for the reintroduction of populations or recovery of the species or ecological community (Department of the Environment and Heritage 2006).

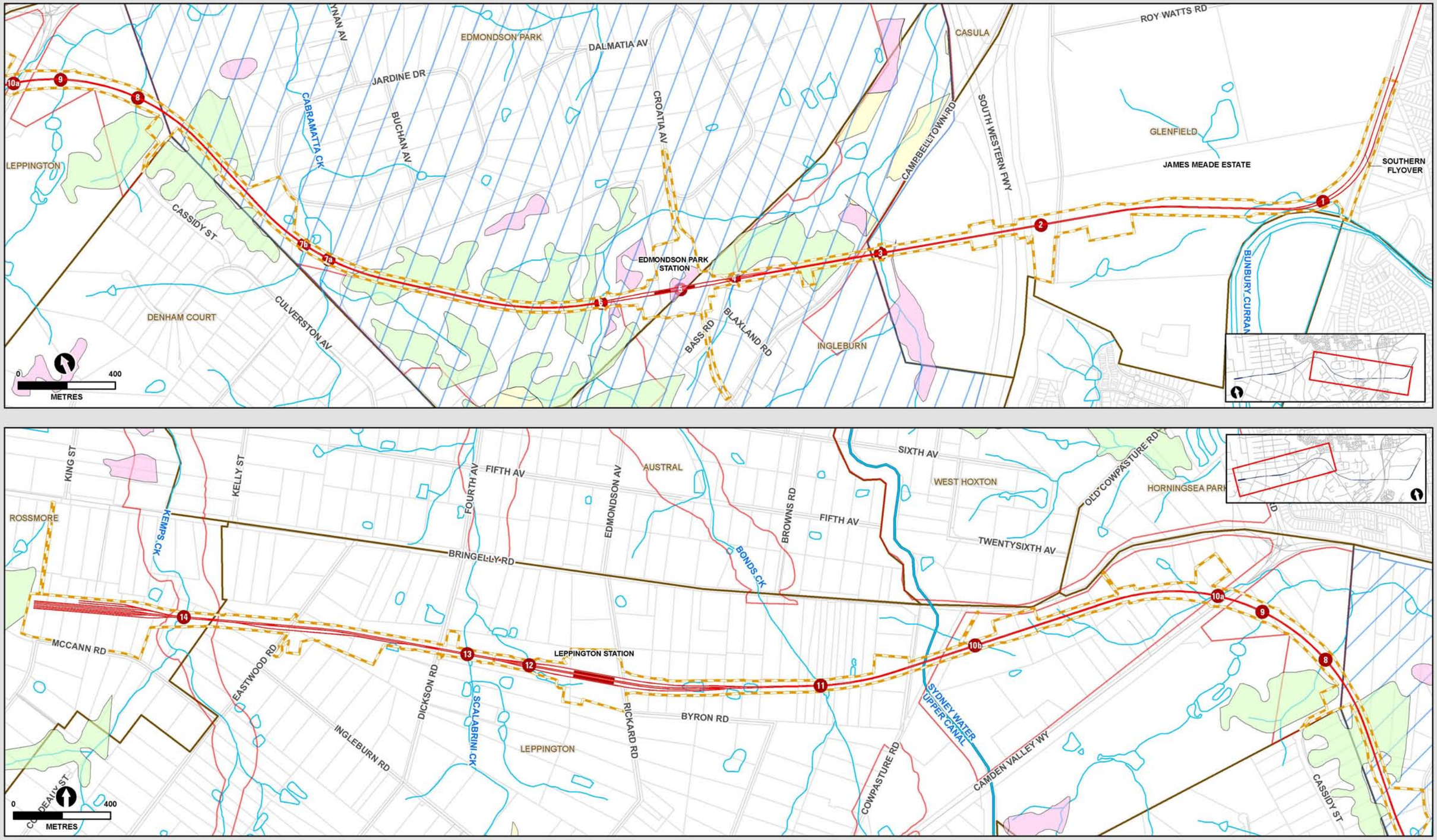


**Figure 5-2** EPBC-listed Cumberland Plain Woodland

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the *Environment Protection and Biodiversity Conservation Act 1999*.

No critical habitat on the Register of Critical Habitat (Department of the Environment Water Heritage and the Arts 2008) occurs within the study area. Further, no habitat in the study area was considered critical for Threatened species.

**Table 5-5 Commonwealth listed Threatened species**

| Name | Conservation Status[1] | Likelihood of occurrence |
|---|---|---|
| **Plants** | | |
| *Acacia pubescens* | V | Low |
| *Caladenia tessellata* | V | Low |
| *Cryptostylis hunteriana* | V | Low |
| *Cynanchum elegans* | E | Low |
| *Dillwynia tenuifolia* | V | Low |
| *Grevillea parviflora ssp. parviflora* | V | Low |
| *Haloragodendron lucasii* | E | Low |
| *Melaleuca deanei* | V | Low |
| *Persoonia nutans* | E | Low |
| *Pimelea spicata* | E | Low |
| *Pomaderris brunnea* | V | Low |
| *Pterostylis saxicola* | E | Low |
| *Pultenaea parviflora* | V | Low |
| **Frogs** | | |
| Giant Burrowing Frog (*Heleioporus australiacus*) | V | Low |
| Green and Golden Bell Frog (*Litoria aurea*) | V | Low |
| Heath Frog (*Litoria littlejohni*) | V | Low |
| Stuttering Frog *(Mixophyes balbus)* | V | Low |
| Giant Barred Frog *(Mixophyes iteratus)* | E | Low |
| **Birds** | | |
| Swift Parrot *(Lathamus discolour)* | E | Low |
| Orange-bellied Parrot *(Neophema chrysogaster)* | CE | Low |
| Painted Snipe *(Rostratula benghalensis)* | V | Low |
| Regent Honeyeater *(Xanthomyza Phrygia)* | E | Low |
| **Mammals** | | |
| Large-eared Pied Bat *(Chalinolobus dwyeri)* | V | Low |
| Spotted-tailed Quoll *(Dasyurus maculates)* | E | Low |
| Brush-tailed Rock-wallaby *(Petrogale penicillata)* | V | Low |
| Long-nosed Potoroo *(Potorous tridactylus)* | V | Low |

| Name | Conservation Status[1] | Likelihood of occurrence |
|---|---|---|
| Grey-headed Flying-fox *(Pteropus poliocephalus)* | V | High, recorded within study area |
| **Reptiles** | | |
| Broad-headed Snake *(Hoplocephalus bungaroides)* | V | Low |
| **Fish** | | |
| Trout Cod (*Maccullochella macquariensis*) | E | Low |
| Australian Grayling *(Prototroctes maraena)* | V | Low |

National conservation status as listed under the *Environment Protection and Biodiversity Conservation Act 1999.* V = Vulnerable E = Endangered, CE = Critically Endangered

### 5.2.5 Migratory species

Thirteen Migratory species were predicted to occur based on the Protected Matters Search Tool (refer Appendix E), including:

- Fork-tailed Swift (*Apus pacificus*)
- Great Egret (*Ardea alba*)
- Cattle Egret (*Ardea ibis*)
- Lathams Snipe (*Gallinago hardwickii*)
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
- White-throated Needletail (*Hirundapus caudacutus*)
- Rainbow Bee-eater (*Merops ornatus*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Satin Flycatcher (*Myiagra cyanoleuca*)
- Orange-bellied Parrot (*Neophema chrysogaster*)
- Rufous Fantail (*Rhipidura rufifrons*)
- Painted Snipe (*Rostratula benghalensis*)
- Regent Honeyeater (*Xanthomyza phrygia*).

In addition, the Square-tailed Kite was recorded previously in the locality (Atlas of NSW Wildlife) and this species is listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999*.

Migratory species are protected under international agreements to which Australia are a signatory. These include 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.

While migratory species of bird may potentially use the area (refer Appendix E), the site would not be classed as an 'important habitat' as defined under the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment and Heritage 2006), in that the site does not 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 development within the study area would significantly affect migratory species and this group is not considered further.

### 5.2.6 The Great Barrier Reef Marine Park

The Great Barrier Reef Marine Park is listed and protected under the *Environment Protection and Biodiversity Conservation Act 1999.* It is over 1000 km to the north, does not occur in the study locality and is unlikely to be affected by the proposal either directly or indirectly.

## 5.3 Commonwealth lands

The project traverses Commonwealth land at the former Ingleburn Military Camp which is Commonwealth land. The environment within the Ingleburn Military Camp that will be affected by the project consists of:

- Shale Plains Woodland in good condition on the north and south side of Campbelltown Road consistent with:
  - Cumberland Plain Woodland – listed as critically endangered under the *Threatened Species Conservation Act 1995.*
  - Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (includes Shale Plains and Hills Woodlands.
  - Shale Plains Woodland in poor condition on the north side of Campbelltown Road in association with area that has been subdivided for housing with a groundcover is dominated by *Pennisetum clandestinum* (Kikuyu) and other exotic species that is not consistent with the *Threatened Species Conservation Act 1995* or *Environment Protection and Biodiversity Conservation Act 1999* listed ecological communities.
  - Alluvial Woodland on the south side of Campbelltown Road consistent with the River-Flat Eucalypt Forest on Coastal Floodplains Endangered ecological community (state listed).
  - Fauna habitats associated with the Shale Plains Woodland and Alluvial Woodland including habitat for state and Commonwealth listed Threatened species.

Under the *Environment Protection and Biodiversity Conservation Act 1999* an approval is required if an action is taken by any person on Commonwealth land that is likely to have a significant impact on the environment (subsection 26(1) of the *Environment Protection and Biodiversity Conservation Act 1999*). The commonwealth lands however occur within the area of the Edmondson Park Conservation Agreement and therefore these impacts have not been considered further.

# 6. Potential impacts of the project

The project would result in a range of direct impacts on existing biodiversity within the construction corridor and potential indirect impacts on biodiversity in the surrounding landscape. These impacts include:

- clearing of native vegetation and disturbance of habitats
- habitat fragmentation
- edge effects
- direct mortality to plants and less mobile animals
- invasion and establishment of weeds and pest species
- increased noise
- cumulative impacts.

These impacts have the potential to affect the Threatened biodiversity identified as occurring, or likely to occur, in the study area.

This section describes the potential impacts of the proposal on the biological environment. Management measures to avoid, minimise and mitigate these potential impacts are discussed in Section 7. These impacts have been separated into impacts likely to occur during construction and impacts likely to occur during operation of the project.

## 6.1 Impacts during construction

### 6.1.1 Clearing of native vegetation

Clearing of native vegetation (land clearing) would be the major direct impact of the project on biodiversity in the study area. It is known to affect Threatened species of flora and fauna and is recognised as a key threatening process under both the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999,* under the following final determination titles:

- Clearing of native vegetation (*Threatened Species Conservation Act 1995*).
- Land clearance (*Environment Protection and Biodiversity Conservation Act 1999*).

Clearing of native vegetation has many adverse effects on both flora and fauna. These include:

- loss of local populations of individual species
- fragmentation of remnants of ecological communities (refer Section 6.1.3)
- introduction of edge effects (refer Section 6.1.4)
- reduction in the viability of ecological communities resulting from loss or disruption of ecological functions
- destruction of flora and fauna habitat and associated loss of biological diversity (habitat removal may include removal of hollow bearing trees, loss of leaf litter layer, changes to soil biota)
- soil erosion, increased salinity and loss of productive land
- riparian zone degradation

- increased habitat for invasive species (adapted from NSW National Parks and Wildlife Service 2001; NSW Scientific Committee 2004).

Clearing of native vegetation has been avoided where possible through the route selection and design process. Nonetheless, total avoidance of vegetation clearing was not possible and 28.9 ha of native vegetation and associated fauna habitat (including native dominated derived grasslands) will be cleared as a result of the proposal (refer Table 6-1). The extent of native vegetation that will be cleared comprises 5.0 ha in non-certified areas and 23.9 ha in certified areas.

Clearing will include 5.0 ha of state-listed Threatened ecological community within non-certified areas of the growth centres (Ingleburn Defence Site, Edmondson Park, Sydney Western Sydney Regional Parklands and Kemps Creek). The remainder of the clearing is within certified areas. Clearing also includes 0.4 ha of Commonwealth-listed Threatened ecological community outside of the Edmondson Park Conservation Agreement Area.

**Table 6-1 Loss of vegetation**

| Vegetation community | Extent of area (ha) | | | | |
|---|---|---|---|---|---|
| | Non-certified areas | Certified areas | Total extent of impact | Equivalent habitat within 1 km | Extent clearing within Edmondson Park Conservation Agreement area[2] |
| **Total construction footprint** | 19.8 | 69.8 | 89.6 | | 23.3 |
| **Vegetation community** | | | | | |
| Shale Plains Woodland | 2.4 | 18.1 | **20.5** | 484.5 (4%) | 12.2 |
| Shale Hills Woodland | 0.7 | 0.3 | **1.0** | 121.1 (1%) | 0.2 |
| Alluvial Woodland | 1.7 | 2.7 | **4.4** | 119.1 (4%) | 1.5 |
| Native dominated derived grasslands | 0.2 | 2.8 | **3.0** | * | 3.0 |
| **Total vegetation cleared** | **5.0** | **23.9** | **28.9** | **724.7 (4%)** | **16.9** |
| **Threatened ecological communities** | | | | | |
| Cumberland Plain Woodland (TSC Act) [1] | 3.3 | 21.2 | **24.5** | 605.6 (4%) | NA |
| Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (EPBC Act) [1] | NA | NA | **5.5** | 175.9 (3%) | **5.1** |
| River-Flat Eucalypt Forest on Coastal Floodplains (TSC Act) | 1.7 | 2.7 | **4.4** | 119.1 (4%) | NA |

* The Broad scale mapping of the vegetation communities can not distinguish native derived grasslands from other areas of 'No native vegetation overstorey', as such these percentage of equivalent habitat within the 1 km cannot be calculated for this vegetation community and fauna habitat type.

1: Although there is significant overlap in these communities, not all occurrences conform to both *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listings. The TSC listing includes Shale Plains Woodland, Shale Hills Woodland and derived grassland. The EPBC listing is based on preservation of larger, good quality remnants and does not include derived grassland or degraded woodland. The area calculations of EPBC listed community is based on Department of Environment, Climate Change and Water mapping and supported by our field data.

2: Clearing covered by the Edmondson Park Conservation Agreement forms part of the total extent of impact (clearing) and overlaps with the clearing in both certified and non-certified areas. However the conservation agreement and the biodiversity certification are separate legislative agreements and clearing should be considered separately for each.

### 6.1.2 Removal of key fauna habitat elements

Clearing of native vegetation would result in the removal of fauna habitat elements including direct and indirect feeding resources, dead trees (fallen and standing), tree hollows, dead wood (fallen) and leaf litter layer (refer Table 6-2). Fauna use these habitat elements for shelter, to hide from predators, find food, avoid extreme weather conditions and for breeding. A total of 28.9 ha of broad-scale fauna habitat would be removed, including 6.6 ha of habitat for the Cumberland Land Snail and 25.9 ha of habitat for bats (refer Table 6-2).

**Table 6-2 Loss of fauna habitats**

| Attribute | Extent (ha) | | | |
|---|---|---|---|---|
| | Non-certified areas | Certified areas | Total extent of impact | Equivalent habitat within 1 km |
| **Fauna habitat type** | | | | |
| Woodlands | 3.1 | 18.4 | 21.5 | 610.3 (3%) |
| Derived grasslands | 0.2 | 2.8 | 3.0 | * |
| Riparian and other aquatic habitat | 1.7 | 2.7 | 4.4 | 119.1 (4%) |
| TOTAL | 5.0 | 23.9 | 28.9 | |
| **Habitat of Threatened species of animal** | | | | |
| Cumberland Land Snail habitat | 0.9 | 5.7 | 6.6 | * |
| Grey-headed Flying-fox habitat | 4.8 | 21.1 | 25.9 | 729.4 (3%) |
| Microbat habitat | 4.8 | 21.1 | 25.9 | 729.4 (3%) |

1. The Broad scale mapping of the vegetation communities can not distinguish native derived grasslands from other areas of 'No native vegetation overstorey', as such these percentage of equivalent habitat within the 1 km cannot be calculated for this vegetation community and fauna habitat type.

The removal of certain fauna habitat elements is recognised as a key threatening process under the *Threatened Species Conservation Act 1995* under the following titles:

- removal of dead wood and dead trees
- loss of hollow-bearing trees.

These fauna habitat elements are limited resources, especially in modified landscapes, and are generally slow to reform following disturbance and many species of animal are dependent these habitat elements to complete their life cycle. For example, species of microbat, birds and possums roost and/or breed in tree hollows.

The area to be cleared as a result of the project consists of fragmented patches of woodland with limited dead trees, fallen dead wood or hollow bearing trees. These key fauna habitat elements would however be directly affected in the Alluvial Woodland at James Meade Estate (the southern flyover), Ingleburn Defence Site and the Landcom Lands at Edmondson Park.

Some areas of woodland and derived native grasslands habitats also provide ground cover resources including fallen timber, bark and leaf litter and dense ground cover vegetation which provide specialised habitat the Threatened Cumberland Land Snail.

Drainage lines and dams (aquatic and riparian habitats) are another fauna habitat type that may be affected by the project (refer Section 6.1.6 and Table 6.3). Aquatic habitats support

higher densities of frogs and insects that surrounding terrestrial environments. As such, they are focal points for a range of predators including various species of birds, reptiles and microbats. Up to seven farm dams, five named drainage lines and nine unnamed (minor) drainage lines are crossed by the project. The project may result in clearing of up to 4.4 ha of riparian vegetation (refer Table 6-2).

### 6.1.3 Habitat fragmentation

Habitat fragmentation is the process of sub-dividing a continuous habitat into smaller isolated fragments (Andren 1994; Ford *et al.* 2001) and can have adverse affect on both flora and fauna. The proposal is estimated to result in the fragmentation at five locations:

- Alluvial Woodland south-east of Campbelltown Road (non-certified area).
- Shale Plains Woodland north-west of Campbelltown Road (Ingleburn Defence Site) (non-certified area).
- Native dominated derived grasslands, Alluvial Woodland and Shale Plains Woodland at Edmondson Park (certified area).
- Alluvial Woodland and Shale Plains Woodland associated with Bonds Creek (certified area).
- Alluvial Woodland and Shale Plains Woodland associated with Kemps Creek (refer Figure 4-1)(non-certified area).

Habitat fragmentation as a result of the project will occur during construction, however will be an ongoing impact of operation of the project.

Habitats within the study area are already highly fragmented as a result of past land uses and are likely to be fragmented further though future development of lands surrounding the proposal associated with the Growth Centres. The additional fragmentation resulting from the proposal would be unlikely to have a significant impact on the viability of species that occur within most of the fragments. Floral species remaining in most of the remnants have a high level of resilience to disturbance and would continue to produce viable seed and germinate in the presence of disturbance factors. Faunal assemblages in most of the remnants are dominated by generalist species that would tolerate a high level of habitat disturbance. The use of fish friendly waterway crossings will also contribute to maintaining connectively at along drainage lines for a range of animals including terrestrial ground dwelling species.

Although the project will introduce a new barrier within the regional corridor network, this is unlikely to present a significant barrier within the already fragmented network for the reasons discussed above. It should be noted that the regional corridor network identified in the Edmondson Park Ecological Assessment (Eco Logical Australia Pty Ltd 2003b) included the proposed rail corridor. Although the project will present a barrier within this corridor network this is unlikely to be significant given the proposed development within the local area.

Species most likely to be adversely affected by fragmentation are those that are less mobile, such as the Cumberland Land Snail, which was recorded in remnant vegetation and bordering native derived grasslands in the Ingleburn Defence Site and the Landcom lands in Edmondson Park (refer Figure 5-1). Little is known about the movement of Cumberland Land Snail (NSW National Parks and Wildlife Service 1999), however the proposal would be likely to form a barrier to the movement of the snail.

### 6.1.4 Edge effects

Edge effects refer to the different microhabitat conditions that occur along the boundaries of remnants of native vegetation. These different microhabitat conditions result from differences in physical conditions, including altered light levels, wind speed, temperature and humidity (Lindenmayer & Burgman 2005).

Other edge effects may include:

- Physical and chemical disturbance to soils (including changes to soil nutrient levels resulting from altered hydrology and runoff) (Hill *et al.* 2005).
- Increased fine particulate (dust) deposits on vegetation containing clay particles and a range of nutrients and pollutants (Angold 1997).
- Increased penetration of feral predators, such as pet cats and dogs, into remnant vegetation (Goldman & Whelan 1997).
- Anthropogenic disturbances, such as increased rubbish dumping (Dunstan & Fox 1996) and rubbish deposition, vandalism and arson.
- Increased influx of exotic plant propagules (i.e. weed seeds).

Clearing of native vegetation would create new boundaries along the boundaries of the remaining patches of woodland vegetation, thereby creating edge effects in areas that were formerly buffered from these effects by adjoining vegetation. The changes to habitat resulting from the introduction of edge effects into previously 'core' areas of remnants would have implications for both flora and fauna.

A change in the microhabitat conditions in edge-affected areas increases the germination and establishment of exotic plants (weeds) — particularly the combination of an increase in light and soil nutrients (from altered hydrology and fine particles). Construction activities have the potential to disperse weeds into areas of remnant vegetation where they do not currently occur. The most likely causes of weed dispersal associated with the project would include earthworks, movement of soil and attachment of seed (and other propagules) to vehicles and machinery. The increased influx of weed seeds (and other propagules) may also contribute to a change in the floristic composition and structure along edges. The species of weed that are of highest risk during the construction period are species that have a short life cycle and are able to germinate in high densities, develop quickly and produce seeds in a short time frame (i.e. grass and annual weeds). These species are likely to rapidly establish in any cleared areas and stockpiles. Other weeds that are of high risk during construction are weeds that are difficult to control once established that may be moved as a result of earthworks. This is a particular threat from species that can reproduce vegetatively such as *Alternanthera philoxeroides* (Alligator Weed), *Opuntia* sp. (Prickly Pear), *Bryophyllum tubiflora* (Mother-of-millions) and *Anredera cordifolia* (Madeira Vine).

Many studies have investigated the distance into remnant vegetation within which edge effects may be detected (Baker et al. 2002; Bali 2000; Goldingay & Whelan 1997; Harris 1988); however, the distance varies with the effect being investigated and the structure of the habitat affected. Based on the findings of Bali (2000), a distance of 50 m from the edge of the estimated construction footprint has been used as a likely extent of edge effects

resulting from the project. Based on this distance, the only areas that would be subject to new edge effects as a result of the proposal would be the larger woodland remnants in Edmondson Park (i.e. between Campbelltown Road and Camden Valley Way). Approximately 10 ha of Cumberland Plain Woodland and 1.0 ha of Alluvial Woodland would be subject to new edge effects, occurring mainly in the area of the Ingleburn Defence Site within the Edmondson Park precinct.Direct mortality to plants and less mobile animals

### 6.1.5 Direct mortality to plants and less mobile animals

Fauna injury or death could occur as a result of construction activities, such as:

- vegetation (fauna habitat) clearing
- collision with vehicles or plant
- incidental trapping or drowning in trenches or other earthworks.

While some mobile species, such as birds, may be able 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 find it difficult to move rapidly over large distances.

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 Cumberland Land Snail and microchiropteran bats.

Cumberland Land Snail will be affected at all locations in the study area where they were recorded through (Ingleburn Defence Site and Edmondson Park, refer Figure 5-1). Microchiropteran bats have potential to be affected wherever remnant woodland vegetation is being cleared.

### 6.1.6 Alteration of the natural flow regimes of rivers, streams, floodplains and wetlands

Barriers to fish passage from the installation of waterway crossings can occur temporarily (i.e. during construction) and/or over the long term if inappropriate structures are used. During construction, run-off from disturbed surfaces could potentially affect water quality in local creeks due to sedimentation. In addition, there is the potential for accidental spillage/leakage of construction materials, fuels, lubricants and hydraulic oils from construction equipment.

Sixteen watercourse and stormwater crossing are proposed along the project as well as the Sydney Water Canal and six farm dams. Table 6-3 provides a comparison of the faunal requirement for each proposed crossing structure at each watercourse and stormwater crossing and farm dam. An additional three crossings will be constructed (upstream of Crossing 4, downstream of Crossing 6 and upstream of Crossing 10b) and these will be assessed further as part of the detailed design.

Overall the existing aquatic habitats at the site and in the study area are highly degraded and in poor condition, with numerous barriers to fish migration, modification of riparian vegetation and habitats, and a general lack of in-stream habitat diversity like large woody debris. No Threatened species of animal was identified that is likely to be dependent on the aquatic habitats within the study area.

**Table 6-3 Comparison of faunal requirements with proposed crossing structures**

| Crossing as per Figure 4-1 | Waterway / dam | Condition of riparian habitats | Fish habitat classification (Fairfull & Witheridge 2003) | Proposed Crossing structure (WMA) | Minimum requirements for fish passage | Riparian connectivity requirement | Overall assessment of proposed crossings for biodiversity |
|---|---|---|---|---|---|---|---|
| 1 | Bunbury Curran Creek | Poor - highly modified and dominated by weeds | Class 3 Minimal Fish Habitat | Viaduct Structure | Culverts required and designed to allow fish passage. Invert should be designed to ensure it is below the bed level of the watercourse, and that ponding can occur. | None | Adequate |
| 2 | Unnamed stormwater drain at Quarter Session Road, Glenfield | Poor – no riparian habitat | Class 4 Unlikely Fish Habitat | Divert to crossing 1 | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | None | Adequate |
| 3 | Tributary of Maxwells Creek (south east of Campbelltown Rd) | Moderate - limited standing water however native dominated vegetation | Class 4 Unlikely Fish Habitat | Skewed culvert | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | Ensure dry passage is provided in culvert for fauna.<br>Clearing of riparian vegetation must be minimised adjacent to the structure. | Adequate |
| 4 | Tributary of Maxwells Creek (in Ingleburn Defence Site) | Moderate – minor ephemeral drainage line with limited riparian habitat | Class 4 Unlikely Fish Habitat | Culvert | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | Not required due to future urban development | Adequate |

| Crossing as per Figure 4-1 | Waterway / dam | Condition of riparian habitats | Fish habitat classification (Fairfull & Witheridge 2003) | Proposed Crossing structure (WMA) | Minimum requirements for fish passage | Riparian connectivity requirement | Overall assessment of proposed crossings for biodiversity |
|---|---|---|---|---|---|---|---|
| 5 | Tributary of Maxwells Creek (in Landcom lands in Edmondson Park) | Poor – undefined channel and no riparian habitat | Class 4 Unlikely Fish Habitat | Diverted to crossing 4 | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | None | Adequate |
| 6 | Tributary of Maxwells Creek (in Landcom lands in Edmondson Park) | Moderate to good – small drainage line with semi-permanent pools, native dominated vegetation and large vegetated buffers | Class 3 Minimal Fish Habitat | Culvert or shallow bridge | Culverts required and designed to allow fish passage. Invert should be designed to ensure it is below the bed level of the watercourse, and that ponding can occur. | Ensure dry passage is provided if culvert for fauna.<br>Clearing of riparian vegetation must be minimised adjacent to the structure. | Adequate |
| 7a and 7b | Cabramatta Creek, Edmondson Park | Moderate - ephemeral drainage line with limited riparian habitat | Unlikely Fish Habitat<br>Class 4 | Bridge | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | Limited connectivity at the point of the crossing, but future enhancement possible. | Adequate |
| - | Farm dam 1 | Poor – no associated emergent aquatic vegetation | Unlikely Fish Habitat<br>Class 4 | - | None | None | Adequate |
| 8 | Unnamed tributaries of Cabramatta Creek 500m east of Camden Valley Way | Poor – minor depression channel across paddock | Unlikely Fish Habitat<br>Class 4 | Culvert | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | None | Adequate |

| Crossing as per Figure 4-1 | Waterway / dam | Condition of riparian habitats | Fish habitat classification (Fairfull & Witheridge 2003) | Proposed Crossing structure (WMA) | Minimum requirements for fish passage | Riparian connectivity requirement | Overall assessment of proposed crossings for biodiversity |
|---|---|---|---|---|---|---|---|
| 9 | Unnamed tributary of Cabramatta Creek 150m east of Camden Valley Way | Poor – minor depression channel across paddock | Class 4 Unlikely Fish Habitat | Culvert | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | None | Adequate |
| 10a | Unnamed tributary of 100m west east of Camden Valley Way | Poor – minor depression channel across paddock | Class 4 Unlikely Fish Habitat | Culvert | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | None | Adequate |
| 10b | Unnamed drainage line | Poor- drainage depression rather than a creek. Highly modified. | Class 4 Unlikely Fish Habitat | | None | None | Adequate |
| - | Farm dam 2 | Poor – no associated emergent aquatic vegetation | Class 4 Unlikely Fish Habitat | - | None | None | Adequate |
| - | Farm dam 3 | Poor – no associated emergent aquatic vegetation | Class 4 Unlikely Fish Habitat | - | None | None | Adequate |
| 10b | Unnamed and unformed drainage depression that flows into Farm dam 4 | Moderate – some associated emergent aquatic vegetation | Class 4 Unlikely Fish Habitat | - | None | None | Adequate |
| - | Sydney Water Canal | Poor – trapezoidal concrete channel | Class 4 Unlikely Fish Habitat | - | None | None | Adequate |

| Crossing as per Figure 4-1 | Waterway / dam | Condition of riparian habitats | Fish habitat classification (Fairfull & Witheridge 2003) | Proposed Crossing structure (WMA) | Minimum requirements for fish passage | Riparian connectivity requirement | Overall assessment of proposed crossings for biodiversity |
|---|---|---|---|---|---|---|---|
| 11 | Bonds Creek | Poor - high density weeds and eroded banks | Class 4 Unlikely Fish Habitat | Bridge | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | Limited connectivity at the point of the crossing, but future enhancement possible. | Adequate |
| - | Farm dam 5 | Poor – no associated emergent aquatic vegetation, surrounded by market gardens | Class 4 Unlikely Fish Habitat | - | None | None | Adequate |
| - | Farm dam 6 | Poor – no associated emergent aquatic vegetation, surrounded by market gardens | Class 4 Unlikely Fish Habitat | - | None | None | Adequate |
| 12 | Unnamed stormwater drain | Poor – no riparian habitat | Class 4 Unlikely Fish Habitat | Culvert | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | No | Adequate |
| 13 | Scalabrini Creek | Poor - high density weeds and eroded banks | Class 4 Unlikely Fish Habitat | Bridge | Causeway, floodway or culvert with allowance for flow of water to downstream areas unhindered. | | |

| Crossing as per Figure 4-1 | Waterway / dam | Condition of riparian habitats | Fish habitat classification (Fairfull & Witheridge 2003) | Proposed Crossing structure (WMA) | Minimum requirements for fish passage | Riparian connectivity requirement | Overall assessment of proposed crossings for biodiversity |
|---|---|---|---|---|---|---|---|
| - | Farm dam 7 | Poor – no associated emergent aquatic vegetation, surrounded by market gardens | Class 4 Unlikely Fish Habitat | - | None | None | Adequate |
| 14 | Kemps Creek | Moderate - ephemeral drainage line with limited riparian habitat | Class 3 minimal Fish Habitat | Bridge | Culverts required and designed to allow fish passage. Invert should be designed to ensure it is below the bed level of the watercourse, and that ponding can occur. | Limited | Adequate |

Three options have been utilised for drainage line crossings along the project alignment: overbridge, reinforced concrete box culvert (RCBC) and diversion. The nature of these works has been determined to meet the flood mitigation specification for the proposal. The overbridges and culverts however are not likely to result in additional hindrance of the limited fish passage in the study area. Crossings 2 and 5 also involve diverting upstream flows, which would result in no flow to areas downstream of the project alignment at these locations (refer Section 7.4.4 for further discussion of waterway crossing structures).

### 6.1.7 Noise and other human disturbance

Construction activities would be likely to increase noise levels, and general disturbance would be associated with the presence of humans within the study site. Increased noise levels could be a cause of disturbance for native animals, resulting in displacement of individuals out of the affected area, disturbance to foraging patterns and disturbance to breeding cycles.

The majority of the species of the animals observed, or likely to occur, within the study area were generalist species that are known to be accustomed to residential and industrial noises. No Threatened species of animal likely to be affected significantly by construction noise were identified.

## 6.2 Impacts during operation

The operation of the project would involve the running of commuter trains between Glenfield and Leppington Stations (and continuing onto the greater suburban Sydney rail network). Other railway and utility undertakings would be required within the rail easement to ensure the project remains a safe, clean and reliable component of the greater rail network.

### 6.2.1 Noise

The main operational impact of the project on biodiversity would be noise disturbance from train operations. The introduction of train noise would be a significant contribution to the post-construction noise levels in the study area, although with future development of the surrounding area the nature of noise in the local area is likely to change. However, as with reference to construction noise, the majority of the species of animals likely to occur within the study area are species that would be accustomed to residential and industrial noises. No Threatened species of animal known to exist at the site is likely to be significantly affected by train noise.

### 6.2.2 Collision

It is unlikely that collision of native fauna with trains on the project would result in a significant impact on local populations of Threatened species in the study area.

The effect of train traffic mortality on fauna populations is often difficult to measure since factors such as area, quality and spatial configuration of the habitat along rail lines, also play a role (Catharinus *et al.* 2006). Data sets on wildlife mortalities from trains are difficult to obtain because of the relative inaccessibility of railway lines; the lack of experienced individuals to observe, identify, and record railway kills; and the inherent difficulty of identifying and investigating railway wildlife (Wells *et al.* 1999).

International studies have shown that dead carcasses attract scavengers on rail tracks, which can increase the collision of raptors with trains (Krone *et al.* 2000). Other studies have focused on the impacts of train collision with local populations of large mammals (Wells *et*

*al.* 1999). However, there are no data available on the mortality rates of Australian fauna due to train collision and it is difficult to predict the extent of impacts associated with increased movements.

The proposal would result in frequent train movements and is likely to result in some collision with native fauna throughout the length of the line as a consequence. Areas where there are likely to be higher chances of collision include areas where the route traverses through remnant woodland patches and riparian habitats of creek systems. It is noted however that rail corridors in the metropolitan area are fenced - this would present a partial barrier to animals entering the rail corridor.

### 6.2.3 Barrier effects

The creation and continued effects of barriers associated with the project corridor would persist throughout the construction and operational phases. Barriers, both physical and biological, would be created and maintained as part of the proposal. Rail lines can act as a barrier through either increased mortality or avoidance (Catharinus *et al.* 2006; Wells *et al.* 1999). Local habitat corridors that occur along the riparian areas of creek lines along the route would not be significantly affected since the project would occur on bridges allowing fauna movements.

Barrier effects are likely to be the most significant at areas where the study area traverses the larger woodland remnants in Edmondson Park (i.e. between Campbelltown Road and Camden Valley Way). This is particularly the case for ground-dwelling species including reptiles, amphibians and the Threatened Cumberland Land Snail. Local populations of mobile faunal species, including birds and bats, are unlikely to be significantly disrupted by barrier effects of the project.

A regional habitat corridor was identified between Camden Valley Way (Cabramatta Creek) and Campbelltown Road (Eco Logical Australia Pty Ltd 2003c). However, this corridor includes mainly patches of remnant vegetation amongst cleared rural and urban development. It is, therefore, unlikely that the project would significantly increase barrier effects along the identified habitat corridors.

### 6.2.4 Changed hydrology/surface run-off

Alterations to hydrological regimes would primarily be associated with the construction phase; although the long-term concentration of flows resulting from the project embankments and funnelling of water through structures such as culverts would have more permanent effects on surface flows. Changed hydrology can alter ecosystems including vegetation communities and fauna habitats. Run-off from contaminated surfaces could also have a negative effect on the ecology of flora and fauna in nearby habitats.

The proposed drainage line and stormwater crossing however will minimise the impacts of changed hydrology and surface run-off on a majority of sensitive habitats. As such, it is unlikely that changed hydrology would negatively affect local populations of flora and fauna during operation. Technical Paper 3 of the EA, Hydrology Assessment, provides a detailed description of the hydrological environment, impacts and mitigation measures.

## 6.3 Cumulative and consequential impacts

The potential biodiversity impacts of the project have been considered. The incremental effects of multiple sources of impact (past, present and future) are referred to as cumulative impacts and provide an opportunity to consider the project in a strategic context. This is necessary so that the impacts associated with the project and other activities in the region are examined collectively.

The project is located in a highly modified landscape dominated by rural-residential and low density urban development in which the remaining areas of remnant vegetation and associated habitat are fragmented.

This existing landscape is expected to change significantly over the next 25 to 30 years with the development of the South West Growth Centre. The project is located at the centre of the growth centre, adjacent to the planned precincts of Edmondson Park, Leppington, Leppington North and Rossmore. Based on preliminary planning information from the Department of Planning (Growth Centres Commission), the South West Growth Centre will be developed to include a mix of major centres, town and village centres, local neighbourhoods and industrial/employment land. Development of the South West Growth Centre is likely to have a considerable impact on biodiversity in the locality, therefore, the biodiversity impacts associated with the project should also be considered in the context of the broader development expected in the South West Growth Centre over the next 25 to 30 years. The project may be considered to have a consequential impact by contributing to this development.

Biodiversity certification has considered the biodiversity values within South West Growth Centre as a whole and as such the cumulative impacts within the Growth Centre have been assessed and offset on a regional basis through planning mechanisms. These include prescriptive minimum offsetting requirements for impacts to non-certified areas (refer Section 7.5) in addition to the requirement to the following outcomes for the Growth Centres (North West and South West):

- Protection of 2,000 ha of native vegetation within the Growth Centres.
- Offsetting of the 1,867 ha of native vegetation to be lost within the Growth Centres through the provision of $530 million of funding for the protection of high value areas both within and outside of the Growth Centres.
- 75% of this funding to be spent outside the Growth Centres, targeting the largest and best vegetation remnants with the remaining funds spent on acquiring land within the Growth Centres that is identified in the Growth Centres.

Cumulative impacts are also accounted through the conservation agreement for Edmondson Park precinct and the strategic assessment of the South West Growth Centre.

## 6.4 Key threatening processes

Threatening processes are those that threaten, or have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities.

A process can be listed as a key threatening process if it could:

- Cause a native species or ecological community to become eligible for inclusion in a Threatened list (other than the conservation dependent category).
- Cause an already listed Threatened species or Threatened ecological community to become more endangered.
- Adversely affect two or more listed Threatened species or Threatened ecological communities.

Key threatening processes are listed under the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999*.

At present there are 34 key threatening processes listed under the *Threatened Species Conservation Act 1995*, and 17 listed under the *Environment Protection and Biodiversity Conservation Act 1999.* The proposal will involve four Key Threatening Processes (refer Table 6-4).

**Table 6-4 Key threatening processes**

| Key threatening process [1] | State[2] | National Act[3] | Associated with proposed development |
|---|---|---|---|
| Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands. | ● | | **Yes** |
| Clearing of native vegetation (as defined and described in the final determination of the Scientific Committee to list the key threatening process) / land clearance. | ● | ● | **Yes** |
| Removal of dead wood and dead trees. | ● | | **Yes** |
| Loss of hollow-bearing trees. | ● | | **Yes** |

Notes: Key threatening process names based on the listing under the *Threatened Species Conservation Act 1995*. Names may differ slightly from those listed under the *Environment Protection and Biodiversity Conservation Act 1999*. 1 - TSC Act = *Threatened Species Conservation Act 1995.* 2 - EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999.*

## 6.5 Species specific impacts

Table 6-5 provides a summary of the specific impacts likely to affect each of the Threatened ecological communities and species recorded or likely to occur in the study area. The location of each Threatened species recorded in the study area and the extent of suitable habitat is provided in the Threatened species profiles supporting the impact assessments (see Appendix F).

The project would have direct impacts on two Threatened ecological communities and habitat for seven Threatened species as a result of vegetation clearing. Assessment of the

significance of these impacts to these Threatened communities and species is provided in Section 8 and Appendix F.

**Table 6-5 Potential impacts on Threatened biodiversity**

| Species or community | Status | | Direct and indirect impacts across the entire study area |
|---|---|---|---|
| | TSC Act[1] | EPBC Act[2] | |
| Cumberland Plain Woodland[1] | CE | - | Loss of 24.5 ha, 3.3 ha of which occurs within non-certified areas |
| Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest | - | CE | Loss of 5.5 ha, 0.4 ha of which occurs outside the Edmondson Park Conservation Agreement area |
| River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions | E | - | Loss of 4.4 ha, 1.7 ha of which occurs within non-certified areas |
| Cumberland Land Snail (*Meridolum corneovirens*) | E | - | Direct mortality of individuals and loss of 6.6 ha of habitat |
| Grey-headed Flying-fox (*Pteropus poliocephalus*) | V | V | Loss of 25.9 ha of foraging habitat |
| Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) | V | - | Loss of 25.9 ha of foraging habitat |
| Eastern Freetail-bat (*Micronomus norfolkensis*) | V | - | Loss of 25.9 ha of foraging habitat |
| Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) | V | - | Loss of 25.9 ha of foraging habitat |
| Greater Broad-nosed Bat (*Scoteanax rueppellii*) | V | - | Loss of 25.9 ha of foraging habitat |
| Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) | V | - | Loss of 25.9 ha of foraging habitat |

1. Conservation status as listed under the *Threatened Species Conservation Act 1995*. E = Endangered. V = Vulnerable.

2. National conservation status as listed under the *Environment Protection and Biodiversity Conservation Act 1999*. V = Vulnerable E = Endangered, CE = Critically Endangered

# 7. Impact mitigation and offsets

This section outlines the impact mitigation measures and offsets strategy proposed for the project.

## 7.1 General principles

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).

## 7.2 Route selection process

Avoidance of environmental impacts has been a driving consideration throughout the route selection and design process.

Planning for a railway serving what is now known as Sydney's South West Growth Centre began in the early 1990s. In 1991, the former State Rail Authority undertook a study to develop and evaluate alignment options for road/rail corridors between Glenfield and the proposed second Sydney Airport. More recent considerations of the project have addressed future planning and development of Sydney's South West Growth Centre. Between 2001 and 2005, the then State Rail Authority conducted a series of studies to review rail alignment options and develop a concept alignment for a rail link between the Main South Line south of Glenfield Station and Leppington.

A preliminary biodiversity assessment was completed as part of a route options comparison of the refined southern and refined northern South West Rail Link routes (Transport Infrastructure Development Corporation 2006). This compared the likely biodiversity impacts of two preferred route options between Edmondson Park and Leppington (the refined northern and southern routes). The Route Options Report also considered a range of other environmental factors including Indigenous and non-Indigenous heritage, noise impacts, visual impacts, and social and community issues. This comparison identified that clearing of native vegetation would be unavoidable along any route between Glenfield and Leppington. The assessment found that the proposed South West Rail Link corridor alignment (the refined northern route) would result in clearing of a greater total area of remnant vegetation than the refined southern route, but a smaller area of vegetation in the 'core' and 'support for core' conservation significance classes would be affected (NSW National Parks and Wildlife Service 2002b). In addition, the stabling facility at the western end of the proposed South West Rail Link corridor alignment was moved following the preliminary assessments to avoid impacts on remnant vegetation to the west of its current proposed location.

## 7.3 Management of the mitigation process

Prior to construction, detailed flora and fauna mitigation measures would be developed and presented as part of a Flora and Fauna Management Sub-plan relating to the construction and operation of the project. The plan would form part of the construction environmental management plan (CEMP) and would address:

- Staff and contractor inductions, in particular the location of sensitive biodiversity and roles and responsibilities relating to protection of all native biodiversity.
- Vegetation clearing protocols, including pre-clearing surveys and fauna salvage/translocation.
- Rehabilitation and restitution of adjoining habitat.
- Weed control.
- Pest management.
- A flora and fauna monitoring program for the project to better understand and manage impacts and rehabilitation actions to flora and fauna.

The plans would include clear objectives and actions for the project including:

- Limiting the clearing of native vegetation to the 28.9 ha assessed to be the project footprint.
- Minimising human interferences to flora and fauna.
- Minimising impact to Threatened species and communities.
- Minimising impacts to aquatic habitats and species.
- The location of Cumberland Land Snail donor and recipient translocation sites. This would need to be developed in consultation with the Growth Centres so that snails can be translocated to sites within future conservation protection (e.g. certified area within the South West Growth Centre subject to condition 12 (red overlay of the Biodiversity Certification) at the Ingleburn Defence Site and Edmondson Park).
- The management of native vegetation and habitats surrounding the construction footprint including control of weeds and pest species.
- The actions to be undertaken to rehabilitate affected areas including revegetation of areas for conservation purposes (refer to Technical Paper 5 - Landscape and Visual Assessment for more details regarding the proposed revegetation works along the project alignment).
- Flora and fauna monitoring undertaken at regular intervals.

## 7.4 Mitigation

The following mitigation measures would be implemented for the project:

- Vegetation clearing would be limited to the 28.9 ha of vegetation outlined in this assessment.
- The limit of vegetation clearing in environmentally sensitive areas would be clearly identified and marked, both on maps and on the ground.
- Environmentally sensitive areas would be marked as 'no-go' areas both on maps and on the ground.
- A trained ecologist would accompany clearing crews in environmentally sensitive areas.
- Clearing protocols, including translocation, would be put in place for clearing of vegetation in environmentally sensitive areas.
- Areas not necessary for the operation of the project would be revegetated.
- A weed control plan would be developed for the project.
- Waterway crossings would be designed to be fish friendly and to maintain connectivity along the creek banks where possible.

These mitigation measures are discussed below.

### 7.4.1 Vegetation and habitat loss

Disturbance to areas of native vegetation and habitat would be unavoidable during the construction process. No vegetation beyond the 28.9 ha assessed as the project footprint would to be affected as a result of the project.

In order to avoid further disturbance to areas outside of those identified, sensitive areas (e.g. areas of Cumberland Plain Woodland in the Edmondson Park precinct) 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). Stockpiling of construction materials and vehicle access would be prohibited in fenced-off areas.

A trained ecologist would accompany clearing crews in sensitive areas in order to ensure disturbance is minimised. The adoption of these measures would limit the extent of habitat disturbance, prevent soil compacting and damage to trees.

Where possible, revegetation of areas disturbed by construction of the project would be undertaken, thereby increasing the habitat value and visual amenity of the areas. Revegetation will be done in accordance with the Landscape Management Plan and design developed for the project (refer to Technical Paper 5 - Landscape and Visual Assessment for more details regarding the proposed revegetation works along the project alignment). This plan has used native species from the Cumberland Plain as the basis for the species palettes.

### 7.4.2 Direct mortality

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 vegetation clearing protocol would be developed and put in place. These protocols would include:
    1. All habitat trees in the area to be cleared would be identified (by survey) and marked.
    2. Marked habitat trees and, where possible, corridors of retained trees linking marked habitat trees with the nearest uncleared (secure) habitat areas would be left standing after initial vegetation clearing for a period of at least 24 hours (to encourage animals to disperse into adjacent uncleared habitat).
    3. After the 24 hour waiting period, standing habitat trees and corridors may be felled, commencing with the most distant trees from secure habitat. Habitat trees would be pushed over using a dozer so that they fall slowly to the ground.
    4. Clearing would be undertaken in the spring to autumn period to facilitate survival of displaced animals.
    5. If habitat trees are in short supply artificial nest sites (nest boxes) would be installed in adjacent (secure) habitat before clearing. This would be undertaken in consultation with the relevant agencies.
    6. All contractors would have the contact numbers of wildlife rescue groups should animals be injured during clearing.
- A trained ecologist would accompany clearing crews in sensitive areas in order to ensure disturbance is minimised and to assist native fauna injured to at risk of injury as a result of the vegetation clearing.
- A Cumberland Land Snail translocation plan would be prepared to salvage Cumberland Land Snail from the habitats where they were recorded (within both certified and non-certified areas) and translocate them to suitable habitats within or adjacent to the railway corridor within non-certified lands, or where this is not possible to biodiversity offset areas.

### 7.4.3 Weed control

A weed management plan would be developed as part of the CEMP and would outline measures:

- for weed control focusing on noxious species, weeds of national significance and other environmental weeds
- for management of soil stockpiles
- to prevent spread of weeds through construction activities.

The emphasis of the weed control program would be to prevent the spread of weeds into areas of conservation significance where weeds are not currently established or only occur in low densities. Within the study area these locations are limited to the Ingleburn Defence Site and Edmondson Park. Measures that prevent the movement of weeds, including soil laden with weed seed or propagules, and measure that suppress the germination of weeds would be the most effective means to achieve the objective of this plan. These measures would include:

- disposal or of weed infested topsoil offsite of stockpiling in away from areas of weed free vegetation
- progressive excavation, construction and rehabilitation opposed to stripping large areas of topsoil
- monitoring and management of stockpiles.

Weed control technique used for the project would involve a combination of mechanical and chemical techniques. Selection of the best suited weed control method would depend on factors including:

- the objective of the weed control program
- the species, or combination of weeds, being managed
- weed density
- the proximity to sensitive receptors (e.g. persons, property, livestock or native flora and fauna)
- the weather of the day.

These variables and species specific control methods would be outlined in the weed management plan.

### 7.4.4 Waterway crossings

The current design has included waterway crossing structures that are suitable to maintain fish passage given the nature and condition of the waterways in the study area (refer Table 6-3). It is further recommended that during detail design that the structures are designed so as to follow the *Guidelines for Design of Fish Friendly Waterway Crossings* (Fairfull & Witheridge 2003) and be developed in consultation with the Department of Primary Industries (Fisheries) and the Department of Water and Energy (which includes the former Department of Natural Resources). Design features should ensure that low flow conditions are maintained in the structures and that appropriate erosion control is put in place. For bridge structures, the location of the bridge pylons should be outside of the channel of the creek. Further, in the case of bridge structures, sufficient width of bank should be maintained so as to allow fauna connectivity along riparian areas. At crossings 3 and 5, both tributaries of Maxwells Creek, dry passage should be provided within the culverts to aid fauna passage.

## 7.5 Biodiversity offsets

Biodiversity offsets would be required in order to maintain or improve biodiversity values as per the guiding principles for Threatened species assessment under Part 3A of the *Environmental Planning and Assessment Act 1979.*

The minimum statutory requirement for biodiversity offsets differ for impacts within the certified and non-certified areas of the South Western Growth Centre, as outlined below. TIDC are committed however to providing an offset package for the entire South West Rail Link project that is based on:

1. direct offsets by adding to reservation or covenanting of land, or
2. enhancement of habitats along the project alignment and offset locations, or
3. financial contribution to biodiversity outcomes, or
4. or a combination of all of the above.

The extent, type and magnitude of the offsets is likely to differ between both state and federal requirements, although one offsets area may account for both sets of requirements.

Development of a Biodiversity offset strategy for the project to the acceptance of the Department of Environment, Climate Change and Water and the Department of Planning will be completed prior to issue of construction certificate. The offsets strategy will include identification of the residual impacts of the proposal that are being offset (as identified in this assessment), lands and/or actions that can be used to offset the impacts, the long term maintenance and management requirements for offsets and a monitoring program to assess the effectiveness of the offsets package.

**Offsets of residual impacts within the South Western Growth Centre**

Within the South Western Growth Centre the project will impact 5.0 ha of native vegetation in non-certified areas and 23.9 ha of native vegetation in certified areas.

The biodiversity certification of the State Environmental Planning Policy (Sydney Regional Growth Centres) 2006 (Minister for Climate Change Environment and Water 2007) provides a framework for calculating offsets to Threatened biodiversity listed under the *Threatened Species Conservation Act 1995* affected within the Growth Centres.

Impacts to biodiversity in certified areas of the Growth Centre are offset through the State Environmental Planning Policy (Sydney Regional Growth Centres) 2006 and do not require additional offsets by the proponent.

Impacts to biodiversity in non-certified areas however require an offset (under condition 11 of the certification order, Minister for Climate Change Environment and Water 2007) which may include:

- The protection of an equal or greater area of existing native vegetation elsewhere in the Growth Centres, and/or
- the revegetation and/or restoration of an area of land elsewhere in the Growth Centres at a ratio of at least 3:1 (subject to conditions in the Biodiversity Certification Order).

Preferably, offsets would be located inside the Growth Centres however, may be located outside the Growth Centres (within the Cumberland Plain of Western Sydney) if the

Strategic Land Release Project Office of the NSW Department of Planning is satisfied that there are no practicable offset options within the Growth Centres. Any revegetation included in the offset package should aim to enhance existing vegetation patches or else enhance connectivity (e.g. along riparian corridors or along the rail corridor itself).

TIDC will develop an offset strategy that addresses the loss of the 5 ha of vegetation in non certified areas (both inside and outside the growth centre). The identification of suitable properties for this offset will be undertaken in consultation with the Department of Planning, the Department of the Environment, Climate Change and Water and local Councils. The offsets will be presented in an overall strategy that may include direct purchase and conservation of land (to be managed by others) or rehabilitation/revegetation of degraded lands that are important in the local or regional conservation network. As part of the overall strategy, management of the land would be agreed to as would monitoring requirements. Management may include control of weeds, natural regeneration and replanting of select species. Monitoring would include setting clear and measureable success thresholds (e.g. cover of weeds) and clear processes to measure the variables. The exact nature of both management and monitoring measures will depend on the agreed offset package. Such a strategy has been developed for the works completed at Glenfield Junction and this would form a template for the offset strategy.

It should be noted that in addition to the offsets to be developed as part of the offset strategy, TIDC will provide landscaping within the rail corridor. This landscaping will include native species and will provide buffers in sensitive areas (e.g. next to Denham Court) as well as potential habitat in itself. However, landscaping has not been included as part of the offsets proposed.

**Offsets of residual impacts under the *Environment Protection and Biodiversity Conservation Act 1999***

Environmental offsets for impact to Matters of National Environmental Significance may be used to maintain or enhance the health, diversity and productivity of the environment as it relates to Matters of National Environmental Significance. Environmental offsets are not applicable to all approvals under the *Environment Protection and Biodiversity Conservation Act 1999* and their requirement is assessed on a case-by-case basis.

The project is consistent with the Edmondson Park Conservation Agreement. Given the conditions of the Conservation Agreement, there is unlikely to be a significant impact on Matters of National Environmental Significance. As such, offsets will not be required under the *Environment Protection and Biodiversity Conservation Act 1999*.

Having said that, offsets provided to address state-listed matters (see above) will also address Commonwealth-listed matters.

# 8. Significance of impacts

The significance of impacts was assessed for all Threatened species recorded or likely to occur in the study area (refer Table 8-1 and Appendix F).

**Table 8-1 Threatened ecological communities and species for which significance assessments were done**

| Species or community | Conservation Status | | Likely to be significantly affected |
|---|---|---|---|
| | State [1] | National [2] | |
| Cumberland Plain Woodland | CE | - | No |
| Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest | - | CE | No |
| River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions | E | - | No |
| Cumberland Land Snail (*Meridolum corneovirens*) | E | - | No |
| Grey-headed Flying-fox (*Pteropus poliocephalus*) | V | V | No |
| Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) | V | - | No |
| Eastern Freetail-bat (*Micronomus norfolkensis*) | V | - | No |
| Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) | V | - | No |
| Greater Broad-nosed Bat (*Scoteanax rueppellii*) | V | - | No |
| Eastern False Pipistrelle *(Falsistrellus tasmaniensis)* | V | - | No |

Notes:

1. State conservation status: CE= Critically endangered; V= Vulnerable, E = Endangered, (*Threatened Species Conservation Act 1995* and *Fisheries Management Act 1994*).

2. National conservation status: CE= Critically endangered; V = Vulnerable, E = Endangered (*Environment Protection and Biodiversity Conservation Act 1999*).

## 8.1 State impact assessments

Projects assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* consider the significance of impacts on biodiversity following on the heads of consideration detailed in the draft Guidelines for Threatened Species Assessment (Department of Environment and Conservation 2005a). Given that it is taken that development is not likely to significantly affect any Threatened species in certified areas (as identified in the biodiversity certification), significance assessments under the *Threatened Species Conservation Act 1995* were based on the residual impact to Threatened species in the non-certified areas only.

These heads of consideration are:

1. **How is the proposal likely to affect the lifecycle of a Threatened species and/or population?**

   The project will affect the lifecycle of Cumberland Land Snail (*Meridolum corneovirens*) through the removal of habitat and direct mortality. The area of Cumberland Land Snail habitat that will be affected is however small (0.9 ha within non-certified areas) and a translocation plan will be prepared to salvage Cumberland Land Snail from the habitats where they were recorded. The project will not affect or disrupt any Grey-headed Flying-fox roosting habitat (camps) and vegetation clearing protocols should avoid impacts to the life cycle of Threatened microbats.

2. **How is the proposal likely to affect the habitat of a Threatened species, population or ecological community?**

   The project will affect the habitat of Threatened species and ecological communities through the direct loss of habitat. 5.0 ha of native dominated vegetation in non-certified areas. This loss of native dominated vegetation comprises:

   - 3.3 ha of Cumberland Plain Woodland
   - 1.7 ha of River-Flat Eucalypt Forest on Coastal Floodplains
   - 0.9 ha of Cumberland Land Snail habitat
   - 4.8 ha of Grey-headed Flying-fox foraging habitat
   - 4.8 ha of habitat for Threatened species of microbat (Yellow-bellied Sheathtail Bat, Eastern Freetail-bat, Eastern Bent-wing Bat, Greater Broad-nosed Bat and Eastern False Pipistrelle).

3. **Does the proposal affect any Threatened species or populations that are at the limit of its known distribution?**

   No Threatened species identified or considered likely to occur in the study area are at the limit of their distribution.

4. **How is the proposal likely to affect current disturbance regimes?**

   The project is unlikely to affect the current disturbance regimes in the habitats not directly affected. The proposal will not modify the intensity or frequency of fires. Drainage line crossings have been designed to ensure the project will not modify the flooding regime. Habitats surrounding the study area are also modified and fragmented and subject to edge effects and weeds.

5. **How is the proposal likely to affect habitat connectivity?**

   While the proposal will result in fragmentation of habitat for this species along the project alignment, it will not fragment habitat within non-certified lands.

6. **How is the proposal likely to affect critical habitat?**

   No critical habitat was identified in the study area and no critical habitat is likely to be affected by the proposal.

The heads of consideration did not identify any significant impacts to Threatened biodiversity that are likely to result from the project. However, offsets determined in accordance with the biodiversity certification order for the State Environmental Planning Policy (Sydney Regional Growth Centres) 2006 will be required if the project is to improve or maintain biodiversity outcomes.

### 8.1.1 Summary of assessment Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979*

Under the draft Guidelines for Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979*, the following thresholds need to be addressed:

**Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values**

The term 'maintain or improve' is defined in the draft Guidelines for Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979*, as: 'no net impact on Threatened species or native vegetation' (Department of Environment and Conservation 2005a). The project and associated ancillary areas would result in the loss of up to approximately 28.9 ha of native vegetation and associated habitat, including Threatened ecological communities and habitat for Threatened species. The potential for significant impacts on vegetation and fauna habitats has been largely avoided through the route selection process and the mitigation measures outlined in this proposal. Management measures would be outlined in the Flora and Fauna Management Sub-plan for the project, which would form part of the Construction Environmental Management Plan. Measures would include those outlined in Section 7 of this report.

Given that the project would result in clearing of native vegetation, including Threatened ecological communities and habitat for Threatened species, it would be necessary to develop offset strategies to which would contribute to the maintenance and improvement of biodiversity values (Department of Environment and Climate Change 2007b; Minister for Climate Change Environment and Water 2007).

**Whether or not the proposal is likely to reduce the long-term viability of a local population of a species, population or ecological community**

The project is unlikely to reduce the long-term viability of any Threatened biodiversity in the locality. Impacts to native vegetation and associated fauna habitats have been avoided through the route selection process where possible. Nonetheless, total avoidance of vegetation clearing was not possible and 28.9 ha of native vegetation (including 5.0 ha in non-certified areas) and associated fauna habitat will be cleared as a result of the proposal (refer table 6-1). As such, an offset package would be developed, which would contribute to the maintenance and improvement of biodiversity values and ensure that the long term viability of local populations of species and ecological communities are maintained.

**Whether or not the proposal is likely to accelerate the extinction of a species, population or ecological community or place it at risk of extinction**

The project would remove up to 28.9 ha of native vegetation (in the non-certified areas) including two Threatened ecological communities and habitat for Threatened species. However, through the implementation of mitigation measures and offsets, it is unlikely that the proposed upgrade would accelerate the extinction of a species, population or community. This is demonstrated by the conclusions of the assessment of significance in that the project is unlikely to have a significant impact on Threatened biodiversity.

**Whether or not the proposal will adversely affect critical habitat**

Critical habitat is listed under both the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999* and both the state and Federal Directors-General maintain a register of this habitat (Department of Environment and Conservation 2007; Department of the Environment and Water Resources 2007).

The study area does not include areas of critical habitat listed for any Threatened species or ecological communities listed under the *Threatened Species Conservation Act 1995* and/or *Environment Protection and Biodiversity Conservation Act 1999*, nor is the study area considered to comprise or contain habitat critical for any of the Threatened species or ecological communities identified or considered likely to occur in the study area.

## 8.2 Commonwealth impact assessments

Cumberland Plain Shale Woodlands and Shale-Gravel Transition and Grey-headed Flying-fox were the only Threatened biodiversity listed under the *Environment Protection and Biodiversity Conservation Act 1999* recorded or considered likely to occur in the study area.

Threatened biodiversity listed under the *Environment Protection and Biodiversity Conservation Act 1999* are required to be assessed following the Principal Significant Impact Guidelines (Department of the Environment and Heritage 2005). As biodiversity certification is not formally recognised by the Department of the Environment, Water, Heritage and the Arts (such as under a bilateral agreement), significance assessments for species listed under the *Environment Protection and Biodiversity Conservation Act 1999* are based on the impacts across the entire project area (certified and non-certified).

The factors for considering Endangered and Vulnerable species under the Principal Significant Impact Guidelines differ slightly, as such different factors were used to consider the significance of the impact to Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and Grey-headed Flying-fox (refer Appendix F).

The impact to Grey-headed Flying-fox is unlikely to be significant for the following reasons:

- The population of Grey-headed Flying-fox in the study area is not an important population in accordance with the definition of an important population under the Principle Significant Impact Guidelines (Department of the Environment and Heritage 2005).
- The project will not disrupt any Grey-headed Flying-fox roosting habitat (camps) and will therefore not affect adversely affect habitat critical to the survival or disrupt the breeding cycle.

- The project will not modify, destroy, remove, isolate or decrease the availability or quality of habitat, introduce invasive species or disease, or interfere with the recovery of the species.

An estimated 5.5 ha of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest will be directly affected by the project. The majority of the occurrences of this community within the project footprint are within Edmondson Park precinct and are covered by the conservation agreement signed between the Department of the Environment, Water, Heritage and the Arts, Department of Planning and the Department of Environment, Climate Change and Water. This agreement declares that a project approved under Part 3A of the *Environmental Planning and Assessment Act 1979* within the precinct is not likely to have a significant impact on Threatened biodiversity as long as it follows the agreement. The agreement also puts in place an offsetting arrangement funded through the infrastructure contributions of the growth centres. As such, the Project within this area is unlikely to have a significant impact on this community in that it is compliant with the agreement. Outside of the conservation agreement area, 0.4 ha of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest will be affected. This is not considered to be significant.

# 9. Summary and conclusions

The project is located in a highly modified landscape dominated by rural-residential and low density urban development in which the remaining areas of remnant vegetation and associated habitat are fragmented. This existing landscape is also expected to change significantly over the next 25 to 30 years with the development of the South West Growth Centre.

Nonetheless, the study area contains a range of high biodiversity values. All remaining patches of native woodland vegetation comprise Threatened ecological communities listed under the *Threatened Species Conservation Act 1995*. Cumberland Plain Woodland, which accounts for approximately 68% of native woodland vegetation in the study area, is listed as Critically Endangered under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* (listed as Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest). Seven Threatened species of animal were also recorded or considered likely to occur in the study area.

Mitigation measures outlined in this document, and to be further developed and refined in the construction environmental management plan, have avoided, reduced and mitigated impacts to biodiversity that will occur as a result of construction and operation of the project. However, disturbance to areas of native vegetation and habitat during construction and operation of the project is unavoidable. These impacts were assessed as unlikely to be significant to the critically endangered Cumberland Shale Plain Woodlands and Shale Gravel Transition Forest community and Commonwealth land as assessed under the *Environment Protection and Biodiversity Conservation Act 1999.* This is due largely to the Edmondson Park Conservation Agreement, with which the project complies.

The assessment of impacts for Threatened biodiversity listed under the *Threatened Species Conservation Act 1995* were based on the premise established in the Order to confer biodiversity certification on the State Environmental Planning policy (Sydney Region Growth Centres) 2006 (Minister for Climate Change Environment and Water 2007) that actions in certified areas are not likely to significantly affect any Threatened species, population or ecological community, or its habitat. As such, impact assessments in accordance with the Department of Environment, Climate Change and Water's draft Guidelines for Threatened species assessment under Part 3A (Department of Environment and Conservation 2005a) were only applied to impacts to non-certified areas within the South West Growth Centre. Given suitable offsets are determined in accordance with the biodiversity certification order, the project should be able to improve or maintain biodiversity outcomes despite the impacts to Threatened ecological communities and species.

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