Australian Government

BUILDING OUR FUTURE

NSW MAKING IT HAPPEN

The Northern Road Upgrade Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

NSW Environmental Impact Statement /
Commonwealth Draft Environmental Impact Statement

Volume 1: Main Report

June 2017

Roads and Maritime Services

The Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

NSW Environmental Impact Statement / Commonwealth Draft Environmental Impact Statement

June 2017

Volume 1: Main Report

Prepared for
Roads and Maritime Services
By Jacobs Australia
RMS: 17.274
ISBN: 978-1-925659-22-1

BLANK PAGE

Contents

Appendices

BLANK PAGE

7.2.9 Residual impacts

The project includes mitigation measures for its predicted construction and operational impacts.

Mitigation measures for construction and operational impacts are outlined in Table 7-37.

Residual impacts from the project's construction would likely result given primarily that some loud processes (e.g. saw cutting, rock breaking) are required, and that construction activity shifts over a wide area making screening of those works difficult. Application of project specific mitigation, including notification procedures, complaints handling process, monitoring and application of alternative methods or techniques would be implemented. Where there is still a high residual impact, consideration would be given to offer of alternative accommodation to impacted residents. While Roads and Maritime acknowledge that residual impact would exist, the application of these reasonable and feasible mitigation measures are would reduce residual impacts to an acceptable level. These residual impacts would be temporary, and in many cases, of short duration as works pass from one site to another.

Noise and vibration guidelines applied by Roads and Maritime and used throughout the assessment of impacts presented in this EIS assume that a balance between the application of reasonable and feasible mitigations and a level of residual level of noise impacts would be achieved. In particular, The NSW [Interim] Construction Noise and Vibration Guideline calls for the application of feasible and reasonable measures to mitigate construction noise and vibration.

The project would result in a residual level of construction and operational noise despite the application of a range of mitigation measures suggested in Table 7-37. Despite this, Roads and Maritime believes that the level of residual noise as a result of the project is acceptable.

7.3 Biodiversity

This chapter provides an assessment of potential impacts to terrestrial and aquatic biodiversity from construction and operation of the project and recommends environmental management measures to reduce these impacts. Details of the assessment undertaken are presented in Appendix I - Biodiversity Assessment Report (BAR), which includes the Biodiversity Offset Strategy (BOS) for the project.

As outlined in section 2.1.2, the Federal Minister for the Environment and Energy determined on 21 July 2016 that approval is required as the action has the potential to have a significant impact on listed threatened species and ecological communities and Commonwealth land and is therefore a 'controlled action' in accordance with the EPBC Act. The controlled action is considered by the Department of the Environment and Energy likely to have a significant impact on the following EPBC Act listed threatened species and ecological communities:

- Critically endangered – Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Cumberland Plain Woodlands)
- Critically endangered – *Lathamus discolor* (Swift Parrot)
- Critically endangered – *Anthochaera phrygia* (Regent Honeyeater)
- Vulnerable – Pultenaea parviflora
- Vulnerable – *Pteropus poliocephalus* (Grey-headed Flying-fox).

Approval of the project is required from the Federal Minister for the Environment and Energy in addition to the planning approvals required under State legislation (refer to Chapter 2 for additional detail regarding the assessment process for the project).

This EIS is subject to a range of legislative and policy requirements as set out in the Secretary's Environment Assessment Requirements (SEARs) and Commonwealth EIS Guidelines issued on 24 August 2016. Table 7-38 sets out the SEARs and Commonwealth EIS Guidelines as they relate to biodiversity and where in the environmental impact statement (EIS) these have been addressed.

Table 7-38 SEARs and Commonwealth EIS Guidelines for Biodiversity

Requirements	Where addressed in the EIS
Secretary's Environmental Assessment Requirements (NSW EP&A Act)	
Biodiversity - including: an assessment of impacts on biodiversity, including terrestrial and aquatic ecology, and riparian corridors, in accordance with the Framework for Biodiversity Assessment (unless otherwise agreed by OEH) and the *Policy and Guidelines for Fish Habitat Conservation And Management—Update 2013* (NSW Department of Primary Industries 2013). The assessment is to be conducted by a person accredited in accordance with s142B(1)(c) of the *Threatened Species Conservation Act 1995*. *Note*: This includes a requirement for a Biodiversity Assessment Report and a Biodiversity Offset Strategy.	Section 7.3 Section 7.3.3 Appendix I - Biodiversity Assessment Report and Biodiversity Offset strategy
Commonwealth EIS Guidelines (Commonwealth EPBC Act) Requirements	
The EIS must include a description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: Listed threatened species (and suitable habitat) and ecological communities that are likely to be present in all areas of potential impact. To satisfy this requirement details must be presented on the scope, timing/effort (survey season/s) and methodology for studies and surveys used to provide information on the relevant listed threatened species/ecological community/habitat. This includes details of: • How best practice survey guidelines have been applied • How surveys are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements.	Section 7.3.2 Section 7.3.1 Section 7.3.1
A description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act: • Ecosystems and their constituent parts, including plants and animals, landscapes and soils • Natural and physical resources, including water resources.	Section 7.3.2 and Appendix I
The EIS should also provide a detailed assessment of any likely impact that this proposed action may facilitate MNES at the local, regional, state, national and international scale.	Section 7.3.3, Section 7.3.7 and Appendix I
The controlled action is considered likely to have a significant impact on the following EPBC listed threatened species and ecological communities:	

Requirements	Where addressed in the EIS
• Critically endangered – Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Cumberland Plain Woodlands) • Critically endangered – *Lathamus discolor* (Swift Parrot) • Critically endangered – *Anthocaera phrygia* (Regent Honeyeater) • Vulnerable – Pultenaea *parviflora* • Vulnerable – *Pteropus poliocephalus* (Grey-headed Flying-fox).	Section 7.3.3 and Appendix I
Impacts to the environment (as defined in section 528) should include: • Changes to water quality on site and downstream of the site; • Hydrological changes • Native flora and fauna habitat removal and degradation (on site and in surrounding areas that may be affected by the action) • Vehicle strike (fauna) • Lighting impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment).	Section 8.2 Section 7.5 Section 7.3.3 Section 7.3.3
The EIS must take into account relevant agreements and plans that cover impacts or known threats to a matter protected by a controlling provision (including but not necessarily limited to): a) Any recovery plan and/or conservation advice for the affected species or ecological community b) Any threat abatement plan for a process that threatens an affected species or ecological community c) Any wildlife conservation plan for the affected species d) Any relevant strategic assessment undertaken in accordance with an agreement under Part 10 of the EPBC Act.	Section 7.3.4
The EIS must include details of an offset package to be implemented to compensate for residual significant impacts associated with the project as well as an analysis of how the offset meets the requirements of the Department's *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy October 2012 (EPBC Act Offset Policy) or a state offsetting policy that has been endorsed by the Commonwealth.	Appendix I Section 7.3.6
The offset package can comprise a combination of direct offsets and other compensatory measures, as long as it meets the requirements of the EPBC Act Offset Policy. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that	Appendix I Section 7.3.6

Requirements	Where addressed in the EIS
is impacted in order to deliver a conservation gain. Offsets should compensate for an impact for the full duration of the impact. Offsets must directly contribute to the ongoing viability of the protected matter impacted by the project and deliver an overall conservation outcome that maintains or improves the viability of the protected matter, compared to what is likely to have occurred under the 'status quo' (i.e. if the action and associated offset had not taken place). Note: Offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact.	Appendix I Section 7.3.6
The EIS must provide: a) Details of the offset package to compensate for significant residual impacts on a protected matter b) An analysis of how the offset package meets the requirements of the EPBC Act Offsets Policy.	Appendix I Section 7.3.6
Details in relation to the proposed offsets package, including: a) The location and size, in hectares, of any offset site(s) b) Maps for each offset site that clearly show: (i) The relevant ecological features (ii) The landscape context (iii) The cadastre boundary c) The current tenure arrangements (including zoning and ownership) of any proposed offset sites d) Confirmed records of presence (or otherwise) of relevant protected matter(s) on the offset site(s) e) Details of studies and surveys used to confirm the presence of individuals and or likely habitat within offset site(s), including the scope, timing/effort (survey season/s) and methodologies employed f) Detailed information regarding the extent (in hectares) and quality of habitat for relevant protected matter(s) on the offset site. The quality of habitat should be assessed in a manner consistent with the approach outlined in the document titled *How to use the offset assessment guide* available at http://www.environment.gov.au/epbc/publications/environmental-offsets-policy.html.	Appendix I Section 7.3.6
Provide information and justification regarding how the offsets package will deliver a conservation outcome that will maintain or improve the viability of the protected matter(s) consistent with the EPBC Act environmental offsets policy (October 2012) including: a) Management actions that will be undertaken to improve or maintain the quality of the proposed offset site(s) for the relevant protected matter(s). Management actions must be clearly described, planned and resourced as to justify any proposed improvements in quality for the protected matter(s) over time b) The time over which management actions will deliver any	Appendix I Section 7.3.6

Requirements	Where addressed in the EIS
proposed improvement or maintenance of habitat quality for the relevant protected matter(s) c) The risk of damage, degradation or destruction to any proposed offset site(s) in the absence of any formal protection and/or management over a foreseeable time period (20 years). Such risk assessments may be based on: (i) Presence of pending development applications, mining leases or other activities on or near the proposed offset site(s) that indicate development intent (ii) Average risk of loss for similar sites (iii) Presence and strength of formal protection mechanisms currently in place d) The legal mechanism(s) that are proposed to protect offset site(s) into the future and avert any risk of damage, degradation or destruction.	
Provide information regarding how the proposed offsets package is additional to that already required, as determined by law or planning regulations, agreed to under other schemes or programs or required under an existing duty-of-care.	Appendix I Section 7.3.6
The overall cost of the proposed offsets package; including costs associated with, but not necessarily limited to: a) Acquisition and transfer of lands/property b) Implementation of all related management actions c) Monitoring, reporting and auditing of offset performance.	Appendix I Section 7.3.6

7.3.1 Assessment Methodology

The process of assessing the potential impacts of the project and developing impact mitigation measures for the various aspects of this report are outlined below.

The information sources used in carrying out the assessment are identified below, where applicable, and comprise Government databases, certified local data and mapping and previous assessments. A complete list of information sources used in the assessment is provided in the working paper. The assessment methodologies described below identify where those sources of information have been verified through ground-truthing and survey.

The assessment presented is based upon available data and the field surveys and are therefore indicative of the environmental condition of the study area at the time of the survey. It should be recognised that conditions, including the presence of threatened or cryptic species, could change with time. To address this limitation, a precautionary approach has been used which aimed to identify the presence and suitability of the habitat for threatened species. Where additional limitations to the survey have been identified, they are outlined in the methodology below.

Approach to biodiversity assessment

The *NSW Biodiversity Offsets Policy for Major Projects* (BOPMP) (Office of Environment and Heritage 2014b) provides a standard method for assessing impacts of major projects on biodiversity in NSW and determines offsetting requirements. In the State Significant Infrastructure (SSI) application process, the EIS must address the SEARs requested by the DPE and apply the Framework for Biodiversity Assessment (FBA) (NSW Office of Environment and Heritage 2014a). The FBA contains the assessment methodology that is adopted by the policy to quantify and describe the impact assessment requirements and offset guidance that apply to Major Projects.

Under the Commonwealth process, the Commonwealth EIS Guidelines provides for an offset package to be implemented to compensate for residual significant impacts in order to meet the requirements of a state offsetting policy that has been endorsed by the Commonwealth. The FBA has been endorsed by the Commonwealth and has therefore been used to assess the biodiversity impacts of the project, including nationally listed threatened species and threatened ecological communities, and calculating the offsetting requirements.

The FBA adopts the BOPMP and provides an assessment methodology to identify terrestrial biodiversity values, assess impacts and quantify and describe biodiversity offsets required for unavoidable impacts. This comprises of three stages:

- Stage 1 - Biodiversity assessment
- Stage 2 - Impact assessment (biodiversity values)
- Stage 3 - Biodiversity Offset Strategy.

For aquatic biodiversity impacts, the FBA refers to the requirements of the *Fisheries NSW Policy and guidelines for fish habitat conservation and management* (Department of Primary Industries 2013). This assessment has been included in the Biodiversity Assessment Report (BAR) for completeness.

The FBA requires proponents to identify and assess the impacts on all nationally listed threatened species and ecological communities. The Commonwealth EIS guidelines outline the specific assessment requirements for matters of national environmental significance (MNES), impacts to the environment of Commonwealth land and content of the EIS.

The biodiversity assessment was completed in accordance with the requirements specified by the SEARs issued on 28 July 2015, the amended SEARs issued on 9 March 2016 and the Commonwealth EIS Guidelines. The SEARs state that biodiversity impacts related to the proposed development including terrestrial and aquatic ecology, and riparian corridors, are to be assessed in accordance with the FBA (unless otherwise agreed by OEH) and the Policy and *Guidelines for Fish Habitat Conservation And Management—Update 2013* (NSW Department of Primary Industries 2013). This includes a requirement for a BAR and a Biodiversity Offset Strategy (BOS) (see Appendix I).

Potential impacts to biodiversity not considered by the FBA are also addressed in the BAR. This includes aquatic biodiversity, habitat fragmentation (ie the physical dividing up of once continuous habitats into separate smaller ‘fragments’), edge effects (ie changes in environmental conditions such as altered light levels, wind speed, temperature that occur along the edges of habitats), injury and mortality to fauna, invasion and spread of weeds, and noise, vibration and dust impacts. These matters were assessed separately and in accordance with the relevant policy and guidelines including the NSW Fisheries *NSW Policy and guidelines for fish habitat conservation and management (update 2013)* (NSW Department of Primary Industries 2013).

Habitat fragmentation *per se* relates to the physical dividing up of once continuous habitats into separate smaller 'fragments'.

Edge effects refer to the changes in environmental conditions (e.g. altered light levels, wind speed, temperature) that occur along the edges of habitats.

The BAR addresses impacts on biodiversity values that require further consideration (ie impacts that are considered to be complicated or severe) based on thresholds detailed in Section 9 of the FBA which includes:

- Impacts on landscape features, being:
  - impacts that would reduce the width of vegetation in the riparian buffer zone bordering significant streams and rivers, important wetlands or estuarine areas, or
  - impacts that would prevent species movement along corridors that have been identified as providing significant biodiversity linkages across the state
  - Impacts on native vegetation that are likely to cause the extinction of an Endangered Ecological Community (EEC) / Critically Endangered Ecological Community (CEEC) from an Interim Biogeographically Regionalisation of Australia (IBRA) sub-region or significantly reduce its viability
  - Impacts on critical habitat or on threatened species or populations that are likely to cause the extinction of a species or population from an IBRA sub-region or significantly reduce its viability.

The biodiversity assessment was conducted by persons accredited in accordance with s142B (1) (c) of the NSW *Threatened Species Conservation Act 1995* (TSC Act). The biodiversity assessment was prepared in accordance with relevant policies and guidelines and refers to the following:

- Framework for Biodiversity Assessment (NSW Office of Environment and Heritage 2014a)
- NSW Biodiversity Offsets Policy for Major Projects (NSW Office of Environment and Heritage 2014b)
- Policy and guidelines for fish habitat conservation and management (update 2013) (NSW Department of Primary Industries 2013)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft (NSW Department of Environment and Conservation 2004)
- NSW Guide to Surveying Threatened Plants (NSW Office of Environment and Heritage 2016)
- Survey Guidelines for Australia's Threatened Orchids: Guidelines for detecting orchids listed as threatened under the EPBC Act 1999 (Department of Environment 2013)
- Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna - Amphibians (NSW Department of Environment and Climate Change 2009)
- Commonwealth Policy Statements on survey guidelines for Australia's threatened fauna including bats birds, frogs, fish, mammals and reptiles (Department of Environment Water Heritage and the Arts 2010a, 2010b, 2010c, 2011a, 2011b)
- Commonwealth's Significant Impact Guidelines 1.1 (Matters of National Environmental Significance)
- Significant Impact Guidelines 1.2 (Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth agencies).

Biodiversity study area

The project is located within the Penrith and Liverpool local government areas (LGAs) and traverses the suburbs of Bringelly, Luddenham, Orchard Hills, Mulgoa and Glenmore Park. The study area is located within the Cumberland sub-region of the Sydney Basin Bioregion as defined by Thackway and Cresswell, 1995. The study area is located wholly on the Cumberland Plain

Mitchell Landscape as mapped by the NSW National Parks and Wildlife Service (2002) and described by the NSW Department of Environment and Climate Change (2008).

The study area contains the construction and operational footprints for the project. A map of the study area is presented in Figure 7-7. The construction footprint is the area proposed to be impacted, cleared and/or disturbed during construction. For the purposes of this biodiversity assessment, it is assumed that there would be complete vegetation clearance within the construction footprint. This precautionary approach has been taken to the assessment to ensure all potential impacts are captured and assessed as the design is yet to be finalised. The construction footprint has the same meaning as 'development site' for the purposes of the FBA, however for consistency with the rest of the EIS is herein referred to as the construction footprint. The operational footprint for the project is the area that would be physically impacted by the operation of the project, including all operational ancillary infrastructures. The operational footprint is fully contained within the construction footprint.

Desktop assessment

A background review of existing information was undertaken in January 2016 to identify the existing environment of the study area and locality (to establish a baseline). The review focused on database searches, relevant ecological reports pertaining to the study area, property boundaries, and relevant GIS layers. Relevant databases and literature included:

- Atlas of NSW Wildlife
- OEH vegetation information system (VIS) database (Office of Environment and Heritage 2015)
- The federal Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE) (Bureau of Meteorology 2016)
- DPI's database for aquatic TECs (NSW Department of Primary Industries 2016)
- EPBC Act protected matters search tool (Commonwealth Department of the Environment and Energy 2016b)
- Available regional vegetation mapping including The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities (Tozer 2003)and the Native Vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands (Tozer et al. 2010)
- Geology of the Penrith 1:100,000 Sheet 9030 (Clarke & Jones, 1991)
- Soil landscapes of the Penrith 1:100,000 Sheet 9030 (Hazelton et al., 1989)
- Western Sydney Airport EIS Biodiversity Assessment (GHD, 2016).

The percent native vegetation cover within the 550 metre landscape buffer from the centreline of the development footprint was digitised based off aerial photography. A 550 metre buffer area along each side of the centre line of the linear shaped development footprint is used as part of the FBA to assess landscape value for linear shaped developments, or multiple fragmentation impacts. This method was chosen in place of using regional vegetation mapping (e.g. NSW National Parks & Wildlife Service 2004; Tozer 2003) to improve the accuracy of the vegetation cover estimates as these mapping projects are not suitable for use at such fine scales.

Broad scale vegetation mapping of the area including the Native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities (Tozer 2003) and the Native Vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands (NSW National Parks & Wildlife Service 2004) were used to inform the identification of Plant Community Types (PCTs). The Geology of the Penrith 1:100,000 Sheet 9030 (Clarke, N. R. & Jones 1991) and Soil landscapes of the Penrith 1:100,000 Sheet 9030 (Hazelton et al. 1989) were also used in the identification of PCTs. Topography was examined in a GIS using a shaded relief raster (hillshade) created from an elevation layer.

The preliminary vegetation mapping was then rapidly ground-truthed during the preliminary rapid site assessment phase where PCTs and vegetation zones were refined (refer to vegetation field survey methodology below).

The BAR (Appendix I) uses the definition of a groundwater dependent ecosystem (GDE) as outlined by Serov et al. (2012) which is an ecosystem which has its species composition and natural ecological processes wholly or partially determined by groundwater. The location of GDEs within the within the Hawkesbury Nepean management zone is mapped by Kuginis et al. (2012).

Habitat assessment

Target threatened species for assessment were largely identified via the BioBanking credit calculator (BBCC). The BBCC is a decision support system provided by OEH to assist assessors to comply with the requirements of the FBA. An accredited assessor must use the Credit Calculator to undertake an assessment of the impacts of the project on biodiversity values and to prepare a BAR. However, the following database searches were undertaken to identify additional species with potential to occur in the study area and included:

- Atlas of NSW Wildlife
- OEH BioBanking Threatened Species Profile Database
- NSW Department of Primary Industries (DPI) Fisheries Fish Records Viewer
- The federal Department of Environment and Energy's Protected Matters Search Tool
- Critical habitat register.

Rapid habitat assessments were conducted at vegetation plot sites to gather information on the type and condition of the fauna habitats present with a focus on identifying the suitability of the habitat for the list of predicted threatened species generated from the BioBanking Calculator and additional species. Under the FBA, the assessor must undertake a plot-based full floristic survey of the development site that is stratified and targeted to assess the expected environmental variation. The plot-based full floristic survey is based on a 20 m × 20 m quadrat (or 400 m2 equivalent for linear areas). At each survey site an assessment was made of the fauna habitat features including the:

- Type and structure of the vegetation, including an assessment of the 'naturalness' in terms of the presence of remnant vegetation or planted and re-growth areas and the extent of modification
- Presence and frequency of large mature trees, tree hollows, standing dead trees (stags) and logs
- Presence of significant keystone species and critical habitat elements for threatened fauna
- Disturbance regimes, both past and ongoing including grazing and weed abundance
- Density of each vegetation strata (structural diversity)
- Presence and quality of wet areas or waterbodies, significant aquatic habitats where present
- Size of remnant patches and extent of connectivity, movement corridors and refuge value.

The habitat assessment data were used to identify the likelihood for predicted species credit species (ie a species that cannot be predicted by habitat surrogates) to occur and inform the detailed survey. Threatened species that cannot reliably be predicted to occur on a development site based on PCT, distribution and habitat criteria are identified by the Threatened Species Profile Database as species credit species.

All threatened species with a moderate to high likelihood of occurrence, that have been identified as requiring survey in the BBCC, or that have been recorded during the surveys are considered target threatened species. The likelihood of occurrence of a threatened species was assessed in accordance with the criteria outlined in Table 7-39.

Table 7-39 Likelihood of occurrence criteria used in the habitat assessment

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey
High	It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (ie. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10 km) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration.
Moderate	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (ie. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10 km). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (ie. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
None	Suitable habitat is absent from the study area.

Field Surveys

Vegetation surveys

The vegetation surveys were completed using field survey methods in line with Chapter 5 of the FBA and implementing the guidelines for *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Working Draft) (NSW Department of Environment and Conservation 2004). The field surveys were undertaken over a period of 11 days from 2 September 2015 to 4 February 2016.

During the initial stages of the assessment a rapid reconnaissance survey was undertaken where the study area was visited to verify and refine the Plant Community Types (PCTs) identified from the desktop assessment. PCTs were classified in accordance with the OEH vegetation information system (VIS) database (Office of Environment and Heritage 2015). Variations in vegetation condition and quality were noted to inform the stratification of PCTs into vegetation zones.

Transects/plots were undertaken in each vegetation zone using a series of 20 x 20 m quadrates nested inside a 20 x 50 m transect. Site attributes were assessed at each transect/plot to obtain a quantitative measure of vegetation condition to be applied for each vegetation zone.

The condition of vegetation patches was assessed according to the criteria provided in the Commonwealth Listing Advice on Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (Threatened Species Scientific Committee 2009).

The vegetation field survey provided good spatial coverage and survey effort of the development site, meeting the requirements of the FBA. However, the field survey was constrained by landowner permissions and restricted access in some areas. After detailed design and prior to the

finalisation of the offset package for the Project, surveys of these areas would be undertaken and new calculations performed as necessary.

Targeted threatened flora surveys

Targeted threatened flora surveys were undertaken for all identified candidate flora species with suitable habitat based on desktop review. Using data from the Threatened Species Profile Database, the assessor must identify a threatened species as a candidate species for the development site if:

(a) the species is identified as a species credit species in the Threatened Species Profile Database, and

(b) the geographic distribution of the species is known or predicted to include the IBRA sub-region in which the development site is located, and

(c) the development site contains habitat features or components associated with the species, as identified in the Threatened Species Profile Database, OR

(d) past surveys undertaken at the development site indicate that the species is present.

The targeted flora surveys followed the methods described in the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004* (NSW Department of Environment and Conservation 2004). The survey timing adhered to the months detailed in the BBCC for each species credit species targeted. The surveys specifically targeted the following species credit species *Pilularia novae-hollandiae*, *Eucalyptus benthamii*, *Dillwynia tenuifolia*, *Acacia pubescens*, *Grevillea juniperina* subsp. j*uniperina*, *Marsdenia viridiflora* subsp. *viridiflora* endangered population, *Cynanchum elegans* and *Pimelea spicata*.

For cryptic species (ie *Pimelea spicata*) that are known to be associated with the PCTs within the study area (i.e. potential habitat was present), the field survey included visiting reference populations to ensure visibility in the study area during the survey period.

Targeted threatened fauna surveys

Targeted threatened fauna surveys were undertaken for species identified as having a moderate to high likelihood of occurring in the study area based on desktop review. The survey approach and methods for the fauna surveys were designed to address the methods described in the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004* and the following guidelines:

- Amphibians – Threatened species survey and assessment guidelines: field survey methods for fauna – Amphibians (2009) http://www.environment.nsw.gov.au/resources/threatenedspecies/09213amphibians.pdf
- Threatened bats – Survey Guidelines for Australia's Threatened Bats, Commonwealth of Australia (2010). http://www.environment.gov.au/epbc/publications/threatened-bats.html
- Threatened birds – Survey Guidelines for Australia's Threatened Birds, Commonwealth of Australia (2010) http://www.environment.gov.au/system/files/resources/107052eb-2041-45b9-9296-b5f514493ae0/files/survey-guidelines-birds.pdf
- Threatened frogs – Survey Guidelines for Australia's Threatened Frogs, Commonwealth of Australia (2011). http://www.environment.gov.au/system/files/resources/ff3eb752-482d-417f-8971-f93a84211518/files/survey-guidelines-frogs.pdf.

Rapid habitat assessments were conducted at vegetation plot sites to gather information on the type and condition of the fauna habitats present, with a focus on identifying the suitability of the habitat for the list of predicted threatened species.

Targeted fauna surveys were undertaken for the Green and Golden Bell Frog, Australasian Bittern, Black Bittern, Cumberland Plain Land Snail, Koala, Regent Honeyeater, and threatened insectivorous bats.

Surveys for birds, including migratory species, were undertaken as part of the field surveys for the EIS. The surveys included area surveys over two hectares for 20 minutes each conducted in late spring and summer during which time most of the listed migratory species are present in eastern Australia. Specific habitats including wetlands were targeted during the survey.

The fauna species which were identified from the background review and habitat assessment that were targeted during the survey are discussed in Table 7-40.

Table 7-40 Targeted fauna survey details

Species	Minimum survey requirements	Survey completed
Green and Golden Bell Frog	All surveys should be undertaken within one week of heavy rainfall (>50 mm in seven days) during spring/summer (October – March) Initial habitat assessment - surveys using a combination of call detection, call playback and spotlighting A minimum of four nights under ideal conditions Small wetlands (<50 m at greatest length) should be covered in about one hour Large sites should be sampled systematically	All dams within 100-200 m of the project corridor where assessed for their habitat value using criteria identified in the literature. In total 38 farm dams or clusters of connected dams along drainage lines were assessed (refer to Appendix I). Potential habitats identified and each searched for one hour by two ecologists using call detection, call playback and spotlighting. Large series of dams at the Defence site surveyed systematically over four nights. Total survey effort was 6 nights. All surveys were conducted within a week of heavy rainfall which ranged from 30-90 mm. The nocturnal field surveys were undertaken over a period of 6 nights from 2 September 2015 to 4 February 2016 (not inclusive).
Regent Honeyeater	20 minute surveys of two hectare plots per stratification unit Area and targeted searches in woodland concentrating on flowering Eucalypts and where other nectar feeding birds are evident 20 hours over 5 days	20 minute dedicated surveys of approx. two hectare plots by one ecologist repeated twice at each of four sites (4 mornings) plus opportunistic surveys during all other site activities (about 25 hours over 10 days). Surveys undertaken at four sites across study area, including opportunistic sightings, targeted both PCTs. The field surveys were undertaken over a period of 6 days from 2 September 2015 to 4 February 2016 (not

Species	Minimum survey requirements	Survey completed
		inclusive).
Cumberland Plain Land Snail	*M. corneovirens* can be surveyed year round and it is not necessary to wait until after wet weather The minimum time required would depend on the size and amount of potential habitat present within the site being assessed	Habitat assessment undertaken at 50 locations across both PCTs, focused at vegetation plot locations. 10 minute search at each habitat assessment plot and general search around sites identified as moderate to high habitat value.
Australasian Bittern and Black Bittern	Observations targeted foraging habitat within wetland within early morning or evenings for this cryptic species. Detection by observation or solicited calls	Evening and spotlighting surveys and call playback over 6 evenings / nights by two ecologists. Survey times varied between 0.5 to 2.0 hrs at each site. In total 7 sites were surveyed for bitterns.
Eastern Bentwing-bat Large-eared Pied Bat	Harp trapping - Four trap nights over two consecutive nights (with one trap placed outside the flyways for one night) per 100 ha of stratification unit Call detection - Two sound activated recording devices utilised for the entire night (a minimum of four hours), starting at dusk for two nights per 100 ha of stratification unit	Harp traps* – four trap nights over two consecutive nights at four different locations (8 trap nights). Poor flyways in study area so traps placed on tracks where available and on edge of flyway or forest edge. Call detection – Four AnaBat™ II bat detectors used each for two nights and each recording from 1900 hours to 0500 hours.

*Harp traps are a type of trap with a square frame made of aluminium (or steel or wood) mounted on adjustable legs with monofilament fishing line strung vertically in the frame in two or more banks. Below the bottom of the frame is a canvas catch bag lined with plastic. There are many harp trap designs and a range of frame sizes for different uses.

Aquatic surveys

Aquatic habitat assessments were conducted on the 20 to 22 February 2016. Sites were assessed against the Policy and Guidelines for Fish Habitat Conservation and Management (update, 2013) (Department of Primary Industries 2013), Fish Passage Requirements for Waterway Crossings (Fairfull & Witheridge, 2003), and Policy and Guidelines for fish Friendly Waterway Crossings (DPI, 2004). These guidelines provide information for waterway classification and ways to minimise impacts to fish and other aquatic wildlife from road projects which may improve the survival rate and protect threatened fish species, populations and their habitat. Due to the low likelihood of threatened fish species present, limited water availability and limited aquatic habitat, fish and macroinvertebrate surveys were deemed unnecessary. Visual inspections allowed the classification of Key Fish Habitat (DPI, 2013).

7.3.2 Existing environment

The following sections outline the existing environmental conditions relevant to terrestrial and aquatic ecology. This is considered to provide a baseline of existing conditions from which potential impacts from the project have been assessed.

Landscape scale biodiversity features

In accordance with Chapter 4 of the FBA, the BAR has identified a number of landscape features such as the IBRA region, IBRA sub-region, Mitchell landscape (landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (OEH, 2014)), rivers and streams, extent of native vegetation in the area assessed for the project.

The landscape scale biodiversity features identified within the biodiversity study area are summarised in Table 7-41 and shown in Figure 7-7.

Table 7-41 Biodiversity landscape features within the biodiversity study area

Landscape feature	Description
Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and sub-region	The study area is located within the Cumberland sub-region of the Sydney Basin Bioregion as defined by Thackway and Cresswell, 1995.
NSW Landscape Regions (Mitchell Landscapes)	The study area is located wholly on the Cumberland Plain Mitchell Landscape as mapped by the NSW National Parks and Wildlife Service (2002) and described by the NSW Department of Environment and Climate Change (2008).
Rivers and streams	The northern portion of the project lies within the Lower Nepean River Management Zone of the Hawkesbury and Lower Nepean Rivers Water Source, while the while the southern portion lies within the Mid Nepean River Catchment Management Zone and the Upper South Creek Management Zone. The Nepean River is the ultimate downstream receiving environment. The project directly traverses a number of unnamed tributaries and drainage lines (sometimes associated with farm dams), as well as the following named creeks: Cosgroves Creek, a second order intermittent stream which is a tributary of South Creek, and Badgerys Creek, a second order intermittent stream containing permanent residual pools.
Wetlands	Artificial wetlands (i.e. farm dams, detention basins, roadside drains, one effluent treatment system) are scattered throughout the study area. There are no naturally occurring wetlands in the study area.
State of regionally significant biodiversity links	The Biodiversity Investment Opportunities Map (BIO Map) (Office of Environment and Heritage 2015a) identifies areas for biodiversity investment funding within the Cumberland sub-region, termed priority investment areas, including core areas and biodiversity corridors of state and regional significance. The northern portion of the study area on the DEOH is mapped as a core area on the BIO Map (Office of Environment and Heritage 2015a). This core area is also identified as Priority Conservation Land from the Cumberland Plain Recovery Plan (Department of Environment Climate Change and Water 2010) and mapped as a Regional Corridor on the BIO Map. Regional Corridor 17, a corridor that connects the Mulgoa Nature Reserve to the vegetation on the DEOH is also mapped in this area on the BIO Map. The BIO Map (Office of Environment and Heritage 2015a) has not been approved by the Chief Executive of OEH and therefore these

Landscape feature	Description
	biodiversity links have not been included in the FBA calculations. There are seven local area biodiversity links within the study area as defined under the FBA. These seven functional local area connecting links contain woody PCTs assumed to have a percentage foliage cover in over-storey and mid-storey or ground cover condition within benchmark levels. The minor riparian buffers (1st and 2nd order streams) within the study area are not eligible for classification under state or regional biodiversity links according to Appendix 5 of the FBA.
Per cent native vegetation cover	Current per cent native vegetation cover is estimated at 11.8 per cent (score 2.5 as outlined in Table 16 of Appendix 5 of the FBA). After the development, per cent native vegetation cover is estimated at 10 per cent (score 1.25 as outlined in Table 16 of Appendix 5 of the FBA). Clarification of the scores is detailed in the BAR, and relates to a score given for each range.

As the project is a linear shaped development, landscape value was also assessed according to Appendix 5 of the FBA (assessing landscape value for linear shaped developments, or multiple fragmentation impacts). To undertake the assessment of landscape values, a 550 m buffer was established either side of the centre line of the proposed alignment. All landscape value calculations were undertaken using ESRI ArcGIS 10.1 software.

The landscape scale biodiversity values identified within the biodiversity study area are summarised in Table 7-42.

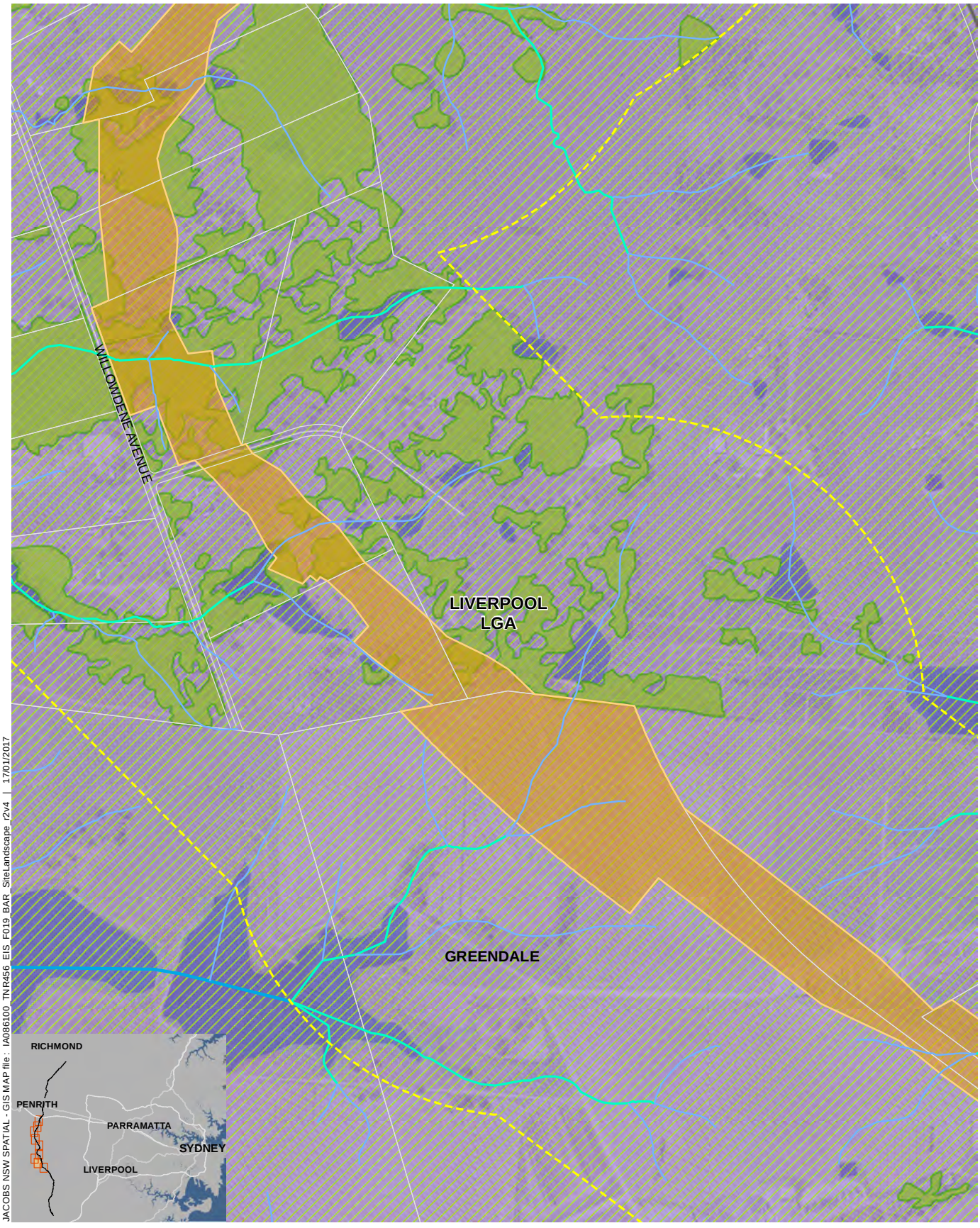
Table 7-42 Biodiversity landscape values within the biodiversity study area

Landscape value	Description
Connectivity value	There are no state or regionally significant biodiversity links in the study area. The project would impact on local area biodiversity links and the score for connectivity value class is 2.5. Local links are mapped in the BAR and have been identified as areas of native vegetation in moderate to good condition that are ≥250 ha and <1000 ha in total, or areas greater than 1000 ha in total AND Width of vegetation in moderate to good condition that is connecting the area is >30 m and <100 m.
Patch size	The project occurs in the Cumberland Plain Mitchell Landscape with is 89 per cent cleared. The development footprint crosses three distinct vegetation patches. Patch 1 is at least 778 ha in size. Patch 2 is at least 1,820 ha in size. Patch 3 is at least 2,573 ha in size. The final patch size score is 12.5 (the average of the three patch scores).
Area to perimeter ratio	The area to perimeter ratio before the development is 22 and after development is 21. This was calculated as follows: • The native vegetation within the 550m buffer zone was digitised using GIS to determine the existing percentage vegetation cover across this assessment area • Any areas less than or equal to one hectare in size was removed from the digitised GIS layer so that only patches of vegetation greater than one

Landscape value	Description
	hectare were included • All other areas not impacted by the development (i.e. intersected, modified or removed) were also removed from the digitised GIS layer. This was then used to calculate the total area and perimeter length of existing vegetation resulting in an area to perimeter ratio before development of 22 The project construction boundary was overlaid onto this GIS layer and any vegetation within the boundary was removed in order to calculate an area to perimeter ratio after development of 21. The proportional change in area to perimeter ratio as calculated by the credit calculator is 4.5 and the score for the proportional change in area to perimeter ratio is therefore 1 based on Table 19 in Appendix 5 of the FBA. This is a relatively small change in area to perimeter ratio and is expected as the vegetation currently has a high area to perimeter ratio (due to many small fragments of vegetation in the landscape) which would not be increased significantly by the project.
Commonwealth land	The project is located on a portion of the DEOH and a portion of Commonwealth land purchased for the Western Sydney Airport. The Orchard Hills Cumberland Plain Woodland is a Listed Place on the Commonwealth Heritage List (CHL 105317) and is located on the DEOH site. The land at Orchard Hills is recognised as the least disturbed and largest remaining remnant of Cumberland Plain Woodland. The tributaries of Blaxland Creek at Orchard Hills are among the least disturbed catchments remaining on the Cumberland Plain and are regarded as possibly the most pristine creek system on Wianamatta Shale left in Western Sydney (Department of the Environment, 2016b).

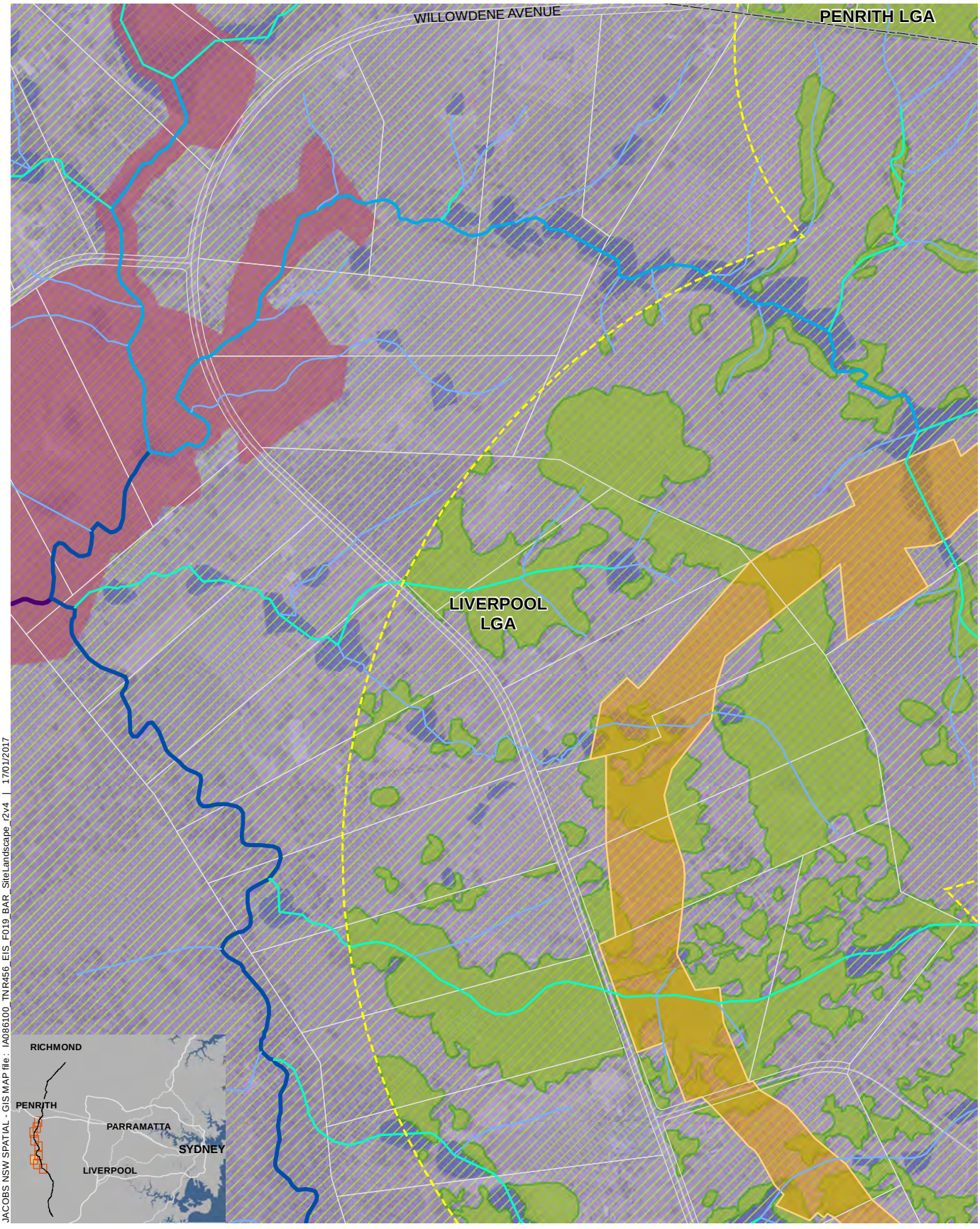
JACOBS NSW SPATIAL - GIS MAP file: IA086100_TNR456_EIS_F019_BAR_SiteLandscape_r2v4 | 17/01/2017

Figure 7-7 | Site location and landscape features



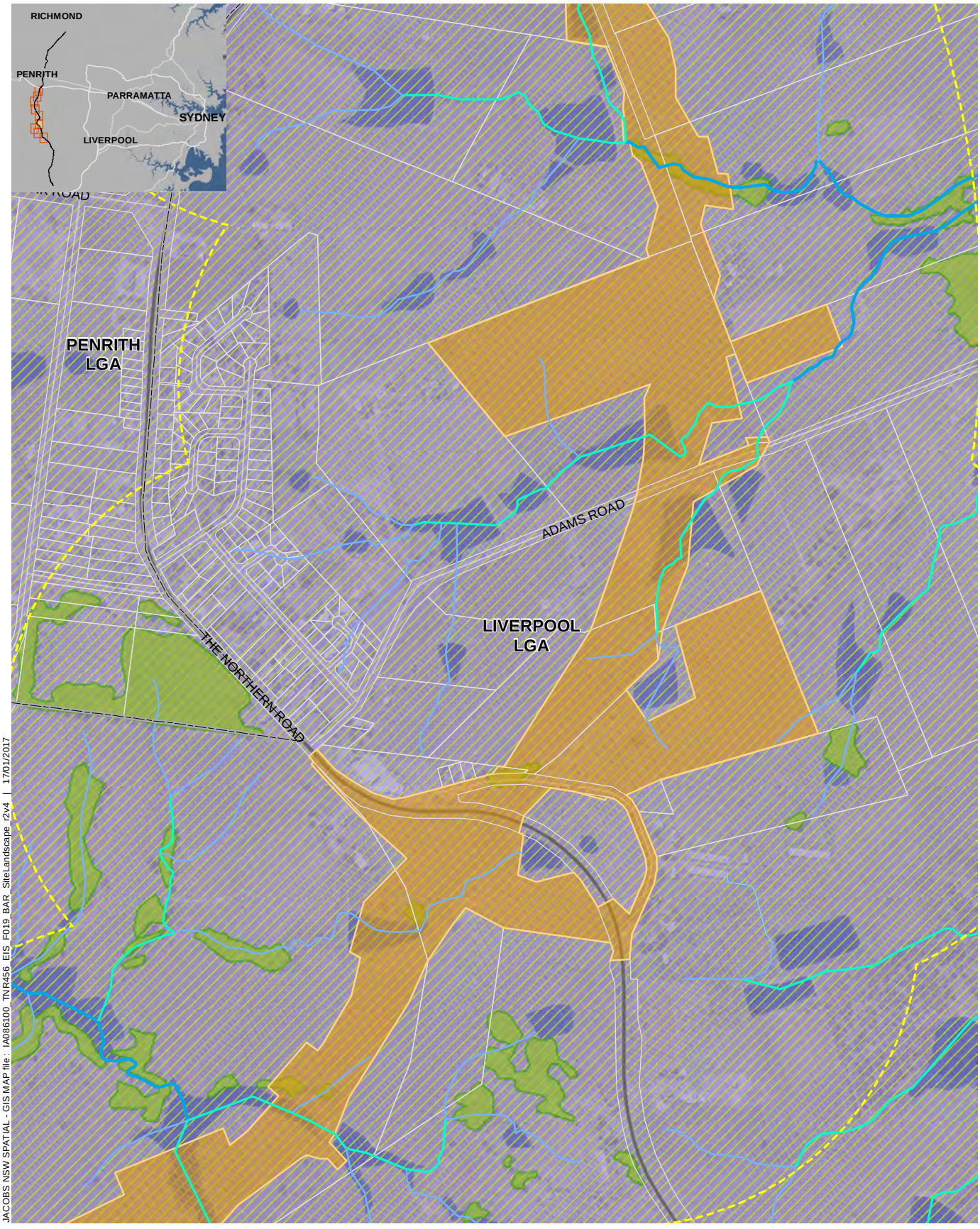
JACOBS NSW SPATIAL - GIS MAP file : IA086100_TNR456_EIS_F019_BAR_SiteLandscape_r2v4 | 17/01/2017

Figure 7-7 | Site location and landscape features



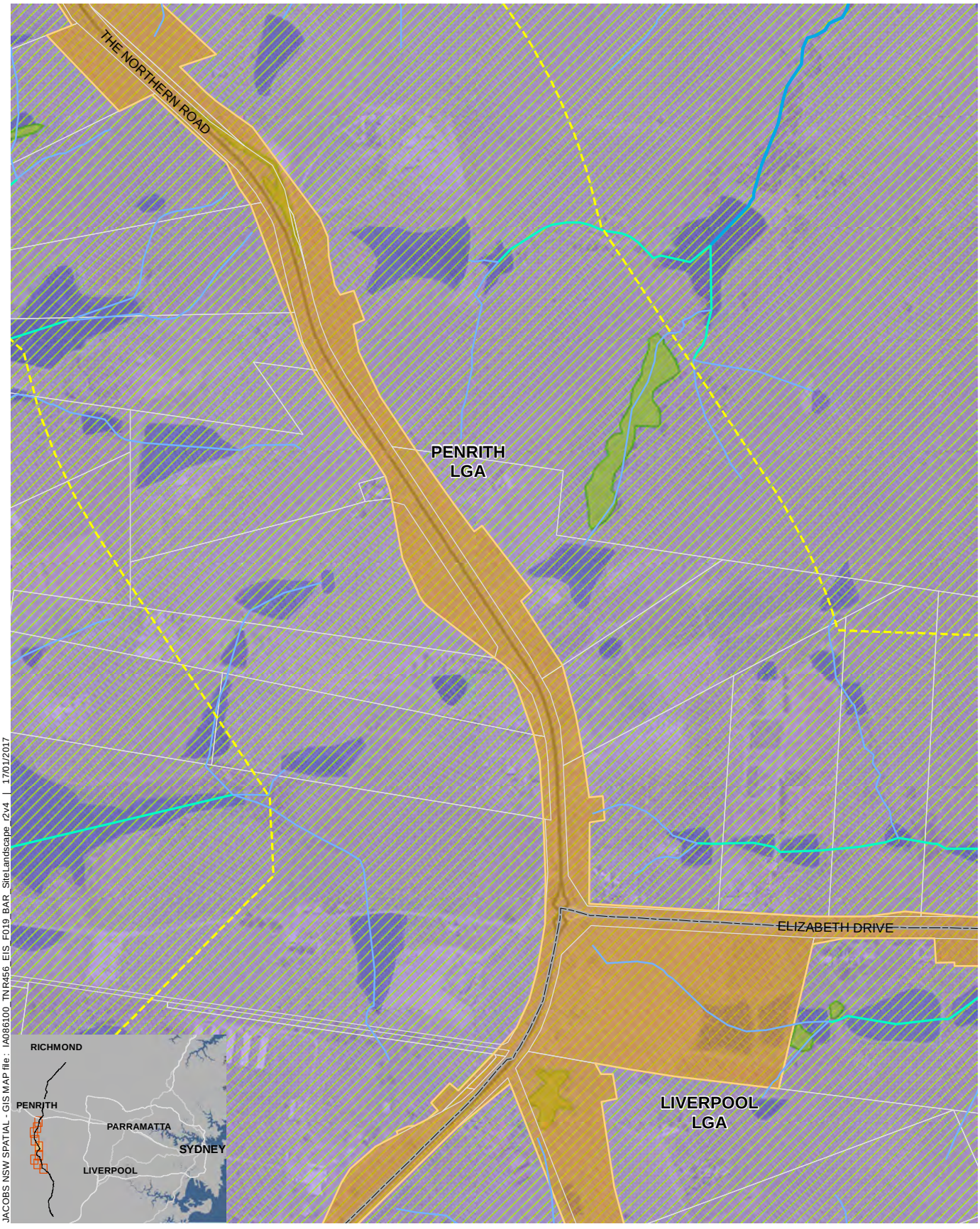
JACOBS NSW SPATIAL - GIS MAP file : IA086100_TNR456_EIS_F019_BAR_SiteLandscape_r2v4 | 17/01/2017

Figure 7-7 | Site location and landscape features



JACOBS NSW SPATIAL - GIS MAP file: IA086100_TNR456_EIS_F019_BAR_SiteLandscape_r2v4 | 17/01/2017

Figure 7-7 | Site location and landscape features



JACOBS NSW SPATIAL - GIS MAP file : IA086100_TNR456_EIS_F019_BAR_SiteLandscape_r2v4 | 17/01/2017

Figure 7-7 | Site location and landscape features

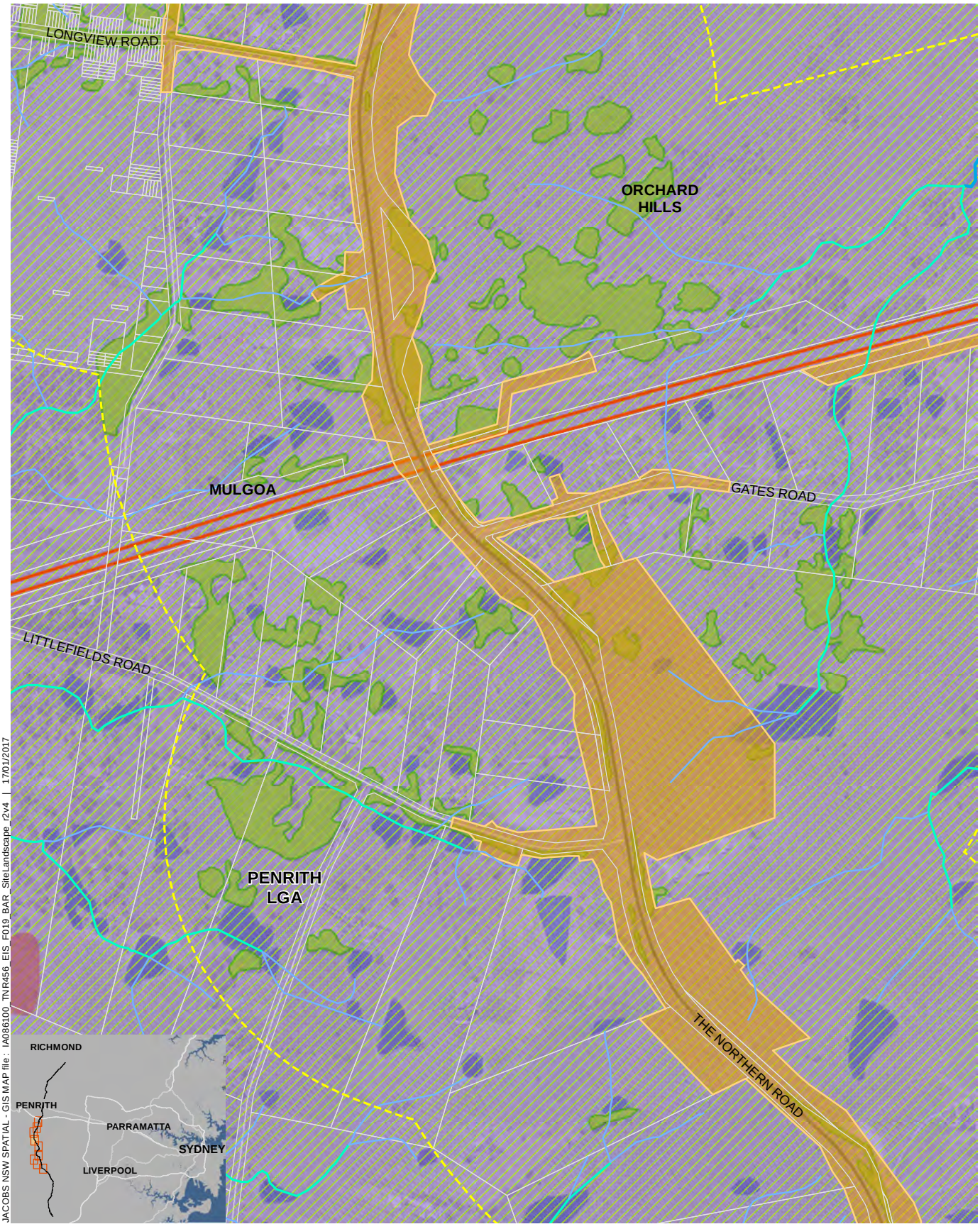


Figure 7-7 | Site location and landscape features

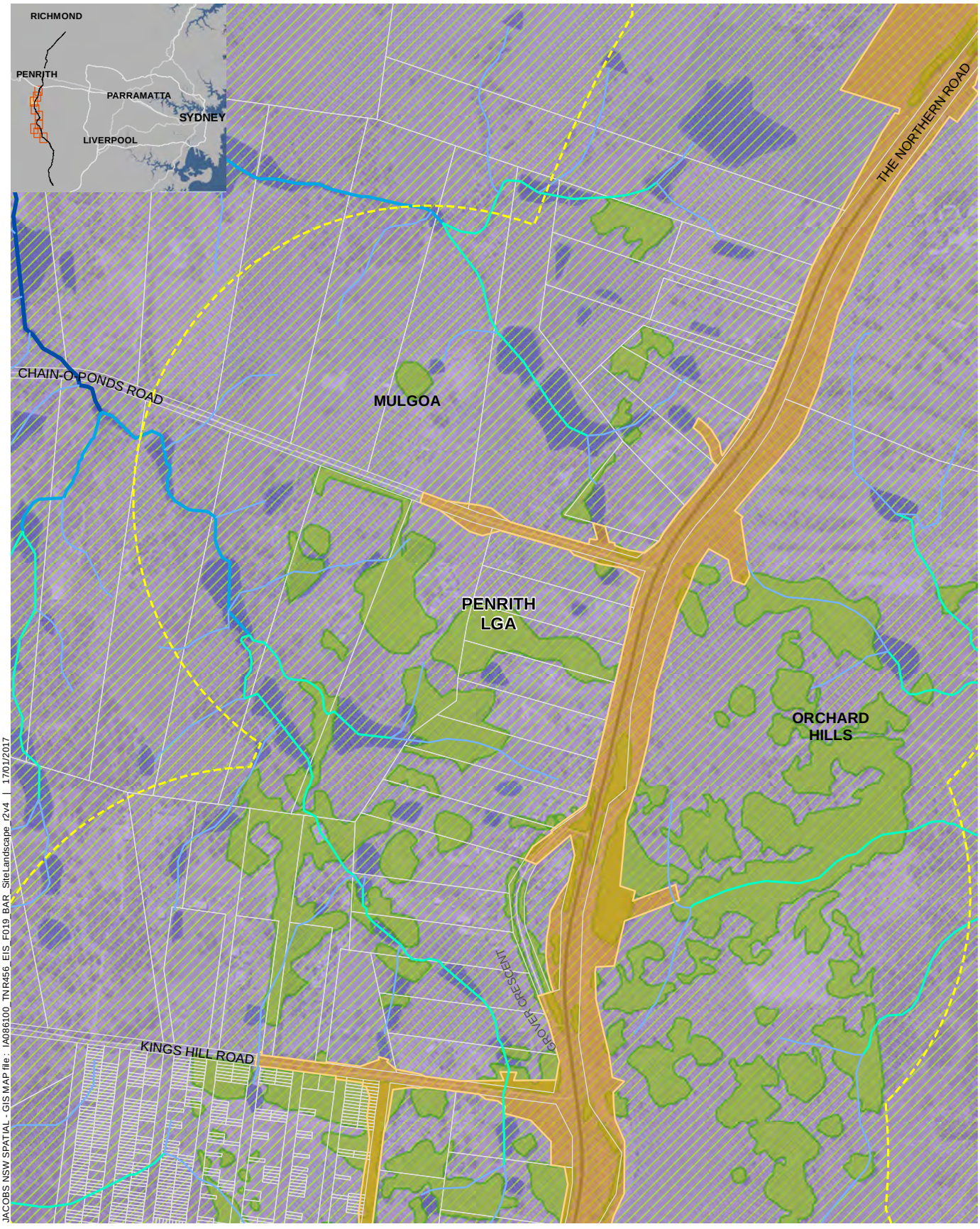


Figure 7-7 | Site location and landscape features

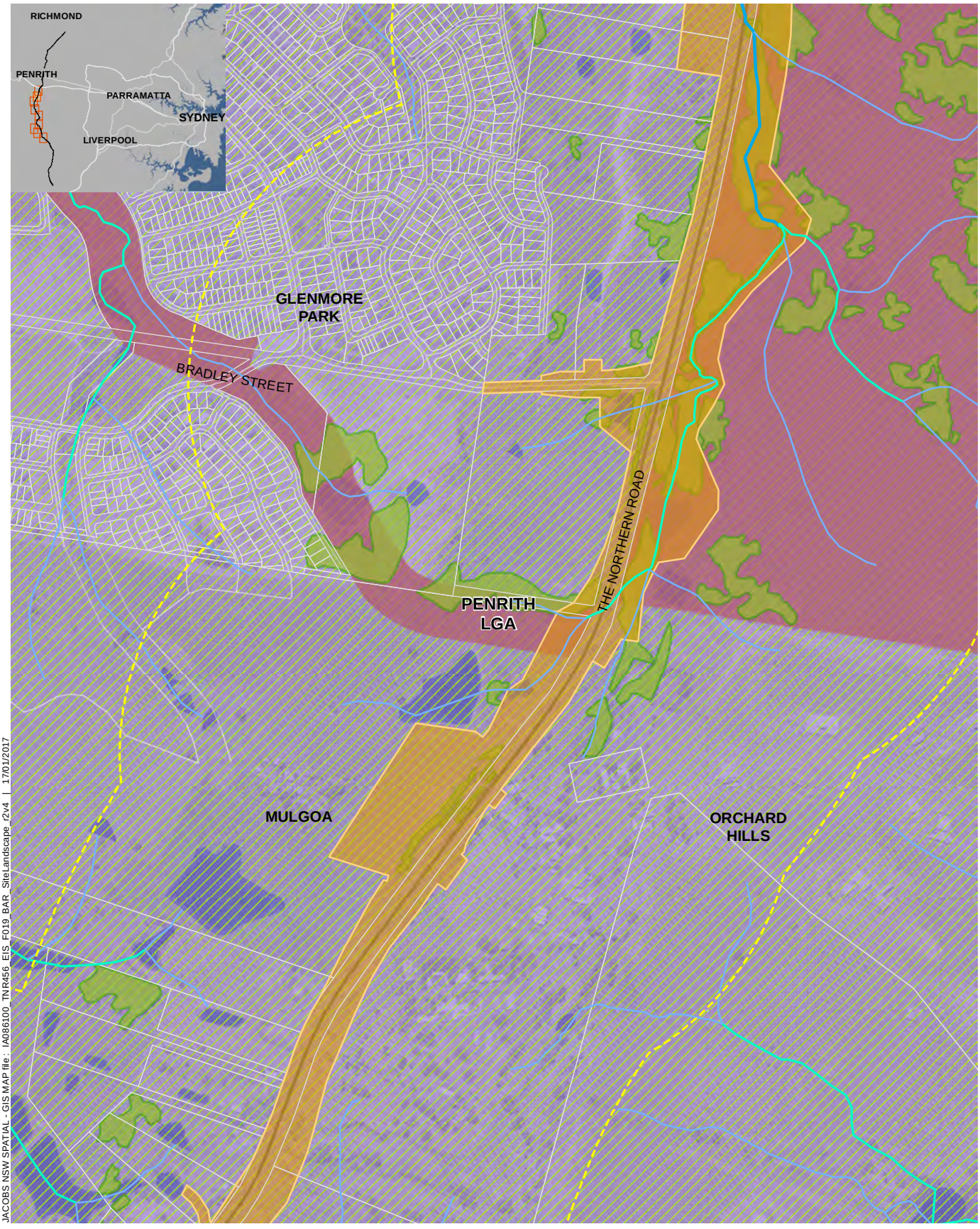


Figure 7-7 | Site location and landscape features

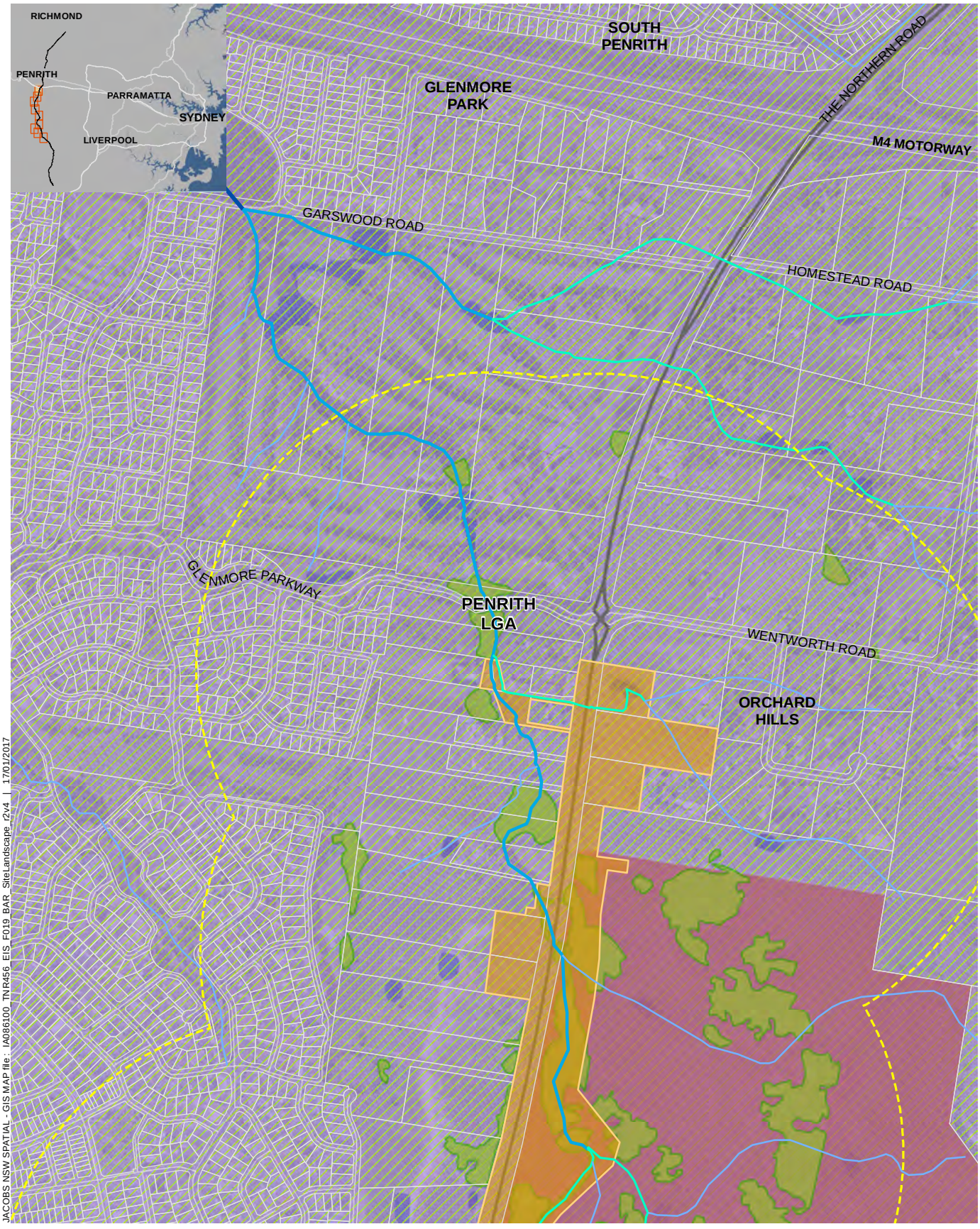


Figure 7-7 | Site location and landscape features

Native vegetation

Plant community types

The extent of native vegetation within the study area was firstly mapped in a GIS using digital aerial photography captured in 2015. This broad scale vegetation mapping of the area was used to inform the initial identification of PCTs for the project. Subsequent to the initial mapping, the PCTs were verified and refined through the detailed floristic assessment collected in the field. This included identification of any noxious weeds.

The field surveys were designed to assess the environmental variation within the study area and any areas with gaps in existing mapping and site information to determine vegetation zones. The condition of PCTs for the study area was assessed in accordance with Chapter 5 of the FBA and vegetation zones assigned by comparing the dominant species, the general description of location, soil type and other attributes as described in the VIS classification database (Office of Environment and Heritage 2015).

Five vegetation types were identified within the study area as described in Table 7-43.

Table 7-43 Plant community types within the study area

PCT code	Plant community type (PCT)	Description
849	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	As per VIS description: The gentle topography associated with the shale plains of western Sydney carries an open grassy woodland dominated by *Eucalyptus moluccana*, *Eucalyptus tereticornis* and *Eucalyptus crebra*/*Eucalyptus fibrosa*. Cumberland Shale Plains Woodland is the second of the grassy woodlands that comprise the Cumberland Plain Woodland in the Sydney Basin Bioregion Critically Endangered Ecological Community listed under the NSW TSC Act. Like the related community Cumberland Shale Hills Woodland it is typified by a sparse to moderate cover of shrubs and a high cover of grasses and forbs. Tozer *et al.* (2010) define the primary habitat for the community as occurring at elevations less than 150 meters above sea level with some sites occurring at higher elevations where the landscape remains gently inclined.
850	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	As per VIS description: Cumberland Shale Hills Woodland is one of two widespread grassy woodland communities which together are recognised as the Cumberland Plain Woodland n the Sydney Basin Bioregion, a Critically Endangered Ecological Community. It is open woodland of *Eucalyptus moluccana* and *Eucalyptus tereticornis* with *Eucalyptus crebra* also common. *Acacia implexa* occurs amongst the small tree layer, often amongst regrowth stands. This species is one of the more distinctive floristic attributes that helps distinguish between the two components of the EEC. Other features are similar in that the two woodland units are characterised by an open shrub layer and a grassy ground cover. Fire history can have an important influence on the abundance of shrubs with density of *Bursaria spinosa* increasing with time since fire. The community occupies higher elevations associated with the hills and rises south from Prospect. It is most extensive in Campbelltown and Liverpool local government areas. It extends west across the

PCT code	Plant community type (PCT)	Description
		Razorback range and once dominated the southern half of the Cumberland Plain. It is restricted to elevations between 50 and 350 m above sea level (Tozer *et al*. 2010).
835	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	As per VIS description provided for PCT 835 above. Within the study area the poorer quality examples of this PCT (Moderate/Good/Poor vegetation zone) occur as small fragmented patches of vegetation left in the landscape after clearing for agriculture and the flooding of small valleys and drainage lines during creation of farm dams. Patches of this vegetation zone occur on the Defence Site Orchard Hills on the low lying land which contains the quaternary alluvial soils of the South Creek soil landscape (gravel, silt, sand, clay) which overly the Cranebrook Formation. Small patches of this vegetation zone occur throughout the study area associated with small ephemeral drainage lines including Cosgroves Creek, and fringing the dams on the unnamed tributaries in Luddenham that flow west into Duncans Creek. A small patch of this vegetation zone also occurs in the southern point of the study area along Badgerys Creek where fine grained sand, silt and clay of quaternary alluvium (South Creek soil landscape) occurs. Altitude of the plots varies from 73 to 91 m above sea level.
806	Derived grasslands on shale hills of the Cumberland Plain (50-300 m asl)	Grassland derived from PCT 850 dominated by *Themeda triandra*.
1071	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	A rushland with sub-stratum growth forms of forbs, herbs, grass and aquatics. Dominated by the exotic *Juncus acutus** with native wetland species and occasional *Casuarina glauca* occurs fringing man-made water bodies, drainage lines and depressions across the study area. Also associated with sites of poor drainage where *Phragmites australis* becomes dominant.

These five PCTs were then classified into ten vegetation zones (labelled 1 to 10) based on areas of native vegetation with the same PCT and of a similar broad condition state (see Figure 7-8). The vegetation zones assigned as Moderate to Good were further classified into a sub-condition class based on observable differences.

Table 7-44 Vegetation zones within the study area

Vegetation zone	Vegetation zone code	Plant community type (PCT)	Threatened ecological community?	Site value score / 100	Extent in study area (ha)
1	849 - Moderate/ Good	Grey Box - Forest Red Gum grassy woodland on flats	Cumberland Plain Woodland in the Sydney Basin	55.56	13.89

Vegetation zone	Vegetation zone code	Plant community type (PCT)	Threatened ecological community?	Site value score / 100	Extent in study area (ha)
		of the Cumberland Plain, Sydney Basin Bioregion	Bioregion		
2	835 - Moderate/ Good	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	53.65	3.24
3	850 – Moderate/Good	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion	57.97	25.12
4	849 – Moderate/Good_Poor	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion	15.94	10.17
5	850 – Moderate/Good-Poor	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion	24.64	13.38
6	835 - Moderate/Good-Poor	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	43.23	10.30

Vegetation zone	Vegetation zone code	Plant community type (PCT)	Threatened ecological community?	Site value score / 100	Extent in study area (ha)
7	850 - Moderate/Good-High	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion	74.64	7.33
8	806 – Moderate/Good-Derived grassland	Derived grasslands on shale hills of the Cumberland Plain (50-300 m asl)	Cumberland Plain Woodland in the Sydney Basin Bioregion	19.05	49.78
9	1071 – Moderate/Good-Other	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Not listed as it is man made	34.06	12.92
10	850 – Moderate/Good-Medium	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion	25.85	2.00
Total					148.13

Notes: * = Vegetation in Moderate/Good condition is all native vegetation that is not in low condition. Vegetation in Low condition is defined as:

a) woody native vegetation with native over-storey percent foliage cover less than 25% of the lower value of the over-storey percent foliage cover benchmark for that vegetation type, and where either:

– less than 50% of ground cover vegetation is indigenous species, or

– greater than 90% of ground cover vegetation is cleared OR

b) native grassland, wetland or herbfield where either:

– less than 50% of ground cover vegetation is indigenous species, or

– more than 90% of ground cover vegetation is cleared.

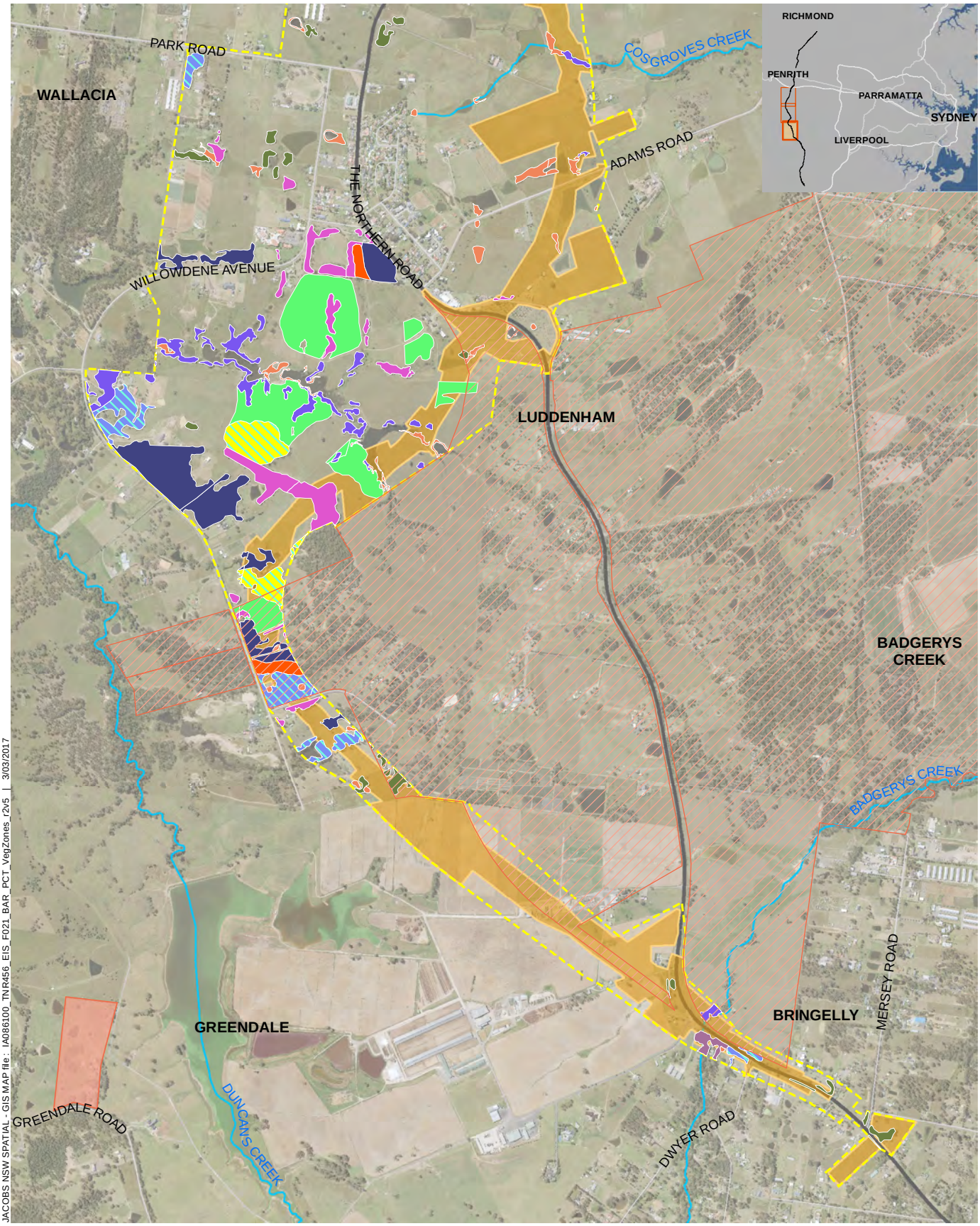


Figure 7-8 | Plant community types and vegetation zones

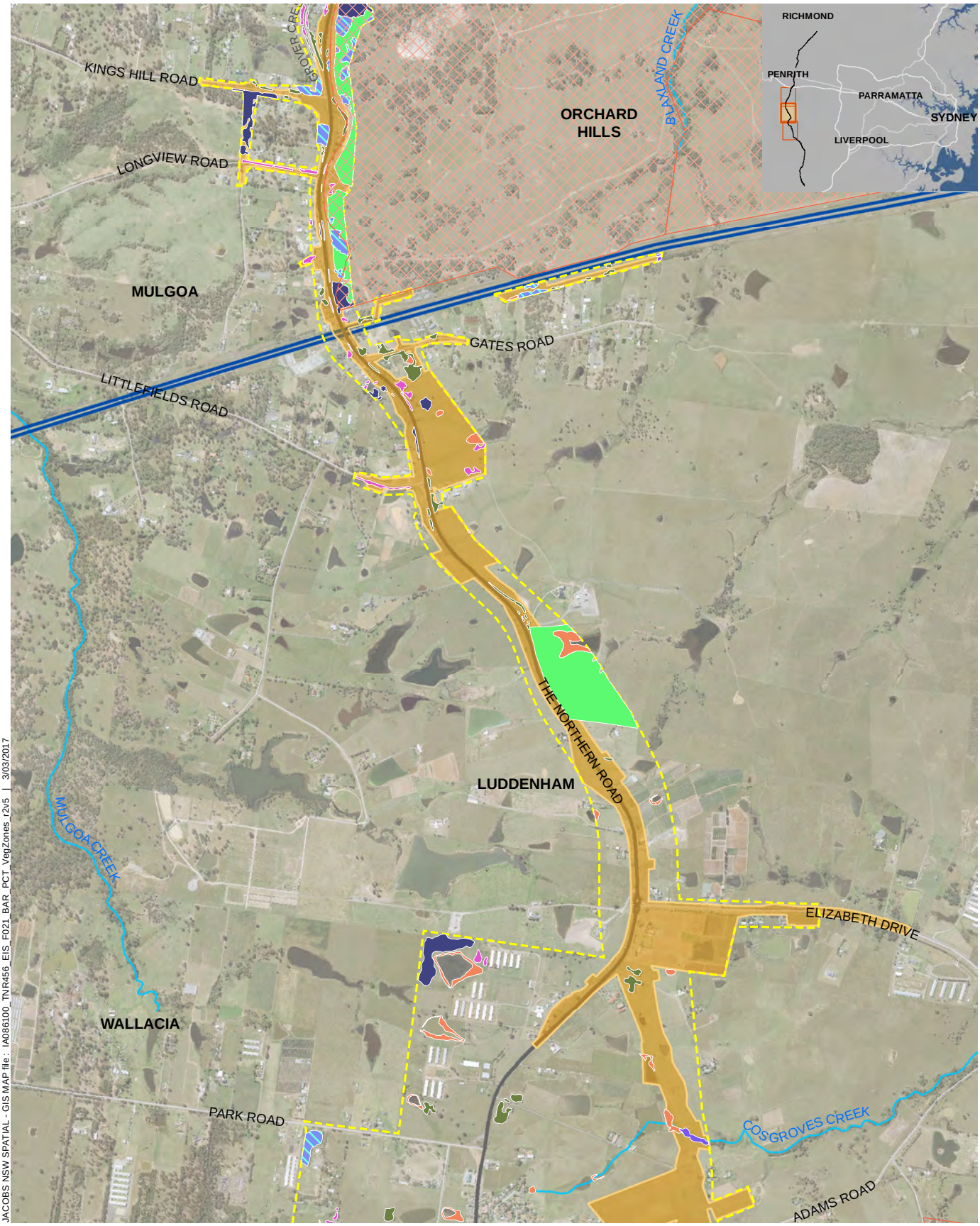


Figure 7-8 | Plant community types and vegetation zones

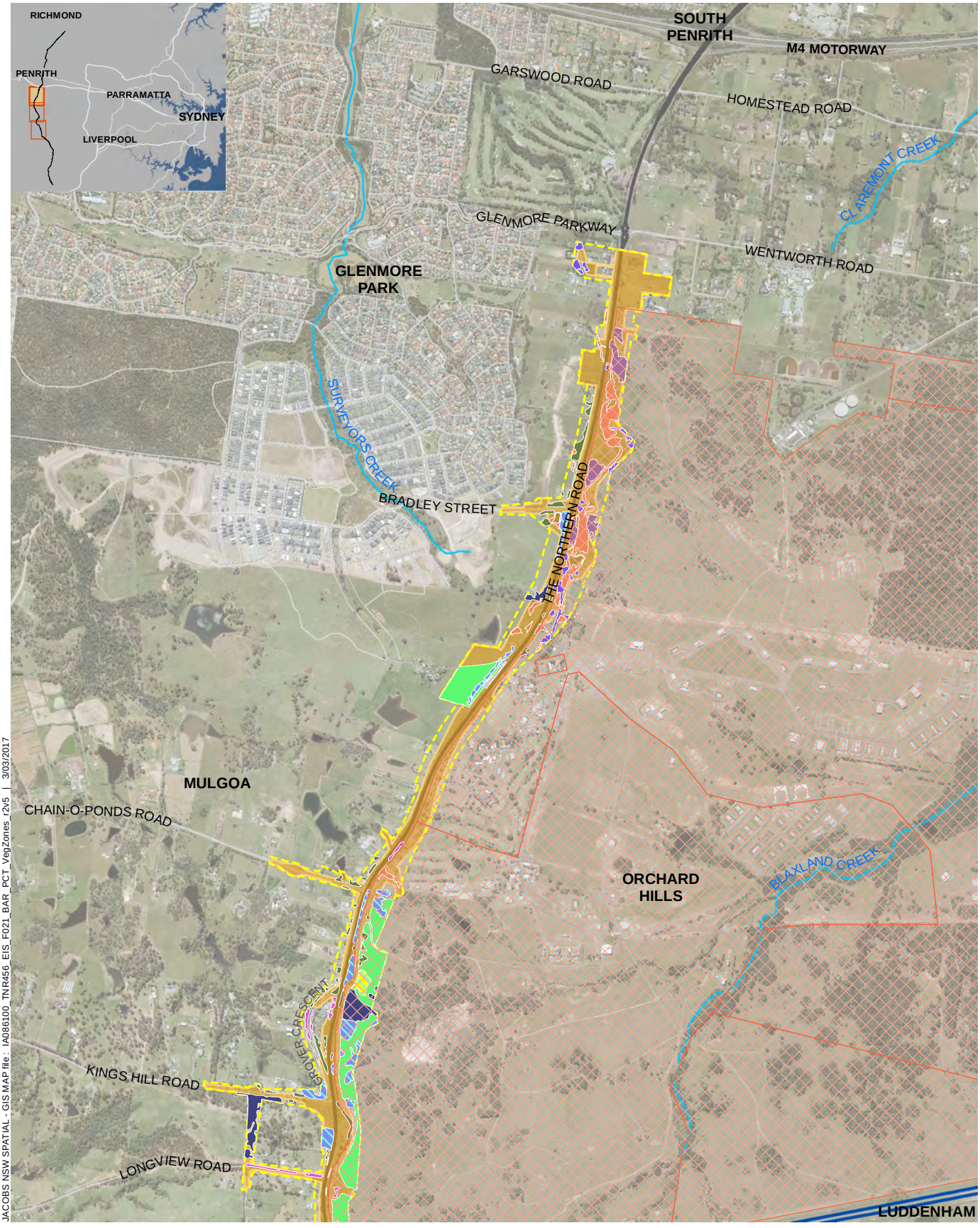


Figure 7-8 | Plant community types and vegetation zones

Groundwater dependent ecosystems

No high probability GDEs are mapped within or near the study area by Kuginis et al. (2012). However, PCT 850 and PCT 849 are identified as having a high probability of being a GDE. Additionally, PCT 835 is considered by Kuginis et al. (2012) to be a high probability groundwater dependent wetland community.

Within the study area, Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain (PCT 850), Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain (PCT 849), Derived grasslands on shale hills of the Cumberland Plain (50-300 m asl) (PCT 806), *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (PCT 1071) and Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain (PCT 835) are considered unlikely to be GDEs given their location in the landscape. In the case of PCT 850, 849 and 806, these communities are classed as vadophytic vegetation (that is, they rely on moisture in the soil surface profile) with no apparent groundwater dependency. PCT 835 and PCT 1071 within the study area are not part of a river baseflow system and are situated along losing stream reaches (streams that 'lose' surface water to ground water). The dams in which PCT 1071 are situated are man-made and rely on surface water.

The flow regimes of the streams within the study area are ephemeral (or would have naturally been ephemeral prior to damming). Ephemeral streams flow only in direct response to precipitation, and the stream channel is above the water table at all times. The majority of watercourses within the study area are ephemeral and most flow events occur in direct response to major rainfall. These systems are not considered to support GDEs (Serov et al. 2012). There is no evidence of base-flow feeding any of the streams within the study area. As such, none of the riparian zones within the study area are considered to be GDEs. This conclusion is supported by the findings of the soils, water and contamination study undertaken for this EIS (see Section 8.2 and Appendix L), which states that there are no listed high priority GDEs located in the study area.

Threatened ecological communities

Threatened Species Conservation Act 1995

The field survey identified two threatened ecological communities (TECs) as listed under the TSC Act within the study area (see Table 7-45). These are shown in Figure 7-9.

Table 7-45 Threatened ecological communities listed under the TSC Act present within the study area

Threatened ecological community	Status TSC Act	Corresponding PCTs	Area (ha)
Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically endangered	849, 850, 806	121.7 (includes 49.78 ha of derived native grasslands)
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	835	13.54

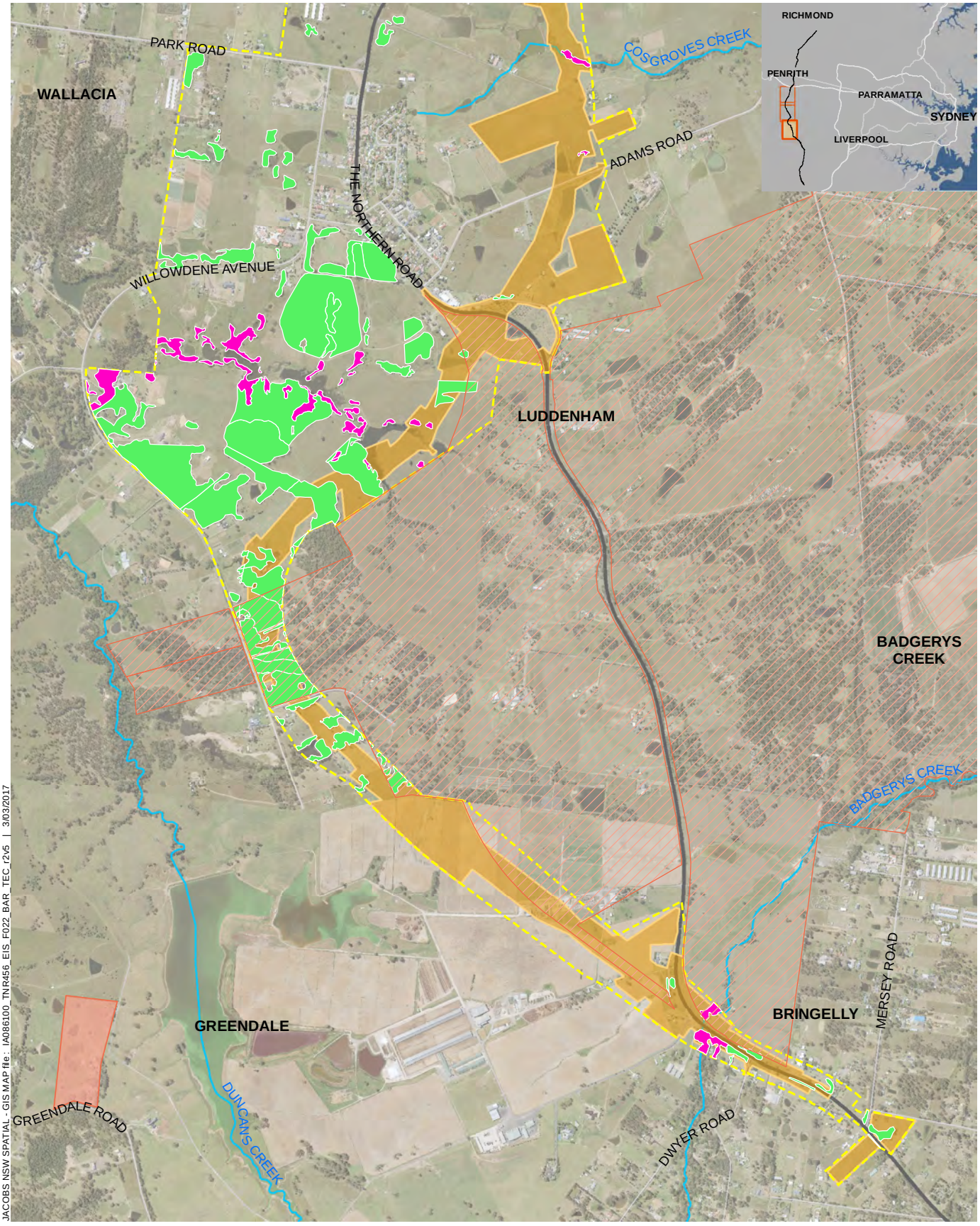
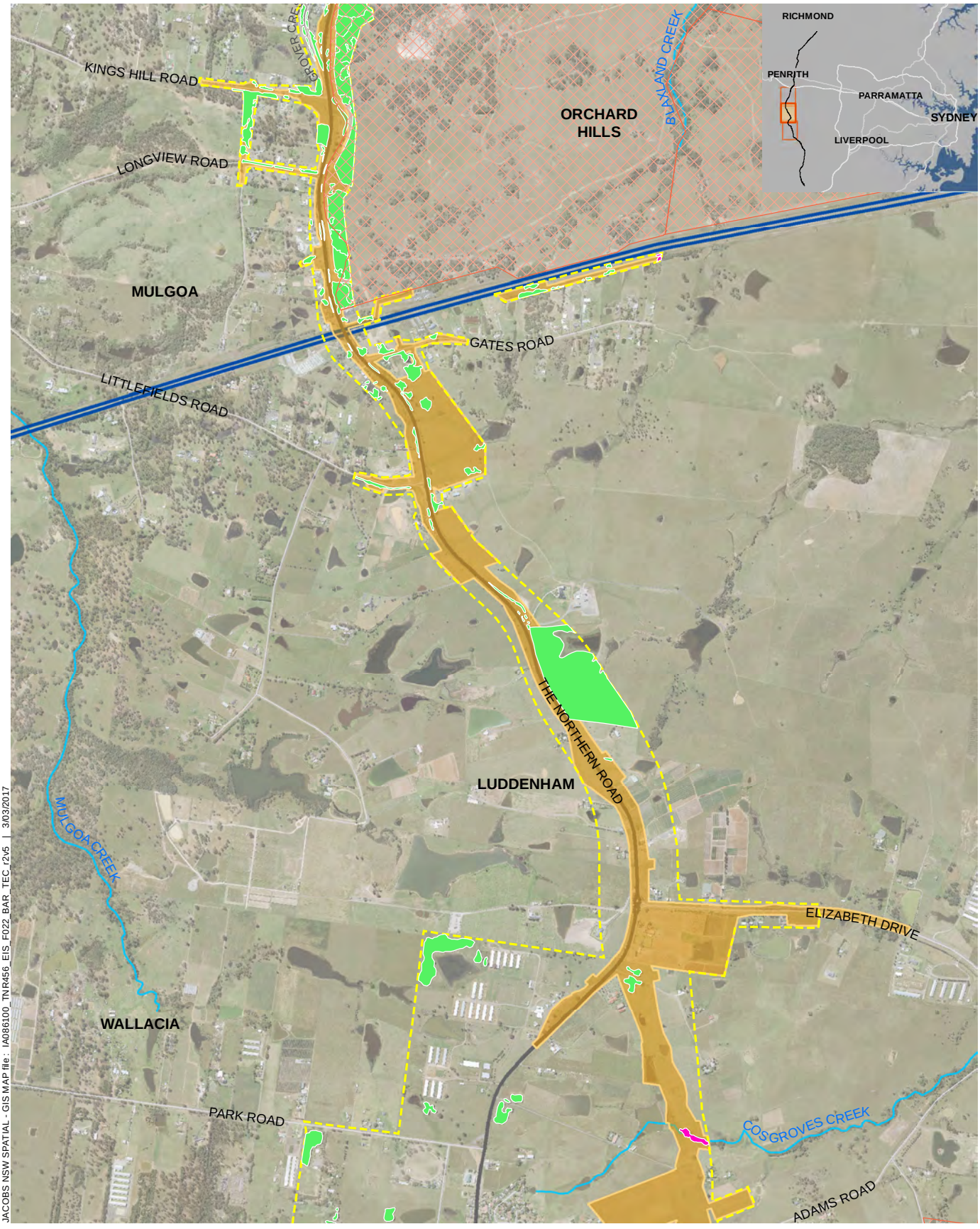


Figure 7-9 | Threatened ecological communities



The Northern Road (Existing)

WaterNSW supply pipelines

Development site boundary

Ecology study area

Western Sydney Airport site (Commonwealth Land)

Defence Establishment Orchard Hills (Commonwealth Land)

Commonwealth Lands

0 0.5 1 km

N

Threatened ecological communities

Cumberland Plain Woodland in the Sydney Basin Bioregion

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

3

2

1

Figure 7-9 | Threatened ecological communities

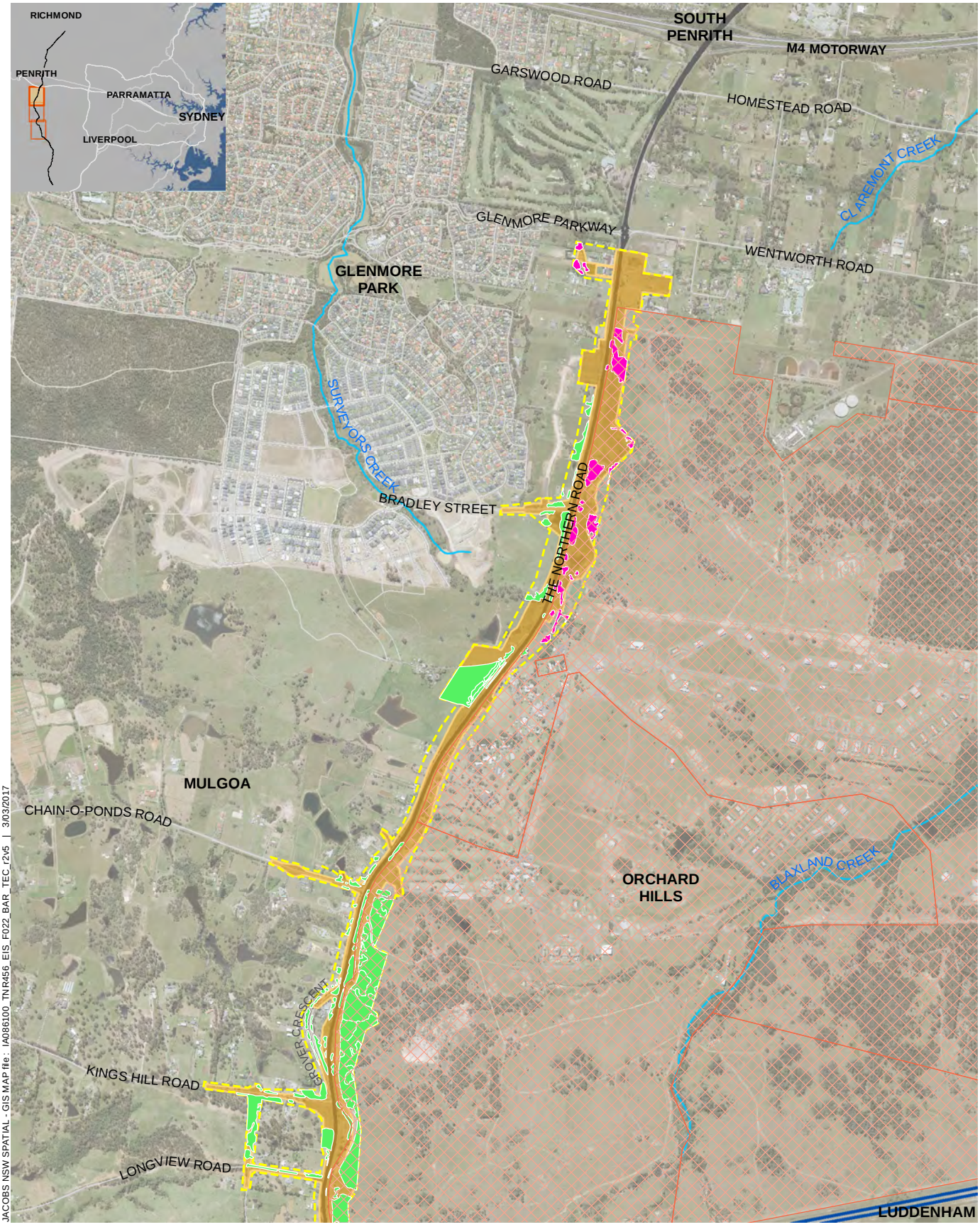


Figure 7-9 | Threatened ecological communities

Environment Protection and Biodiversity Conservation Act 1999

Eight TECs listed under the EPBC Act were identified as potentially occurring during desktop searches. One TEC, Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (listed as critically endangered) was identified in the study area during the surveys.

Three PCTs representative of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest are present including:

- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)
- Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)
- Derived grasslands on shale hills of the Cumberland Plain (50-300 m asl) (PCTID 806).

Detailed floristic plots were undertaken within the patches of PCT 849, PCT 850 and PCT 806 within the study area to determine vegetation quality. The condition of patches was assessed according to the criteria provided in the *Commonwealth Listing Advice on Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* (Threatened Species Scientific Committee 2009). Only the highest quality patches of these three PCTs are considered to be consistent with the EPBC Act listing. In accordance with the condition criteria provided in the *Commonwealth Listing Advice on Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* (Threatened Species Scientific Committee 2009), two categories of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest are present within the study area:

- Category A - core thresholds that apply under most circumstances: patches with an understorey dominated by natives and a minimum size that is functional and consistent with the minimum mapping unit size applied in NSW
- Category C - patches with connectivity to other large native vegetation remnants in the landscape. This category also includes areas of Derived Native Grasslands where the grasslands are contiguous with the TEC.

Within the study area, the patches of Category A Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (patches that meet the core thresholds) are located in two main areas: the southern portion of the DEOH and on private properties along Willowdene Avenue. There is part of one larger patch (>5 ha in size) within the study area which is on private property off Willowdene Avenue (see Figure 7-10). An additional Category A patch is present outside of the study area along Willowdene Avenue but would not be impacted by the proposed action.

The Category C patches are lower condition patches of Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and Derived Native Grasslands that are contiguous with Category A patches. These Category C patches are located on Commonwealth owned and private property off Willowdene Avenue and on the southern portion of the DEOH.

The Orchard Hills Cumberland Plain Woodland is a Listed Place on the Commonwealth Heritage List (CHL 105317). The land at Orchard Hills is recognised as the least disturbed and largest remaining remnant of Cumberland Plain Woodland. The tributaries of Blaxland Creek at Orchard Hills are among the least disturbed catchments remaining on the Cumberland Plain and are regarded as possibly the most pristine creek system on Wianamatta Shale left in Western Sydney (Department of the Environment, 2016b).

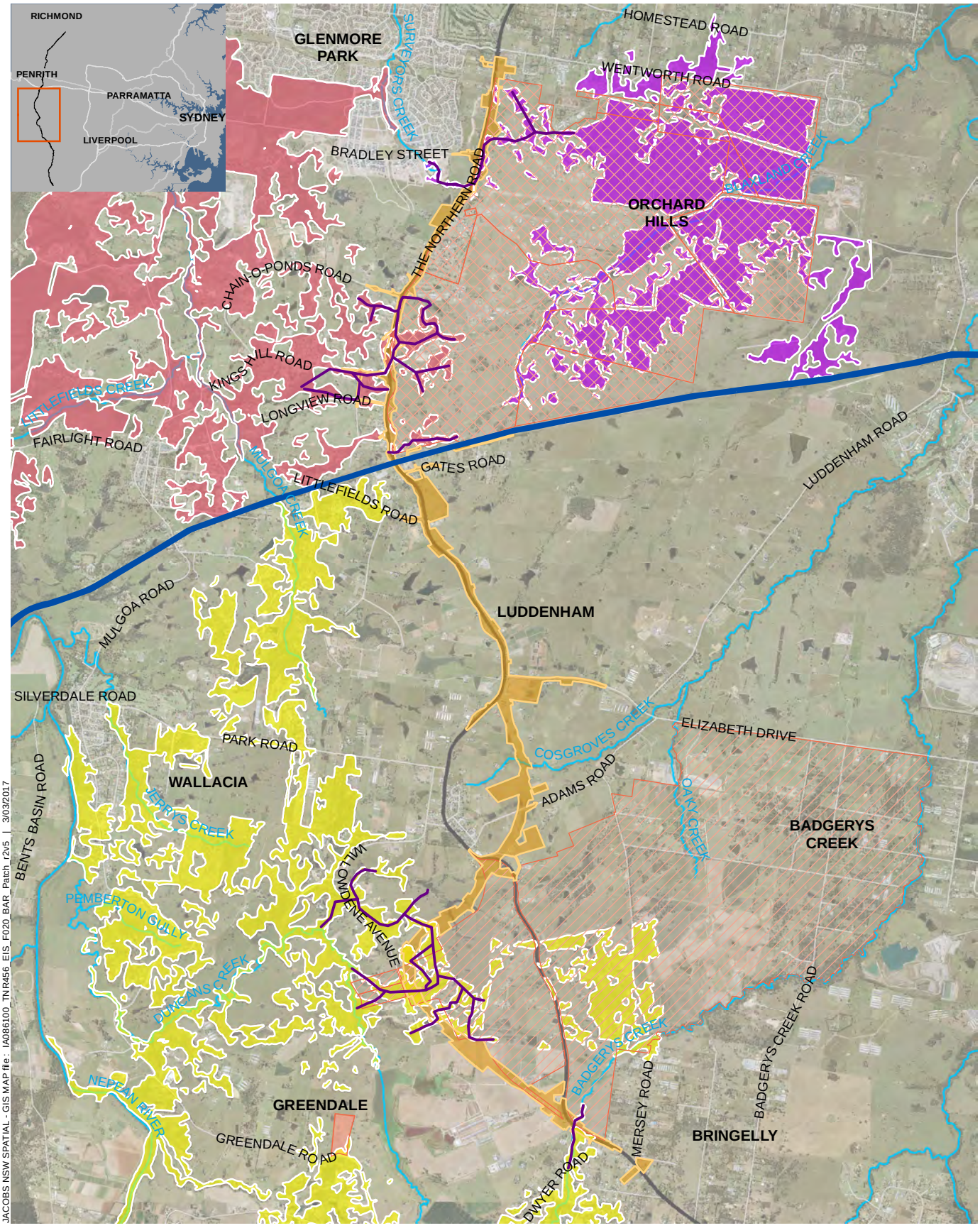


Figure 7-10 | Patch size

Threatened flora species

Database searches and desktop review identified 36 threatened flora species listed under the TSC Act including 26 listed under the EPBC Act within the 10 km search radius around the study area as outlined in the threatened species survey.

Table 7-46. These have been assessed as candidate species and formed the target of the threatened species survey.

Table 7-46 Threatened flora – likelihood of occurrence

Common Name *(Scientific Name)*	Status[1]		Likelihood of occurrence
	TSC Act	EPBC Act	
Austral Pillwort (*Pilularia novae-hollandiae*)	E	-	Low
Bargo Geebung (*Persoonia bargoensis*)	E	V	None
Brown Pomaderris (*Pomaderris brunnea*)	E	V	None
Bynoes Wattle (*Acacia bynoeana*)	E	V	Low
Camden White Gum (*Eucalyptus benthamii*)	V	V	None
Dillwynia tenuifolia	V	-	Low
Dillwynia tenuifolia (a shrub) population, Kemps Creek	EP	-	None
Downy Wattle (*Acacia pubescens*)	V	V	Low
Dwarf Kerrawang (*Commersonia prostrata* formerly *Rulingia prostrata)*	E	E	None
Hibbertia sp. Bankstown (syn. *Hibbertia puberula* subsp. *glabrescens*)	CE	CE	None
Hypsela sessiliflora (syn. *Isotoma fluviatilis*)	E	EX	None
Illawarra Greenhood (*Pterostylis gibbosa*)	E	E	Low
Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*)	V	-	Low
Marsdenia viridiflora subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	EP	-	Recorded
Micromyrtus minutiflora	E	V	Low
Pimelea curviflora subsp. *curviflora*	V	V	None

Common Name *(Scientific Name)*	Status[1]		Likelihood of occurrence
	TSC Act	EPBC Act	
Spiked Rice-flower (*Pimelea spicata*)	E	E	Low
Sydney Plains Greenhood (*Pterostylis saxicola*)	E	E	None
Tall Knotweed (*Persicaria elatior*)	V	V	Low
White-flowered Wax Plant (*Cynanchum elegans*)	E	E	Low
Allocasuarina glareicola	E	E	None
Asterolasia elegans	E	E	None
Leafless Tongue Orchid (*Cryptostylis hunteriana*)	V	V	None
Bauer's Midge Orchid (*Genoplesium baueri*)	E	E	None
Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	V	V	None
Square Raspwort (*Haloragis exalata* subsp. *exalata*)	V	V	None
Deane's Paperbark (*Melaleuca deanei*)	V	V	None
Omeo Storksbill (*Pelargonium* sp. Striatellum (G.W.Carr 10345))	E	E	None
Needle Geebung (*Persoonia acerosa*)	V	V	None
Persoonia hirsuta (Hairy Geebung)	E	E	Low
Nodding Geebung (*Persoonia nutans*)	E	E	Low
Smooth Bush-pea (*Pultenaea glabra*)	V	V	None
Pultenaea parviflora	E	V	Recorded
Eastern Underground Orchid (*Rhizanthella slateri*)	V	E	Low
Kangaloon Sun Orchid (*Thelymitra kangaloonica*)	CE	CE	None

Common Name *(Scientific Name)*	Status[1]		Likelihood of occurrence
	TSC Act	EPBC Act	
Austral Toadflax (*Thesium australe*)	V	V	Low

1. Status: E = endangered, CE = critically endangered, EP = endangered population, V= vulnerable, EX = extinct

Targeted surveys were completed for all identified candidate flora species with suitable habitat. The field surveys recorded one threatened flora species listed under the TSC Act and EPBC Act: *Pultenaea parviflora* (listed as endangered under the TSC Act and vulnerable under the EPBC Act). Four *Pultenaea parviflora* plants were found in the study area. The plants were located in three areas across two locations within the western road reserve of the Northern Road, and the along Kings Hill Road. Two plants are present in the road reserve at 2465 The Northern Road Mulgoa and one plant is present at the top of the road cutting about 420 m south of the first two plants on the western side of The Northern Road at 2509 The Northern Road Mulgoa. One plant was found in the corner of the property at 34 Kings Hill Road. Based on the data from the OEH Atlas of NSW Wildlife (OEH, 2015b), the *Pultenaea parviflora* plants within the study area would represent an extension of the known south western distribution of this species.

No other threatened flora species were recorded during the field survey. Targeted surveys for other listed threatened flora species was undertaken including detailed survey for *Pimelea spicata*. Three *Pimelea spicata* reference sites were surveyed in January 2016 including the Mt Annan Botanic Gardens, Camden Golf Course bushcare site, and Western Sydney Parklands. *Pimelea spicata* was flowering at all three reference sites during the survey period. *Pimelea spicata* was not recorded during the surveys undertaken for the biodiversity assessment despite targeted survey in habitat using parallel transects.

One endangered population listed under the TSC Act: *Marsdenia viridiflora* R. Br. subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas was recorded during the field surveys. This endangered population was recorded in four locations (all relatively disturbed) adjacent to the current The Northern Road alignment (two locations on the fence of the DEOH, and roadside vegetation adjacent to 2509 The Northern Road, and 2627 The Northern Road). Table 7-47 outlines the results of the threatened flora species surveys.

Table 7-47 Threatened flora species survey results

Species	Record detail	Habitat feature/ component
Pultenaea parviflora	4 plants recorded across three areas in two locations within the western road reserve of The Northern Road and along Kings Hill Road	PCT 806 Also likely to occur in PCT 849 and PCT 850
Marsdenia viridiflora subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	Recorded in four locations (all relatively disturbed) adjacent to the current The Northern Road alignment (two locations on the fence of the DEOH, and roadside vegetation adjacent to 2509 The Northern Road, and 2627 The Northern Road)	PCT 849 and PCT 850

Threatened fauna species

Database searches and desktop review identified 51 threatened fauna species listed under the TSC Act including 20 listed under the EPBC Act within the 10 km search radius around the study area as outlined in Table 7-48. Habitat assessment confirmed the presence of potential habitat for 24 of these species.

Table 7-48 Threatened fauna – likelihood of occurrence

Common Name *(Scientific Name)*	Status		Likelihood of occurrence
	TSC Act	EPBC Act	
Australian Painted Snipe *(Rostratula australis)*	V	E	Low
Australasian Bittern *(Botaurus poiciloptilus)*	E	E	Low
Australian Grayling (*Prototroctes maraena*)	E (FM Act)	V	Low
Barking Owl (*Ninox connivens*)	V	-	Moderate
Black Bittern (*Ixobrychus flavicollis*)	V	-	Low
Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis subsp. gularis*)	V	-	Moderate
Black-tailed Godwit (*Limosa limosa*)	V	M	Low
Broad-headed Snake (*Hoplocephalus bungaroides*)	V	V	None
Brown Treecreeper (eastern subspecies) (*Climacteris picumnus subsp. victoriae*)	V	-	Low
Brush-tailed Rock-wallaby (*Petrogale penicillata*)	E	V	None
Bush Stone-curlew (*Burhinus grallarius*)	E	-	Low
Comb-crested Jacana (*Irediparra gallinacea*)	V	-	Low
Cumberland Plain Land Snail (*Meridolum corneovirens*)	E	-	Recorded
Diamond Firetail (*Stagonopleura guttata*)	V	-	Moderate
Dural Land Snail (*Pommerhelix duralensis*)	-	E	None

Common Name *(Scientific Name)*	Status		Likelihood of occurrence
	TSC Act	EPBC Act	
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	V	-	Recorded
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	V	-	Recorded
Eastern Freetail-bat (*Mormopterus norfolkensis*)	V	-	Recorded
Eastern Pygmy Possum (*Cercartetus nanus*)	V	-	Low
Flame Robin (*Petroica phoenicea*)	V	-	Moderate
Freckled Duck (*Stictonetta naevosa*)	V	-	Low
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	V	-	Moderate
Gang-gang Cockatoo population, Hornsby and Ku-ring-gai Local Government Areas	EP	-	None
Giant Burrowing Frog (*Heleioporus australiacus*)	V	V	Low
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	V	-	Moderate
Green and Golden Bell Frog (*Litoria aurea*)	E	V	Low
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Recorded
Hooded Robin (south-eastern form) (*Melanodryas cucullata subsp. cucullata*)	V	-	Low
Koala (*Phascolarctos cinereus*)	V	V	Low
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	Moderate
Little Eagle (*Hieraaetus morphnoides*)	V	-	Moderate
Little Lorikeet (*Glossopsitta pusilla*)	V	-	Moderate

Common Name *(Scientific Name)*	Status		Likelihood of occurrence
	TSC Act	EPBC Act	
Littlejohn's Tree Frog (*Litoria littlejohni*)	V	V	Low
Macquarie Perch (*Macquaria australasica*)	E (FM Act)	E	Low
Masked Owl (*Tyto novaehollandiae*)	V	-	Moderate
New Holland Mouse (*Pseudomys novaehollandiae*)	-	V	Low
Painted Honeyeater (*Grantiella picta*)	V	V	Low
Powerful Owl (*Ninox strenua*)	V	-	Moderate
Regent Honeyeater (*Anthochaera phrygia*)	E	CE	Moderate
Scarlet Robin (*Petroica boodang*)	V	-	Moderate
Speckled Warbler (*Chthonicola sagittatus*)	V	-	Moderate
Spotted Harrier (*Circus assimilis*)	V	-	Moderate
Spotted-tailed Quoll (*Dasyurus maculatus*)	V	E	Low
Square-tailed Kite (*Lophoictinia isura*)	V	-	Moderate
Squirrel Glider (*Petaurus norfolcensis*)	V	-	Low
Stuttering Frog (*Mixophyes balbus*)	V	E	Low
Swift Parrot (*Lathamus discolor*)	E	CE	Moderate
Turquoise Parrot (*Neophema pulchella*)	V	-	Low
Varied Sittella (*Daphoenositta chrysoptera*)	V	-	Moderate
White-fronted Chat (*Epthianura albifrons*)	V	-	Low

Common Name *(Scientific Name)*	Status		Likelihood of occurrence
	TSC Act	EPBC Act	
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	V	-	Moderate

1. Status: E = endangered, CE = critically endangered, EP = endangered population, V= vulnerable, M = migratory

Cumberland Plain Land Snail

The Cumberland Plain Land Snail was recorded in the study area. Live snails and shells were found in a variety of habitats from high quality woodland, to woodland with a heavily grazed understorey. Shells (often heavily bleached) were also found in dense swards of the exotic grass *Eragrostis curvula* on roadsides particularly along Willowdene Avenue.

Microchiropteran bats

Three threatened insectivorous bats were recorded via Anabat: Eastern Bentwing-bat, Eastern False Pipistrelle, and Eastern Freetail-bat. Foraging habitat for these species is widespread throughout the study area. These species are likely to fly across cleared land to move between habitat patches. Large trees in the study area (e.g. the large old *Eucalyptus tereticornis* tree to the north of the wetlands on the DEOH) may provide potential roosting habitat for the Eastern False Pipistrelle, and Eastern Freetail-bat.

The Grey-headed Flying-fox was recorded in one location on private property off Willowdene Avenue during spotlight surveys.

No other threatened fauna species were recorded during the surveys. However, the following species are considered moderately likely to occur:

- The Regent Honeyeater is considered moderately likely to occur in the study area based on the presence of suitable foraging habitat (about 84.97 ha)
- The Swift Parrot is considered moderately likely to occur in the study area during winter based on the presence of suitable foraging habitat and recent records near to the study area (about 84.97 ha)
- A population of the Large-eared Pied Bat is considered moderately likely to utilise the study area due to the proximity of the foraging habitat (about 84.97 ha) to the lower Blue Mountains and recent records of the species from the locality (i.e. from Mulgoa Nature Reserve)
- Green and Golden Bell Frog. This species was not recorded in the study area and there are no reported existing populations of the Green and Golden Bell Frog in the study area
- Australasian Bittern and Black Bittern There is one record of the cryptic Australasian Bittern in the study area, in 2003 to the south of Badgerys Creek, this species and the Black Bittern are considered to have a low to moderate chance of occurring.

Table 7-49 outlines the results of the threatened fauna species surveys. Recorded threatened species identified during the surveys are shown on Figure 7-11.

Table 7-49 Threatened fauna species survey results

Species	Identification method (assumed, recorded, expert report)	Vegetation zone code / TEC
Cumberland Plain Land Snail	Recorded	PCT 835 (River-Flat Eucalypt Forest TEC) PCT 849, PCT 850, PCT 806

Species	Identification method (assumed, recorded, expert report)	Vegetation zone code / TEC
		(Cumberland Plain Woodland TEC)
Eastern Bentwing-bat	Recorded (probable call recording)	PCT 835 (River-Flat Eucalypt Forest on Coastal Floodplains TEC) PCT 849, PCT 850 (Cumberland Plain Woodland TEC)
Eastern False Pipistrelle	Recorded (possible call identification)	PCT 835 (River-Flat Eucalypt Forest TEC) PCT 849, PCT 850 (Cumberland Plain TEC)
Eastern Freetail-bat	Recorded (possible call identification)	PCT 835 (River-Flat Eucalypt Forest TEC) PCT 849, PCT 850 (Cumberland Plain Woodland TEC)
Grey-headed Flying-fox	Recorded	PCT 835 (River-Flat Eucalypt Forest TEC) PCT 849, PCT 850 (Cumberland Plain Woodland TEC)

Aquatic biodiversity

The relevant water source is the Hawkesbury and Lower Nepean Rivers Water Source and the relevant management zone for the northern portion of the project is the Lower Nepean River Management Zone, and the Mid Nepean River Catchment Management Zone and the Upper South Creek Management Zone for the southern portion of the project. The catchment is relatively flat with gently undulating hills. The project directly traverses Badgerys Creek and Cosgrove Creek. There are a number of other unnamed tributaries/drainage lines and farm dams traversed by the project. The predominant catchment land uses are residential, rural residential and various forms of agriculture. The rural areas are predominantly agriculture including cattle grazing.

The Nepean River is the downstream receiving environment to the project area; however, the project itself is located close to the catchment divide, just west of the eastern boundary. The Nepean River is significant both environmentally and economically and provides for a range of domestic and irrigation uses. Several threatened species including Macquarie Perch (*Macquaria australasica*), Australian Grayling (*Prototroctes marena*), Silver Perch (*Bidyanus bidyanus*), Murray Cod (*Maccullochella peelii peelii*) and Trout Cod (*Maccullochella macquariensis*) have been recorded within the Hawkesbury-Nepean Catchment based on database searches; however, habitat for these species is not present within the study area and there are no records in the study area.

No protected or threatened fish species are considered likely to occur within the study area due to the limited water and aquatic habitat present.

Fish habitat classification criteria for watercourses in the project area and recommended crossings types are provided in Table 7-50.

No watercourse crossings have been mapped as Key Fish Habitat by DPI Water (2007), however five waterway crossings in the study area have been identified as Type 1 – Key Fish Habitats (DPI, 2013), as they contain a combination of native aquatic plants and/or woody snags. These watercourses are impacted, intermittently flowing waterways which are also identified as Class 2 – Moderate Key Fish Habitat (Fairfull & Witheridge, 2003) due to the presence of limited in stream aquatic vegetation. These are shown as key waterways in Figure 8-6.

Table 7-50 Fish habitat classification criteria for watercourses and recommended crossings types

Site	Description	Key Fish Habitat Classification, and Fish Passage Classification
Site 17 – Badgerys Creek 	Site 17 is an intermittent stream, Badgerys Creek which is crossed by the Project. It contains permanent residual pools which provide refuge habitat for fish. The substrate consists of sand, gravel and clay. A variety of instream macrophytes are present including Cumbungi (*Typha* sp.), *Eleocharis*, *Vallisneria*, Duckweed (Lemna), and Water Primrose (*Ludwigia peploides*). The presence of macrophytes and instream woody snags provides fish habitat, however no threatened or protected fish species are expected to occur within the Creek. Visual inspection sighted the invasive pest species, Gambusia (*Gambusia holbrooki*) within the Creek. Surrounding landuse is agriculture, primarily cattle grazing which has led to some bank degradation. Riparian vegetation is sparse, consisting of both natural and exotic vegetation. Water quality appears moderate, tannin stained with some frothing and instream rubbish. Runoff from surrounding agriculture is likely to impact upon water quality.	Class: Class 2 – Key Fish habitat Key Fish Habitat – Type 1 Highly sensitive key fish habitat
Site 20 – Unnamed Gully upstream of Duncan's Creek 	Site 20 is an unmapped, unnamed gully associated with Leppington Dam and Duncans Creek. It has minimal channel definition, and no water was present at the time of inspection, despite heavy rainfall in the past 24 hours. No instream aquatic habitat is present. The surrounding land use is agriculture including cattle grazing and various crops. Downstream is a large dam 'Leppington Dam' which forms part of Duncans Creek. Duncans Creek is a perennial stream; however the Leppington Dam is an artificial barrier to fish migration and would affect the natural flow regimes within Duncans Creek. Water quality within the Dam appears poor, with frothing and an extensive green algae bloom (pictured), suggesting high nutrient concentrations are likely to be present and are likely to result in deoxygenation events within the dam. No fish were sighted during visual inspections.	Class: Class 4 – Unlikely Key Fish Habitat Key Fish Habitat: Type 3 Minimally sensitive key fish habitat.

Site	Description	Key Fish Habitat Classification, and Fish Passage Classification
Site 23 – Farm Dam 	Site 23 is a farm dam situated immediately downstream of alignment. The dam is part of a series of disconnected ponds situated within an undefined gully. The dam is used for cattle, and has poor water quality, with high turbidity and frothing upon the water surface. Limited aquatic habitat is present and consists of a small density of the aquatic macrophyte Water Primrose (*Ludwigia peploides*). The substrate consists of a relatively even distribution of silt, clay, sand, gravel and pebble. A lot of rubbish such as tiles, bricks and broken glass is also present. No fish were sighted during vidual inspections, and no threatened or protected fish species are expected to occur within the dam.	Class: Class 3 – Moderate Key Fish habitat Key Fish Habitat: n/a (farm dam)
Site 27 – Farm Dam 	Site 27 is a farm dam, situated immediately downstream of site 23, downstream of the alignment. The dam is part of a series of disconnected ponds situated within an undefined gully. The dam is used for cattle and has poor, stagnant water quality with high turbidity and a thick algal bloom suggesting elevated nutrient concentrations. Substrate is predominantly silt, clay and detritus. Variety of aquatic habitat is present including submerged woody logs, and a variety of aquatic macrophytes including Water Primrose (*Ludwigia peploides*), Nardoo (*Marsilea mutica*), *Eleocharis* sp., Floating Pondweed (*Potamogeton sulcatus*) and several sedge species (*Cyperus* sp.). Gambusia (*Gambusia holbrooki*) were sighted during visual inspections, however no threatened or protected fish species are expected to occur within the dam.	Class: Class 3 – Moderate Key Fish habitat Key Fish Habitat: n/a (farm dam)

Site	Description	Key Fish Habitat Classification, and Fish Passage Classification
Site 29a – Unnamed watercourse 	Site 29a is an intermittent stream which is crossed by the Project. It has low to no flow, despite rainfall occurring within the past 24 hours. Creek will only flow when the dams upstream (including site 29a) overflows. Variety of substrates present including boulder, pebble, gravel, clay, sand and silt. Large quantities of detritus are present within the residual pools. Some instream woody snags are present. Macrophytes present include Water Primrose (*Ludwigia peploides*), Sedge (*Cyperus* sp.) and Watermilfoil (*Myriophyllum* sp.). Water quality appears moderate, with anoxic odour within residual pools, tannin staining and filamentous algae present. Some rubbish such as tyres are present within the site. No fish were sighted during vidual inspections, and no threatened or protected fish species are expected to occur within the stream.	Class: Class 2 – Moderate Key Fish habitat Key Fish Habitat: Type 1
Site 29b – Farm Dam 	Site 29b is a farm dam immediately upstream of the alignment. Dam acts as a barrier to fish passage, and disrupts the natural hydrology of the creek downstream (site 29a). Water quality appears poor, with an anoxic odour and thick algae present. Substrate consists of an even distribution of silt, clay, sand, gravel and pebble. A thick layer of detritus is present throughout the dam. Macrophytes present include Water Primrose (*Ludwigia peploides*) and Watermilfoil (*Myriophyllum* sp.). No fish were sighted during vidual inspections, and no threatened or protected fish species are expected to occur within the dam.	Class: Class 3 – Moderate Key Fish habitat Key Fish Habitat: n/a (farm dam)

Site	Description	Key Fish Habitat Classification, and Fish Passage Classification
Site 212 - Cosgrove Creek 	Site 212 is an intermittent stream, Cosgrove Creek which is crossed by the project. At the time of inspection it consisted of a series of shallow disconnected pools. The bed and banks of the channel are degraded by cattle access. The substrate consists of silt and clay. Water quality appears poor, with thick algae bloom, oily film and frothing present in some of the stagnant pools. Aquatic macrophytes present include Azolla, Duckweed (Lemna) and Floating Pondweed (*Potamogeton sulcatus*). Typha Sedges are present further downstream. A large density of Gambusia (*Gambusia holbrooki*) were sighted during visual inspections, however no threatened or protected fish species are expected to occur within the dam.	Class: Class 2 – Moderate Key Fish habitat Key Fish Habitat: Type 1
Site 215 – Farm Dam 	Site 215 is a series of farm dams which are crossed by the project. It is fed by an undefined gully which only flows when the upstream dams overflow. The bed and banks of the channel are degraded by cattle access. The substrate consists of silt and clay. Aquatic macrophytes present within the site include Cumbungi (*Typha* sp.). No fish were sighted during vidual inspections, and no threatened or protected fish species are expected to occur within the dam.	Class: Class 3 – Moderate Key Fish habitat Key Fish Habitat: n/a (farm dam)

Site	Description	Key Fish Habitat Classification, and Fish Passage Classification
Site 39 – Unnamed Dam and Watercourse 	Site 39 is a large farm dam, fed by several minor 1st and 2nd order streams. These streams are ephemeral with minimal channel definition, only flowing when the upstream dams overflow. A variety of aquatic habitat is present including submerged woody logs, and a variety of aquatic macrophytes including Water Primrose (*Ludwigia peploides*), Nardoo (*Marsilea mutica*), Eleocharis sp., Cumbungi (*Typha* sp.), Floating Pondweed (*Potamogeton sulcatus*) and several sedge species (*Cyperus* sp.). No fish were sighted during vidual inspections, however Gambusia (*Gambusia holbrooki*) are likely to be present. No threatened or protected fish species are expected to occur within the dam.	Class: Class 2 – Moderate Key Fish habitat Key Fish Habitat: Type 1
Unnamed tributary of Surveyors Creek Location: 286887.04 E, 6257728.9 N 	The unnamed tributary of Surveyors Creek is an ephemeral stream which is crossed by the project. At the time of inspection no water was present and the channel was densely populated by Typha Sedges. No fish were sighted during vidual inspections, however Gambusia (*Gambusia holbrooki*) are likely to be present. No threatened or protected fish species are expected to occur within the dam.	Class: Class 2 – Moderate Key Fish habitat Key Fish Habitat: Type 1

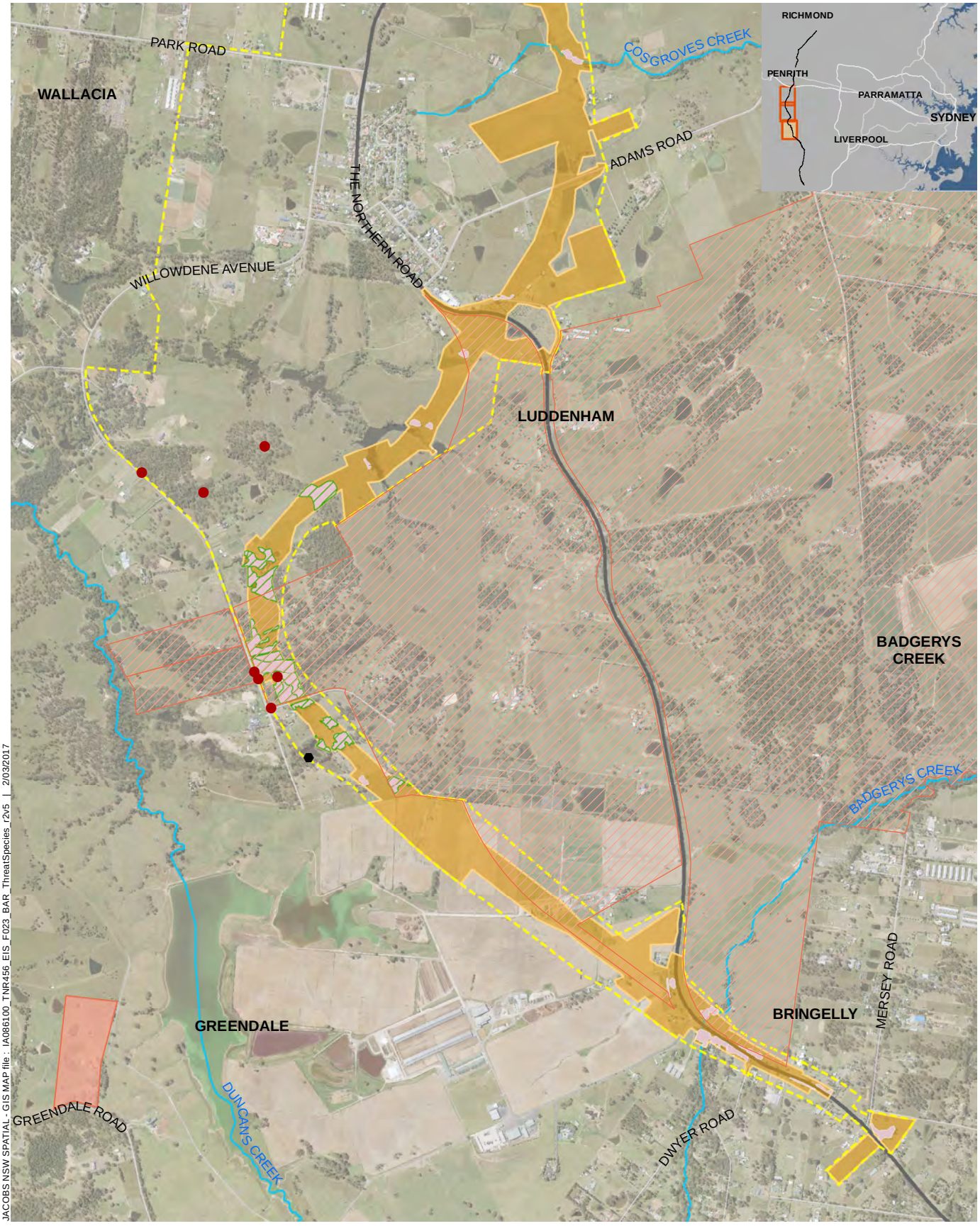


Figure 7-11 | Recorded threatened species

JACOBS NSW SPATIAL - GIS MAP file : IA086100_TNR456_EIS_F023_BAR_ThreatSpecies_r2v5 | 2/03/2017

Figure 7-11 | Recorded threatened species

JACOBS NSW SPATIAL - GIS MAP file: IA086100_TNR456_EIS_F023_BAR_ThreatSpecies_r2v5 | 2/03/2017

Figure 7-11 | Recorded threatened species

Listed migratory species

No migratory species listed under the EPBC Act were recorded during the targeted bird surveys; however, the Latham's Snipe was recorded opportunistically in the study area on three occasions. It was recorded in the same location in an area of flooded grassland on DEOH. The Latham's Snipe is considered likely to utilise the extensive network of farm dams, however this habitat is not considered to comprise important habitat.

The Cattle Egret was observed repeatedly in paddocks throughout the study area and broader locality. The Great Egret is also considered moderately likely to occur in the wetlands throughout the study area. The White-throated Needletail and Fork-tailed Swift are considered likely to fly over the study area during migration.

7.3.3 Avoidance and minimisation

Chapter 4 of the EIS describes the alternatives that were considered as part of the project development process and explains how and why the project was selected as the preferred option. Chapter 4 of the EIS also outlines how particular elements of the project have been refined. During the short listing process for Segment 2, options 6 and 7 were not progressed further due to impacts to critical endangered and threatened ecological communities. A route selection process was initiated and during the short listing options process, key areas were identified where additional field based investigations would assist in assessing the route options. Early biodiversity field investigations were carried out between July and September 2015 which involved rapid biodiversity assessments with the data used to inform final route selection.

An analysis of the biodiversity data was undertaken with reference to the route options proposed. The analysis was undertaken within a GIS by overlaying the eastern and western route options onto the vegetation mapping layer that showed TECs and known or potential habitat for threatened species. Potential worst case impacts were quantified based on a 100 m wide corridor and considered impacts to TECs, further fragmentation of woodland, and the direct loss of vegetation / habitat.

A comparison of the impacts of the eastern and western short-listed route options to threatened ecological communities determined that impacts to TSC Act listed TECs were estimated to be marginally greater for the eastern option. However, impacts to EPBC Act listed TECs were estimated to potentially be marginally greater for the western option (refer to Appendix I). Both options were identified to impact on PCTs; however, the total loss of vegetation and habitat would be greatest with the eastern option.

The data collected for each option indicated that fragmentation would be comparable for each option although the western option around Duncans Creek would likely result in greater vegetation loss and fragmentation due to the traverse of the creek in two locations.

7.3.4 Assessment of potential impacts

Nine of the ten vegetation zones identified within the development footprint require impacts to be assessed under the FBA. One vegetation zone within the development footprint (Vegetation zone 4, Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate/Good_Poor condition) was identified as having a site value score of less than 17 (this vegetation zone had a site score of 15.94). As such, impacts to this vegetation zone do not require assessment under the FBA and offsets for this vegetation zone do not need to be calculated.

Impacts to biodiversity requiring assessment under the FBA include:

- Removal of native vegetation including threatened ecological communities
- Removal of threatened fauna species habitat and habitat features
- Removal of threatened plants.

Impacts to biodiversity that are not covered by the FBA would also occur including:

- Impacts to the Orchard Hills Cumberland Plain Woodland
- Impacts to habitat for listed migratory species
- Impacts to aquatic biodiversity
- Fragmentation of biodiversity links and habitat corridors
- Edge effects on adjacent native vegetation and habitat
- Injury and mortality of fauna (including vehicle strike)
- Invasion and spread of weeds and pests
- Invasion and spread of pathogens and disease
- Noise, vibration, dust, light and contaminants
- Cumulative impacts.

In addition to the FBA, the BAR has also addressed the biodiversity assessment requirements under the EPBC Act which include impacts to the environment of Commonwealth land.

An assessment of the potential impacts of the project during construction and operation are detailed below and environmental management measures to avoid, minimise, mitigate and offset these impacts are discussed in Section 7.

Approved threat abatement plans

Threat abatement plans establish a national framework to guide and coordinate Australia's response to key threatening processes registered under the EPBC Act. The plans identify research, management and other actions needed to ensure the long-term survival of native species and ecological communities affected by key threatening processes. A list of approved threat abatement plans is included in Appendix I. It is noted that not all of the approved threat abatement plans are applicable to the project.

The threat abatement plans that relate to the project involve invasion and spread of pests (i.e. goats, rabbits, red fox, feral cats, and pigs) and pathogens (i.e. beak and feather disease, *Phytophthora cinnamomi,* and chytrid fungus). Pest species and pathogens would be managed within the project site according to the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). This would ensure to the greatest extent possible that invasion and spread of pests and pathogens are managed throughout the project lifecycle. The potential impacts from pests and pathogens are discussed further in the relevant section below.

In summary, the project does not include any activities that would interfere with any of the relevant threat abatement plans.

Recovery plans

Two relevant recovery plans have been considered below in relation to the project as follows:

- Regent Honeyeater he National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*) (Commonwealth of Australia, 2016)
- The National Recovery Plan for the Swift Parrot (Saunders & Tzaros, 2011) (Swift Parrot Recovery Team, 2001).

These are discussed in more detail in the relevant sections below and in Appendix I. In summary, the project is not expected to interfere with the strategies, objectives or associated actions outlined in any of these plans.

Potential construction impacts

Removal of native vegetation

The potential loss of vegetation and habitat associated with the project is summarised in Table 7-51. The construction footprint would remove up to 39.61 ha of remnant native vegetation. These impacts have been quantified based on the development footprint and take into consideration potential disturbance during construction including compound sites and access tracks. Impacts associated with native vegetation removal would be long-term.

Removal of TSC Act listed threatened ecological communities

The removal of native vegetation includes removal of about 29.14 ha of the TSC Act listed critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community. The vegetation removal also involves removal of about 4.29 ha of the TSC Act listed River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community. These impacts would be long-term.

Table 7-51 Impacts to native vegetation to be assessed under the FBA

Vegetation zone	PCT	Condition	Status (TSC Act)	Percent cleared in CMA	Area to be impacted (ha)
1	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)	Moderate/ Good	CEEC	95%	6.67
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835)	Moderate/ Good	EEC	95%	2.53
3	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)	Moderate/ Good	CEEC	90%	4.91
5	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)	Moderate/ Good-Poor	CEEC	90%	3.21
6	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835)	Moderate/ Good-Poor	EEC	95%	1.76

Vegetation zone	PCT	Condition	Status (TSC	Percent cleared in	Area to be
7	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 849)	Moderate/ Good-High	CEEC	90%	1.25
8	Derived grasslands on shale hills of the Cumberland Plain (50-300 m asl) (PCT 806)	Moderate/ Good-Derived grassland	CEEC	-	12.01
9	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (PCT 1071)	Moderate/ Good-Other	-	70%	6.17
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)	Moderate/ Good-Medium	CEEC	90%	1.09
Total vegetation removal to be assessed					**39.6**

Removal of EPBC Act listed threatened ecological communities

Based on the estimated construction footprint, the project would result in the direct clearing of about 16.37 ha of the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community listed under the EPBC Act. This clearing includes:

- 10.69 ha of core Category A vegetation
- 1.47 ha of Category C vegetation
- 4.21 ha of Category C Derived Native Grassland.

An assessment of significance pursuant to the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment, 2013) was completed for the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPSWSGTF) ecological community (refer to Appendix I). An overall conclusion has been made that the action is likely to result in a significant impact to the critically endangered CPSWSGTF as it would:

- Reduce the extent of the CEEC by about 16.37 ha
- Adversely affect habitat critical to the survival of the CEEC
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the CEECs survival
- Cause a substantial change in the species composition of an occurrence of the CEEC, including causing a decline or loss of functionally important species
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, particularly form potential weed invasion
- Interfere with the recovery of an ecological community.

These impacts would be long-term.

Removal of threatened plants

There would be an impact to the following threatened plant and endangered population:

- *Pultenaea parviflora* (Endangered – TSC Act, Vulnerable EPBC Act). The proposed action would result in the direct clearing of four *Pultenaea parviflora* plants for the construction of batters. The area of surrounding habitat likely to possess a soil seedbank for this species is about 0.98 ha.
- *Marsdenia viridiflora* subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas (Endangered population – TSC Act).

The predicted impact to *Pultenaea parviflora* and the *Marsdenia viridiflora* subsp. *viridiflora* endangered population are outlined in Table 7-52.

The construction footprint contains (and therefore would remove) all known individuals and habitat for the *Marsdenia viridiflora* subsp. *viridiflora* endangered population in the study area. The construction footprint would also remove all known *Pultenaea parviflora* plants in the study area.

An assessment of significance pursuant to the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment 2013) was completed for *Pultenaea parviflora* (refer to Appendix I). Given the conservation status of this species (vulnerable) and the low magnitude of the impact, an overall conclusion has been made that the action is unlikely to result in a significant impact to *Pultenaea parviflora*. A significant impact to *Pultenaea parviflora* is not predicted for the following reasons:

- The larger core population, to which the impacted sub-population belongs, would still exist about three kilometres to the east within the DEOH. There is also potential for additional Pultenaea parviflora plants from the sub-population to be present on private property further to the west of the study area (e.g. Lot 23 and Lot 85 Longview Road Mulgoa, 99 Vineyard Road Mulgoa). Overall, the removal of three plants form this apparent outlying sub-population would not lead to a long-term decrease in the size of the important population
- The project would not result in the breaking apart of large blocks of high quality habitat for *Pultenaea parviflora* and would not fragment a continuous population of *Pultenaea parviflora*
- The area of habitat to be impacted by the project is directly adjacent to The Northern Road in the road reserve. In the context of existing larger populations and areas of habitat that are clearly more critical to the survival of this species, the habitat to be affected is not considered critical
- While the project would disrupt the breeding cycle of the *Pultenaea parviflora* sub-population, the breeding cycle of the overall core population would continue

- The project would result in a small decrease in the availability of habitat for *Pultenaea parviflora* of about 0.98 ha. This habitat represents about 0.7 per cent of the 126 ha of suitable habitat for the core population on the DEOH. Removal of 0.98 ha of habitat is unlikely to be so detrimental as to cause this species to decline.

The identified impacts to threatened plant species would be long-term.

Table 7-52 Summary of threatened plant species impacts

Threatened species	Status		Habitat or individuals to be impacted
	TSC Act	EPBC Act	
Pultenaea parviflora	Endangered	Vulnerable	4 individuals
Marsdenia viridiflora subsp. viridiflora – endangered population	Endangered population	-	35 individuals

Removal of threatened fauna species habitat and habitat features

There are about 49.58 ha of suitable habitat (in good condition and where live snails or shells were found during the field survey) for the Cumberland Plain Land Snail (Endangered - TSC Act) in the study area. Of this, about 13 ha would be impacted by construction.

The Grey-headed Flying-fox (Vulnerable TSC Act and EPBC Act) was recorded in one location on private property off Willowdene Avenue during spotlight surveys. Three additional threatened fauna species were identified as having a moderate to high likelihood of occurring within the study area (these species were not recorded during the survey). These included:

- Regent Honeyeater (Critically Endangered – TSC Act and EPBC Act)
- Swift Parrot (Endangered TSC Act, Critically Endangered EPBC Act)
- Large-eared Pied Bat (Vulnerable TSC Act and EPBC Act).

The predicted impact to threatened fauna species is outlined below in Table 7-53. These impacts would be long-term. An assessment of significance pursuant to the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment, 2013) was completed for these the Grey-headed Flying-fox, Regent Honeyeater, Swift Parrot and Large-eared Pied Bat (refer to Appendix I). The project is considered unlikely to result in a significant impact to any of the EPBC Act listed threatened fauna species.

The Regent Honeyeater and Swift Parrot would suffer a reduction in extent of marginal foraging habitat of about 26.25 ha. Within the study area, this potential loss represents about 31 percent of the available habitat for these species. Within the Cumberland sub-region, this potential habitat removal represents less than 0.1 percent of the currently available habitat for these species. The state and national extent of habitat for these species is not known but the proportional impacts from the project to habitat at these scales would be less than 0.1 per cent. The impacts are predicted to be minimal as these species are unlikely to use the study area consistently. The project is unlikely to reduce the population size of the Regent Honeyeater or Swift Parrot or decrease the reproductive success of these species as no breeding habitat would be affected. The action would not interfere with and key breeding sites or foraging areas and would not interfere with the recovery of these species.

The National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*) (Commonwealth of Australia 2016) contains four overarching strategies for recovery of the Regent Honeyeater (refer to Appendix I). One of the actions associated with these strategies is to protect intact (high quality) areas of Regent Honeyeater breeding and foraging habitat. The study area is not recognised as a high quality area of Regent Honeyeater breeding or foraging habitat therefore the project would not interfere with this action. The remaining research and on ground actions associated with the strategies are not applicable to the project.

The National Recovery Plan for the Swift Parrot (Saunders & Tzaros, 2011) (Swift Parrot Recovery Team, 2001) outlines objectives and associated recovery actions for this species (refer to Appendix I). The objectives are not applicable to the biodiversity assessment study area or project. The identified recovery actions mostly relate to identifying the extent and quality of habitat, monitoring, raising community awareness, and coordinating and reviewing the recovery process. There is an action relating to management and protection of Swift Parrot habitat at the landscape scale. However, this action applies to fencing off habitat on private land to encourage regeneration of habitat, revising forestry practices, developing a strategic management plan for Swift Parrot breeding habitat in Tasmania, and providing Swift Parrot conservation information for consideration during the New South Wales Local Government Local Environmental Planning review process. Therefore these recovery actions will not be interfered with by the project.

The Grey-headed Flying-fox would suffer a small reduction in extent of suitable local foraging habitat of about 26.25 ha. Within the Cumberland sub-region, this potential habitat removal represents less than 0.1 percent of the currently available habitat in the region. The state and national extent of habitat for these species is not known but the proportional impacts from the project to habitat at these scales would be less than 0.1 per cent. No breeding camps or other important habitat would be impacted. As such, the project is considered unlikely to reduce the population size of the Grey-headed Flying-fox or decrease the reproductive success of this species. The project would not interfere with the recovery of the Grey-headed Flying-fox and would not contribute to the key threats to this species. An overall conclusion has been made that the action is unlikely to result in a significant impact to the Grey-headed Flying-fox.

The Large-eared Pied Bat would suffer a small reduction in extent of foraging habitat of about 26.25 ha. Within the Cumberland sub-region, this potential habitat removal represents less than 0.1 percent of the currently available habitat in the region. The state and national extent of habitat for these species is not known but the proportional impacts from the project to habitat at these scales would be less than 0.1 per cent. No breeding habitat (i.e. caves) would be impacted. As such, the project is unlikely to reduce the population size of this species or decrease its reproductive success. The project is considered unlikely to result in a significant impact to the Large-eared Pied Bat.

Table 7-53 Summary of threatened fauna species impacts

Threatened species	Status		Habitat or individuals to be impacted	Habitat or individuals in the study area
	TSC Act	EPBC Act		
Cumberland Plain Land Snail	Endangered	-	13 ha of habitat	74.95 ha of habitat
Grey-headed Flying-fox	Vulnerable	Vulnerable	26.25ha of habitat	84.97 ha of habitat
Regent Honeyeater	Critically endangered	Critically endangered	26.25 ha of habitat	84.97 ha of habitat
Swift Parrot	Endangered	Critically endangered	26.25 ha of habitat	84.97 ha of habitat
Large-eared Pied Bat	Vulnerable	Vulnerable	26.25 ha of habitat	84.97 ha of habitat

Impacts to habitat for EPBC listed migratory species

An assessment of significance pursuant to the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment, 2013) was completed for recorded migratory species and those with a moderate or high likelihood of occurrence (refer to Appendix I). In accordance with the guideline, 'Important habitat' for a migratory species is defined as (Department of the Environment, 2013):

- 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 that is of critical importance to the species at particular life-cycle stages
- Habitat utilised by a migratory species which is at the limit of the species range
- Habitat within an area where the species is declining.

Habitat in the study area is not considered to comprise important habitat for the Latham's Snipe or other potentially occurring migratory species. The assessment concluded that although the proposed action is expected to result in the loss of occasional habitat for migratory species, but not important habitat, the proposed action is unlikely to result in a significant impact on migratory species listed under the EPBC Act.

The remaining discussion on potential biodiversity impacts is not covered by the FBA although are considered relevant to the project.

Seasonal and temporal variation in impacts to threatened fauna species

The threatened species that were recorded within the study area and those that are considered likely to occur utilise the habitats in different ways during differing seasons or in some cases will only utilise the habitat during specific times of the year. In some cases, the habitat may not be used every year and may only be visited when environmental conditions are favourable. As such, the potential impacts of the project on threatened fauna species will vary temporally.

The Grey-headed Flying-fox (Vulnerable TSC Act and EPBC Act) was recorded in one location on private property off Willowdene Avenue during spotlight surveys. This species is considered likely to occur throughout the study area based on the presence of suitable foraging habitat. There are no roost camps in the study area and the project will not impact on any known permanent roosting, breeding / maternity sites. As such, the direct impacts of the project during the Grey-headed Flying-fox breeding season is likely to be negligible. The foraging habitat to be impacted may be productive from winter to spring (based on the widely ranging flowering period of *Eucalyptus tereticornis* and *Eucalyptus molluccana*) so the ability of the Grey-headed Flying-fox to forage in the area of impact would be impacted at this time. During some years conditions may not be suitable for foraging as the trees may not flower but it is not possible to predict when or whether this may occur. As such, there are no specific management measures outlined regarding seasonal impacts of key species, however, pre clearing surveys would be conducted to identify the presence of any species.

The Regent Honeyeater may utilise habitat within the study area on occasion outside of the breeding season when birds disperse from core habitats (ie during winter). Likewise, the Swift Parrot would only be present on occasion in the habitat during winter (outside of the breeding season) when it migrates to mainland Australia from Tasmania. No direct impacts to these species would occur during the breeding season. Impacts are limited to the loss of some potential foraging habitat that may be productive in winter during some years when environmental conditions are favourable. The study area will only be used on occasion by these two species when more favourable inland foraging habitats (ie box gum woodlands, box ironbark woodlands) or coastal habitats (ie spotted gum and swamp mahogany forests) fail to produce sufficient resources. The impact of the project to the habitat would only be realised by these two species during winter in years when other more preferred foraging habitat fail to produce sufficient resources.

Any Large-eared Pied Bats that would forage in the study area are likely to roost in the sandstone escarpments of the lower Blue Mountains. There are no maternity roosts in the study area. This species has been observed to establish nursery colonies in September with adult males dispersing after the young are born in early summer. Juvenile bats and females leave the roost before the

winter months. This suggests the main foraging period for males and females in the study area may be during autumn and winter (April to September) and the impact to this species would likely be most pronounced during this time.

Impacts to aquatic biodiversity

The construction of the project has the potential to impact aquatic ecosystems due to changes in water quality, habitat loss and instream barriers.

Construction activity around watercourses in the project area has potential to result in temporary changes to flow and loss of aquatic habitat associated with the removal of woody snags, changes to instream substrate and loss of aquatic plants (macrophytes).

The construction of the project has the potential to impact on water quality. The main impact to water quality during construction comes from vegetation clearing and earthworks, and including cut and fill activities.

Stockpiling of earthworks could potentially reduce downstream water quality during wet weather if not managed appropriately. Whilst there are numerous locations for stockpile sites (as documented in the Working Paper – Soils, Water and Contamination), they have been located such that no stock piles or compound sites are within 50 m of a Type 1 Fish Habitat.

The removal of large woody debris or snags is listed under Schedule 6 of the FM Act as a key threatening process. All woody debris and snags encountered during construction would be relocated instream to ensure impacts to the presence and availability of woody debris is prevented.

Many of the watercourses in the study area are artificial dams, situated in minor gullies which are either first or second order streams, and as such are not considered key fish habitat. Threatened species are unlikely to be present within these dams. However, there is a possibility that native and invasive fish species have colonised these dams. Should dams or creeks be dewatered during the construction of the project, then native fish species would need to be relocated in to a similar aquatic environment to which it was found by trained aquatic ecologists under a Fisheries Permit issued by the NSW DPI.

Aquatic impacts during construction of the project would be short-term and managed through the implementation of appropriate management measures.

Fragmentation of biodiversity links and habitat corridors

Habitat fragmentation *per se* relates to the physical dividing up of once continuous habitats into separate smaller ‘fragments’ (Fahrig 2002). The historic human activities including clearing for agriculture have resulted in the Cumberland Plain becoming a highly fragmented landscape. Most vegetation now occurs as small fragments in an agricultural setting of improved pasture and cropping.

The exisitng The Northern Road and the perimeter fence (about two metres high) around the DEOH currently create a physical barrier to movements of fauna. The project is considered unlikely to result in a large increase to landscape scale fragmentation. The project is however likely to result in localised fragmentation of local wildlife corridors between The Northern Road and Willowdene Avenue where some intact habitat patches would be broken apart and the hard barrier introduced by the project would restrict fauna movement. The widening of the existing The Northern Road in the north of the study area would further the barrier effects of this roadway where it bisects Regional Corridor 17 as identified in the OEH BIOMAP.

The predicted level of fragmentation from the project is not expected to be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. Functional connectivity for many species would remain in the study area. However, local division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability may result from the local fragmentation caused by the project which would result in long-term impacts to some local wildlife.

Edge effects on adjacent native vegetation and habitat

The development of linear infrastructure is known to cause disturbance in terms of reducing habitat quality and patch size. This is due to the greater potential for edge effects and habitat fragmentation and barrier effects associated with these forms of development due to their impact footprint and perimeter.

Within the study area, and construction footprint, many patches of vegetation are small, irregularly shaped, and fragmented. As such, many areas of vegetation within and directly adjacent to the construction footprint are already subject to considerable edge effects. However, there is potential for a high magnitude residual impact to occur to some of the more intact habitats within the study area from edge effects (such as those off Willowdene Avenue). These impacts would be long-term.

Overall, new edge effects from the project are predicted to result in the modification of about 1.94 ha of vegetation that would remain at the edge of the project once construction is complete (based off a 50 metre edge effect buffer).

Injury and mortality of fauna (including vehicle strike)

Fauna injury or death has the greatest potential to occur during vegetation clearing and the extent of this impact would be proportionate to the extent of vegetation that is cleared. Some mobile species, such as birds, may be able to move away from the path of clearing and may not be greatly affected unless they are nesting. However, other species that are less mobile (e.g. ground dwelling reptiles), or those that are nocturnal and nest or roost in trees during the day (e.g. arboreal mammals and microchiropteran bat species), may find it difficult to move rapidly when disturbed. Common fauna species such as possums, reptiles and frogs are the most likely to be affected.

Entrapment of wildlife in any trenches that are dug is a possibility if the trenches are deep and steep sided. Wildlife may also become trapped in machinery that is stored in the study area overnight that may result in injury or death.

Invasion and spread of weeds and pests

Proliferation of weed and pest species due to the project may be a key impact to biodiversity in the study area. Proliferation of weed and pest species is an indirect impact (i.e. not a direct result of project activities) that may have cumulative effects as each project activity may act together to increase the chances of weed and pest proliferation throughout the study area. Proliferation of weed and pest species is likely to occur during construction and the impacts would be greatest as a result of vegetation clearing during the construction phase. This impact has potential to have the greatest impact to the quality and integrity of TECs and threatened species habitat.

Without appropriate management strategies, project activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited or in low density. Project activities also have the potential to import new weed species into the study area. The most likely causes of weed dispersal and importation associated with the project include earthworks, movement of soil, and attachment of seed (and other propagules) to vehicles and machinery during all phases. Large expanses of the study area have significant weed growth. Therefore, the potential for habitat modification from weed invasion resulting from the project is highest where activities take place in relatively intact areas such as the higher condition areas of Cumberland Plain Woodland along Willowdene Avenue that exhibit low weed diversity and abundance.

The study area is currently habitat for a range of pest species including rabbits. Project activities have the potential to disperse pest species out of the project footprint across the surrounding landscape and increase the ability of pest species to utilise habitats due to habitat removal, noise, and human presence during construction and operation. In the context of the project this impact is predicted to be minimal as all vegetation in the study area is likely to be impacted by foxes and cats. The magnitude of this impact would be low.

The forests of southwest Sydney are currently experiencing ‘Bell miner associated dieback' (also known as BMAD). This form of tree canopy dieback is caused by over-abundant psyllids (sap-sucking insects that create a sugary excretion called lerp) in conjunction with Bell Miners that feed on the psyllids and the lerp. Bell miners are aggressive and exclude other bird species (that would

feed on psyllids) from their territories. This can lead to psyllid populations increasing to the extent that they cause substantial canopy damage. In western Sydney, *Eucalyptus moluccana* (Grey Box) trees appear to be the most affected, as is the case with the vegetation in the study area. Substantial landscape scale defoliation of Grey Box trees is occurring in these areas and given this species is a key component of the critically endangered Cumberland Plain Woodland ecological community, this phenomena is of concern. As such, 'Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners' is listed as a key threatening process under the TSC Act.

The project would involve vegetation removal and some localised fragmentation of local wildlife corridors between The Northern Road and Willowdene Avenue where some intact habitat patches would be broken apart. This could increase the prevalence and severity of BMAD in the locality due to increased fragmentation and removal of trees used as habitat by psyllids and Bell Miners. The magnitude of this impact is unknown and the potential extent and severity of any increased effects of BMAD cannot be quantified. The influence of the project on BMAD is however likely to be insignificant when compared to the broad scale clearing that has occurred in the past for agriculture and urban development. Additionally the project would not interfere with the objectives or proposed actions as identified by the BMAD working group and outlined in the BMAD strategy, and would not interfere with any of the 10 priority actions identified to help recover species affected by BMAD (refer to Appendix I for further details).

Invasion and spread of pathogens and disease

Several pathogens known from NSW have potential to impact on biodiversity as a result their movement and infection during construction. Of these, three are listed as a key threatening process under either the EPBC Act and/or TSC Act including:

- Dieback caused by Phytophthora (Root Rot; EPBC Act and TSC Act)
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (EPBC Act and TSC Act)
- Introduction and establishment of exotic Rust Fungi of the order Pucciniales on plants of the family Myrtaceae (TSC Act).

While these pathogens were not observed or tested for in the study area the potential for pathogens to occur should be managed during construction. The most likely causes of pathogen dispersal and importation associated with the project include earthworks, movement of soil, and attachment of plant matter to vehicles and machinery during all project phases (construction and operation).

Noise, vibration, dust, light and contaminants

Some night works would be required. The noise and vibration from construction activities associated with the project will potentially disturb fauna and may disrupt foraging, reproductive, or movement behaviours. The impacts from noise emissions are likely to be localised to the construction areas and are not considered likely to have a significant, long-term, impact on wildlife populations outside the area of impact. Within the area of impact, some sensitive species (e.g. woodland birds) may avoid the noise and some more tolerant species, including small mammals, will habituate over the longer-term.

Dust pollution is likely to be greatest during periods of substantial earthworks, vegetation clearing, vehicle movements for construction and decommissioning activities and during adverse weather (such as high wind) conditions. However, deposition of dust on foliage is likely to be highly localised, intermittent, and temporary (particularly during the wet season) and is therefore not considered likely to be a major impact of the project.

Some night works would be required during construction and lighting will be installed on the roadside. As such, the immediate area surrounding the project activities will be subject to artificial lighting, essentially creating 'daylight' conditions. Ecological light pollution may potentially affect nocturnal fauna by interrupting their life cycle.

During the construction phase localised release of contaminants (i.e. hydraulic fluids, oils, fluids, etc.) into the surrounding environment (including drainage lines) may accidentally occur. The most likely result of contaminant discharge will be the localised contamination of soil and potential direct physical trauma to flora and fauna that are exposed to contaminants. Accidental release of contaminants is likely to be localised.

Potential operational impacts

Fragmentation of biodiversity links and habitat corridors

Barrier effects occur where particular species are either unable or are unwilling to move between suitable areas of habitat due to the imposition of a 'barrier' (e.g. a newly created inhospitable habitat type or physical barrier such as the project). The operation of the project would create barrier effects that restrict fauna movement and this impact is likely to be most obvious for fauna groups including mammals, frogs, and reptiles. Mobile species such as birds and bats may not be affected to the same extent.

In terms of potential operational impacts on aquatic fauna, inappropriate design or type of water crossing can impede or prevent fish from travelling within their natural range. Detailed design of culverts would ensure that barriers to fish are not created. Construction of permanent and temporary waterway crossings such as bridges, causeways, fords and culverts are known to have significant impacts upon passage of fish. The project would require the traversing of minor waterways and farm dams. Water crossing structures have been designed to minimise the impacts of altering the natural flow regimes of the rivers and streams within the region. Detailed design of bridges and culverts would be undertaken in accordance with Fairfull & Witheridge (2003) and DPI (2004) should ensure that barriers to fish are not created and associated long-term impacts to the existing hydrology are minimised.

Additionally, there is potential for hydrology and flooding to be altered during operation which may result in increased rate, velocity and concentration of flow from the widened carriageway and new drainage system and structures. The changes to hydrology and flooding may affect biodiversity values by altering the frequency, magnitude and distribution of inundation of land adjacent to creeklines during floods and by altering the geomorphology and channel structure of waterways. Changes may include a shift in the distribution and identity of riparian species, resuspension and resettlement of instream sediments and scouring of the stream bed which may result in loss or gain of aquatic macrophytes and a shift in aquatic fauna community structure.

To mitigate impacts, Roads and Maritime would consult with property owners regarding upgrades to farm dam spillways to manage areas where increased flows are predicted. Energy dissipation and scour protection measures such as rock riprap or rock gabion mattresses would be utilised along transverse drainage structures to reduce erosion. Stormwater detention ponds will control discharge to the downstream environment.

Injury and mortality of fauna (including vehicle strike)

There is of the potential for fauna mortality during the operational phase the project through vehicle collision (i.e. roadkill). Vehicle collision is a direct impact that reduces local population numbers and is a common occurrence in Australia (Coffin 2007; Rowden et al. 2008). Mammals, reptiles, amphibians and birds would potentially be impacted by vehicle strike, particularly those common species (e.g. macropods) that are tolerant of disturbance and/or those species that can utilise roadways for movement pathways or as foraging habitat.

As there are no definitive data on current rates of roadkill or fauna population densities in the study area, the consequences of vehicle strike on local populations is unknown. With the creation of a new road the potential for vehicle strike is introduced but the significance of such an impact cannot be predicted. The impact on threatened species however is expected to be minimal and, based on evidence from other arterial roads in the locality, most vehicle strike impacts can be expected to occur to common mammals such as possums and macropods and exotic animals including foxes.

Invasion and spread of weeds and pests

Proliferation of weed and pest species is likely to occur during operation. The effects of proliferation of weed and pest species may not be experienced immediately or even in the short-term, however, would likely commence a few months after the construction phase commences and gradually increase over months and seasons as the project is operational resulting in potential long-term impacts.

Noise, vibration, dust, light and contaminants

There would be increased noise and vibration levels in the study area and immediate surrounds during operation as vehicles use the roadway. The noise and vibration from vehicles would potentially disturb fauna and may disrupt foraging, reproductive, or movement behaviours. Within the area of impact, some sensitive species (e.g. woodland birds) may avoid the noise and some more tolerant species, including small mammals, would habituate over the longer-term.

Dust is likely to be generated throughout the lifecycle of the project through vehicle movements and the greatest impacts during operation would be to vegetation directly adjacent to the road. The deposition of dust on foliage is likely to be highly localised, intermittent, and temporary (particularly during the wetter seasons) and is therefore considered unlikely to be a major impact of the project.

During operation the roadside would be subject to artificial lighting, essentially creating permanent 'daylight' conditions. Ecological light pollution may potentially affect nocturnal fauna by interrupting their life cycle but some species may benefit from the lighting due to increased food availability (insects attracted to lights) around these areas. Due to the frequency and sustained nature of the lighting, it is unlikely that animals would habituate to the light disturbance and a long-term impact in the area of lighting is likely.

During operation the accidental release of contaminants is likely, which would potentially result in localised contamination of soil and potential direct physical trauma to flora and fauna that come into contact with contaminants. Similarly pollutant runoff during operation of the road would have the potential to impact on water quality, however this would be managed through the implementation of water quality vegetated swales and rock check dams (refer to Section 8.2) which have been assessed to sufficiently reduce and manage water quality impacts to sensitive receiving waters (ie Key Fish Habitat) during operation. Therefore impacts to aquatic habitat identified for the project are expected to be minimal.

7.3.5 Summary of impacts to the environment of Commonwealth land

A summary of potential impacts to the environment of Commonwealth land as a result of construction and operation of the project is provided in this section as it relates to biodiversity. This includes an assessment of ecosystems and their constituent parts and water resources as it relates to the portions of Commonwealth land associated with the project. This includes the DEOH land, and land that has been acquired by the Commonwealth for the purposes of developing the Western Sydney Airport at Badgerys Creek.

The portion of the project within Commonwealth land is estimated at about 43.32 ha. Within this footprint, the following impacts to biodiversity are expected:

- Up to 13.34 ha of remnant native vegetation including about:
  - 10.51 ha of the Threatened Species Conservation Act (TSC Act) listed, critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community
  - 2.84 ha of the TSC Act listed River-Flat Eucalypt Forest on Coastal Floodplains
- About 10.07 ha of the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community

- Potential impact to aquatic ecosystems due to changes in water quality, habitat loss and instream barriers associated with works in and around waterways identified as Key Fish Habitat located within or immediately adjacent to Commonwealth land, most notably Badgerys Creek and the unnamed tributary of Surveyors Creek
- Potential impacts to aquatic and riparian habitats due to changes to flooding and hydrology during operation of the project would be restricted to direct scouring of waterways, drainage lines and shallow-rooted riparian groundcover on Commonwealth lands. There would be an increase in scour potential for a short distance from the project corridor in drainage lines flowing through DEOH site which may deepen the water way and cause some bank erosion. Increases to the 100 year ARI peak flows are not expected to impact waterways or vegetation communities due to the infrequent and short term nature of the impact
- Localised fragmentation of local wildlife corridors between The Northern Road and Willowdene Avenue where some intact habitat patches would be broken apart and the hard barrier introduced by the project would restrict fauna movement. The widening of the existing The Northern Road in the north of the study area would further the barrier effects of this roadway where it bisects Regional Corridor 17 as identified in the OEH BIOMAP
- Potential high magnitude residual impact to occur as a result of edge effects to some of the more intact habitats such as those off Willowdene Avenue
- Potential injury or death of fauna on Commonwealth land, for example during vegetation clearing
- Potential for the invasion and spread of weeds, pests, pathogens and disease which would potentially impact on the environment of Commonwealth land
- General construction and operational related impacts associated with noise, vibration, dust, light and contaminants as outlined above where they impact the environment of Commonwealth land.

Potential impacts would be restricted to direct scouring of waterways, drainage lines and shallow-rooted riparian groundcover on Commonwealth lands.

The Orchard Hills Cumberland Plain Woodland is listed on the Commonwealth Heritage List (CHL) and Register of the National Estate (RNE) for its natural heritage values.

About 9.15 ha of native vegetation from the western edges of the Orchard Hills Cumberland Plain Woodland Listed Place would be removed by the project. This is considered to be medium scale native vegetation clearance which would permanently destroy some of the structural elements upon which the Orchard Hills Cumberland Plain Woodland Listed Place is based. However, the core vegetation areas in the centre and east of the Orchard Hills Cumberland Plain Woodland would not be affected. Further details of the impact of the project on remnant vegetation are described above. An assessment of impacts to the heritage values of the site is provided in Section 8.4.

Given the extent of clearing of EPBC listed critically endangered Cumberland Plain Woodland on Commonwealth land, the impact is assessed as significant. Biodiversity offsets would be required to compensate for the loss of the vegetation community in accordance with the FBA. Refer to Section 7.3.5 for a discussion on matters for further consideration under the FBA and Section 7.3.8 for details on biodiversity offset requirements.

7.3.6 Matters for further consideration

Matters for further consideration can those for which impacts are considered to be complicated or severe. The assessment is based on thresholds detailed in Section 9 of the FBA. Matters for further consideration can also be included as part of the SEARs. It is noted that there are no matters for further consideration nominated in the SEARs for the project.

While there would be an impact to a Critically Endangered Ecological Community (Cumberland Plain Woodland), the project is considered unlikely to cause the extinction of this CEEC from the

IBRA sub-region. The project is however, considered likely to significantly reduce the viability of the Cumberland Plain Woodland. In accordance with the FBA, impacts on this CEEC are a matter for further consideration. Detailed discussion on the potential impacts on the CEEC are discussed in the BAR.

The area and condition of the Cumberland Plain Woodland to be impacted directly by the project includes about 29.14 ha of this CEEC. Of this, about 1.25 ha is considered to be in high condition and about 11.58 ha in moderate/good condition.

The extent of Cumberland Plain Woodland within an area of 1,000 ha and 10,000 ha surrounding the proposed development footprint has been estimated using a GIS and available regional mapping (Tozer 2003) as follows:

- There are about 136 ha of Cumberland Plain Woodland mapped within 1,000 ha of the project
- There are about 2,053 ha of Cumberland Plain Woodland mapped within 10,000 ha of the project.

The extent of Cumberland Plain Woodland remaining within the Cumberland sub-region has been estimated using a GIS and available regional mapping (Tozer 2003). There are about 24,422 ha of Cumberland Plain Woodland mapped within the Cumberland sub-region.

Where Cumberland Plain Woodland would be removed by the action, all abiotic factors (i.e. water, nutrients and soil) would be permanently modified and/or destroyed through vegetation removal and construction of infrastructure.

The composition of Cumberland Plain Woodland is likely to be modified as a result of the action through weed invasion and removal of vegetation. The patches of Cumberland Plain Woodland are in poor to high condition and a reduction in ecological function can be expected from the action in the form of:

- altered community structure
- altered species composition
- disruption of ecological processes (e.g. altered drainage)
- invasion and establishment of exotic species
- degradation of habitat
- fragmentation of habitat.

Machinery associated with vegetation clearance and subsequent construction for the project has the potential to introduce and transmit weed propagules and Phytophthora to remaining native vegetation remnants. This is a potential indirect impact through the spread and transmission of weeds and pathogens into retained habitat near the road.

This can be mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene but an impact, particularly from weeds, is likely.

7.3.7 Environmental management measures

Expected environmental outcomes

Potential impacts to biodiversity were considered during options and design development (as described in Section 4) with the aim of avoiding or minimising impacts as far as possible. Despite this, unavoidable impacts would occur, including impacts to threatened ecological communities and threatened species.

All practicable steps to avoid or minimise impacts to biodiversity would be implemented during the detailed design phase to reduce the scope of the overall impact. This would include the application of measures such as road design refinements to reduce the project footprint and incorporating design features to minimise impacts, where practical.

Specific outcomes that would be achieved through the implementation of environmental management measures include:

- Ensure controls and procedures are implemented during construction and operational activities to avoid, minimise or manage potential adverse impacts to biodiversity values within and adjacent to the project
- Minimising the removal of vegetation, in particular native vegetation
- Ensuring the appropriate re-establishment of native vegetation following construction of the project
- Minimising the removal of habitat and protection of surrounding habitat
- Reinstatement of habitat following construction of the project
- Development and implementation of appropriate offsets for the project
- Ensure measures are implemented to comply with the relevant legislative requirements and project conditions of approval.

Expected effectiveness

Roads and Maritime have experience in managing potential biodiversity impacts as a result of road developments of similar scale and scope to this project.

These measures are based on the following documents, as well as best management practice and specialist experience:

- Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects (NSW Roads and Traffic Authority 2011)
- Policy and Guidelines for fish habitat conservation and management (Department of Primary Industries 2013).

Roads and Maritimes' Biodiversity Guidelines were developed in consultation with the NSW office of Environment and Heritage (OEH), NSW department of Primary Industries, biodiversity specialists and Roads and Maritime staff including project managers, construction personnel and designers.

Waterway crossings throughout the project have been designed in accordance with Policy and Guidelines for Fish Habitat Conservation and Management (update 2013) (Department of Primary Industries 2013), *Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge 2003), and *Policy and Guidelines for fish Friendly Waterway Crossings* (DPI 2004). These guidelines provide an effective mitigation, built into design, to minimise impacts to fish and other aquatic wildlife from road projects which may improve the survival rate and protect threatened fish species.

A construction Flora and Fauna Management Plan (FFMP) would be prepared as part of the CEMP prior to construction. The plan would be prepared to address the requirements of the project approvals, the environmental management measures outlined in this EIS and all applicable legislation. The key components of the FFMP are based on Roads and Maritime biodiversity guidelines. The individual guides are for managing specific aspects of biodiversity. These guidelines were developed in consultation with the NSW office of Environment and Heritage (OEH), NSW department of Primary Industries (Fisheries), biodiversity specialists and Roads and Maritime staff including project managers, construction personnel and designers. The guidelines also outline specific and tailored requirements for monitoring and reporting to record the success of the biodiversity management measures.

As such, the measures outlined in the FFMP are considered to be proven effective in managing potential impacts to biodiversity.

Through the implementation of the construction FFMP, it is expected that residual impacts from construction on biodiversity values would be minimised as far as reasonably practicable. This would include minimising disturbance to vegetation communities during construction and

implementation of site management procedures to minimise the potential for harming native fauna. Further discussion on the residual impacts the project would have on biodiversity and proposed offset strategies are discussed in Section 7.3.9.

Audits and reporting of the effectiveness of environmental management measures is generally carried out to show compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP and FFMP prepared for the project.

Further information regarding proposed offsetting measures and their effectiveness is provided in Section 7.3.9.

Table 7-54 outlines environmental management measures that have been developed to specifically manage potential impacts which have been predicted as a result of the proposed works.

Table 7-54 Biodiversity environmental management measures

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
General construction impacts	B-1	A Flora and Fauna Management Plan (FFMP) would be developed for the project. The plan would include procedures for pre-clearance surveys that are consistent with the Roads and Maritime Biodiversity Guidelines (RTA 2011). The FFMP would outline: • Details of pre-construction surveys to verify the construction boundaries/ footprint of the project and to confirm the vegetation to be cleared as part of the project, identify habitat trees to be felled in a staged approach and identification of fauna release areas should fauna be encountered during vegetation removal • Updated sensitive aerial vegetation maps based on clearance surveys and previous survey work • Exclusion zones and fencing or other means to demarcate vegetation to be retained (endangered ecological communities) in close proximity to the works • Clearing of vegetation and removal of bush rock (Guide 7) including implementation of the pre-clearing process (Guide 1) and the associated staged habitat removal process where hollow-bearing trees, habitat trees or bush rock is to be removed • Weed management (see Guide 6) through the use of mechanical weed control methods	Contractor	Pre- construction	Proven to be effective. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		such as slashing or mowing, as well as a range of herbicides • Pathogen management (see Guide 7) through the implementation of hygiene protocols such as the provision of vehicle and boot wash down facilities and ensuring vehicles and footwear are free of soil before entering or exiting the site, as well as the establishment of exclusion zones and designated access tracks • Mechanism for the monitoring, review and amendment of this sub-plan.			
Removal of native vegetation, threatened species and threatened species habitat	B-2	Native vegetation removal would be minimised through detailed design.	Roads and Maritime	Detailed design	Expected effective. The design has been optimised throughout design options to minimise impacts to vegetation
	B-3	Pre-clearing surveys would be undertaken in accordance with *Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Identify and locate habitat features on site,	Contractor	Pre- construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		and mark those to be protected during clearing • Identify suitable habitat areas for fauna relocation (if encountered during clearing works) • 24 hours prior to clearing, licensed wildlife carers and/or ecologists should capture and/or remove fauna that have the potential to be disturbed as a result of clearing activities and relocate to the pre-determined location (as above) • Carry out staged habitat removal (Guide 4) where fauna habitat features have been identified and marked.			
	B-4	Vegetation removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bush rock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation • Retain stumps in riparian zones and aquatic	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		habitats to reduce the potential for bank erosion • Separate woody vegetation into millable timber, secondary re-use (Guide 5) or exotic (non-native) vegetation • Non-woody vegetation should be incorporated into the stripping of topsoil to retain any organic materials and nutrients • The staged habitat removal process is to be used when identified habitat is to be removed, with a licensed wildlife carer or ecologist on site • Undertake bush rock removal in a way that minimises damage to the bush rock, avoids excessive soil disturbance and avoids climatic seasons when species are utilising this resource • The Australian Standard AS 4373 Pruning of amenity trees should be followed for all pruning works.			
	B-5	The unexpected species find procedure is to be followed under Biodiversity Guidelines: • Protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority 2011) if threatened ecological communities, flora or fauna not assessed in the biodiversity assessment, are identified in the project site. The procedure is as follows:	Contractor	Construction	Proven to be effective. Reporting requirements of the FFMP to be adhered to.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		• Threatened flora or fauna species unexpectedly encountered stop work, • Notify the environment manager, • Environmental manager would arrange for an ecologist to conduct an assessment of significance of the likely impact, develop management options and notify OEH, DPI and DoEE as appropriate, • If a significant impact is not likely to occur, recommence work and maintain regular inspections, • If a significant impact is likely to occur: • Consult with OEH, DPI and DoEE as appropriate, • Obtain approvals, licenses or permits as required, • Recommence works once advice is sought and necessary approvals, licences and permits are obtained, • Include species in subsequent inductions, toolbox talks and update the CEMP.			
	B-6	Native vegetation would be re-established in accordance with *Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011). These measures would be outlined in the	Contractor	Post construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Use experienced and licensed seed collectors to carry out seed collection in accordance with RTA *Seed Collection QA Specification R176* and the Florabank Guidelines and Model Code of Practice • Planting operations should be in accordance with *RTA Landscape Planting QA Specification R179* • Collect local native topsoils and leaf litter and store for use in revegetation works • Ensure areas to be revegetated have an appropriate level of natural drainage, avoid compaction of soils in those areas and ensure suitable moisture requirements are maintained • Implement planting as per the planting plan for the project, including planting during suitable conditions, spacing and diversity of plants, etc. • Inspection, monitoring and maintenance of revegetated areas should be conducted in accordance with the Landscape Management Plan.			to confirm effectiveness of measures.
	B-7	Habitat removal would be minimised through	Roads and	Detailed design	Expected effective.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		detailed design.	Maritime		The design has been optimised throughout design options to minimise impacts to vegetation
	B-8	Habitat removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation • Retain stumps in riparian zones and aquatic habitats to reduce the potential for bank erosion • Separate woody vegetation into millable timber, secondary re-use (Guide 5) or exotic (non-native) vegetation • Non-woody vegetation should be incorporated into the stripping of topsoil to retain any organic materials and nutrients • The staged habitat removal process is to be	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		used when identified habitat is to be removed, with a licensed wildlife carer or ecologist on site • Undertake bush rock removal in a way that minimises damage to the bush rock, avoids excessive soil disturbance and avoids climatic seasons when species are utilising this resource The Australian Standard AS 4373 Pruning of amenity trees should be followed for all pruning works.			
	B-9	Habitat would be replaced or re-instated in accordance with *Guide 5: Re-use of woody debris and bushrock* and *Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Separate weeds from native vegetation • Carry out removal, stockpiling, transportation and relocation of woody debris and/or bush rock in a manner that minimises disturbance to native vegetation or bush rock • Engage an ecologist to provide advice on positioning woody debris and bush rock in	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		designated relocation areas • Keep topsoil disturbance to a minimum.			
Aquatic impacts	B-10	Aquatic habitat would be protected in accordance with *Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011) and Section 3.3.2 Standard precautions and mitigation measures of the *Policy and guidelines for fish habitat conservation and management Update 2013* (Department of Primary Industries 2013). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Avoid activities in aquatic habitats and riparian zones as much as practicable • Establish exclusion zones and set up exclusion fencing around sensitive areas • Keep vehicles and machinery away from the banks of a waterway where possible • Refuelling of vehicles and plant, and chemical storage and decanting should not take place within 50 metres of aquatic habitats • Avoid clearing within the riparian zone during	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		periods when flooding is likely to occur • Retain the roots of trees on the bank of a waterway in order to maintain bank stability • During rehabilitation, stabilise the banks of the waterway through revegetation and/or armouring according to available landscape plans • Remove all temporary works, flow diversion barriers and sediment control barriers within aquatic habitats as soon as practicable and in a manner that does not promote future channel erosion.			
Removal of woody debris	B-11	All large woody debris or snags would be relocated instream (Guide 10).	Contractor	Construction	Expected to be effective.
Changes to hydrology	B-12	Changes to existing surface water flows would be minimised through detailed design.	Roads and Maritime	Detailed design	Expected to be effective. Drainage upgrades for the project have been designed and optimised to minimise changes to existing flows as much as possible.
	B-13	Measures to mitigate potential water quality impacts during construction are outlined in Section 8.1 and Section 8.2 of the EIS.	Contractor	Construction	N/A
Fragmentation of identified biodiversity links and habitat	B-14	Connectivity measures have been considered during design in accordance with the *Wildlife Connectivity Guidelines for Road Projects* (RMS in prep). In particular, design where connectivity	Roads and Maritime and Contractor	Detailed design, during construction and post construction	Expected to be effective if done in accordance with the Wildlife Connectivity Guidelines.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
corridors		has been considered included culvert design, lighting and fencing.			Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.
Edge effects on adjacent native vegetation and habitat	B-15	Exclusion zones would be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011).These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Identify exclusion zones on a suitable plan as required to prevent damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease • Mark out exclusion zones on site with temporary markings such as pegs or paint and where possible use a qualified surveyor • Erect signs to inform personnel of the purpose of exclusion zone fencing • Ensure all exclusion zones are regularly inspected and repairs to fencing are made where required • Maintain exclusion fencing until the potential for disturbance within the excluded zone has been eliminated through other means.	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		Removal of fencing should be undertaken in consultation with environmental staff. • Communicate the importance of exclusion zones, and any changes to the zones, to all site staff and visitors (eg in toolbox talks and inductions).			
Injury and mortality of fauna	B-16	Fauna would be managed in accordance with *Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Allow fauna to leave an area without intervention as much as possible • Use a licensed fauna ecologist or wildlife carer with specific animal handling experience to carry out any fauna handling • Include the procedures to follow if fauna is found or injured on site in project inductions • Release fauna into pre-determined habitat identified for fauna release • Release fauna into similar habitats, as near as possible to their capture location. Release nocturnal fauna at dusk	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		• Temporary fauna fencing may be required on projects to reduce the chances of road kill/injury from public traffic or construction machinery.			
Invasion and spread of weeds	B-17	Weed species would be managed in accordance with *Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Use an ecologist or person trained in weed management and identification to undertake a site weed assessment to identify and describe or map weed infested areas within the site and adjacent areas. • Develop a Weed Management Plan for the site • Map and mark areas that are infested with weeds as an exclusion zone with fencing and signage to limit access by personnel and vehicles • Minimise soil disturbance within weed infested areas • Use mechanical weed control methods such as slashing or mowing, as well as a range of	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		herbicides to avoid the development of herbicide resistance • Mow/slash areas infested with weeds before they seed. This may reduce the propagation of new plants • Clean machinery, vehicles and footwear before moving to a new location • Securely cover loads of weed-contaminated material to prevent weed plant material falling or blowing off vehicles • Dispose of weed-contaminated soil at an appropriate waste management facility.			
Invasion and spread of pathogens and disease	B-18	Pathogens would be managed in accordance with *Guide 7 – Pathogen Management: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Ensure vehicles and footwear are free of soil before entering or exiting the site (ie directed to wash down area before entering or exiting the site) • Provide vehicle and boot wash down facilities • Set up exclusion zones with fencing and	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Impact	Ref #	Environmental Management Measures	Responsibility	Timing	Effectiveness of measures
		signage to restrict access into contaminated areas. • Restrict vehicles to designated tracks, trails and parking areas.			
Noise, light and vibration	B-19	Shading and artificial light impacts would be minimised through detailed design. Measures to mitigate potential noise and vibration impacts are provided in Section 7.2 of the EIS.	Roads and Maritime	Detailed design	Expected to be effective.

7.3.8 Residual impacts to listed threatened species and ecological communities

Residual impacts are those that remain after the implementation of avoidance and minimisation measures and after mitigation measures have been implemented for the project. Due to the design and nature of the project (i.e. a road widening and construction of new road sections), total avoidance and mitigation of biodiversity impacts cannot be reasonably achieved. The predicted residual impacts of the project on listed threatened species and ecological communities some of which are located on or adjacent to Commonwealth land. Despite avoidance and minimisation, significant residual impacts from the clearing of native vegetation would occur.

Vegetation removal would occur during construction of the project which would result in residual impacts associated with the loss of vegetation and associated habitat across the project. The most significant of these would be the impact on up to 39.6 ha of remnant native vegetation, including about 16.37 ha of the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community listed under the EPBC Act. The project would adversely affect habitat critical to the survival of the CEEC, as well as other indirect impacts to its survival. These impacts would be long-term and significant, even after the implementation of mitigation measures. The predicted impacts to the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community on Commonwealth land is considered likely to contribute to the significant residual impacts of the project.

Impacts on threatened plant, fauna species habitat and habitat features have not been assessed as significant, therefore residual impacts although likely to occur, are not expected to be significant. The same can be said for impacts to migratory species and aquatic species, impacts to which would be reduced though the implementation of mitigation measures.

The predicted level of localised habitat fragmentation that would occur as a result of the project is not expected to be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. As such residual impacts as a result of habitat fragmentation are not expected to be significant.

In terms of edge effects, there is potential for a significant high magnitude residual impact to occur to some of the more intact habitats within the study area from edge effects (such as those off Willowdene Avenue).

These construction related impacts would be long-term and would carry over into the operational stage of the project. Other operational residual impacts that may occur would be fauna injury or mortality as a result of the introduction of a new or extended road corridor into the environment; however this is not expected to have a significant impact.

The BOS includes details of offsets to be implemented to compensate for residual significant impacts associated with the project in accordance with the BOPMP and FBA which have been endorsed by the Commonwealth.

7.3.9 Biodiversity offsets

Despite avoidance and mitigation measures to minimise impacts to biodiversity, residual impacts from the clearing of threatened ecological communities and threatened species as a result of the construction and operation of the project are significant and require offsetting.

In accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014), the required offsets for the project have been calculated using the FBA methodology and the BBCC. A summary of the biodiversity offset credits required for the project is presented in Table 7-55 and further detail is provided in the Biodiversity Offset Strategy (Appendix I). Note that the Commonwealth EIS guidelines make an allowance for offsets to be assessed in accordance with State policy. The FBA has been endorsed by the Commonwealth.

Table 7-55 Summary of biodiversity offset credits required

Threatened ecological communities		
Plant community type	**Area impacted (ha)**	**Ecosystem credits required**
Derived grasslands on shale hills of the Cumberland Plain (50-300 m asl) (PCT 806)	12.01	223
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835)	4.29	178
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)	11.44	307
Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT 850)	10.47	409
Phragmites australis and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (PCT 1071)	6.17	142
Total	44.38	1,259
Threatened species		
Species	**Impact (ha or individuals)**	**Species credits required**
Pultenaea parviflora	4.00	60
Marsdenia viridiflora subsp. viridiflora - endangered population	35.00	1,400
Cumberland Plain Land Snail	13 ha	169
Regent Honeyeater	26.25 ha	2,021

Biodiversity offset investigations

The FBA outlines two options to fulfil the offset requirement for the project, which can be used alone or in combination, these include:

- Retiring biodiversity credits – like for like offsets are secured and credits retired (or the variation criteria are applied)
- Contributing to supplementary measures.

Investigations for sourcing the required credits to meet the offset obligations are underway, with a range of offset options already identified. Initial investigations included a desktop assessment of available offsets undertaken by Eco Logical Australia in March 2016. Potential sources of credits (ecosystem and species) were identified through:

- A search of the BioBanking Public Registers on the OEH BioBanking webpage

- Communication with credit owners, accredited BioBanking assessors and other sources closely involved with the biodiversity credit market
- Communication with local Councils who are currently pursuing options to establish Biobank sites on their own Council land, or who were known to be interested
- Investigation of potential properties.

An updated review of the available credits on the BioBanking Credits Register was undertaken in July 2016 and indicates that appropriate offsets are generally available (in the form of ecosystem credits) and the approach for securing the offset requirements is the purchase of credits available on the BioBanking Credit Register.

Biodiversity offset options

Biodiversity offset options are detailed in the BOS prepared for the project (Appendix I). The BOS indicates that a direct like-for-like offset is available for most ecosystem credits required for the project including critically endangered ecological communities listed under the TSC Act and the EPBC Act. Ecosystem credits measure the loss in biodiversity values of a project and the gain in biodiversity values at an offset site (OEH 2014). They are assigned to a threatened species that can be predicted by habitat surrogates. However, there is a current shortfall in credits available on the BioBanking Credit Register for:

- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (HN 630)
- Pultenaea parviflora
- *Marsdenia viridiflora* subsp. *viridiflora* - endangered population
- Cumberland Plain Land Snail
- Regent Honeyeater.

Properties that may have potential to provide species credits for *Pultenaea parviflora* and Cumberland Plain Land Snail have been identified. A search of the BioBanking Public Register indicates that an expression of interest may contain species credits for the *Marsdenia viridiflora* subsp. *viridiflora* - endangered population and Regent Honeyeater, subject to further investigation. The BioBanking public register has been checked for available credits and a credits wanted request was placed on the BioBanking credits wanted register on 21 July 2016.

Where like-for-like offsets are unable to be identified after taking reasonable steps, in accordance with the NSW Biodiversity Offset Policy for Major Projects (OEH, 2014), variation rules may apply for non-EPBC Act listed matters. The variation rules allow vegetation to be offset with a broader suite of similar vegetation types in the locality that have similar percentage of historical clearing. They also allow species to be offset with similar species in the locality that use the same habitat and are under a similar or greater level of threat.

In the case of *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (HN 630), variation rules may need to be applied due to the current shortfall of credits available for this PCT on the BioBanking Public Register. However, before variation rules can be used, Roads and Maritime would:

- Continue to check the BioBanking public register and
- Liaise with the OEH offices and relevant local councils to obtain a list of potential sites that meet the requirements for offsetting

If appropriate offset sites cannot be found, Roads and Maritime would then provide funds for supplementary measures.

This BOS addresses the requirements of the Commonwealth EIS Guidelines regarding offsets. The approach taken to offsets for the project is a direct offset that aims to provide ‘like for like’ offset for all biodiversity values, with this being the minimum requirement for those matters listed under the EPBC Act. The offset package itself will be finalised after the offset investigations have