Roads & Maritime

The Northern Road Upgrade between Glenmore Parkway and Jamison Road

Biodiversity Assessment

August 2016

Roads and Maritime Services

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Executive summary

Roads and Maritime Services (Roads and Maritime) is proposing to upgrade The Northern Road between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith (referred to as 'the proposal'). The proposal would upgrade The Northern Road to an eight-lane divided road, with three general traffic lanes and a kerbside bus lane in each direction, separated by a median.

This report details the methods and results of a biodiversity survey and assessment to identify the distribution and abundance of threatened species, populations and ecological communities in the area of the proposal. This report assesses the extent and magnitude of potential ecological impacts.

The proposal is located in the Cumberland sub-region of the Sydney Basin Bioregion and the Cumberland Plain Mitchell Landscape where only 11 per cent of the original native vegetation remains. There are around 17 hectares of native vegetation within the study area in varying in condition from poor to moderate. There are no large, undisturbed patches, of vegetation in the study area and most discrete native vegetation patches are less than one hectare in size. The exception to this is the planted vegetation along the M4 Motorway and a patch of native vegetation at 1840 The Northern Road, Orchard Hills (adjacent to Frogmore Road). Planted vegetation is prevalent throughout the study area and includes a wide mix of native and exotic species. The native vegetation in the study area is composed of three Plant Community Types (PCTs) as defined under the NSW Vegetation Information System (VIS) database:

- Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (includes revegetation along the M4 Motorway)
- Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion – man made dams.

Natural fauna habitats in the locality have been largely removed and/or heavily modified by residential and urban development and road infrastructure. However, the habitats in the study area provide limited shelter, breeding and foraging resources for several common frog, reptile and bird species, and are likely to provide habitat for common mammals. Hollow bearing trees were sparse and the lack of hollow-bearing trees is a symptom of the young age cohort of trees and extent of previously clearing. The majority of the vegetation along the M4 Motorway corridor has been planted after construction of the motorway and as such lacks maturity (apart from small pockets with remnant mature trees).

Two threatened ecological communities (TECs) listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) are present in the study area:

- Cumberland Plain Woodland in the Sydney Basin Bioregion (listed as critically endangered)
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (listed as endangered).

The vegetation provides some habitat for threatened fauna species. These are all highly mobile species and include the Eastern Bentwing-bat, Eastern Freetail-bat, Southern Myotis, Grey-headed Flying-fox and Swift Parrot. This is generally limited to foraging habitat but the Eastern Freetail-bat may roost in the hollow-bearing trees in the study area. The M4 Motorway bridge is not considered optimal as a roost site for bats, and the likelihood of bats roosting under the bridge is considered low. A survey for roosting bats was conducted near Glenmore Parkway given the presence of culverts potentially needing to be demolished or modified as part of the project. The survey determined that bats were not present at the time and there are limited opportunities for bats to

roost in these structures. However, the potential for bats to roost in these structures prior to their demolition should be considered.

The construction footprint would impact on up to around 2.4 hectares of remnant native vegetation and up to 3.9 hectares of planted vegetation along the M4 Motorway (6.3 hectares in total). The predicted impacts to remnant Cumberland Plain Woodland in the Sydney Basin Bioregion TEC is around 1.9 hectares. Impacts to the River-Flat Eucalypt Forest TEC are predicted to be minimal at 0.4 hectares. When considered in the context of the locality (the area within 10 km of the proposal) the proportional impact is small.

All vegetation to be impacted is considered potential foraging habitat for threatened species including the Eastern Bentwing-bat, Eastern Freetail-bat, Southern Myotis, Grey-headed Flying-fox and Swift Parrot.

An Assessment of Significance has been conducted for threatened species and ecological communities that have been positively identified or that are considered to have a moderate or high likelihood of occurring in the study area. Provided the mitigation measures detailed in Chapter 5 are adequately implemented, the proposal is unlikely to have a significant impact on any threatened species, populations or ecological communities listed under the TSC Act and/or EPBC Act.

Some residual impacts would occur. It is Roads and Maritime policy that biodiversity offsets are to be provided where more than 1 hectare of high conservation value vegetation is cleared. As such, an offset strategy is required to be prepared for the proposal targeting an offset for the critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion. An indicative offset requirement is provided.

Contents

1 Introduction

1.1 Background

Roads and Maritime Services (Roads and Maritime) is proposing to upgrade The Northern Road between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith (referred to as 'the proposal' for the purposes of this report). The proposal would upgrade The Northern Road to an eight-lane divided road, with three general traffic lanes and a kerbside bus lane in each direction, separated by a raised concrete median. Beyond Jamison Road, The Northern Road continues as a six-lane carriageway to the north.

The proposal is located about 45 km west of the Sydney central business district and 5 km south of Penrith (refer to **Figure 1-1**).

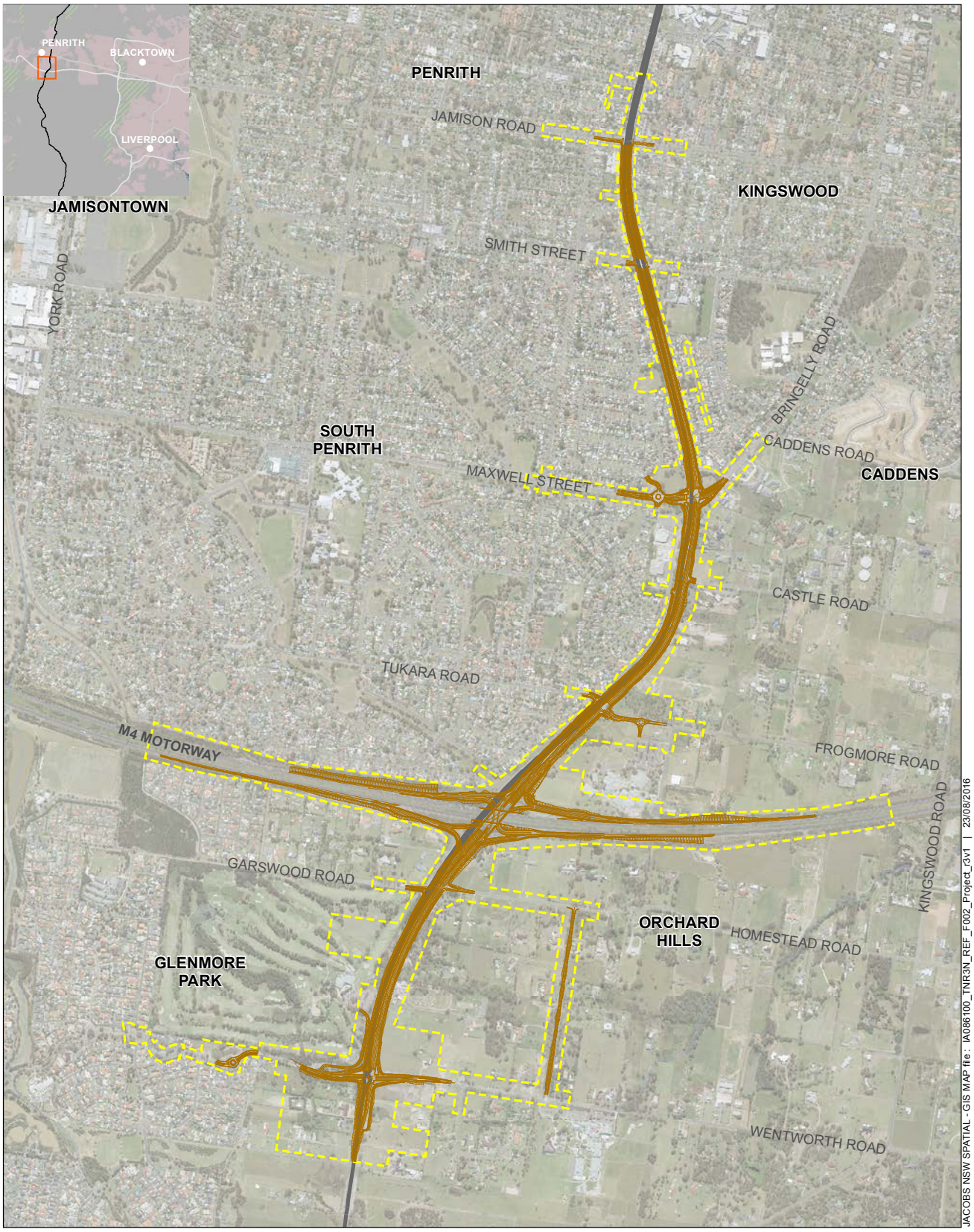
The Northern Road is classified as a State Road and forms part of route A9, which connects Campbelltown to Windsor. The Northern Road also provides connections between the Western Sydney Priority Growth Area, the Western Sydney Employment Area, the M4 Motorway, and the site for the proposed western Sydney airport at Badgerys Creek. This section of The Northern Road is currently a four-lane road, largely divided by a grass median. Between 200 metres south of Smith Street and 200 metres north of Frogmore Road there is a 1.3 kilometre section that is undivided. There are five signalised, and six unsignalised intersections, as well as various uncontrolled property accesses along this section of The Northern Road.

It is anticipated that construction of the proposal would commence in early 2017 and would be open to traffic by mid-2020.

1.2 Objectives

This report details the methods and results of a biodiversity survey and assessment to identify the distribution and abundance of threatened species, populations and ecological communities in the area of the proposal to assess the extent and magnitude of ecological impacts associated with the proposal. The report addresses the requirements for assessment of significance under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The report also addresses the requirements of the *Fisheries Management Act 1994.* Mitigation measures to ameliorate ecological impacts arising from the proposal are also provided. The aims of the biodiversity assessment are to:

- Describe the characteristics and ecological condition of the vegetation communities and habitats within the study area.
- Determine the occurrence, or likelihood of occurrence of threatened species, populations and communities listed under the *Threatened Species Conservation 1995* (TSC Act), EPBC Act and FM Act within the study area.
- Describe the potential impacts on biodiversity in the study area because of the proposal.
- Undertake an Assessment of Significance for threatened species and communities that are confirmed or considered likely to occur within the study area.
- Propose measures to mitigate impacts on ecological values.
- Conduct a condition assessment using the BioBanking assessment methodology to identify the condition of the vegetation to be impacted for use in determining future offset options.



Legend

The Northern Road Upgrade between Glenmore Parkway and Jamison Road

Proposal area

The Northern Road (Existing)

0 0.5 1 km

N

Figure 1-1 | The Northern Road Upgrade between Glenmore Parkway and Jamison Road

1.3 Key features of the proposal

Roads and Maritime proposes to upgrade about four kilometres of The Northern Road between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith (refer to **Figure 1-2**). The main features of the proposal are:

- An eight-lane divided road (three general traffic lanes and a kerbside bus lane in each direction) from just south of Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith
- An upgrade to the M4 Motorway interchange, including:
  - Construction of a new two-span bridge over the M4 Motorway, located to the east of the existing bridge alignment
  - Replacement of the existing two sets of traffic lights at the M4 Motorway interchange, with a single set of traffic lights to control all movements at the interchange
  - Widening of ramps to accommodate future Smart Motorway requirements
  - Demolition of the existing bridge over the M4 Motorway
- New traffic lights on The Northern Road at:
  - The Glenmore Parkway and Wentworth Road intersection
  - The Frogmore Road and Tukara Road intersection
- Altered intersection arrangements at:
  - The Northern Road and Homestead Road (left-in, left-out only)
  - The Northern Road and Castle Road (left-in, left-out only)
- Upgrade of The Northern Road and Glenmore Parkway / Wentworth Road intersection, comprising:
  - Traffic lights to replace the existing roundabout, allowing all movements
  - Separate left-turn lanes on all approach roads to the intersection
  - Additional left-turn and right-turn capacity from both approach roads onto The Northern Road
  - A new dedicated access road into the Penrith Golf and Recreation Club, meeting Glenmore Parkway at a new T-intersection about 175 metres west of The Northern Road, with all left and right turn movements allowed
  - A new single-lane roundabout on Glenmore Parkway west of the proposed new Golf Club access road, to facilitate U-turn movements for traffic entering or leaving Fairwater Court and Garswood Road
- Changes to local roads, including:
  - Extension of Cross Road to provide a new local connection between Wentworth Road and Homestead Road
  - A new roundabout on Frogmore Road, west of the existing intersection with Simeon Road providing access to Penrith Christian School
  - Removal of the existing roundabout at Maxwell Street and Aspen Street, and replacement with a new four-leg roundabout realigned to include Hilliger Road, with traffic lights on the Aspen Street leg only
- New pedestrian and cyclist facilities, including:
  - A three-metre wide shared path along the western side of The Northern Road between Glenmore Parkway and Jamison Road
  - A three-metre wide shared path along the eastern side of The Northern Road between Wentworth Road and Bringelly Road
  - A 1.5 metre wide footpath on the eastern side of The Northern Road between Bringelly Road and Jamison Road
- New or additional pedestrian crossing signals at:
  - The Northern Road intersection with Glenmore Parkway and Wentworth Road
  - The M4 Motorway interchange
  - The Northern Road intersection with Frogmore Road and Tukara Road
  - The Northern Road intersection with Maxwell Street and Bringelly Road

  - The intersection of The Northern Road and Jamison Road
- New retaining walls along:
  - The eastern side of The Northern Road, south of Homestead Road
  - Both sides of the M4 Motorway beneath the proposed bridge (reinforced soil walls)
  - The northern side of the eastbound M4 on-ramp, towards the eastern end of the ramp
  - The western side of The Northern Road, south of Tukara Road
  - The eastern side of The Northern Road adjacent to the Flower Power Garden Centre, south of Castle Road
  - The eastern side of The Northern Road, south of Bringelly Road
  - The eastern and western side of The Northern Road at numerous locations between Maxwell Street / Bringelly Road and Smith Street
  - The southern side of Smith Street, west of the intersection with The Northern Road
  - The eastern and western side of The Northern Road at numerous locations between Smith Street and Jamison Road
- Upgrade of drainage infrastructure, including:
  - New or upgraded cross-drainage structures to replace existing cross-drainage where required
  - New longitudinal drainage including open concrete or grass-lined catch drains, grassed swales, pits and pipes
- New noise barriers at the following locations:
  - A noise mound along the northern side of the eastbound M4 Motorway off-ramp (the mound would be about 670 metres long and six metres high)
  - A noise wall along the eastbound M4 Motorway off-ramp from the end of the noise mound, continuing north along the western side of The Northern Road to Aspen Street (the wall would be about one kilometre long and up to 4.5 metres high)
  - A noise wall along the eastbound M4 Motorway on-ramp, between the motorway and the buildings at the Penrith Christian School (the wall would be about 325 metres long and up to 4.5 metres high)
- Two permanent variable message signs (VMS) on The Northern Road near the M4 Motorway interchange
- New street lighting
- New landscaping
- Relocation of utility services and construction/installation of new utility services
- Relocation of some bus stops and construction of new bus stops
- Changes to property accesses along The Northern Road to left-in, left-out only
- Adjustments to private properties to accommodate the proposal, including driveways, front yards, retaining walls, utility connections and fencing
- Establishment and use of temporary site compounds during construction.

It is anticipated that construction of the proposal would start during 2017 and is expected to be completed by mid-2020.

1.4 Study area

The proposal is located along the existing Northern Road in western Sydney extending from Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith. The following areas are discussed throughout the report and are defined as:

- Proposal footprint: this area comprises the limits of the upgrade design and compound site locations with an additional five metre buffer to allow for a small contingency surrounding the proposal for construction activities
- Study area: includes the proposal footprint and surrounding area that may be used for site access
- Locality: This is taken to be a 10 kilometre radius surrounding the proposal footprint.

The study area is located in the Sydney Basin bioregion (Thackway & Cresswell 1995) and within the Hawkesbury-Nepean Catchment Management Area (CMA) in the Cumberland sub-region. This region is significant for biodiversity because it supports several endemic flora and fauna species found only on the Cumberland Plain.

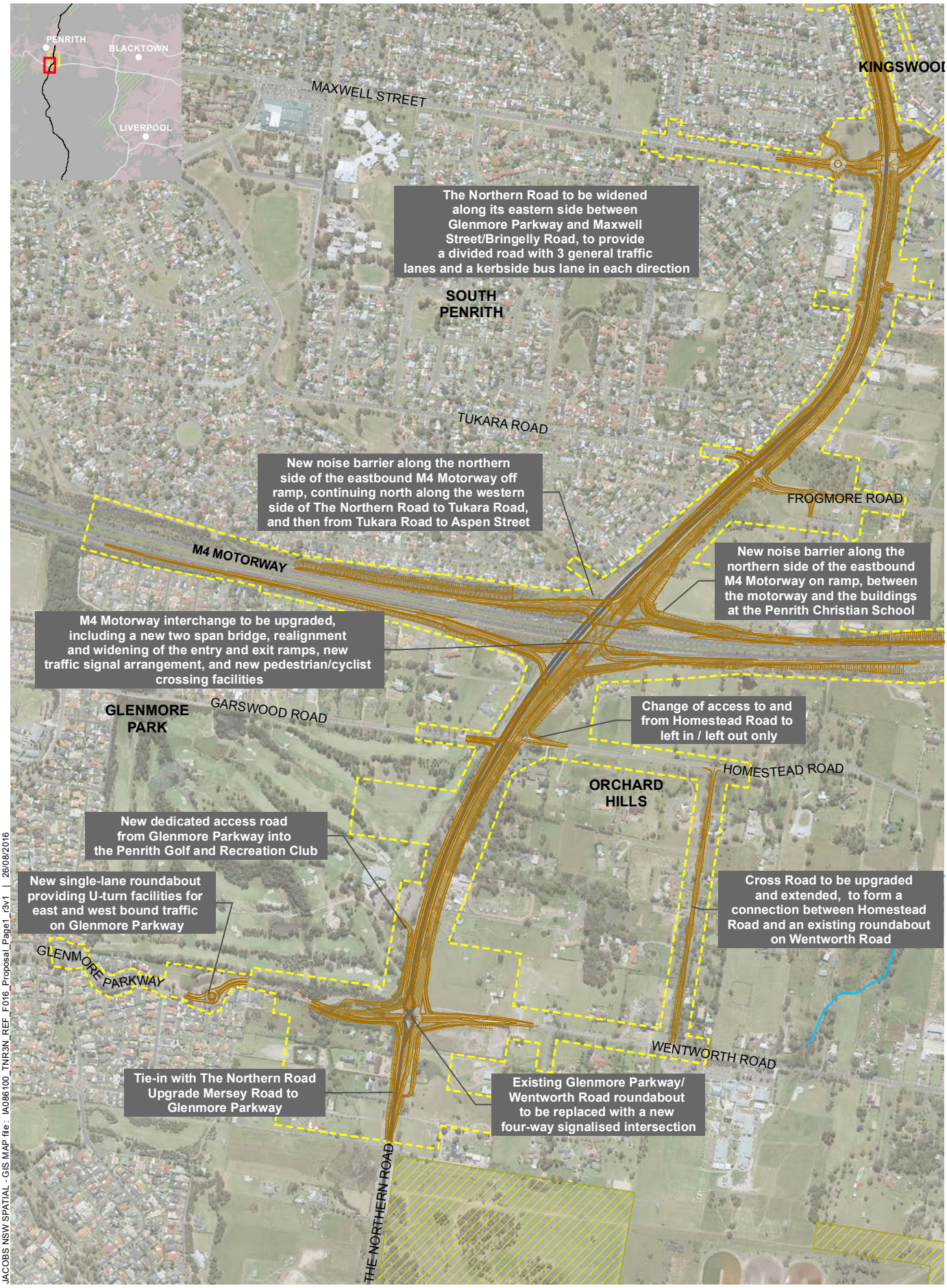


Figure 1-2 | Main features of the proposal

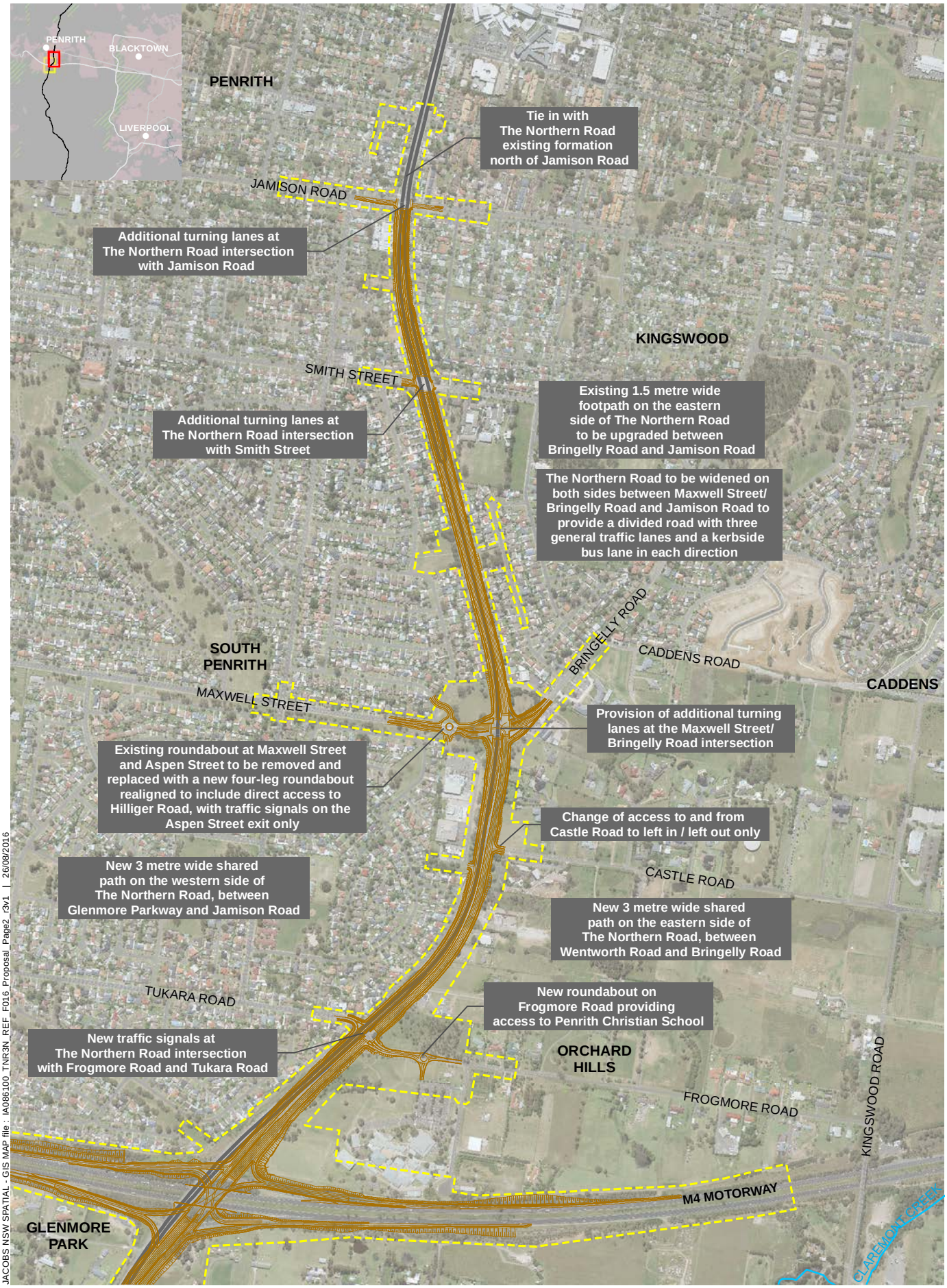


Figure 1-2 | Main features of the proposal **Page 2 of 2**

1.5 Legislative context

The information presented in this report identifies the potential biodiversity impacts of the proposal in relation to the relevant State and Commonwealth environmental and threatened species legislation and policy. Relevant legislation and policy includes the:

- NSW *Environmental Planning and Assessment Act 1979* (EP&A Act)
- NSW *Threatened Species Conservation 1995* (TSC Act)
- NSW *Noxious Weeds Act 1993* (NW Act)
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.5.1 Environmental Planning and Assessment Act 1979

Under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) (section 111 and section112), all proposals must include an assessment of threatened flora and fauna and their habitats that are likely to occur within the area of the activity or that may be indirectly affected by the construction and operation of an activity. The assessment has to address whether the proposed activity 'is likely to have a significant effect' on the threatened biodiversity identified, and a decision made on whether an Environmental Impact Statement (EIS) or Species Impact Statement (SIS) is required. In order to make this decision, a determining authority must consider the effect of an activity on:

- Threatened species, populations and ecological communities, and their habitats (listed under the TSC Act) and whether there is likely to be a significant effect on these (as determined in section 5A of the EP&A Act)
- Critical habitat (listed under the TSC Act)
- Any other protected fauna or protected native plants within the meaning of the *National Parks and Wildlife Act 1974*.

Section 5A of the EP&A Act outlines the seven factors that must be taken into account when deciding whether a proposal would be likely to have a significant impact on threatened biodiversity or their habitats (Assessment of Significance – seven-part test).

1.5.2 NSW Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) identifies threatened species, populations and ecological communities, as listed under Schedules 1, 1A and 2 that are to be identified as potential subject species and therefore require a significance assessment under section 5A of the EP&A Act. The TSC Act also lists Key Threatening Processes comprising matters that threaten the survival or evolutionary development of a species, population or ecological community.

1.5.3 NSW Noxious Weeds Act 1993

The objectives of the *Noxious Weeds Act 1993* are to reduce the negative impact of weeds on the economy, community and environment of NSW. This involves: establishing control mechanisms to prevent the establishment of significant new weeds; prevent, eliminate or restrict the spread of particular significant weeds; effectively manage widespread significant weeds; and to provide for the monitoring of and reporting on the effectiveness of the management of weeds in NSW.

1.5.4 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act protects the environment, particularly matters of national environmental significance (Matters of NES) and assessment of the environment on Commonwealth land. It streamlines the national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and cultural places. The EPBC Act identifies nine Matters of NES:

- World Heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)
- A water resource, in relation to coal seam gas development and large coal mining development.

The EPBC Act is triggered by actions that would be likely to have a significant impact upon Matters of NES. Under the EPBC Act, such actions require approval from the Commonwealth Environment Minister and should be referred to the Commonwealth Department of the Environment (DoE) for consideration. Actions deemed by DoE to require Commonwealth approval would be 'controlled actions' which require an environmental assessment. The EPBC Act also lists Key Threatening Processes comprising matters that threaten the survival or evolutionary development of a native species or ecological community.

Strategic assessment

Some essential roads and traffic management works undertaken by Roads and Maritime (such as this proposal) do not require further consideration under the EPBC Act if undertaken in accordance with the *Program Report – Strategic Assessment of environmental assessment and decision making by NSW Roads and Maritime Services, May 2015* (Roads and Maritime Services 2015). On 7 September 2015, the Minister for the Environment endorsed the Program and subsequently approved a class of actions relating to rudimentary, small-scale road and traffic management works. These activities (including the proposal) do require environmental assessment under Part 5 of the EP&A Act.

1.5.5 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. In particular, this includes:

- To conserve fish stocks and key fish habitats
- To conserve threatened species, populations and ecological communities of fish and marine vegetation
- To promote ecologically sustainable development, including the conservation of biological diversity and, consistently with those objects
- To promote viable commercial fishing and aquaculture industries
- To promote quality recreational fishing opportunities
- To appropriately share fisheries resources between the users of those resources
- To provide social and economic benefits for the wider community of New South Wales
- To recognise the spiritual, social and customary significance to Aboriginal persons of fisheries resources and to protect, and promote the continuation of, Aboriginal cultural fishing.

The *Act* is administered by NSW Department of Primary Industries (DPI) which has jurisdiction over all fish, marine vegetation, freshwater areas (intermittent and permanent) and submerged land.

Permits and approvals may be required under Parts 4 and 5 of the EPA&A Act, or under the FM Act, subject to the type of activities and consenting authority.
Permits or licences may be required for:

- Dredging or reclamation (i.e. any excavation within, or filling or draining of, water land or the removal of woody debris, snags, rocks or freshwater native aquatic vegetation or the removal of

any other material from water land that disturbs, moves or harms these in-stream habitats) (Section 199-201).
- Obstruction of free passage of fish (Section 218-219)
- Harming threatened species or damaging their habitat.

Examples of activities that may require a permit include:

- Bridges, culverts, causeways (both piped and unpiped) or other road-crossings of waterways (temporary or permanent) which require placing material on the bed of the waterway (i.e. reclamation) and/or which may obstruct the free passage of fish.
- Channelisation, relocation or realignment of waterways.
- Installation of pipelines across a waterway (involving dredging or reclamation),
- Installation of stormwater outlets (involving reclamation of the bed or bank of a waterway).
- Stream bed or bank stabilisation works (involving dredging or reclamation to halt erosion).

2 Methodology

2.1 Personnel

A field survey was conducted on the 30 September 2015 with additional surveys undertaken on 19 January and 31 March 2016 by an experienced botanist and a fauna ecologist licensed to conduct field surveys under the NPW Act (Scientific Research Permit SL100044). Ethical approval to conduct research was obtained from the Department of Primary Industries Animal Care and Ethics Committee (Animal Research Authority (09/1895). The qualifications and role of personnel involved in the field assessments are provided in **Table 2-1**.

Table 2-1 Qualifications and role of key personnel

Personnel	Qualifications	Project tasks
Lukas Clews	MScStud; DipCons&LandMgmt; GradCertAppSc; BSc; Accredited Biobanking Assessor	Biodiversity assessment report; flora surveys, vegetation mapping
Chris Thomson	BAppSc; GradCertNatRes, Accredited Biobanking Assessor	Fauna survey and habitat assessment

2.2 Database search and literature review

Database searches and review of literature was undertaken for records of Commonwealth and State listed threatened species, populations and ecological communities. Searches were conducted within a 10 kilometre radius and included the following:

- 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 (Department of Primary Industries 2016a)
- Atlas of NSW Wildlife maintained by the OEH (Office of Environment and Heritage 2016)
- EPBC Act protected matters search tool (Department of the Environment 2016)
- 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)
- DPI Noxious Weed listings (Department of Primary Industries 2016b)
- *M4 Smart Motorway Biodiversity Assessment* (Jacobs 2015).

The database searches focused on identifying and listing the threatened flora and fauna species, populations and ecological communities previously recorded within the locality. Following collation of database records and species and community profiles a 'likelihood of occurrence' assessment was prepared with reference to the broad habitats contained within the study area (see appendix B). This was further refined following field surveys and assessment of the habitat present and habitat quality.

2.3 Field survey

2.3.1 Vegetation community and flora field survey

A combination of aerial photograph interpretation, broad-scale vegetation mapping, and elevation data was used to stratify the vegetation and habitats in the study area. Data and vegetation mapping from the M4 Smart Motorway Biodiversity Assessment (Jacobs 2015) was also used to categorise the vegetation within the M4 corridor, which included a review of the original M4 landscape plans. The stratification of vegetation map units was based on a number of factors including the vegetation structure, dominant species, soil types, and landscape position and disturbance history. The location and number of sampling sites used in the field survey was determined according to the extent and condition of each vegetation type present to ensure adequate representation. Refer to **Figure 2-1** for location of sampling sites.

The flora survey aimed to provide baseline data for the presence of threatened plant species, populations and ecological communities to provide a basis for the prediction of impacts. It comprised the following steps:

- A thorough review of the broad-scale vegetation mapping and threatened species records to gain an appreciation of the diversity of flora including threatened species that could potentially occur in the study area
- Stratified sampling techniques to classify and map vegetation communities, threatened species habitat, and develop an inventory of flora species specific to each vegetation association
- Targeted searches for threatened flora species in areas of suitable habitat.

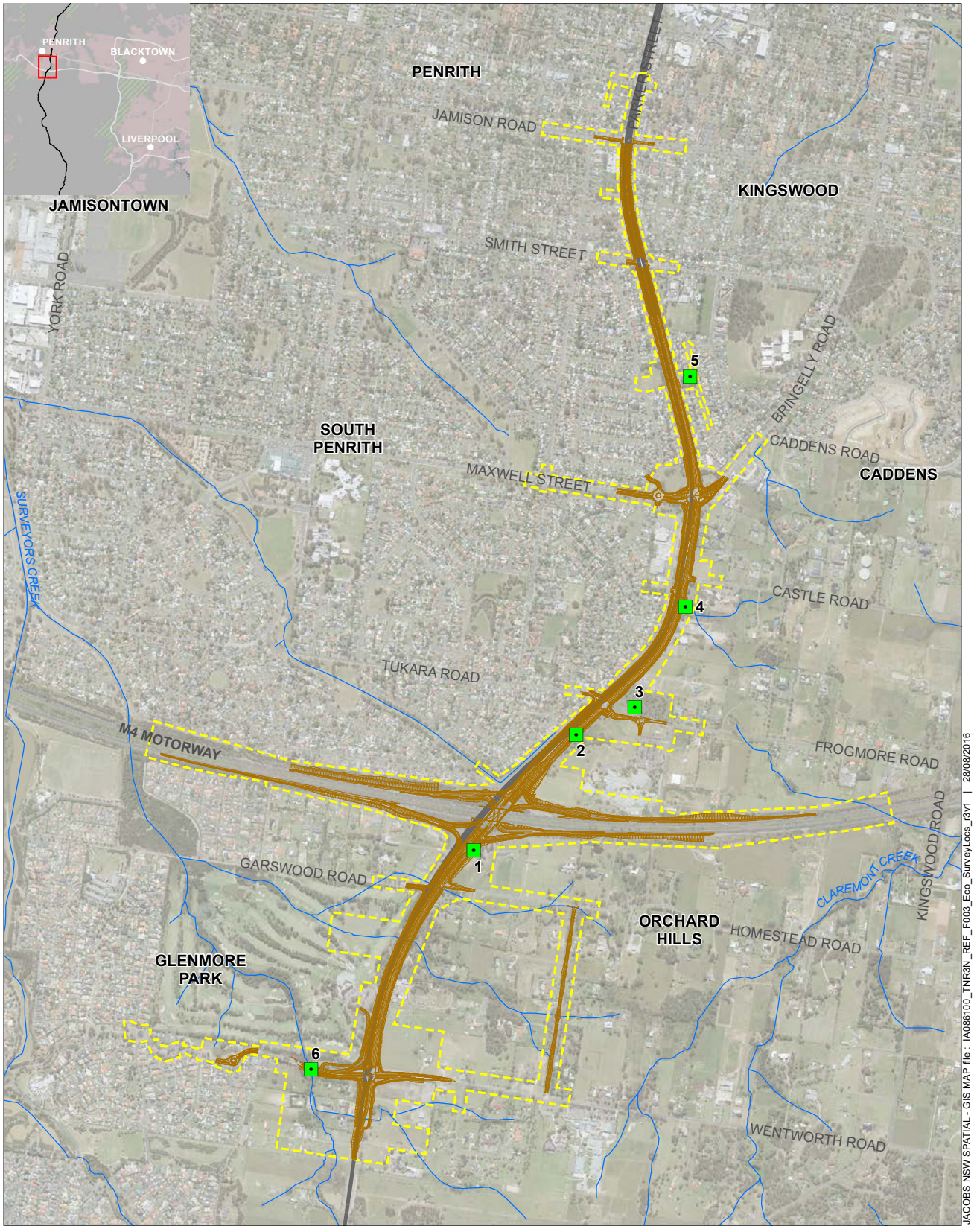
Plot/transect sampling

Standard plot/transect based sampling as defined in the BioBanking Assessment Methodology 2014 (BBAM) was used in conjunction with general traverses of the study area. The plot/transect technique was used. However, no attempt was made to meet the BBAM minimum survey requirements per vegetation zone area, as the assessment is not a BioBanking assessment. The BBAM plot/transect survey was undertaken on 30 September 2015 with additional surveys undertaken on 19 January and 31 March 2016.

Quantitative data on plant species richness and abundance, and habitat attributes, were collected from a series of plot/transect sampled within vegetation associations. Data collected within each plot/transect included:

- Native species richness (measured in a 20 x 20 metre quadrat)
- Native overstorey cover (measured along a 50 metre line transect)
- Native midstorey cover (measured along a 50 metre line transect)
- Native ground cover (grasses) (measured along a 50 metre line transect)
- Native ground cover (shrubs) (measured along a 50 metre line transect)
- Native ground cover (other) (measured along a 50 metre line transect)
- Exotic plant cover (measured along a 50 metre line transect)
- Number of trees with hollows (estimated by counting the number of trees with hollows visible from the ground in the 50 x 20 metre plot)
- Proportion of over-storey species occurring as regeneration (assessed across the entire vegetation zone)
- Total length of fallen logs (the total length of woody material greater than 10 centimetres in diameter within the 50 x 20 metre plot).

To determine vegetation quality, the vegetation was aligned to a Plant Community Type (PCT) as defined under the NSW Native Vegetation Information System (VIS) 2.1 and compared to the published quality benchmarks. Where the collection of quantitative data was not possible (eg where a vegetation patch was too small or very disturbed), qualitative information was gathered on the vegetation and habitats. Data from the M4 Smart Motorway Biodiversity Assessment (Jacobs 2015) was also used to assess the vegetation within the M4 corridor.



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road
- Study area
- Survey plot locations

0 0.5 1 km

N

Figure 2-1 | Biodiversity survey locations

Transects and traverses

Transect sampling was used to identify the location of vegetation community types and boundaries. The length of the study area was traversed by vehicle and by foot and areas of interest outside of the study area were also investigated. Traverses of the study area were undertaken over three days on 30 September, 19 January and 31 March 2016 to inform this assessment.

Transects and traverses were undertaken throughout the study area to develop a flora inventory (Appendix B), complete searches for threatened species, and determine potential impacts from clearing. The distribution of vegetation communities was also recorded along with the location of any significant habitat features. The location of any threatened species, vegetation community boundaries, and any other ecological factors were recorded with a Geographic Positioning System (GPS) receiver.

Digital mapping of vegetation communities was conducted using ArcGIS® software. A combination of field data, aerial photograph interpretation and biophysical data such as elevation and soil type were used to delineate community boundaries. Description of the vegetation communities was based on their structure and dominant species.

Habitat condition assessment

A vegetation and habitat condition assessment was conducted using the BBAM 2014. The assessment aimed to provide a measure of habitat condition for each of the vegetation types affected by the proposal and identify the floristic diversity, structure of the vegetation, the type and distribution of plant communities present as well as the density of fauna habitat features in the study area. The location of condition assessment plots are shown in **Figure 2-1**.

Threatened Ecological Community assessment

Identification of Cumberland Plain Woodland as listed under the TSC Act and EPBC Act was undertaken using the final determination from the NSW Scientific Committee (NSW Scientific Committee 2014) and the approved conservation advice from the Commonwealth Threatened Species Scientific Committee (Threatened Species Scientific Committee 2014). Condition thresholds are not provided for the state-listed community. Condition thresholds for the federally listed community have been developed and these are detailed in **Table 2-2**.

The area of vegetation patches was determined during the field survey and refined using Geographic Information System (GIS) software. The cover of perennial understorey species was determined using the vegetation and condition assessment methods as specified in **Section 2.3.2**.

In accordance with the condition criteria in **Table 2-2**, none of the vegetation within the study area meets the condition thresholds to be considered part of the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community (EPBC Act) (see **Section 3**).

Table 2-2 Condition thresholds for the federally listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

Category and rationale	Thresholds
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	Minimum patch size is ≥0.5 ha AND ≥50 percent of the perennial understorey vegetation cover is made up of native species
OR	

Category and rationale	Thresholds
B. larger patches which are inherently valuable due to their rarity	The patch size is ≥5 ha AND ≥30 percent of the perennial understorey vegetation cover is made up of native species
OR	
C. Patches with connectivity to other large native vegetation remnants in the landscape	The patch size is ≥0.5 ha; AND ≥30 percent of the perennial understorey vegetation cover is made up of native species; AND The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥5 ha in area
OR	
D. Patches that have large mature trees or trees with hollows (habitat) that are very scarce on the Cumberland Plain	The patch size is ≥0.5 ha in size; AND ≥30 percent of the perennial understorey vegetation cover is made up of native species; AND The patch has at least one tree with hollows per hectare or at least one large tree (≥80 cm dbh) per hectare from the upper tree layer outlined from the community description.

2.3.2 Fauna field survey

The fauna survey and habitat assessment was targeted within the road reserve. The survey method included rapid habitat assessment at multiple sites, searches for evidence of threatened fauna, and opportunistically recording fauna species active at the time of the survey.

Habitat assessment

Habitat assessment data were collected in the vegetation between the residential areas and the motorway (**Figure 2.1**). Details of the habitat type and condition were noted from variable plot sizes depending on the width of the road reserve and size of the vegetation patch. The details and habitat criteria assessed included:

- Geographic coordinates and photograph
- Type and structure of the vegetation, including an assessment of the 'naturalness' in terms of the presence of native remnant vegetation or planted and regrowth areas
- Dominant flora species and a subjective assessment of the floristic diversity at different structural layers, flowering and fruiting resources
- Tree species and proportion of each species
- Presence of significant keystone species and critical habitat elements for threatened fauna
- Disturbance regimes including the presence key threatening processes such invasion of exotic perennial grasses and exotic vines and scramblers
- The presence of tree hollows, standing dead trees (stags) rock outcrops and boulders, and hollow logs providing potential shelter for hollow-dependent fauna
- The structure or the habitat in terms of complexity and presence of shelter and food resources for fauna, in particular threatened species
- Presence and condition of wet areas where present
- Size of remnant patches and extent of connectivity to habitats outside the road reserve.

The habitat quality data were used in combination with the opportunistic fauna survey to identify the conservation value of the habitats for fauna, in particular threatened fauna known from the locality. The condition of the habitat along the study area was rated and mapped based on a combination of the assessment criteria as summarised in **Table 2-3**.

Surveying for koala habitat involved the identification of koala feed trees (primary, secondary and supplementary) within the study area. The quality of the habitat for koalas was determined using data recorded during BBAM 2014 plots. A search for koala plots was undertaken at each of the vegetation plots sampled.

Habitat for the Cumberland Plain Land Snail was examined by recording habitat features such as the presence of sheltering habitat (ie logs, bark, leaf litter, refuse), patch size, grazing or mowing regime, and the cover of native species and density of the ground cover. A search for Cumberland Plain Snails was conducted at each of the vegetation plots sampled.

Any culverts were examined for the potential as roosting habitat for bats. The bridge over the M4 Motorway was not examined for the potential as roosting habitat for bats due to safety issues surrounding access under the bridge and traffic.

General fauna survey

Survey methods for general fauna species including birds, reptiles and amphibians involved random meandering throughout the study area, and recording opportunistic sightings. Surveys also included searching habitat features (eg turning rocks, logs and scrap metal). All species identified during the survey were recorded.

Threatened species searches

The occurrence of specific habitat features appropriate for threatened fauna species known or potentially occurring at site was evaluated as part of the habitat assessment. Features known to be used by threatened species were assessed such as hollow-bearing trees, nest trees, watercourses, specific food trees, wetland habitats, leaf litter, logs, and artificial structures suitable for roosting or denning purposes. A search was conducted at each habitat assessment site for evidence of habitat use by threatened fauna species including:

- Koala scats around the base and scratch marks on the trunk of suitable feed trees. Scat searches using the SAT technique were undertaken throughout the study area where feed trees were present
- Regurgitation pellets and nest/roost sites for forest owls known from the locality and threatened diurnal raptors
- Chewed cones beneath Allocasuarina/Casuarina trees indicating Glossy Black Cockatoo feeding
- Searches for Cumberland Plain Land Snail involved looking for active specimens on tree trunks, turning over suitable ground shelter including fallen timber, sheets of iron and exposed rocks, raking back litter and debris from the ground, and searching in dense grass clumps.

No other targeted fauna survey techniques such as mammal trapping, bat (anabat) surveys, spotlighting, frog surveys or call playback, were undertaken.

Table 2-3 Fauna habitat condition assessment criteria

Condition	Characteristics	Patch size / connectivity	Naturalness	Floristic diversity	Ground cover	Habitat features	Weed abundance
High	Vegetation still retains the majority of native species and structural characteristics of the pre-European equivalent. Such vegetation is usually in a near natural state and displays resilience to weed invasion due to intact ground cover, shrub and canopy layers and lack of soil disturbance. Some limited weed cover is present in edge habitats.	>2 hectares and well connectivity outside the road reserve and along road corridor	Remnant woodland / forest	High	Intact	Habitat for threatened fauna, mature trees abundant and tree hollows, dead trees and natural logs	Low
Moderate	Vegetation generally still retains most of its structural integrity but has been partially disturbed and has lost some component of its original species complement. Weed invasion varies from slight to high.	>2 hectares and tentative links to other vegetation outside the road reserve	Disturbed Remnant woodland / forest	Moderate	Intact with few or no invasive grasses	Some habitat for threatened fauna, mature trees low density, few hollows and logs	Moderate – High
Low	Modified areas where most of the native diversity and vegetation structure has been lost. Includes patches and thin strips of roadside vegetation, areas of grassland and shrubby vegetation. Environmental weeds are often co-dominant with the original indigenous species, particularly invasive grasses.	<1-2 hectares and fragmented	Roadside landscape plantings	Low-Moderate	Partially intact with high proportion of invasive grasses mown or heavily grazed	Limited habitat for threatened fauna, mature trees absent, no hollows or logs	High – Moderate
Very Low	Includes cleared paddock areas and roadside clearings dominated by exotic species including noxious weeds. Some regenerating shrubs and native groundcovers may be present in low abundance. Some of these areas support planted trees and shrubs including native and exotic species.	<1-2 hectares and isolated	Roadside landscape plantings	Low	None dominated by invasive grasses mown or heavily grazed	No habitat for threatened fauna, mature trees absent, no hollows or logs	High

2.4 Terrestrial ecology survey effort

A summary of the survey effort undertaken in the study area for this assessment is provided in **Table 2-4**.

Table 2-4 Summary of survey effort

Survey method		Survey completed	Total survey hours
BBAM 2014 plot/transects	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate	2	8 person hours
	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Poor	3	
	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Poor (M4 Revegetation)	0 Data from the M4 Smart Motorways Biodiversity Assessment used	
	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate	1	
	Phragmites australis and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion - Poor	0 Collection of quantitative data was not possible as vegetation patch was too small	
Other survey completed			
Random meander transects		Undertaken throughout the study area while walking through the habitats.	8 person hours
Fauna habitat assessment		Undertaken as part of each BBAM 2014 plot/transect. Four hours of habitat assessment including quantification of hollow tree resources, fallen woody debris cover, and vegetation composition and structure.	
General fauna survey		Undertaken opportunistically throughout the 8 hours while on site. No strict timed surveys were undertaken.	
Threatened fauna searches		Undertaken opportunistically throughout the 8 hours while on site.	

2.5 Aquatic surveys

Aquatic habitat assessments were conducted on the 20-22nd February 2016. Sites were assessed against the Department of Primary Industries *Policy and Guidelines for Fish Habitat Conservation and Management* (2013) (**Table 2-5**), and *Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge 2003) (**Table 2-6**). These guidelines provide information for waterway classification and ways to minimise impacts to fish and other aquatic wildlife from road projects that may improve the survival rate and protect threatened fish species, populations and their habitat. Site inspections were visual only and no fish surveys were undertaken.

Table 2-5 Key Fish Habitat and associated sensitivity classification scheme (adapted for freshwaters only)

Key Fish Habitat and associated Sensitivity Classification Scheme	
Type 1 – Highly sensitive key fish habitat	Marine park or an aquatic reserve. SEPP 14 Coastal wetlands, wetland recognised under international agreements , or listed in the Directory of Important Wetlands of Australia Freshwater habitats that contain in-stream gravel beds, rocks greater than 500mm in two dimensions, snags greater than 300mm in diameter or three metres in length, or native aquatic plants.* Any known or expected threatened species habitat or area of declared 'critical habitat' under the FM Act.
Type 2 – Moderately sensitive key fish habitat	Aquatic habitat within 100m of a marine park, an aquatic reserve or intertidal protected area. Freshwater habitats other than those defined in Type 1. * Weir pools and dams up to full supply level where the weir or dam is across a natural waterway.
Type 3 – Minimally sensitive key fish habitat	Coastal or freshwater habitats not included in Types 1 or 2* Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

*Farm Dams on first and second order streams or unmapped gullies **are not considered key fish habitat** (Source: DPI 2013)

Table 2-6 Fish habitat classification criteria for watercourses and recommended crossings types

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

(Source: Fairfull & Witheridge, 2003

2.6 Limitations

The list of flora and fauna species recorded from this study should not be seen to be fully comprehensive, but rather an indication of the species present at the time of the survey. A period

of several seasons or years is needed to identify all the species present in an area, especially as some species are only apparent at certain times of the year (eg orchids, annual herbs and grasses, or migratory birds). Some species require specific weather conditions for optimum detection (eg frogs). The conclusions of this report are therefore based upon available data and the field surveys and are therefore merely indicative of the environmental condition of the site at the time of the survey. It should be recognised that site conditions, including the presence of threatened 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.

A precautionary approach was used concerning identifying the presence of suitable habitat for where there is insufficient evidence to discount the presence of the species due to seasonal limitations or other constraints.

The methods used and time spent surveying the M4 Motorway road corridor was limited. The M4 corridor was not accessed due to health and safety issues with working adjacent to a motorway. Limited areas of the M4 corridor were surveyed. Data from the *M4 Smart Motorway Biodiversity Assessment* (Jacobs 2015) was therefore used in this report to supplement the assessment in this area.

2.7 Threatened species assessment

2.7.1 Likelihood of occurrence

State and nationally listed threatened species identified from the background reviews were considered in terms of their likelihood to occur in the habitats present within the study area based on their identified habitat requirements. The results of this review are provided in Appendix A. The likelihood of occurrence was classified according to the criteria described in **Table 2-7**. Habitat assessment for all potentially occurring threatened species was undertaken during the surveys with particular emphasis on those species considered to have a high or moderate likelihood of occurrence. Species with a high or moderate likelihood of occurrence were subject to assessments of significance under the TSC Act, EPBC Act and/or FM Act as appropriate. A low likelihood of occurrence does not mean that the particular species would not occur in the study area, but that there is a low likelihood based on the habitat that is present.

Table 2-7 Likelihood of occurrence includes one or more of the following criteria

Likelihood of Occurrence	Criteria
Unlikely	Species not recorded during field surveys and fit one or more of the following criteria: • Species highly restricted to certain geographical areas not within the study area • Species with specific habitat requirements that are not present in the study area.
Low	Species not recorded during field surveys and fit one or more of the following criteria: • Have not been recorded previously in the study area/locality and for which the study area is beyond the current distribution range • Have been recorded sporadically in the locality in the past but are considered a low likelihood to use the study area as habitat due to the absence of any high quality habitat features upon which the species depends • Use specific habitats or resources not present in the study area • Are flora species that were specifically targeted by seasonal surveys and not recorded.

Likelihood of Occurrence	Criteria
Moderate	Species not recorded during the field surveys that fit one or more of the following criteria: • Have frequently been recorded in the study area/locality and are known to be present in the locality • Use specific habitats or resources that are present in the study area (eg for foraging or roosting/breeding) • Species that are unlikely to maintain sedentary populations however may seasonally use resources within the study area opportunistically or during migration if the habitat is good quality • Are flora species that were not targeted by seasonal surveys but have suitable habitat in the study area.
High	Species recorded during the field surveys or species not recorded that fit one or more of the following criteria: • Have frequently been recorded previously in the study area/surrounds • Use habitat types or resources that are present in the study area and/or the habitats in the study area are in good condition • Are known or likely to maintain resident populations in the study area • Are known or likely to visit the site during regular seasonal movements or migration due to the presence of high quality habitats.
Present	A species recorded in the study area during the field surveys.

2.7.2 Assessment of Significance

Significance assessments were conducted for species that were identified in the study area or that were considered to have a moderate or high likelihood of occurring in the study area based on the assessment criteria in **Table 2-7**.

For threatened biodiversity listed under the TSC Act the threatened species assessment was undertaken as outlined under Section 5A of the EP&A Act (known as the seven-part test). The document *Threatened Species Assessment Guidelines: The Assessment of Significance* (Department of Environment and Climate Change 2007) outlines a set of guidelines to help applicants/proponents of a development or activity with interpreting and applying the factors of assessment in the seven-part test. The guidance provided by the Department of Environment and Climate Change (2007) has been used in this report.

For threatened biodiversity listed under the EPBC Act a significance assessment have been completed in accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of the Environment 2013).

3 Existing environment

3.1 Landscape context

The study area is located within the Cumberland sub-region of the Sydney Basin Bioregion as defined by Thackway and Cresswell (1995) and 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 (2008a). A brief summary of the characteristic geology, landforms, soils and vegetation of the Cumberland region (as it applies to the study area) is provided below as described by Morgan (2001). The Cumberland Plain Mitchell Landscape is an over cleared landscape with 89 per cent of native vegetation having been cleared. Only 11 per cent of the original native vegetation remains.

The landscape is predominantly low rolling hills and wide valleys in a rain shadow area below the Blue Mountains (Morgan 2001). Geology is dominated by undifferentiated middle Triassic Wianamatta group shales (Bringelly Shale) with Quaternary alluvium present along streams in the north and south of the study area (Clarke & Jones 1991). Soils overlying the Wianamatta Shale are predominantly of the residual Blacktown soil landscape with some areas of the erosional Luddenham soil landscape (red and brown texture contrast soils on crests and slopes, grading into harsher yellow texture-contrast soils in valleys and sometimes affected by salt in tributary valley floors (Department of Environment and Climate Change 2008a; Hazelton *et al.* 1989; Morgan 2001). The modern floodplain alluvium of the South Creek soil landscape is present along streams (Hazelton *et al.* 1989; Morgan 2001). The vegetation is characterised by *Eucalyptus moluccana* and *Eucalyptus tereticornis* woodland. Alluvial areas contain *Angophora subvelutina*, *Eucalyptus amplifolia*, and *Casuarina glauca*. Man-made dams possess a range of aquatic species.

3.2 Vegetation communities and habitat

3.2.1 Vegetation communities

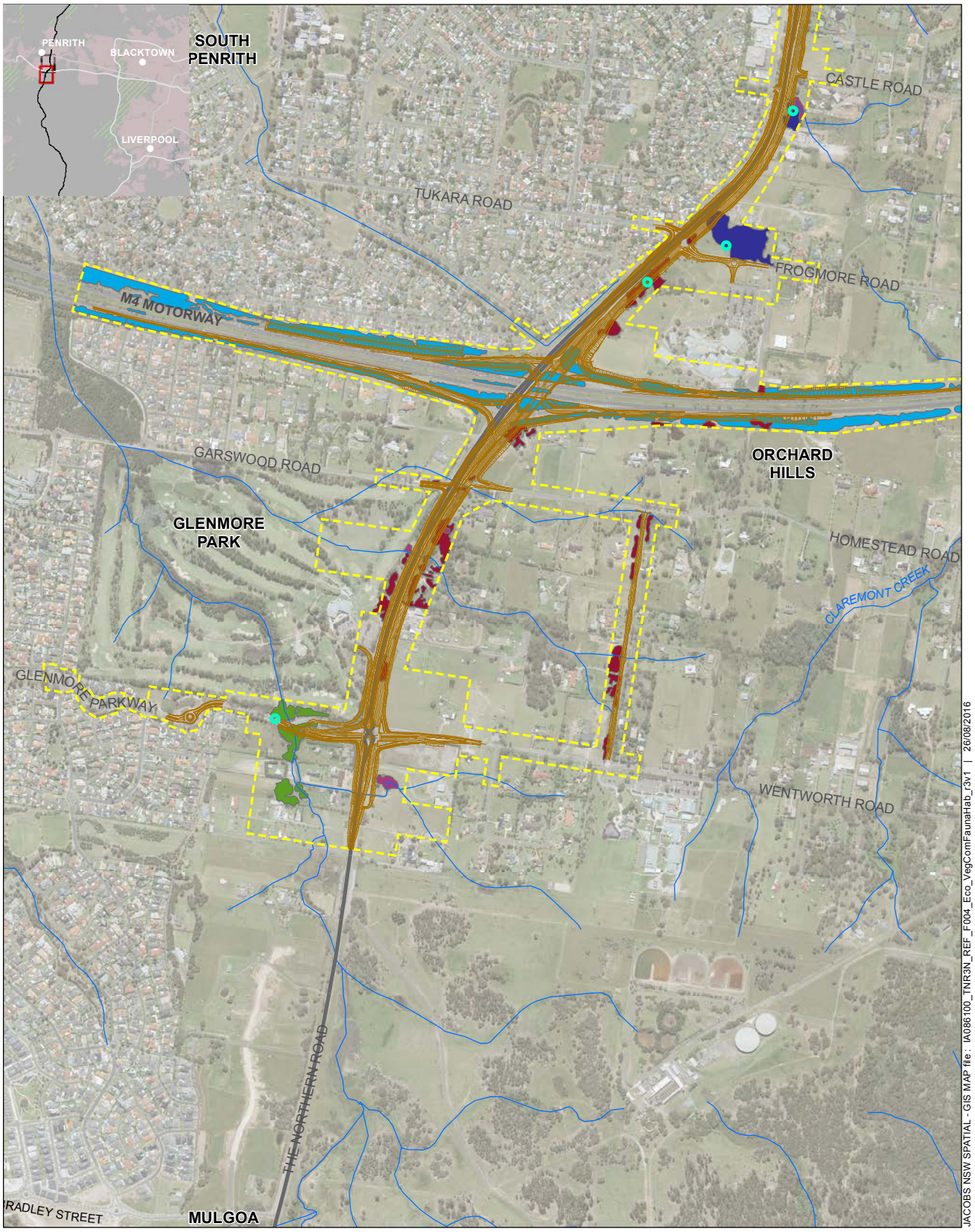
The native vegetation in the study area is mapped by Tozer (2003) as Shale Plains Woodland with some small patches of Alluvial Woodland along streams. The detailed floristic survey undertaken for this assessment allowed for quantitative analysis of the vegetation within the study area against published descriptions of PCTs identified in the NSW VIS and final determinations of threatened ecological communities published by the NSW Scientific Committee the Commonwealth Threatened Species Scientific Committee.

The data analysis indicates the presence of the following PCTs in the study area (see **Figure 3-1**):

- Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (includes revegetation along the M4 Motorway) (see **Table 3-1**, **3-2** and **3-3**)
- Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (see **Table 3-4**)
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion – man made dams (see **Table 3-5**).

There are around 17.6 hectares of native vegetation within the study area in varying levels of condition from poor to moderate (this includes 11.4 hectares of revegetation along the M4 Motorway) (see **Table 3-6**).

Planted vegetation is prevalent throughout the study area (particularly along the M4 Motorway and The Northern Road edges) and includes a wide mix of native and exotic species. The type and quality of the planted vegetation along the M4 Motorway was determined from mapping and plot data from the M4 Smart Motorway Biodiversity Assessment (Jacobs 2015) which was based on review of original landscaping plans provided by RMS.



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road
- Study area
- Fauna habitat

Vegetation communities and condition

- Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion - Moderate condition
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Moderate condition
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Poor condition
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Poor condition (M4 Motorway Revegetation)
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion - Moderate/Good - Poor condition

0 250 500 m

N

2
1

Figure 3-1 | Distribution of vegetation communities and fauna habitats

Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road
- Study area
- Fauna habitat

Vegetation communities and condition

- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Moderate condition
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Poor condition
- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - Poor condition (M4 Motorway Revegetation)
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion - Moderate/Good - Poor condition

0 250 500 m

N

2
1

Figure 3-1 | Distribution of vegetation communities and fauna habitats

Table 3-1 Description of Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Moderate condition)

Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT: 849) – Moderate condition	
PCT ID: 849 **BVT ID:** HN528 **Conservation status:** Critically Endangered (TSC Act) as Cumberland Plain Woodland in the Sydney Basin Bioregion. Not consistent with the EPBC Act listed community Cumberland Plain shale Woodlands and Shale-Gravel Transition Forest due to having perennial native ground layer cover of <30%. Many patches smaller than 0.5 ha. **Extent in the study area:** 1.5 hectares **Extent cleared:** 95% in Hawkesbury Nepean	 **Plate 1 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion at Plot 3 at 1840 The Northern Road Orchard Hills**
Description: Canopy: A sparse cover (projected foliage cover from 10% – 16.5%) of small to medium size trees present mostly 0.3 metres DBH (diameter at breast height) or less and from 15 – 20 metres in height. Dominated by *Eucalyptus moluccana* with *Eucalyptus tereticornis* and occasional *Eucalyptus crebra* and *Corymbia maculata*. Canopy regeneration evident in moderate condition patches. **Midstorey:** native midstorey largely absent from 0% – 1% with rare Bursaria spinosa. Exotic midstorey from 0% – 9% with *Olea europaea* subsp. *cuspidata*. **Groundcover:** Native grasses (*Chloris truncata, Aristida vagans, Cymbopogon refractus, Microlaena stipoides, Themeda triandra*, and *Cynodon dactylon*) from 0% – 26% cover. Native herbs and forbs (*Dichondra repens, Lomandra filiformis,* and *Brunoniella australis*) from 0% – 24% cover. Climbers including *Glycine tabacina* and Harden*bergia violacea* present. Exotic grasses (eg *Paspalum dilatatum, Setaria gracilis, Eragrostis curvula, Axonopus fissifolius*, and *Briza subaristata*) dominant ranging from 60% – 74% cover.	
Fauna habitat features: Fauna habitats are poor as the vegetation patches are small, disturbed and are primarily composed of young trees with a mown ground layer. Four hollow bearing trees were found that may be suitable for common bird species and bats. Woody debris on ground varies from 13.5 metres to 20 metres (resulting from trees that had been cut and piled rather than natural attrition of dead trees).	
Condition: Moderate. The canopy of this community is sparse and the midstorey is largely absent. Canopy regeneration present suggesting a level of resilience and ability to regenerate. The ground layer is largely dominated by exotic species (>50% cover) but in some patches native species were co-dominant. The moderate condition patches of the Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion PCT show potential for recovery if the mowing regime was removed and the native midstorey and groundcover left to naturally grow and set seed.	

Table 3-2 Description of Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Poor condition)

Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT: 849) – Poor condition	
PCT ID: 849 **BVT ID:** HN528 **Conservation status:** Critically Endangered (TSC Act) as Cumberland Plain Woodland in the Sydney Basin Bioregion. Not consistent with the EPBC Act listed community Cumberland Plain shale Woodlands and Shale-Gravel Transition Forest due to having perennial native ground layer cover of <30%. Many patches smaller than 0.5 ha. **Extent in the study area:** 3.3 hectares 11.4 hectares of revegetation along the M4 Motorway **Extent cleared:** 95% in Hawkesbury Nepean	 **Plate 2 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Poor condition along the unmade Cross Road, Orchard Hills**
Description: Canopy: A sparse cover (projected foliage cover from 12.5% – 22%) of small to medium size trees present mostly 0.3 metres DBH or less and from 15 – 20 metres in height. Dominated by *Eucalyptus moluccana* with *Eucalyptus tereticornis*. No evidence of canopy regeneration. **Midstorey:** native midstorey largely absent (0% cover) with most patches underscrubbed and maintained with regular mowing or intensive grazing by sheep. Exotic midstorey absent (0%). **Groundcover:** Cover of native grasses (*Aristida vagans, Paspalidium distans, Themeda triandra*, and *Cynodon dactylon*) variable from 0% – 22% cover. Native herbs and forbs (*Dichondra repens, Brunoniella australis*) from 0% – 16% cover. Climbers including *Glycine tabacina* present. Exotic grasses (eg *Paspalum dilatatum, Setaria gracilis, Eragrostis curvula, Axonopus fissifolius*, and *Briza subaristata*) dominant ranging from 18% – 92% cover.	
Fauna habitat features: Fauna habitat value was poor as the vegetation patches were small, disturbed and primarily composed of young trees with a regularly mown ground layer. Midstorey vegetation is absent which reduced habitat value significantly. Three hollow bearing trees were found that might be suitable for common bird species and bats. Woody debris on ground varies from zero to three metres.	
Condition: Poor. The canopy of this community is sparse and the midstorey is largely absent. Canopy regeneration is absent due to mowing regime. The ground layer is dominated by exotic species (with the exception of Plot 2). The poor condition patches of the Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion PCT show limited recovery potential due to their small size, isolated nature, limited cover of native species, and lack of any high quality habitat features.	

Table 3-3 Description of Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Poor condition – M4 Revegetation)

Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT: 849) – Poor condition – M4 Revegetation	
PCT ID: 849 **BVT ID:** HN528 **Conservation status:** Critically Endangered (TSC Act) as Cumberland Plain Woodland in the Sydney Basin Bioregion. Not consistent with the EPBC Act listed community Cumberland Plain shale Woodlands and Shale-Gravel Transition Forest due to having perennial native ground layer cover of <30%. **Extent in the study area:** 11.4 hectares of revegetation along the M4 Motorway **Extent cleared:** 95% in Hawkesbury Nepean	 **Plate 3 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion – Poor condition along the unmade Cross Road, Orchard Hills**
Description: Canopy: Common tree species planted include *Eucalyptus moluccana, Eucalyptus tereticornis,* and *Eucalyptus crebra*. Other trees not associated with Cumberland Plain Woodland including *Eucalyptus sideroxylon* are present. Trees range from 5 – 10 metres in height. **Midstorey:** native midstorey is sparse and planted. Species include *Kunzea ambigua, Acacia parramattensis, Acacia falcata, Bursaria spinosa, Melaleuca linariifolia,* Other species including *Callistemon viminalis,* and *Acacia fimbriata* have also been planted. **Groundcover:** Dominated by exotic grasses (eg *Chloris gayana* and *Pennisetum clandestinum*).	
Fauna habitat features: Fauna habitat was considered low quality (Jacobs 2015). The habitats rarely contain any native groundcover species and possess a dense tall sward of exotic grasses. There are little to no open patches in the ground layer. The planted shrub layer is sparse. The habitat structure is simplified and lacks structural maturity. The habitat lacks important features such as hollows, timber on the ground and shrubs or tall canopy. Common fauna species include the introduced Blackbird, Spotted Turtle-dove, and Common Myna as well as Australian Magpie, Crested Pigeon and Garden Sunskink (Jacobs 2015).	
Condition: Poor. Identified as a planted (or restored) example of shale plains woodland in the M4 Smart Motorway Biodiversity Assessment (Jacobs 2015). The vegetation has been planted in the M4 corridor. The age of plantings varies throughout the M4 corridor with the oldest plantings being undertaken 10 – 15 years ago. The vegetation rarely supports any native groundcovers and has a sparse planted shrub layer. Considerable soil disturbance has occurred in the areas of revegetation and consequently the vegetation is dominated by exotic plants in the ground layer (Jacobs 2015).	

Table 3-4 Description of Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion – Moderate condition

Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT: 835) – Moderate condition	
PCT ID: 835 **BVT ID:** HN526 **Conservation status:** Endangered (TSC Act) as River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions **Extent in the study area:** 1.1 hectares **Extent cleared:** 95% in Hawkesbury Nepean	 **Plate 4 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion along Glenmore Parkway**
Description: Canopy: A sparse cover (projected foliage cover 36%) of small to medium to large size trees present from 0.3 metres to 0.6 metres DBH and from 15 – 20 metres in height. Dominated by *Eucalyptus amplifolia* with lower tree layer of *Casuarina glauca*. *Melaleuca styphelioides* occasional. Canopy regeneration evident. **Midstorey:** Native midstorey absent (0% cover) with exotic midstorey species including *Ligustrum sinense, Senna pendula* and *Phoenix canariensis* dominant (25.5% cover). **Groundcover:** Groundcover generally sparse due to dense and deep cover of *Casuarina glauca* cladodes that have suppressed germination of groundcover plants through allelopathy. The native grass *Oplismenus imbecillis* had 4% cover. Other native groundcovers including *Commelina cyanea, Einadia nutans and Einadia polygonoides* were recorded at 14% cover. Aquatic species including *Typha orientalis, Persicaria* spp., and *Damasonium minus* present along and within the creek. Exotic species (eg *Chloris gayana, Xanthium strumarium, Asparagus aethiopicus, Cardiospermum grandiflorum, Araujia sericifera, Solanum pseudocapsicum*) dominant at 36% cover.	
Fauna habitat features: Fauna habitats are in moderate condition. While the patch adjacent to the Glenmore Parkway is small it is the only and best condition patch of the Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion PCT in the study area. No hollow bearing trees were present (trees examined from ground only so some hollows may have been missed) due to the relatively young age of the vegetation and good health of the canopy species. This limits the value of the habitat for nesting or roosting. No large woody debris was recorded in the ground layer that limits sheltering and foraging opportunities for fauna. The Glenmore Parkway crosses an unnamed creek via a series of seven box culverts (see Section 3.2.4 for more detail) which may provide a roosting opportunity for bats.	
Condition: Moderate. The canopy of this community is typical for this PCT and within benchmark levels. Canopy regeneration is present suggesting a level of resilience and ability to recovery from disturbance. The ground layer is sparse and largely composed of dead cladodes from *Casuarina glauca* trees but is otherwise dominated by exotic species with some patches of native groundcover persisting.	

Table 3-5 Description of *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion – Poor condition

***Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (PCT: 1071) – Poor condition**	
PCT ID: 1071 **BVT ID:** HN630 **Conservation status:** Artificial wetlands created on previously dry land specifically for purposes such as sewerage treatment, stormwater management and farm production, are not regarded as part of the Freshwater Wetlands on Coastal Floodplains TEC (NSW Scientific Committee 2010) **Extent in the study area:** 0.3 hectares **Extent cleared:** 70% in Hawkesbury Nepean	 **Plate 5 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion opposite Flower Power nursery along The Northern Road**
Description: No quantitative plot/transect surveys were undertaken within the *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion PCT in the study area due to the small size and disturbed nature of the patches of this PCT. As such, only qualitative observations are provided. This PCT is present in the study area due to the creation of dams along ephemeral drainage lines that have been colonised by wetland species. There are no naturally occurring patches of this PCT within the study area. **Canopy:** Absent in the dams. Some trees at edges including *Eucalyptus* spp. and *Casuarina glauca*. Likely to be within benchmark levels of 3 – 37% cover. **Midstorey:** Native midstorey absent within the dams. Likely to be below the benchmark of 15-68% due to lack of natural wetland morphology (ie dams are deep in the centre with little opportunity for establishment of midstorey vegetation). **Groundcover:** Groundcover variable with some patches of this PCT covered in a dense layer of *Typha orientalis* and *Phragmites australis* (eg the patch on the Penrith Golf Course, parts of the dam opposite Flower Power) likely to meet benchmark levels. Species including *Ludwigia peploides* subsp. *montevidensis* and *Persicaria* spp. present. Other patches only possess these species at the shallow edges (ie the dam at 1938 The Northern Road, and 2014 The Northern Road).	
Fauna habitat features: The wetlands where open water is present may be suitable for common waterbird species including Purple Swamp Hen, Dusky Moor Hen and common ducks such as Australian Wood Duck and Pacific Black Duck. Habitat is also suitable for small birds such as the Australian Reed Warbler that frequent thick reed beds. The absence of extensive shallow edges or mudflats limits the habitat suitability for waders or other wetland bird species. The dense cover of *Typha orientalis* is suitable for a range of common frog species including the Eastern Sedge frog and Striped Marsh Frog. Dense populations of the Mosquito Fish (*Gambusia holbrooki*) limit the habitat suitability for species susceptible to predation.	
Condition: Poor. The dams are artificial and disturbed. The prevalence of Mosquito Fish limits habitat potential for frogs and the absence of extensive shallow edges or mudflats limit the habitat suitability for wading birds. Vegetation structure is poor and dominant species are pioneer colonisers of disturbed wet areas.	

Table 3-6 Summary of Plant Community Types within the study area

Plant Community Type	Condition	Extent in the study area (ha)
Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate	1.5
Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Poor	3.3
Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Poor (M4 Revegetation)	11.4
Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate	1.1
Phragmites australis and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Poor	0.3
	Total	17.6

3.2.2 Vegetation condition

Vegetation condition in each PCT was assessed using the BBAM 2014. The results of the plot assessments are summarised in **Table 3-7**. No quantitative data was collected from the *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion PCT as the patches were either too small or did not possess sufficient vegetation for a plot/transect to be undertaken.

Table 3-7 Site scores from vegetation and habitat condition assessment plots

Plot	Plant community type (PCT)	Condition category	Site score* out of 100
1	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Poor	21.7
2		Poor	23.3
3		Moderate	30
4		Moderate	40.8
5		Poor	20.8
6	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Poor	34.2

Notes: * = BioBanking score for Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion PCT scaled according to the direction provided in Section 5.3.3 of the BBAM 2014 to deal with attribute benchmarks of zero.

The vegetation within the study area is recovering from past disturbance and is suffering from ongoing disturbances from farming and urban development. Considerable underscrubbing and disturbance from mowing has occurred. Sheep grazing and mowing regimes are preventing midstorey species from being present. Native species richness is low across the study area with plots containing from seven to a maximum of 15 native species per plot. This is typical of small disturbed vegetation remnants in western Sydney.

3.2.3 Vegetation patch size and connectivity

Due to the highly disturbed and planted nature of much of the vegetation within the study area, the patch size of vegetation within the study area was small. Average patch sizes for PCTs in the study area are provided in **Table 3-8**. The small patch size and irregular shape of the vegetation patches within the study area limit the carrying capacity of the habitats and suggest that no undisturbed core habitats are present. Average patch size ranged from 0.09 to 0.3 hectares.

North – south connectivity along The Northern Road is currently limited as the small vegetation fragments are separated by expanses (greater than 100 metres) of cleared land, residential dwellings, local roadways, the hard barrier posed by the dual carriageway of the M4 Motorway and the current Northern Road, sports fields, parks, and grazing paddocks. Some east – west wildlife connectivity is present in the revegetation along the M4 Motorway corridor and fauna may pass under The Northern Road along the M4 Motorway. However, the current M4 Motorway and Northern Road intersection forms a significant barrier to wildlife movement in an east – west direction.

Table 3-8 Vegetation patch size in the study area

Map Unit	Average patch size within the study area (ha)	Range of patch sizes within the study area (ha)	
		Min size	Max size
Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.3	0.01	1.82
Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	0.13	0.1	0.16
Phragmites australis and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	0.09	0.03	0.14

3.2.4 Fauna habitat and condition

Natural fauna habitats in the locality have been largely removed and/or modified for residential development and road infrastructure. Although somewhat isolated and fragmented, habitat in the study area includes:

- Remnant or regrowth grassy and shrubby woodland
- Riparian and aquatic habitats
- Planted native species mix
- Cleared and modified agricultural and residential landscapes.

The habitat values for fauna in the study area are generally limited. The generally young age of the vegetation, altered vegetation structure with absent midstorey, and the heavily grazed or mown ground layer significantly limits the value of the habitats. The habitats within the study area are generally only suitable for common urban adapted species that can tolerate disturbance or thrive on human presence.

The habitats in the study area provide shelter, breeding and foraging resources for several common frog, reptile and bird species, and are likely to provide habitat for common mammals such as the Common Brushtail Possum. No Cumberland Plain Land Snails were found in the study area and this species is not expected to occur due to the absence of leaf litter and bark that would provide sheltering opportunities and the roadside mowing regime that would kill any snail that were present. There is generally an absence of structural maturity and only occasional tree hollows were

present which reduced the value of the habitat as sheltering or refuge areas for larger birds or hollow dependent mammals. The overall condition of fauna habitat was considered poor.

The *M4 Smart Motorway Biodiversity Assessment* (Jacobs 2015) indicates that the revegetated area along the M4 Motorway is mostly composed of young native landscape plantings established as part of the original motorway landscaping works. Small fragments of remnant and regrowth vegetation are dispersed among this revegetation. The vegetation in this area is dense and generally dominated by exotic grasses such as *Chloris gayana* in the ground layer. The dense midstorey is likely to provide suitable habitat for small birds that require dense cover. There is a general absence of structural maturity and few tree hollows or logs, reducing the value of the habitat as sheltering or refuge areas for larger or hollow dependent fauna and providing only mostly foraging habitat for common urban species. Some sheltering habitat is provided for reptiles and invertebrates through extensive rubbish dumping and dense grasses. The overall habitat condition was considered poor.

Hollow-bearing trees

Hollow bearing trees were sparse with three hollow bearing trees present in Plot 4, two hollow bearing trees in Plot 2, and one hollow bearing tree in Plot 3. The lack of hollow-bearing trees within the study area is a symptom of the young age cohort of trees. The majority of the vegetation along the M4 Motorway corridor has been planted after construction of the M4 motorway and the majority of trees lack habitat features such as hollows.

Culverts

A series of seven box culverts are present under the Glenmore Parkway where the road crosses an unnamed creek and tributary of Surveyors Creek (see **Figure 3-2**). These culverts may be suitable as roosting habitat for bats such as the Southern Myotis and/or the Eastern Bentwing-bat that are known from the locality. The box culverts are 1.5 metres high and around 17 metres long, open at both ends, and as such would receive airflow and potentially strong winds during windy conditions. The culverts are not sealed and the temperature inside is likely to fluctuate with outside temperatures. Optimal dark conditions are not present within the culverts with bright daylight entering from both sides (see **Figure 3-2**). The culvert walls are smooth concrete and joints are sealed well with no gaps are present. Any bats would have to roost in the angle created by the wall / roof joint. For these reasons the box culverts are not considered optimal as roosting habitat for cave-dwelling bat species and indeed no bats or evidence of past use were observed in the culverts during the inspection. However, the culverts may be used as a roost site on occasion.

Figure 3-2 The box culverts under the Glenmore Parkway showing entrance and internal view (camera flash not used to show light conditions inside culvert)

M4 Motorway Bridge

The bridge on The Northern Road that crosses the M4 Motorway was not inspected during the field surveys due to safety issues regarding traffic and the slope of the road cutting. However, review of available photography, bridge design features, and location provides some evidence on the likelihood of the bridge being used as a roost for bats (refer to **Figure 3-3**).

The Northern Road bridge over the M4 Motorway is made from precast post tensioned I girders with precast concrete panels between the bottom flanges to form a box like structure. Precast concrete cladding panels with an exposed pebble type finish have been used at the edge girders. The cladding panels along the soffit and edge girders tend to butt up against each other, but there may be some gaps that bats may be able to fit through to get into the voids between the girders. Bats may also be able to get in between cladding panel and edge girders. Bridges formed from pre-stressed concrete girders, such as the bridge on The Northern Road over the M4 Motorway, have been identified as a preferred type of bridge for night and day roosts for bats in North America (Keeley & Tuttle 1999).

The bridge is primarily composed of concrete, which provides good thermal mass. The bridge is not shaded and is exposed to full sun for the majority of the day. These features may make the bridge suitable as a bat roost due to the retained warmth of the concrete that would provide a buffer from outside temperature fluctuations. The bridge is also a suitable height from the ground meaning that predation rates on bats would be reduced. These are important features as bats are attracted to bridges that provide protected roosts and have a large thermal mass that remains warm (Keeley & Tuttle 1999). Parallel box beam bridges with suitable crevices are used as day roosts in North America more than any other bridge type (Keeley & Tuttle 1999).

As a close inspection of the bridge could not be undertaken, there may potentially be drainage holes or bird nests under the bridge that bats may use as a roost site. Bats may also use any gaps between girders. However, the bridge over the M4 Motorway is quite open being raised high off the ground and subject to considerable traffic flow, activity, wind and noise from vehicles using The Northern Road on top and the M4 Motorway below. It is well recognised that bats exhibit avoidance behaviour of large roadways with marked decreases in bat activity and diversity seen in proximity to major roads (Berthinussen & Altringham 2012; Zurcher *et al.* 2010) and bridges situated over busy roads are not recognised as optimal bat roosting habitat (Keeley & Tuttle 1999). The habitat around the M4 Motorway is likely to be less than optimal for bats as highway traffic noise has been suggested as a main factor in decreased bat foraging performance (Siemers & Schaub 2011). Bats are also considered to perceive vehicles as a threat and display anti-predator avoidance behaviour in response to their presence (Zurcher *et al.* 2010). Lighting is also another factor and the presence of light pollution from street lights has been shown to have negative impacts upon the selection of flight routes by bats (Stone *et al.* 2009).

Due to the location of the bridge above the M4 Motorway and the traffic on the bridge along The Northern Road, the bridge is subject to considerable traffic noise, lighting and wind impacts. Due to the traffic noise, and as bats are known to avoid major roads, the bridge is considered to have a low likelihood of providing habitat for roosting bats.

Figure 3-3 The Northern Road bridge over the M4 Motorway (source: Google street view)

3.3 Groundwater dependant ecosystems

This report 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.

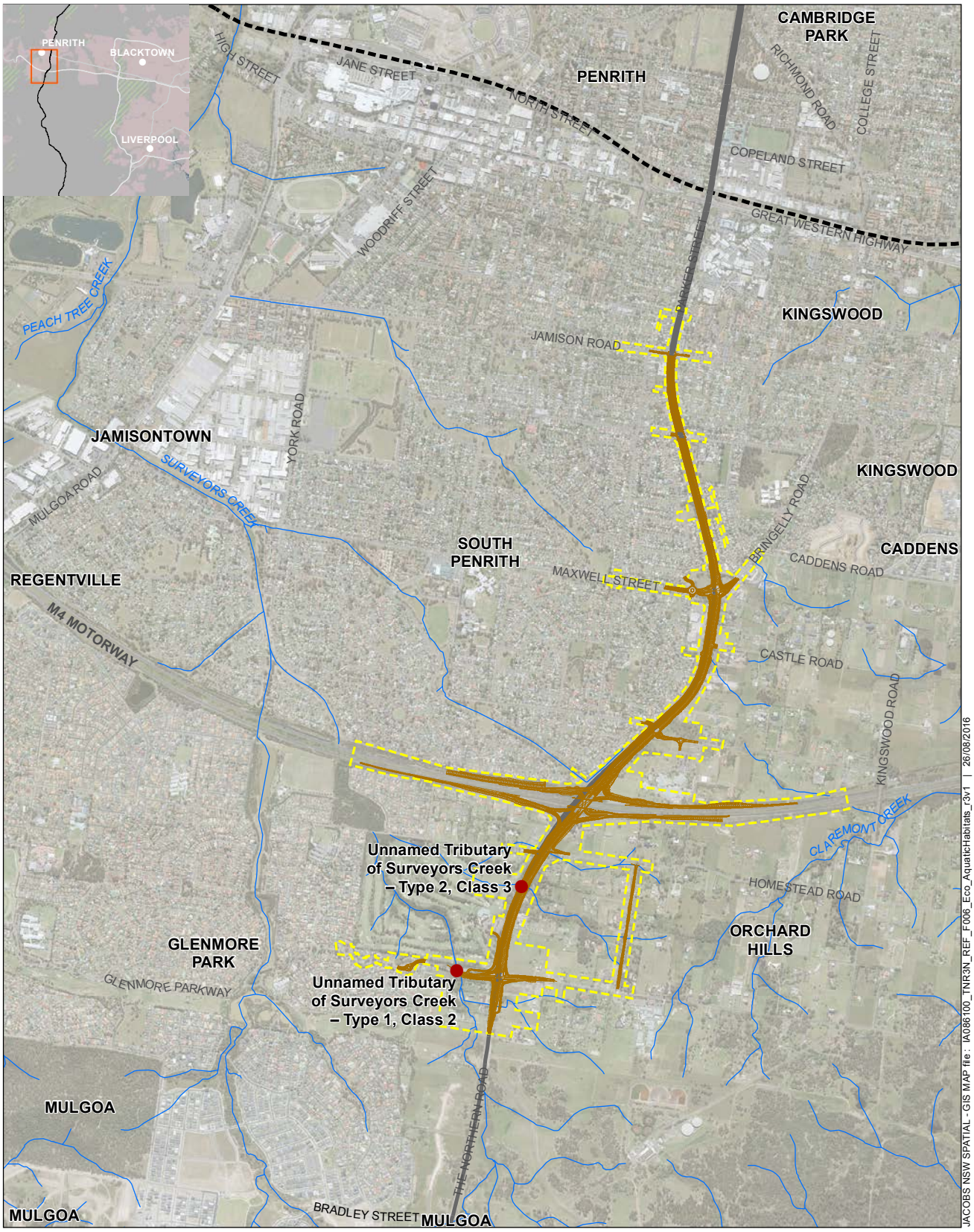
The location of GDEs within the Hawkesbury Nepean catchment are mapped by Kuginis *et al.* (2012). No high probability GDEs are mapped within or near the study area. However, the PCTs within the study area are identified by Kuginis *et al.* (2012) as having a high probability of being a GDE within the Hawkesbury Nepean catchment. The Cumberland River-flat Forest vegetation type is considered by Kuginis *et al.* (2012) to be a high probability groundwater dependent wetland community within the Hawkesbury Nepean CMA area.

However, 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 at all times above the water table. The majority of watercourses within the study area are ephemeral, most flow events occur in direct response to major rainfall, and flow is frequently of short duration. These systems are not considered to support GDEs (Serov *et al*. 2012). There is no evidence of baseflow (ie springs or diffuse flow from saturated sediment or bedrock) feeding any of the streams within the study area.

3.4 Aquatic habitat and threatened species

The project lies within the Lower Nepean River Management Zone of the Hawkesbury and Lower Nepean Rivers Water Source. The catchment is relatively flat with gently undulating hills. The proposal directly traverses an eastern tributary of Surveyors Creekwhich flows to Peach Tree Creek and ultimately drains to the Nepean River at Penrith. There are a number of other unmapped, unnamed minor drainage lines/gullies.

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. Two threatened species, the Macquarie Perch (*Macquaria australasica*) and Australian Grayling (*Prototroctes marena*) have been recorded within the Hawkesbury-Nepean Catchment; however, habitat for these species is not present within the study area. The Australian Grayling inhabits clear, flowing waters. The habitat and water quality in the study is degraded and not suitable for this species. The Macquarie Perch are now considered isolated to the upper reaches of catchments in southern NSW. The nearest known population is in Cataract Dam. The degraded waterways in the study area are not suitable for this species.



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road (Existing)
- Study area
- Aquatic habitats

0 0.5 1 km

N

Figure 3-4 | Aquatic habitat

The tributary of Surveyors Creek at Glenmore Parkway has been identified as Type 1 – Key Fish Habitat (DPI 2013), due to the presence of a combination of native aquatic plants and woody snags and a variety of instream substrates. This watercourse is an impacted, intermittent watercourse, which is also identified as Class 2 – Moderate Fish Habitat (Fairfull & Witheridge, 2003) due to the presence of limited in stream aquatic vegetation.

Only one other mapped waterway is potentially impacted by the proposal, an unnamed tributary of Surveyors Creek crossed by the Northern Road at Penrith Golf and Recreation Club. It is a minor semi-permanent pool that forms within an ephemeral waterway during rain events, with limited aquatic habitat. It has been identified as a Type 2 – Moderate Fish Habitat (DPI 2013) and classified as a Class 3 – Minimal Fish Habitat (Fairfull & Witheridge, 2003) waterway. Refer to **Figure 3-4** for aquatic habitat locations.

3.5 General flora and fauna

A list of plants and animals recorded during the field surveys is provided in Appendix A.

The surveys recorded 86 plant species across the six floristic plots of which 48 (55 per cent) were exotic species (see Appendix A). There were five weeds declared as noxious in the Local Control Authority area of Hawkesbury River County Council (refer to **Table 3-9**). The diversity of native and exotic species is typical of disturbed roadside areas and small patches of disturbed and regrowth bushland in western Sydney.

Thirty-four vertebrate fauna species were recorded from this survey. This includes 31 bird species, two frog species and one reptile species. The fauna species recorded in the study area are typical common species that are resistant to or benefit from human disturbance.

Table 3-9 Noxious weed species listed in the Local Control Authority area of Hawkesbury River County Council recorded in the study area

Species	Prevalence on Site	Noxious Class
African Olive *Olea europaea* subsp. *cuspidata*	Plot 4. Low abundance throughout the study area.	Class 4: Locally Controlled Weed The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.
Asparagus Fern *Asparagus aethiopicus*	Plot 4 and 6. Only present in low abundance.	Class 4: Locally Controlled Weed The plant must not be sold, propagated or knowingly distributed.
Fireweed *Senecio madagascariensis*	Plot 1, 2, 3 and 4 in low abundance. Likely to be widespread in grassland and disturbed areas.	Class 4: Locally Controlled Weed The plant must not be sold, propagated or knowingly distributed.
Mother of Millions *Bryophyllum* species	Plot 4. Common in Plot 4 but not found elsewhere.	Class 3: Regionally Controlled Weed The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed.
Small-leaved Privet *Ligustrum sinense*	Plot 6. High abundance in Plot 6 only.	Class 4: Locally Controlled Weed The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread

3.6 Threatened biodiversity

3.6.1 Threatened ecological communities

Two threatened ecological communities (TECs) listed under the TSC Act were identified in the study area. A brief description of each TEC is provided in **Table 3-10** and the distribution of TECs is mapped in **Figure 3-5**.

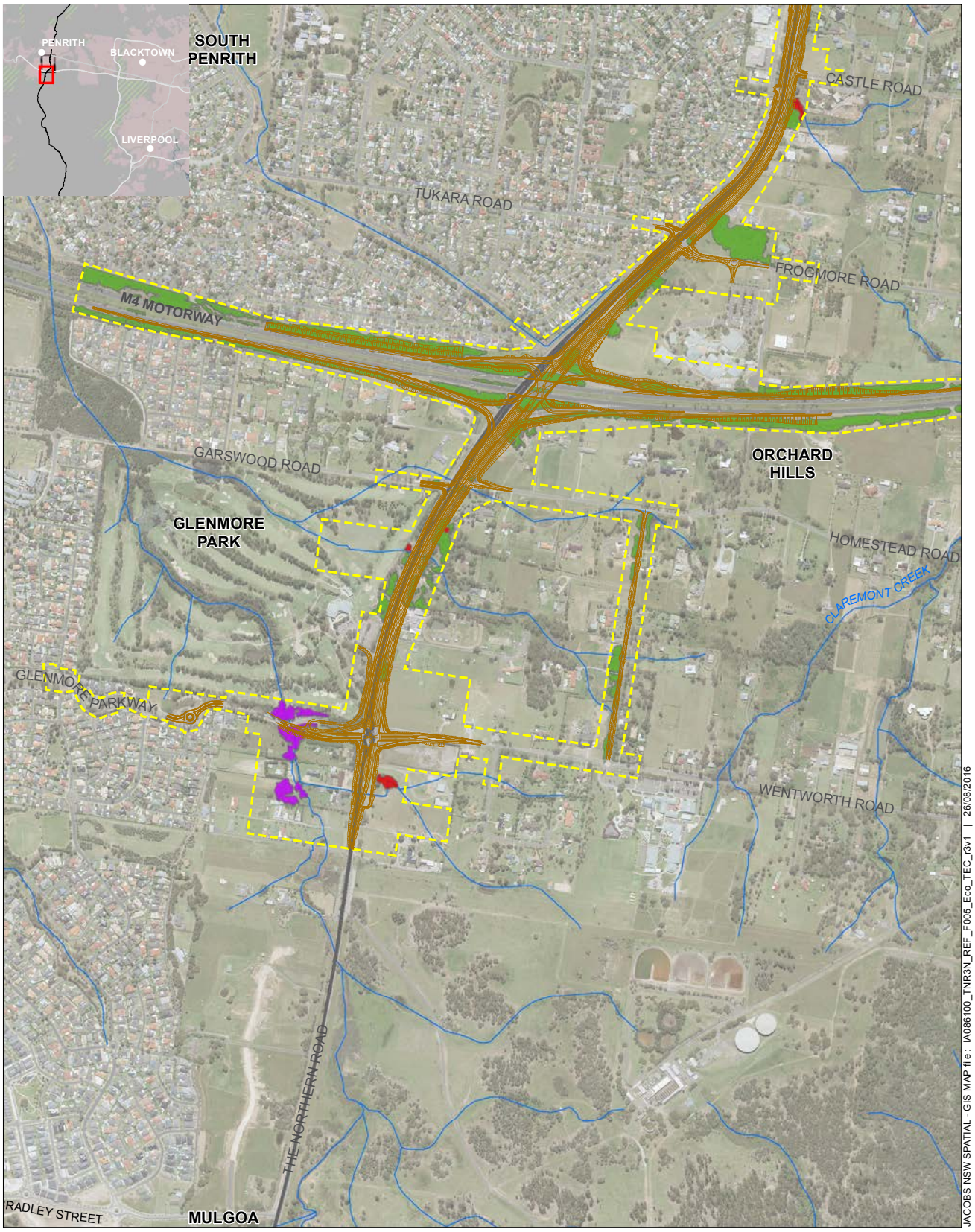
The revegetation along the M4 Motorway has been previously mapped and identified as part of the TSC Act listed Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community (Jacobs 2015). Areas planted with diagnostic overstorey species (ie *Eucalyptus tereticornis* and *Eucalyptus moluccana*) in a suitable landscape position, such as that within the study area, were identified as being the state-listed community. The mapping provided in the M4 Smart Motorway Biodiversity Assessment (Jacobs 2015) identifies the vegetation in the M4 corridor within the study area as part of the TSC Act listed Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community. The assessment of the planted vegetation in the M4 corridor within this report aims to be consistent with the classification provided in the M4 Smart Motorway Biodiversity Assessment.

No nationally listed threatened ecological communities (listed under the EPBC Act) are present. The patches of Cumberland Plain Woodland in the study area are generally too small and/or the groundcover does not possess the required cover of perennial native species to be classified under the EPBC Act as the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community.

Table 3-10 Description of threatened ecological communities in the development site

Threatened ecological community	Listing advice description	Description of TEC in the study area	Area in study area (ha)
Cumberland Plain Woodland in the Sydney Basin Bioregion (Critically Endangered, TSC Act)	Cumberland Plain Woodland is the name given to the ecological community in the Sydney Basin bioregion associated with clay soils derived from Wianamatta Group geology, or more rarely alluvial substrates, on the Cumberland Plain. Cumberland Plain Woodland is characterised by an upper-storey that is usually dominated by *Eucalyptus moluccana* and *Eucalyptus tereticornis*, often with *Eucalyptus crebra*, *Eucalyptus eugenioides*, *Corymbia maculata* or other less frequently occurring eucalypts, including *Angophora floribunda*, *Angophora subvelutina*, *Eucalyptus amplifolia* and *Eucalyptus fibrosa*.	Located on the Cumberland Plain in the Sydney Basin Bioregion on clay soils derived from Wianamatta Group geology. Characterised by an upper-storey that is dominated by *Eucalyptus moluccana* and *Eucalyptus tereticornis* with occasional *Eucalyptus crebra* and *Corymbia maculata*. The Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion PCT corresponds to this TEC.	4.8 11.4 (Historical M4 Motorway revegetation - established)
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats,	Located in the Sydney Basin Bioregion on clay-loam soils on a drainage line associated with a coastal floodplain.	1.1

Threatened ecological community	Listing advice description	Description of TEC in the study area	Area in study area (ha)
Bioregions (Endangered, TSC Act)	drainage lines and river terraces associated with coastal floodplains. The composition of River-Flat Eucalypt Forest on Coastal Floodplains is primarily determined by the frequency and duration of waterlogging and the texture, nutrient and moisture content of the soil. It has a tall open tree layer of eucalypts and the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis, Eucalyptus amplifolia, Angophora floribunda* and *Angophora subvelutina*. A layer of small trees may be present, including *Melaleuca decora*, *Melaleuca styphelioides*, *Backhousia myrtifolia, Melia azaderach, Casuarina cunninghamiana* subsp. *cunninghamiana* and *Casuarina glauca*.	It has an open tree layer of eucalypts dominated by *Eucalyptus amplifolia* with a lower tree layer of *Casuarina glauca.* The Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion PCT corresponds to this TEC.	



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road
- Study area

Threatened ecological communities

- Cumberland Plain Woodland in the Sydney Basin Bioregion (TSC Act)
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (TSC Act)
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (TSC Act)

0 250 500 m

N

2
1

Figure 3-5 | Distribution of threatened ecological communities in the study area

Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road
- Study area

Threatened ecological communities

- Cumberland Plain Woodland in the Sydney Basin Bioregion (TSC Act)
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (TSC Act)

0 250 500 m

N

2
1

Figure 3-5 | Distribution of threatened ecological communities in the study area

3.6.2 Threatened flora species

Twenty-nine threatened flora species and one endangered population have been previously recorded or modelled as having potential to occur in the locality (see Appendix B). Many of these species favour habitats that are not represented in the study area (ie sandstone geology of the lower Blue Mountains, tertiary gravels), are only known to exist in populations restricted to specific localities (eg alluvium of the Nepean River floodplain), or are presumed extinct.

No threatened flora species were recorded in the study area during the field survey. Furthermore, the habitats in the study area are not considered optimal for any of the threatened flora species listed in Appendix B due to the degraded nature of the vegetation, mowing and/or grazing regimes, disturbance to the soil, and dominance of exotic species. Overall, threatened flora species are considered to have a low likelihood of occurrence or are unlikely to occur (see Appendix B).

3.6.3 Threatened fauna species

Based on regional records and the presence of suitable habitat, 53 threatened fauna species have been identified in the locality (see Appendix B). This includes 16 mammals, 27 birds, one reptile, five frogs, two invertebrates, and two fish. The study area does not contain suitable habitat for some species listed in Appendix B (eg no sandstone ridge tops or gullies, no wet or rainforest habitat) and the habitats within the study area are poor quality and generally do not possess the features required for the threatened species listed in Appendix B to complete their life cycles. No suitable habitat for threatened fish is present in the study area. No threatened fauna species were recorded during the field survey.

However, the study area does provide some limited habitat for three species of threatened bat: the Eastern Bentwing-bat, the Eastern Freetail-bat, and the Southern Myotis (all listed as vulnerable under the TSC Act). These three species have been recorded widely from the study area and are likely to forage in the habitats. The box culverts underneath the Glenmore Parkway may provide a suitable roost site for Eastern Bentwing-bat and the Southern Myotis. While these species were not found roosting in the culverts during the survey, these species may utilise the culverts seasonally or may use the culverts as a component of a larger collection of roosting resource in the locality. The bridge over the M4 Motorway, while constructed in a manner conducive to bat roosting is considered a low likelihood of being a bat roost site due to the disturbance from motorway traffic. The hollow bearing trees in the study area may provide a roosting resource for the Eastern Freetail-bat, however this is very limited and not optimum.

The Grey-headed Flying-fox (listed as vulnerable under the TSC Act ad EPBC Act) is considered moderately likely to forage in the trees within the study area, particularly Eucalyptus moluccana, Eucalyptus tereticornis and planted specimens of Corymbia citriodora, Eucalyptus cladocalyx and Eucalyptus sideroxylon in the broader locality. Flowering and fruiting plants in gardens and parks are likely to be used extensively by this species. No roost camps are present in the study area but the bats from the Emu Plains camp, and the Ropes Creek camp, are likely to forage in the study area.

The Swift Parrot (listed as endangered under the TSC Act and EPBC Act) has been recorded in the locality from Nepean Hospital in 2003, the Southland Shopping Centre in 2008, the Penrith Leagues Club in 2003, Penrith Railway Station in 2012 and in street trees in Glenmore Park in 2014. The Swift Parrot sporadically occurs in the urbanised areas of the Penrith LGA during winter and may pass through the study area during movements between larger foraging habitats (ie from Castlereagh Nature Reserve to Mulgoa Nature Reserve) where it may rest and forage in street trees or small vegetation remnants. Although no significant areas of foraging habitat are present, the Swift Parrot is considered moderately likely to occur in the study area on occasion.

The habitat in the vegetation patches within the study area is considered too disturbed to be moderate or good quality habitat for the Cumberland Plain Land Snail (the mowing regime would

have killed individuals and the ground cover provides few sheltering opportunities). No Cumberland Plain Land Snails were recorded in the study area despite targeted searches.

While species including the Spotted-tail Quoll have been recorded close to the study area in 1989, the habitats in the study area are considered unlikely to support a population of this species due to the small size of habitat patches and the lack of required habitat features. The degree of isolation of the small habitat patches from larger habitats that may contain a source population suggests that the Spotted-tail Quoll is unlikely to occur in the study area.

3.7 Migratory species

Eleven migratory bird species were identified in the EPBC Act Protected Matters Search Tool as potentially occurring in the locality based on the distributional range of the species and modelled habitat. These migratory species, along with their preferred habitat requirements and an assessment of their likely presence in the study area are listed in Appendix B. From this review, only the Fork-tailed Swift, White-throated Needletail and Latham's Snipe are considered moderately likely to occur in the study area. The Fork-tailed Swift and White-throated Needletail may fly over the study area but would not use it as habitat. The Latham's Snipe may potentially use the wetlands on a seasonal basis for foraging and roosting when in Australia.

While some migratory species of bird are likely use the study area and locality, the study area would not be classed as an 'important habitat' as defined under the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment 2013), in that the study area does not contain:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species (ecologically significant proportions are defined by the *Draft referral guideline for 14 birds listed as migratory species under the EPBC Act* (Department of the Environment 2015a)
- 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.

The *Draft referral guideline for 14 birds listed as migratory species under the EPBC Act* (Department of the Environment 2015a) indicates that in most cases, significant impacts on the White-throated Needletail or Fork-tailed Swift are unlikely to occur and consideration for them in a referral is not required. A nationally significant proportion of the population (0.1 percent of the population) for these two species is: White-throated Needletail – 10 birds and Fork-tailed Swift – 100 birds. This number of birds would not be supported by the study area, as the habitats are not large enough or high enough quality.

The *EPBC Act Policy Statement 3.21: Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (Department of the Environment 2015b) identifies the types of actions likely to result in significant impacts on migratory shorebirds in Australia. For a significant impact to occur, the habitat must be defined as important. Important habitat for Latham's snipe is described as areas that have previously been identified as internationally important for the species, or areas that support at least 18 individuals of the species. It is unlikely that the small dams in the study area would support a large important population of the Latham's Snipe.

The proposal would not substantially modify, destroy or isolate an area of important habitat for the migratory species and it would not seriously disrupt the lifecycle of an ecologically significant proportion of a population of migratory birds. As such, there is a low risk of a significant impact to these migratory species from the proposal and migratory species are not considered further in this report.

4 Potential impacts

4.1 Loss of vegetation and habitat

Loss of vegetation and habitats may result in a range of direct and indirect impacts to vegetation communities and species of plant and animal including:

- Reduction in the extent of vegetation communities and associated habitats
- Loss of local populations of individual species
- Fragmentation of remnants of vegetation communities or local populations of individual species
- Increased edge effects and habitat for invasive species
- Reduction in the viability of ecological communities resulting from loss or disruption of ecological functions (eg increased desiccation, light penetration, herbivory, weed invasion, predation, parasitism)
- Destruction of flora and fauna habitat and associated loss of biological diversity (habitat removal may include removal of hollow bearing trees, loss of leaf litter layer, and resultant changes to soil biota)
- Riparian zone degradation
- Soil exposure and altered water flow patterns resulting in increased erosion and sedimentation.

The potential loss of vegetation and habitat associated with the proposal is summarised in **Table 4-1**. The construction footprint would impact on up to around 2.4 hectares of remnant native vegetation and up to 3.9 hectares of planted vegetation along the M4 Motorway (6.3 hectares in total) (see **Table 4-1**). This represents around 36 per cent of the vegetation within the study area (the large proportional impact is due to the long narrow study area that is almost entirely occupied by the proposal footprint). When considered in the context of the locality (the area within 10 km of the proposal) the proportional impact is small (see **Table 4-1**). The local occurrence of the impacted vegetation is identified based on vegetation ground-truthed in the road reserve (i.e. between the edge of the existing road and the adjoining property boundaries) and contiguous vegetation of the same type. The large proportional impact is due to the narrow road reserve and the extent of the proposal footprint covering a large portion of the road reserve. This local occurrence does not represent the extent of similar vegetation types within the locality.

Impacts have been quantified based on the current road design, with an added five metre buffer to account for any other potential disturbance during construction. Compound sites are proposed to be located in currently cleared and disturbed areas and no native vegetation would be removed for compound sites in accordance with the direction provided in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011).

A buffer has not been applied to account for indirect impacts such as edge effects. The vegetation within the study area is irregularly shaped and subject to a range of disturbances which has resulted in existing edge effects being prevalent in the vegetation (ie weed invasion, light penetration, wind penetration, noise from the M4 Motorway and Northern Road, etc.). The study area does not contain any large core areas of habitat that are not affected by edge effects. As such, the clearing associated with the proposal is not anticipated to result in any noteworthy increase in indirect impacts such as edge effects.

Avoidance, minimisation and mitigation measures designed to reduce the impact of vegetation removal are provided in **Section 5**.

Table 4-1 Predicted loss of vegetation from the proposal

Plant Community Type	Condition	Extent in the study area (ha)	Potential impact (ha)	Impact as % of local occurrence (in study area)*	Impact in the context of the locality (within 10 km)
Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate	1.5	0.3	20%	0.18% (3,190 ha mapped in the locality)
Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Poor	3.3	1.6	48%	
Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Poor (Historical M4 Revegetation - established)	11.4	3.9	34%	
Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate	1.1	0.4	36%	0.02% (1,703 ha mapped in the locality)
Phragmites australis and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Poor	0.3	0.1	33%	Dams not mapped but extensive
	Total	17.6	6.3	36%	0.12%

Note: * the local occurrence includes only vegetation in the road reserve (between the edge of the existing road and the adjoining property boundaries). The large proportional impact is due to the narrow study area and the large proposal footprint within the study area.

4.1.1 Threatened biodiversity

Threatened ecological communities (TECs)

The predicted impact to TECs from the proposal is outlined in **Table 4-2**. The greatest impacts are to planted vegetation along the M4 Motorway that is considered representative of the Cumberland Plain Woodland in the Sydney Basin Bioregion TEC (TSC Act) (see **Table 4-2** and Jacobs 2015).The local occurrence of a TEC is usually considered the area of the TEC that occurs within the study area. In this assessment, the study area was the entire road reserve where the TEC was estimated at 4.8 hectares. However, the local occurrence of a TEC may also include adjacent contiguous areas of vegetation outside the study area. In this assessment, contiguous areas of the TEC that are outside of the road reserve were considered part of the local occurrence. Areas of the TEC within 100 metres of each other were considered contiguous for this assessment. The local occurrence of the Cumberland Plain Woodland in the Sydney Basin Bioregion TEC is estimated at around 8.4 hectares. The predicted impacts to remnant Cumberland Plain Woodland in the Sydney Basin Bioregion TEC is around 1.9 hectares, which represents around 23 percent of the local occurrence of this TEC (see **Table 4-2**). This is a large proportional extent of removal. When considered in the context of the locality (the area within 10 km of the proposal) the proportional impact is small at around 0.18 percent (see **Table 4-2**).

When combined with planted vegetation along the M4 Motorway, impacts to the Cumberland Plain Woodland in the Sydney Basin Bioregion TEC increase to around 5.8 hectares. However, when considered in the context of the locality (the area within 10 km of the proposal) the proportional

impact is small at 0.24 percent (see **Table 4-2**). The revegetation along the M4 is replaceable so impacts to this vegetation are not considered as important as impacts to remnant vegetation with an established soil seed bank. However, there would be a time lag of 10 – 15 years until any plantings would reach the same structure as currently exists.

Impacts to the River-Flat Eucalypt Forest TEC are predicted to be minimal but the vegetation to be removed represents a large portion of the local occurrence (ie that within the study area) of this TEC at 33 percent (see **Table 4-2**). When considered in the context of the locality (the area within 10 km of the proposal) the proportional impact is small at 0.02 percent (see **Table 4-2**).

When the impacts outlined below (and in **Table 4-2**) are considered in the local context, the impacts in terms of hectares removed are relatively small but the proportional impacts are large. The study area has been extensively cleared of native vegetation in the past. Few patches of native vegetation remain in the study area and the areas immediately adjacent. The vegetation that does remain is directly bordering the existing roadways within the road reserve. Due to the nature of the proposal, the study area is narrow and linear and follows existing roadways closely. The existing vegetation is along the roadways. The proposal involves road widening and the proposal footprint follows the roadways and occupies a large proportion of the study area.

Table 4-2 Predicted loss of TECs from the proposal

Threatened ecological community (TSC Act)	Status	Extent in the road reserve (ha)	Extent of local occurrence (ha)	Potential impact (ha)	Impact as % of local occurrence	Impact in the context of the locality (within 10 km)
Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically endangered	4.8	8.4 (includes extent in study area and 3.6 ha of contiguous vegetation)	1.9	23%	0.18% (3,190 ha mapped in the locality
Cumberland Plain Woodland in the Sydney Basin Bioregion – M4 revegetation	Critically endangered	11.4	16.1 (Includes extent in study area and 4.7 ha of contiguous vegetation)	3.9	24%	
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	1.1	1.1	0.4	36%	0.02% (1,703 ha mapped in the locality)

Threatened species habitat

The vegetation to be impacted provides some habitat for threatened fauna species. These are all highly mobile species and include the Eastern Bentwing-bat, Eastern Freetail-bat, Southern Myotis, Grey-headed Flying-fox and Swift Parrot. This is generally limited to foraging habitat but the Eastern Freetail-bat may roost in the hollow-bearing trees in the study area.

The predicted impacts to habitat for threatened species are outlined in **Table 4-3**. All vegetation to be impacted is considered potential foraging habitat for these threatened species. The overall impact to foraging habitat is predicted at around 6.3 hectares, which represents around 24 percent of the local occurrence of habitat for these species.

Potential disturbance to the culverts under the Glenmore Parkway may result in potential roost disturbance but these impacts cannot be quantified at this stage as no bats were found during the field inspection and impacts are subject to detailed design. A precautionary approach has been used in this report to assume that the culverts are potential roost sites.

Five hollow bearing trees would be removed by the proposal and these trees may provide suitable roosting habitat for the Eastern Freetail-bat.

Table 4-3 Predicted loss of habitat for threatened species from the proposal

Threatened species)	TSC Act	EPBC Act	Extent of habitat in the study area (ha)*	Extent of local occurrence (ha)	Potential impact (ha)
Eastern Bentwing-bat	V	–	17.6 May forage in all vegetation in the study area (cannot define specific areas). May potentially roost in box culverts under Glenmore Parkway	25.9	6.3 Potential disturbance to culverts
Eastern Freetail-bat	V	–	17.6 May forage in all vegetation in the study area (cannot define specific areas). May roost in hollow-bearing trees	25.9	6.3 5 hollow bearing trees
Southern Myotis	V	–	17.6 Likely to forage in all vegetation in the study area but a focus on dams and drainage lines is expected. May potentially roost in box culverts under Glenmore Parkway	25.9	6.3 Potential disturbance to culverts
Grey-headed Flying-fox	V	V	17.6 Foraging and potential roosting habitat only. No impact to breeding habitat. May forage in all vegetation in the study area (cannot define specific areas)	25.9	6.3
Swift Parrot	E	E	17.6 Foraging and potential roosting habitat only. No impact to breeding habitat. May forage in all vegetation in the study area (cannot define specific areas)	25.9	6.3

4.2 Wildlife connectivity and habitat fragmentation

Habitat fragmentation *per se* is a landscape scale process that involves the division of a single large area of habitat into two or more smaller areas, with the occurrence of a new habitat type in the area between the newly created habitat fragments. The vegetation and habitats in the study area are typified by small fragments (ranging from 152 square metres to 1.8 hectares in size).

There are 44 vegetation fragments within the study area with an average fragment size of 0.36 hectares. No large contiguous areas of native vegetation are present along The Northern Road

North – south connectivity along The Northern Road is currently limited. The small vegetation fragments are broken apart by expanses of cleared land now occupied by residential dwellings, local roadways, the dual carriageway of the M4 Motorway, sports fields, parks, and grazing paddocks. The proposal involves widening of The Northern Road that runs in a north – south direction. Therefore, no additional impacts to north – south connectivity are expected. The widening of The Northern Road would however result in some habitat loss (see **Section 4.1**) which would result in small increases to isolation of vegetation fragments in the landscape as some vegetation fragments would be reduced in size from the proposal.

Some east – west wildlife connectivity is present in the revegetation along the M4 Motorway corridor. However, the current M4 Motorway and Northern Road intersection forms a significant barrier to wildlife movement in an east – west direction. This intersection would be upgraded as part of the proposal but no further habitat fragmentation is expected. There would be an increase in isolation of the habitats along the M4 Motorway to the east and west of the intersection with removal of between 10 to 50 metres of vegetation from the edge of patches.

The proposal would not divide or break apart an area of continuous habitat but the widening of The Northern Road would contribute to an increase in isolation of habitats to a small degree. Some small 'islands' of habitat in the road reserve would be made smaller resulting in an increased distance between habitats on the eastern and western sides of The Northern Road.

Mitigation measures designed to reduce the impact of the proposal on wildlife connectivity and habitat fragmentation are provided in **Section 5**.

4.3 Injury and mortality

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 (eg ground dwelling reptiles), or those that are nocturnal and nest or roost in trees during the day (eg 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.

Avoidance, minimisation and mitigation measures designed to reduce an injury and death of fauna are provided in **Section 5**.

4.4 Proliferation of weeds

Proliferation of weed species is likely to occur as vegetation is removed, soil is disturbed and machinery move about the work site. The impacts from weed invasion would likely commence a few months after construction and gradually increase over months and seasons. Proliferation of weed species has the potential to impact on the quality and integrity of the native vegetation within the study area including habitat for threatened species (although the areas of native vegetation and habitat within the study area are currently generally poor and subject to significant weed invasion).

Weed species were recorded in the study area during the field survey (see Section 3 and Appendix A). During construction there is potential to disperse these weed seeds and plant material into adjoining areas of vegetation or off site. The most likely causes of weed dispersal are associated

with clearing of vegetation and stockpile of contaminated mulch and topsoil during earthworks, and movement of soil and attachment of seed (and other propagules) to construction vehicles and machinery. Mitigation measures designed to limit the spread and germination of noxious weeds are provided in Section 5.

4.5 Pathogens

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 treated as a risk during construction.

Mitigation measures to deal with the potential introduction and spread of pathogens are provided in Section 5.

4.6 Noise, vibration and light

Considering the existing levels of noise and vibration from the surrounding urban development and the high levels of use of the existing Northern Road and M4 Motorway by vehicle, it is unlikely there would be a significant increase in noise and vibration during operation of the road that would result in any increased impacts to biodiversity within the study area. There is however potential for impacts to locally common fauna from noise and vibration during construction, which may result in fauna temporarily avoiding habitats adjacent to the construction, however traffic noise on The Northern Road is likely to be significant deterrent to most fauna groups already.

Lighting would be used at night to enable work to be completed that may result in impacts to nocturnal fauna. Common nocturnal species such as possums and microbats may avoid the habitat in the study area during construction as temporary ‘daylight’ conditions would be created by the mobile lighting system. This impact is considered temporary and would not have long lasting effects on the biodiversity of the study area.

4.7 Impact of relevant key threatening processes

Key threatening processes identified as potential consequences of the proposal include those associated with habitat degradation, such as vegetation clearing (see **Table 4-4**). There is also potential for other, currently active threatening processes to be accelerated (eg weed invasion, introduction of pests and diseases and alteration of hydrological regimes). However, mitigation measures would be implemented to minimise their effect.

Table 4-4 Key threatening processes relevant to the proposal

Threatening Process	Relevant legislation	Increased by the proposal?	Proposed Mitigation
Habitat Degradation			
Land clearance/Clearing of native vegetation	EPBC Act, TSC Act	Yes	Section 5
Loss of hollow-bearing trees	TSC Act	Yes	
Removal of dead wood and dead trees	TSC Act	Yes	
Removal of large woody debris	FM Act	Potential	
Degradation of native riparian vegetation	FM Act	Potential	
Instream Structures	FM Act	Potential	
Pathogens			
Infection of amphibians with chytrid fungus resulting in chytridiomycosis/Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	EPBC Act, TSC Act	Potential	Section 5
Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)/Infection of native plants by *Phytophthora cinnamomi*	EPBC Act, TSC Act	Potential	
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Potential	
Weeds			
Invasion of native plant communities by exotic perennial grasses	TSC Act	Potential	Section 5
Invasion and establishment of exotic vines and scramblers	TSC Act		
Invasion of native plant communities by African Olive (*Olea europaea* subsp. *cuspidata*)	TSC Act		
Invasion, establishment and spread of *Lantana camara*	TSC Act		

4.8 Aquatic Impacts

The construction and operation of the proposal has the potential to impact aquatic ecosystems due to changes in water quality, habitat loss and instream barriers. Only one watercourse, a tributary of Surveyors Creek at Glenmore Parkway was identified as Type 1 – Key Fish habitat, Class 2, as it had a combination of native aquatic plants, woody snags and a variety of instream substrates. The

only other watercourse, the unnamed tributary of Surveyors Creek was identified as Type 2 – Moderate Fish Habitat, Class 3. All freshwater streams, whether perennial or ephemeral and which support aquatic vegetation or other habitat are always classified at least Type 1 or Type 2.

4.8.1 Waterways modified by the project

A worst-case scenario has been adopted for the purpose of this assessment to determine potential impacts to the tributary of Surveyors Creek at Glenmore Parkway. However, it is noted that based on concept design, impacts will be limited to removing debris from these culverts. This will be determined during detailed design. For the purpose of this assessment, it is assumed that the existing seven side-by-side box culverts will be extended and debris (accumulated silt and woody debris) will be removed. Excavation is likely to be required downstream and upstream of the culverts and a dry working area might be needed during construction.

Construction activity around watercourses 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). These impacts are detailed further below.

The tributary of Surveyors Creek at Glenmore Parkway is the only watercourse in the proposal area that contains permanent or near permanent flows, and as such may support a variety of fish and macroinvertebrate families.

4.8.2 Water Quality

The construction and operation of the project has the potential to impact on water quality. Impacts to water quality during construction come from stockpiling of earthworks, and actual construction works such as cut and fill.

Construction of the waterway crossings would result in temporary localised disturbance and potential loss of riparian habitat. This could either occur at the crossing location, or in locations where the road runs closely parallel to the riparian habitats including the zone immediately adjacent to creeks. Large scale clearing of vegetation results in erosion and sedimentation, which means more sediment, nutrients, salt, pesticides and other toxicants are transported into rivers and streams deteriorating water quality. More sediments in the water increase turbidity and reduce clarity (and light penetration) which restricts photosynthesis of aquatic plants. Sediments in water also absorb heat, therefore increasing water temperatures that can reduce dissolved oxygen as warmer water holds less oxygen than cold water. Increased nutrient loads of nitrogen and phosphorus that are bound to sediments entering the water can result in eutrophication and the occurrence of algal blooms.

Stockpiling of earthworks causes a risk to 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 stockpiles are within 50 metres of the Type 1 Fish Habitat at the Surveyors Creek tributary at Glenmore Parkway. Potential impacts include increased turbidity and nutrients in waterway as a result of sediments from earthworks stockpiles being washed into waterways. Stockpiles of vegetation from cutting of trees and shrubs may result in tannins leaching into the waterways and increased organics. This can increase stream Biological Oxygen Demand (BOD) and decrease dissolved oxygen which can affect aquatic life.

Increased pollutant load in road runoff is the main impact to water quality associated with the operation of the project. Pollutants in road runoff include nutrients, heavy metals, pesticides, herbicides and hydrocarbons which can impact negatively on the aquatic environment. To minimise the impact of runoff during the operation, runoff from the project would be directed to detention basins before being discharged to drains and then local waterways. Basins
Impacts are expected to be minimal due to implementation of measures such as ensuring appropriate design of water storage areas and temporary drainage systems, controlling runoff from construction areas, and the implementation of routine water quality monitoring.

4.8.3 Removal of woody debris

The removal of large woody debris or snags is listed under Schedule 6 of the FM Act as a Key Threatening Process. Woody debris plays an important role in freshwater ecosystems by providing essential habitat for aquatic organisms, providing a refuge from predation and a resting place away from the main flow of the waterway and providing important refuge and breeding habitat for fish including threatened species. Woody debris also provides habitat for a number of plants, algae, microorganisms and invertebrates. Tree trunks and fallen branches are also structurally important for stabilising stream beds and banks.

Woody debris is a significant component of aquatic habitat within the tributary to Surveyors Creek at Glenmore Parkway. Construction of the proposal may require the temporary removal of woody debris and snags during excavation and/or the establishment of a dry area. The removal of woody debris is considered as dredging under the FM Act and requires a permit or consultation with the Minister for Primary Industries.

4.8.4 Instream barriers

Construction and operation of both permanent and temporary waterway crossings such as causeways, fords and culverts are known to have significant impacts upon passage of fish. Short term impacts include localised disturbance to riparian and instream habitats such as increased sedimentation and shading. Long-term impacts include the impediment of fish movements within their natural range, habitat changes or pollution.

Inappropriate design or type of water crossings can impede or prevent fish from travelling within their natural range. Instream structures can have similar impacts on native fish as permanent structures. Further, barriers to fish passage can prevent breeding or re-population of waterways through restricting access of fish to spawning grounds (Fairfull & Witheridge 2003). Permits would be required for activities that block fish passage (even temporarily) or for instream structures. Temporary barriers in Class 2 streams (unnamed tributary of Surveyors Creek) require adequate fish passage for DPI approval. A permit would also be required for all Type 1-3 habitats where free passage of fish is obstructed. Any potential impacts on fish passage in the tributaries of Surveyors Creek would be mitigated during detailed design of culverts.

Construction works undertaken within 50 metres of waterways has the potential to impact on bank stability and water quality through excavation, clearing or placement of construction stockpiles. Potential impacts associated with construction works include loss of suitable bank habitat, loss of in-stream shading and increased sedimentation of the watercourses through surface runoff. Detailed design would ensure that no stockpiles are placed within 50 metres of Type 1 – Key Fish Habitat waterways.

4.9 Cumulative impacts

The potential biodiversity impacts of the project must be considered as a consequence of the construction and operation of the project within the existing environment. The project would not act alone in causing impacts to biodiversity. The incremental effects of multiple sources of impact (past, present and future) are referred to as cumulative impacts and provide an opportunity to consider the project within a strategic context.

The accumulating impacts of historic vegetation clearing for agriculture, urban development, and development and maintenance of infrastructure would likely include continued loss of biodiversity on the Cumberland Plain. The Cumberland Plain Mitchell Landscape is an over cleared landscape with 89 per cent of native vegetation having been cleared. Only 11 per cent of the original native vegetation remains. Due to the likely expansion of western Sydney and creation of housing and associated infrastructure, further impacts to biodiversity are likely to result in this region.

While data from all recent projects in the locality is not freely available, some information on the likely biodiversity impacts from recent projects is available as follows:

- The construction footprint of the M4 Managed Motorway project is anticipated to impact on about 31.25 hectares of planted and remnant vegetation in various states of condition. This area of clearing includes 3.82 hectares of remnant vegetation (Jacobs 2015)
- The construction footprint of the Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park is predicted to impact on up to 37.5 hectares of remnant native vegetation (Jacobs 2016).
- The construction footprint of the western Sydney airport is predicted to impact on 280.8 ha of native vegetation (GHD 2015).

When considered together, these projects combine to remove about 328.33 ha of remnant native vegetation from the Cumberland Plain. This is a large cumulative impact in terms of the over cleared nature of the region.

It has been proposed that when a landscape reaches a vegetation retention threshold of ~30 per cent, most species would be lost from the ecosystem (McAlpine et al. 2002). With only 11 per cent of the original vegetation remaining in the Cumberland Plain Mitchell Landscape and all native vegetation classified as endangered or critically endangered, this landscape has passed a critical threshold from which any further impacts are likely to result in detrimental and irreversible impacts to biodiversity.

5 Mitigation measures

In managing biodiversity, Roads and Maritime aims to achieve a balanced outcome, taking account of environmental considerations together with economic and community objectives. This includes a balanced approach to examining the particular environmental consequences of an activity, recognising that achieving an optimal outcome often requires compromise and decisions regarding environmental values. A key part of Roads and Maritime's management of biodiversity for this proposal is the application of the 'avoid, minimise, mitigate and offset' hierarchy.

Roads and Maritime's current approach with respect to biodiversity is:

1. Avoid and minimise impacts as the highest priority
2. Mitigate impacts where avoidance is not feasible or practicable in the particular circumstance
3. Offset where residual, significant unavoidable impacts would occur.

5.1 Avoidance of ecological impacts

Avoiding environmental impacts as the first step is consistent with the application of the precautionary principle. Roads and Maritime's first priority is to avoid impacts to the environment. This is can be achieved by early consideration of environmental issues from identification of constraints at project inception through to options analysis and selection of a preferred option, design investigation and assessment of the preferred option, detailed design, and implementation of on-ground safeguards during construction and operation and maintenance of the activity.

The primary method to avoid impacts is to locate activities away from areas of known or potential high biodiversity value. In identifying suitable work sites, the first preference is to locate existing cleared and disturbed areas that have good access, are not within immediate proximity to waterways, and that support good site management practices (for example, management of material stockpiles).

5.2 Minimising ecological impacts

Where it is not possible to avoid impacts, the project would be designed to minimise impacts as far as possible. This would include the application of measures such as road design refinements in the detailed design phase to reduce the scope of the overall impact. However, the ability to minimise impacts for this proposal is limited as the impacts are to occur at the edge of the road that needs to be widened.

5.3 Recommended mitigation measures

Once all practicable steps to avoid or minimise impacts have been implemented at the design phase, mitigation measures would be implemented to further lessen the potential ecological impacts of the proposal. Mitigation measures are to be undertaken during the construction and operational phases. The Roads and Maritime guidelines and procedures identify a range of mitigation techniques to be applied, including managing the vegetation clearing process, re-establishment of native vegetation at the end of a project, weed management, provision of supplementary fauna habitat (such as nest boxes for appropriate species), and installation of erosion and sediment controls as appropriate. The following mitigation measures as outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) are recommended for implementation.

5.3.1 Planning for vegetation clearance

the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) outlines the process that Roads and Maritime would use during vegetation clearance. The process is described below.

Prior to the commencement of construction, Roads and Maritime requires that construction contractors provide details on the approach proposed for the clearing of all vegetation, both living and dead, and the mulching of native trees, stockpiling, and the removal from site and disposal of all materials from built structures, rubbish, weeds and exotic plants.

Roads and Maritime requires that contractors submit documentation (that includes input by qualified, experienced and where necessary licensed ecologists) on the scope of clearing proposed. Roads and Maritime would undertake an on-site inspection of areas to be cleared, and would confirm the location and protection of any no-go (sensitive) areas to be retained prior to allowing the contractor to commence any vegetation clearing.

Prior to the commencement of vegetation clearing the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) require that the following activities are undertaken:

- Review of the environmental assessment and associated documentation for the project to identify known locations of biodiversity features
- Identify nearby habitat that would be suitable for the release of fauna that may be encountered during the pre-clearing process or habitat removal
- Development of an unexpected threatened species finds procedure (to be incorporated into the Construction EMP and / or Flora Fauna Management Plan (see Section 5.3.3)
- Incorporation of any biodiversity management measures identified during the pre-clearing process into the project Construction EMP and/or project design
- In the weeks prior to commencement of clearing, engage an experienced (and licensed) ecologist to:
  - Confirm the locations of previously identified biodiversity features (including specifically the presence of threatened flora and fauna species that were previously identified)
  - Identify any fauna that have the potential to be disturbed, injured or killed as a result of clearing activities (eg nesting birds)
- In the 24 hour period prior to commencement of clearing, licensed wildlife carers and/or ecologists should:
  - Capture and/or remove and relocate fauna that have the potential to be disturbed, injured or killed as a result of clearing activities
  - Inform clearing contractors of any changes to the sequence of clearing because of fauna present if required.

5.3.2 Exclusion zones

An exclusion zone is a designated ‘no-go’ area that is clearly identified and appropriately fenced to prevent damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease (exclusion zones may also be used to define approved clearing limits for a project). Exclusion zones are regularly applied in Roads and Maritime projects to limit clearing of vegetation to approved locations, protect threatened flora, threatened ecological communities, conservation areas, habitat features including hollow-bearing trees, aquatic habitats and areas of bushrock.

As outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011), exclusion zones would be established to avoid damage to native vegetation and fauna habitats outside of the areas needed for construction and to prevent the distribution of pests, weeds and disease. Temporary fencing would need to be installed to indicate the limits of clearing. Exclusion zones would also be used to identify suitable locations for the storage of materials and stockpiles (ie outside of exclusion zones) and to mark tree protection zones to ensure the health and root systems of trees that are to be retained are not impacted.

The correct establishment of exclusion zones is critical for a project to comply with safeguard requirements and avoid breaches of legislation. As such, exclusion zones and clearing limits would

be marked out by a qualified surveyor to ensure accuracy. The location of exclusion fencing to be installed would be identified on plans within the CEMP and the function and importance of the exclusion zones communicated to construction personnel. The condition of exclusion zones must be monitored during construction to ensure their effectiveness.

5.3.3 Staged vegetation removal

The *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) outline a staged approach for habitat removal which must be followed during vegetation clearing. The procedure us as follows:

- Habitat removal is conducted in at least two stages (for example, clearing non-habitat trees at least 24 hours prior to clearing habitat trees) so as to allow respite between the initial disturbance of the clearing process and the final removal of habitat
- The timing of habitat removal considers the seasonal impact of clearing on potentially affected species and if possible, clearing is avoided during times when these species are breeding
- Habitat trees must be carefully felled using equipment that allows the trees to be lowered to the ground with minimal impact (eg claw extension) and any trees removed must not be felled towards exclusion zones
- An experienced and licensed wildlife carer and/or ecologist inspects habitat once it is removed (ie after a tree is felled) and any animals found are captured, inspected for injury then relocated to pre-determined habitat identified for fauna release
- The outcomes of the clearing process must be documented (reporting is usually the responsibility of an ecologist or environment officer) and reports provided to relevant Roads and Maritime staff.

5.3.4 Erosion and sediment control

Before commencing any vegetation clearing, Roads and Maritime requires that all soil erosion and sedimentation controls that are required are adequately installed and maintained for the life of construction.

5.3.5 Habitat management

The *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) require that contract specifications include requirements for woody debris and bushrock to be re-used on site (ie for habitat improvement) wherever possible. An ecologist would be engaged to provide advice on the re-use of woody debris and bushrock to ensure it does not have a negative impact on the receiving environment and to assist in determining appropriate positioning of woody debris and bushrock in designated relocation areas.

The *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) address the provision of supplementary fauna habitat, such as nest boxes. Where nest boxes are identified as an appropriate safeguard or mitigation (such as with this proposal due to the removal of hollow bearing trees), Roads and Maritime requires that an ecologist be engaged to develop and assist in implementation of a nest box strategy. The following elements must be considered by the ecologist when developing the nest box strategy:

- The target species, including the tree hollow preferences of native hollow-dependant fauna known or likely to occur in the locality
- The sizes, types and quantities of potential tree hollows to be removed as well as the sizes, types and quantities of tree hollows existing in adjacent areas
- The design, materials and quantity of nest boxes required
- Whether the nest boxes are required to fill a short term gap in the availability of hollows (eg during construction) or to compensate for the long term reduced availability of hollows
- Monitoring and maintenance of the nest boxes.

Monitoring of each nest box by a qualified ecologist is generally recommended to occur at least every six months during construction, together with targeted monitoring to account for nesting seasons of key target species.

5.3.6 Management of unexpected species finds

The unexpected threatened species finds procedure would be followed as outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011). If a threatened species is found unexpectedly during works, work is to stop immediately and the environment manager is to be notified. The environment manager would then arrange for an ecologist to assess the significance of the likely impact, develop management options and notify OEH and DoE as appropriate.

This procedure is particularly relevant to the potential presence of bats. The procedure is to be adopted through the construction phase of the proposal. If any threatened species or populations were found on site during works the unexpected species finds procedure would also be implemented. The unexpected finds procedure would form part of the Construction Environmental Management Plan (CEMP).

Given the presence of the culverts to be demolished at Glenmore Park, the potential for bats to roost in these structures prior to their demolition should be considered. To mitigate this potential impact a series of progressive steps is required to minimise harm to any bats, which may be roosting in the culverts from the initial assessment stage through to the commencement of construction. The actions are

1. Conduct a further bat survey and roost assessment immediately prior to the demolition, if bats are not present works can proceed as planned
2. If bats found to be present review the results of the survey in terms of species, number of individuals, and presence of young
2. Develop an appropriate work schedule (ie timing of works should avoid bat breeding season and of particular importance is the presence of young)
3. After breeding season conduct a close inspection of the works area prior to commencement of works; and if required
4. Removal and relocation of a bat colony from the works area.

5.3.7 Minimising fauna injury and mortality

The fauna handling and vegetation clearing procedures provided in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) must be followed. The following should be implemented to minimise injury and mortality of fauna:

- The pre-clearing process as outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) must be followed (see Section 5.3.1)
- Staged vegetation removal would be undertaken and would be supervised by an ecologist who would be present on site to relocate any fauna that may be encountered
- Allow fauna to leave an area without intervention as much as possible
- In circumstances where the handling of fauna is completely unavoidable, best practice methods need to be followed as outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011)
- Include the procedures in project inductions for construction staff to implement if fauna is found or injured on site and also the importance of not feeding any wildlife that may be encountered on construction sites
- Never deliberately kill any native fauna, including snakes, as all native species are protected under the NPW Act
- Keep records of fauna captured and relocated
- Report any injury to or death of a threatened species to Roads and Maritime environmental staff.

5.3.8 Weed management

The construction of roads has the potential to introduce and promote the spread of weed species. The *Noxious Weeds Act 1993* has provisions for the control of certain weeds and Roads and Maritime is required to control noxious weeds under this Act.

A weed management plan would be developed as part of the CEMP and would be implemented during construction. The procedures to be implemented for weed management are outlined in detail in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011). The project manager and/or environment manager must ensure the following best practice methods for weed management are undertaken:

- Mow/slash areas infested with weeds before they seed. This may reduce the propagation of new plants
- Program works from least to most weed infested areas
- 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
- Remove weeds immediately onto suitable trucks and dispose of without stockpiling
- Separate weeds from native vegetation where native vegetation is to be used for mulch
- Dispose of weeds to an appropriate waste management facility
- Do not use weeds for mulch
- Send samples of topsoil being imported onto site to a National Association of Testing Authorities (NATA) approved soil laboratory to ensure it contains no weed seeds or propagules.

5.3.9 Pathogen management

Several pathogens that have the potential to impact on the environment and biodiversity may be introduced and spread during the construction of road projects. They include:

- Phytophthora (*Phytophthora cinnamomi*)
- Chytrid fungus (*Batrachochytrium dendrobatidis*)
- Myrtle rust (*Uredo rangelli*)
- Fusarium wilt/Panama disease (*Fusarium oxysporum*) (generally only an issue in northern NSW).

The *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011) outlines Roads and Maritime's approach to pathogen management. If pathogens/disease causing agents are found to be present, measures to prevent the introduction and/or spread of these pathogens/disease causing agents are to be incorporated into the CEMP for the proposal. Management of disease is a dynamic process and the project manager and/or environment manager should check the DPI website for the most up-to-date hygiene protocols for each pathogen and for the most recent locations of contamination. A pest and disease management plan should be developed for the proposal that would include (but not necessarily be limited to) measures including:

- Providing vehicle and boot wash down facilities and ensuring vehicles and footwear are free of soil before entering or exiting the site
- Regular communication to staff and contractors during inductions and toolbox talks, of the risk of spreading pathogens and the mitigation measures required on site
- Programming construction works to move from uninfected areas to any known infected areas
- Restricting vehicles to designated tracks, trails and parking areas
- Testing from a NATA approved laboratory may be required to confirm the presence of pathogens in soil and/or water
- Set up exclusion zones with fencing and signage to restrict access into contaminated areas.

5.3.10 Re-establishment of native vegetation

Due to the predicted impacts on planted native vegetation, a landscape management plan should be developed which provides specific details for the re-establishment of native vegetation in suitable areas adjacent to the proposal. Any access tracks, compounds and laydown areas should also have any native vegetation re-established if these areas are disturbed during construction. This approach will compensate for the removal of planted vegetation along the M4 Motorway and Northern Road intersection that is likely to occur.

Detailed guidelines for the re-establishment of native vegetation on road projects are provided in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (NSW Roads and Traffic Authority 2011). Any areas of revegetation must only include planting of native species that are found in adjacent vegetation communities. The species chosen for revegetation may be selected from the species list provided in Appendix B (or may be other species typical of the target vegetation communities). Species from the Poaceae (grasses), Phormiaceae (dianellas) and Lomandraceae (lomandras) families are suitable to re-establish a ground cover. Seed would be collected from the site (or adjacent vegetation) or obtained from a local nursey to ensure local provenance of plant stock so that the local gene pool is not diluted. An outline of the management requirements is as follows:

- Ecologists and landscape architects should work together on the preparation of revegetation plans and specifications that clearly identify the locations of areas to be revegetated
- Allocate sufficient time for the collection of seed to be used in revegetation. Carry out all seed collection in accordance with RTA Seed Collection QA Specification R176 and the *Florabank Guidelines and Model Code of Practice*. Use experienced and licensed seed collectors to carry out seed collection
- Where possible, procured plants should be grown from local provenance seed
- Consideration should be given to a range of characteristics such as species, height and drought tolerance when procuring native plants
- Planting operations should be in accordance with RTA Landscape Planting QA Specification R179
- Use only plants that have been certified disease free for revegetation works
- Collect local native topsoils and leaf litter and store for use in revegetation works. Soils in areas to be revegetated should match surrounding soil conditions as closely as possible unless adjacent areas are weedy or contaminated
- Ensure areas to be revegetated have an appropriate level of natural drainage. Avoid compaction of soils in areas identified for revegetation. Where compaction has occurred, the soil should be loosened
- When planting consider seasonal risks of frost, drought, flooding and sun exposure to avoid damaging plants and to encourage growth
- Ensure plant spacing and diversity follows the landscaping plan for the project, reflects local conditions and is dense enough to ensure plants achieve a timely coverage of the ground
- Consider appropriate shade and drainage conditions when planting. Provide mulching around plants for dry or potentially weedy sites to help retain moisture and suppress weeds
- Inspection, monitoring and maintenance of revegetated areas should be conducted in accordance with the landscape management plan. Outline the roles and responsibilities in landscape management and revegetation plans including the schedule for monitoring and maintenance activities.

5.3.11 Aquatic Habitat Management

Impacts to watercourses and aquatic ecology are predicted to be minimal, however construction and operation of the project has the potential to impact aquatic ecosystems due to changes in water quality, habitat loss and instream barriers. The project manager and/or environment manager must ensure the following best practice methods for aquatic habitat are undertaken including:

- Create a soil, erosion and sediment control plan
- Ensure chemicals and fuels are appropriately stored and bunded
- Locate all stock pile compounds at Type 1 Fish Habitat waterways more than 50m away from the waterway
- Minimise instream and riparian disturbance and do not remove sediment, woody snags or debris from a stream or stream channel
- Develop and conduct water quality monitoring
- Design Culverts in accordance with *Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge 2003).

5.4 Managing fragmentation and loss of connectivity

Impacts to connectivity form the proposal are predicted to be minimal. However, some impacts to connectivity would occur, notably increases in isolation of habitat patches. The existing levels of east-west habitat connectivity along the M4 Motorway, and north-south connectivity along The Northern Road, can be enhanced through appropriate habitat re-establishment and protection of existing habitats where possible. Landscaping should use locally indigenous species to provide for functional habitat connectivity where physical connectivity is not possible.

Roads and Maritime follows a number of guiding principles for managing wildlife connectivity when developing, designing, assessing and implementing road and traffic management activities:

- Apply the 'avoid, minimise, mitigate, offset' hierarchy
- Identify and start to manage wildlife connectivity issues at the earliest stage in the project development process
- Maintaining or improving wildlife connectivity opportunities
- Consider a landscape-scale perspective
- Design wildlife connectivity measures to maximise benefits for all wildlife.

5.5 Offsetting ecological impacts

Although efforts have been made to avoid, minimise and mitigate potential ecological impacts from the proposal, some residual impacts would occur. In these circumstances, Roads and Maritime implements appropriate actions to ensure residual impacts to biodiversity are offset. A number of documents were reviewed to identify the need for biodiversity offsets for this proposal. This included the:

- *Roads and Maritime Guideline for Biodiversity Offsets* (Roads and Maritime Services 2011)
- *EPBC Act Environmental Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012)
- *Principles for the use of Biodiversity Offsets in NSW* (Department of Environment and Climate Change 2008b)
- *Program Report – Strategic Assessment of environmental assessment and decision making by NSW Roads and Maritime Services, May 2015* (Roads and Maritime Services 2015).

This biodiversity assessment identifies that the proposal is not likely to have a significant impact on any threatened biodiversity listed under the TSC Act or EPBC Act (see Section 6 below and Appendix E). In this instance, and due to the Strategic Assessment, the EPBC Act environmental offsets policy does not apply.

It is Roads and Maritime policy that biodiversity offsets are to be provided where more than 1 hectare of high conservation value vegetation is cleared (Roads and Maritime Services 2011). Around 1.9 hectares of remnant vegetation meeting the description of the critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion would be removed by the proposal (see Section 4.1.1).

As such, an offset strategy is required to be prepared for the proposal under the *Roads and Maritime Guideline for Biodiversity Offsets* (Roads and Maritime Services 2011). Any proposed offset would be in line with the OEH *Principles for the use of Biodiversity Offsets in NSW* (Department of Environment and Climate Change 2008b).The Major Projects module of the BioBanking credit calculator has been used to identify an offset requirement for the proposal (see **Table 5-1**). This offset requirement is indicative as the FBA was not used to undertake the biodiversity assessment and the BioBanking credit calculator has been used in this instance to provide an indication of a suitable offset for the residual impacts of the proposal.

Table 5-1 Indicative ecosystem credits required to offset impacts to Cumberland Plain Woodland

Plant community type (PCT)	Impact (ha)	EEC Offset Multiplier	TS with highest credit req	TS offset multiplier	Ecosystem credits required
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	1.9	3.0	Eastern Freetail-bat	2.2	41

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6 Assessment of significance

An Assessment of Significance has been conducted for threatened species and ecological communities that have been positively identified or that are considered to have a moderate or high likelihood of occurring in the study area.

6.1 Environmental Planning and Assessment Act 1979

The EP&A Act requires that a seven-part test be undertaken to assess the likelihood of a significant impact occurring to a threatened species, population or ecological community listed under the TSC Act.

The document *Threatened Species Assessment Guidelines: The Assessment of Significance* (Department of Environment and Climate Change 2007) outlines a set of guidelines to help applicants/proponents of a development or activity with interpreting and applying the factors of assessment in the seven-part test. The guidance provided by the Department of Environment and Climate Change (2007) has been used here in preparing these seven-part tests.

Full details of assessment of significance under the EP&A Act are presented in Appendix C. The conclusions of the EP&A Act are provided in **Table 6-1**, which indicates that a significant impact is considered unlikely on any threatened ecological communities or species listed under the TSC Act.

Table 6-1 Summary of EP&A Act assessments of significance

Species	Status (TSC Act)	Seven-part test questions							Likely Significant Impact	Potential to occur in the Study area
		1	2	3	4	5	6	7		
Cumberland Plain Woodland in the Sydney Basin Bioregion	CE	NA	NA	N	Y	N	N	Y	No	Present
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	NA	NA	N	Y	N	N	Y	No	Present
Eastern Bentwing-bat	V	N	NA	NA	N	N	N	Y	No	Foraging habitat and potential roosting habitat in culverts
Eastern Freetail-bat	V	Y	NA	NA	N	N	N	Y	No	Foraging habitat and potential roosting habitat in hollow-bearing trees
Southern Myotis	V	Y	NA	NA	N	N	N	Y	No	Foraging habitat and potential roosting habitat in culverts
Grey-headed Flying-fox	V	N	NA	NA	N	N	N	Y	No	Foraging habitat
Swift Parrot	E	N	NA	NA	N	N	N	Y	No	Foraging habitat

Species	Status (TSC Act)	Seven-part test questions	Likely Significant Impact	Potential to occur in the Study area

* Y= Yes (negative impact), N = No (no or positive impact), X = not applicable,

Significance assessment questions

1. In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction
2. In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction
3. In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
    (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
    (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction
4. In relation to the habitat of a threatened species, population or ecological community:
    (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed
    (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action
    (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality
5. Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)
6. Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan
7. Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

6.2 Environment Protection and Biodiversity Conservation Act 1999

For threatened biodiversity listed under the EPBC Act, significance assessments have been completed in accordance with the *Matters of National Environmental Significance, Significant Impact Guidelines 1.1* (Department of the Environment 2013). The following species were assessed, as they are considered moderately likely to occur based on the presence of suitable foraging habitat:

- Grey-headed Flying-fox (vulnerable)
- Swift Parrot (endangered).

The summary of the EPBC Act assessment of significance are provided in **Table 6-2** which indicates that a significant impact is considered unlikely for any Matter of NES and a referral of the proposal would not be required. Full details of the assessment of significance for threatened species under the EPBC Act are presented in Appendix C.

Table 6-2 Summary of EPBC Act assessments of significance

Species/Ecological Community	*Assessment of significance questions (EPBC Act)									Likely Significant Impact	Important Population+
	1	2	3	4	5	6	7	8	9		
Vulnerable species											
Grey-headed Flying-fox (*Pteropus poliocephalus*)	N	N	N	N	N	N	N	N	N	No	Yes
Endangered species											
Swift Parrot (*Lathamus discolour*)	N	N	N	N	N	N	N	N	N	No	NA

* Assessment of significance questions
1) Lead to a long-term decrease in the size of a population
2) Reduce the area of occupancy of the species
3) Fragment an existing population into two or more populations
4) Adversely affect habitat critical to the survival of a species
5) Disrupt the breeding cycle of a population
6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
7) Result in invasive species that are harmful to a species becoming established in the species' habitat
8) Introduce disease that may cause the species to decline
9) Interfere with the recovery of the species.

+ Important population as determined by the EPBC Act is a population of a vulnerable species that:
- is likely to be key source populations either for breeding or dispersal
- is likely to be necessary for maintaining genetic diversity
- is at or near the limit of the species range

The Grey-headed Flying-fox exists as one interconnected population along the east coast of Australia. Therefore, it is considered an important population for the purposes of this assessment.

7 Conclusion

There are around 17 hectares of native vegetation within the study area in varying in condition from poor to moderate. There are no large, undisturbed patches, of vegetation in the study area and most discrete native vegetation patches are less than 1 hectare in size. The exception to this is the planted vegetation along the M4 Motorway and a patch of native vegetation at 1840 The Northern Road, Orchard Hills (adjacent to Frogmore Road). Planted vegetation is prevalent throughout the study area and includes a wide mix of native and exotic species.

Natural fauna habitats in the locality have been largely removed and/or heavily modified by residential and urban development and road infrastructure. However, the habitats in the study area provide limited shelter, breeding and foraging resources for several common frog, reptile and bird species, and are likely to provide habitat for common mammals. Hollow bearing trees were sparse and the lack of hollow-bearing trees is a symptom of the young age cohort of trees and extent of previously clearing. The majority of the vegetation along the M4 Motorway corridor has been planted after construction of the M4 motorway and as such lacks maturity (apart from small pockets with remnant mature trees).

Two threatened ecological communities (TECs) listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) are present in the study area:

- 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.

The vegetation provides some habitat for threatened fauna species. These are all highly mobile species and include the Eastern Bentwing-bat, Eastern Freetail-bat, Southern Myotis, Grey-headed Flying-fox and Swift Parrot. This is generally limited to foraging habitat but the Eastern Freetail-bat may roost in the hollow-bearing trees in the study area. The M4 Motorway overpass is not considered optimal as a roost site for bats, and the likelihood of bats roosting under the bridge is considered low. A survey for roosting bats was conducted near Glenmore Parkway given the presence of culverts to be demolished as part of the project. The survey determined that bats were not present at the time and there are limited opportunities for bats to roost in these structures. However, the potential for bats to roost in these structures prior to their demolition should be considered.

The construction footprint would impact on up to around 2.4 hectares of remnant native vegetation and up to 3.9 hectares of planted vegetation along the M4 Motorway (6.3 hectares in total). The predicted impacts to remnant Cumberland Plain Woodland in the Sydney Basin Bioregion TEC is around 1.9 hectares. Impacts to the River-Flat Eucalypt Forest TEC are predicted to be minimal at 0.4 hectares. When considered in the context of the locality (the area within 10 km of the proposal) the proportional impact is small.

An Assessment of Significance has been conducted for threatened species and ecological communities that have been positively identified or that are considered to have a moderate or high likelihood of occurring in the study area. Provided the mitigation measures detailed in Chapter 5 are adequately implemented, the proposal is unlikely to have a significant impact on any threatened species, populations or ecological communities listed under the TSC Act and/or EPBC Act.

Some residual impacts would occur. It is Roads and Maritime policy that biodiversity offsets are to be provided where more than 1 hectare of high conservation value vegetation is cleared. As such, an offset strategy is required to be prepared for the proposal.

8 References

Berthinussen, A & Altringham, J 2012, 'The effect of a major road on bat activity and diversity', *Journal of Applied Ecology*, vol. 49, no. 1, pp. 82-9.

Bureau of Meteorology 2016, *Groundwater Dependent Ecosystems Atlas*, <http://www.bom.gov.au/water/groundwater/gde/>.

Clarke, NR & Jones, DC 1991, *Geology of the Penrith 1:100,000 Sheet 9030*, 1st edn, Geological Survey of New South Wales, Sydney,

Department of Environment and Climate Change 2007, *Threatened species assessment guidelines. The assessment of significance*, Department of Environment and Climate Change, Hurstville.

Department of Environment and Climate Change 2008a, *Descriptions for NSW (Mitchell) Landscapes Version 2 (2002)* Department of Environment and Climate Change, Sydney.

Department of Environment and Climate Change 2008b, *Principles for the use of Biodiversity Offsets in NSW*.

Department of Environment Climate Change and Water 2009, *Draft National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus*, Department of Environment, Climate Change and Water, Sydney.

Department of Environment Climate Change and Water 2011, *Cumberland Plain Recovery Plan*, Department of Environment, Climate Change and Water, Sydney,

Department of Primary Industries 2016a, *Listed threatened species, populations and ecological communities*, <http://www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what-current>.

Department of Primary Industries 2016b, *Noxious Weed Declarations Web Site*, <http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed>.

Department of Sustainability Environment Water Population and Communities 2012, *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*, Australian Government, Canberra,

Department of the Environment 2013, *Matters of National Environmental Significance Significant Impact Guidelines 1.1*, Commonwealth Government Department of the Environment, Canberra

Department of the Environment 2015a, *Draft referral guideline for 14 birds listed as migratory species under the EPBC Act*, Commonwealth of Australia, Canberra.

Department of the Environment 2015b, *EPBC Act Policy Statement 3.21: Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species*, Department of the Environment, Canberra.

Department of the Environment 2016, *Protected Matters Search Tool*, <http://www.environment.gov.au/epbc/pmst/index.html>.

Fairfull, S & Witheridge, G 2003, *Why do fish need to cross the road? Fish passage requirements for waterway crossings*, NSW Fisheries, Cronulla.

GHD 2015, *Western Sydney Airport EIS Biodiversity Assessment*, Sydney.

Hazelton, PA, Bannerman, SM & Tillie, PJ 1989, *Soil landscapes of the Penrith 1:100,000 Sheet 9030*, Soil conservation Service of NSW, Sydney. ,

Jacobs 2015, *M4 Smart Motorway Biodiversity Assessment* Jacobs, Sydney.

Jacobs 2016, *The Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park Biodiversity Assessment Report (BAR)*, St Leonards.

Keeley, BW & Tuttle, MD 1999, *Bats in American Bridges*, Bat Conservation International Inc., Austin, Texas.

Kuginis, L, Byrne, G, Serov, P & Williams, JP 2012, *Risk assessment guidelines for groundwater dependent ecosystems Volume 3 – Identification of high probability groundwater dependent ecosystems on the coastal plains of NSW and their ecological value*, Department of Primary Industries, Office of Water, Sydney.

McAlpine, CA, Fensham, RJ & Temple-Smith, DE 2002, 'Biodiversity conservation and vegetation clearance in Queensland:principles and thresholds', *The Rangeland Journal*, vol. 24, no. 36-55.

McConville, A 2014, 'The ecology of the east-coast free-tailed bat (Mormopterus norfolkensis) in the Hunter region', University of Newcastle.

Morgan, G 2001, *Delineation and description of the Eastern Environmental Subregions (provinces) in New South Wales Study*, NSWNPWS, <http://www.environment.nsw.gov.au/bioregions/SydneyBasin-Subregions.htm>.

NSW National Parks and Wildlife Service 2002, *Landscapes (Mitchell) of NSW*, NSW National Parks and Wildlife Service, Hurstville

NSW Roads and Traffic Authority 2011, *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects*, NSW Roads and Traffic Authority, Sydney.

NSW Scientific Committee 2010, *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - Determination to make minor amendment to Part 3 of Schedule 1 of the Threatened Species Conservation Act*, Hurstville.

Office of Environment and Heritage 2015, *NSW Vegetation Information System: Classification 2.1*, NSW Government, viewed 03/08/2015 2015, <http://www.environment.nsw.gov.au/NSWVCA20PRapp/default.aspx>.

Office of Environment and Heritage 2016, *BioNet the Atlas of NSW Wildlife Database Search*, <http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx>.

Roads and Maritime Services 2011, *Guideline for Biodiversity Offsets*, Roads and Maritime Services, Sydney.

Roads and Maritime Services 2015, *Environmental Assessment and Decision-making by NSW Roads and Maritime Services: Strategic Assessment - Under Part 10, Environment Protection and Biodiversity Conservation Act 1999 Strategic Assessment Report - Final*, Roads and Maritime Services, Sydney.

Serov, P, Kuginis, L & Williams, JP 2012, *Risk assessment guidelines for groundwater dependent ecosystems, Volume 1 – The conceptual framework*, NSW Department of Primary Industries, Office of Water, Sydney.

Siemers, BM & Schaub, A 2011, 'Hunting at the highway: traffic noise reduces foraging efficiency in acoustic predators', *Proceedings of the Royal Society of London B: Biological Sciences*, vol. 278, no. 1712, pp. 1646-52.

Stone, EL, Jones, G & Harris, S 2009, 'Street Lighting Disturbs Commuting Bats', *Current Biology*, vol. 19, no. 13, pp. 1123-7.

Swift Parrot Recovery Team 2001, *Swift Parrot Recovery Plan*, Department of Primary Industries, Water and Environment, Hobart.

Thackway, R & Cresswell, ID 1995, *An Interim Biogeographic Regionalisation of Australia*, Australian Nature Conservation Agency, Canberra.

Tozer, M 2003, 'The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities', *Cunninghamia*, vol. 8, no. 1, pp. 1-75.

Tozer, M, Turner, K, Keith, D, Tindall, D, Pennay, C, Simpson, C, MacKenzie, B, Beukers, P & Cox, S 2010, 'Native Vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands', *Cunninghamia*, vol. 11, no. 3, pp. 359-406.

Zurcher, AA, Sparks, DW & Bennett, VJ 2010, 'Why the Bat Did Not Cross the Road?', *Acta Chiropterologica*, vol. 12, no. 2, pp. 337-40.

Terms and acronyms used in this Biodiversity Assessment

Term / acronym	Meaning
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: • genetic diversity — the variety of genes (or units of heredity) in any population • species diversity — the variety of species • ecosystem diversity — the variety of communities or ecosystems.
Bioregion	The broader bioregional context defined by Thackway and Creswell (1995) as the Sydney Bioregion as defined in the Interim Biogeographic Regionalisation for Australia.
Carrying capacity	The carrying capacity of a species in an environment is the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water and other necessities available in the environment.
CEMP	Construction Environmental Management Plan.
CMA	Catchment Management Authority.
Critical habitat	Critical habitat is listed under the TSC Act and a register is maintained of this habitat.
DBH	Diameter at breast height.
DEC	Department of Environment and Conservation.
DECC	Department of Environment and Climate Change.
DECCW	Department of Environment, Climate Change and Water.
DoE	Commonwealth Department of the Environment.
DPI	Department of Primary Industries.
Ecological community	An assemblage of species occupying a particular area.
EIS	Environmental Impact Statement.
EP&A Act	*Environmental Planning and Assessment Act 1979*.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
GPS	Global positioning system. A navigational tool that uses radio receivers to pick up signals from four or more satellites to provide determination of location.
Habitat	An area or areas permanently, periodically or occasionally occupied by a species, population or ecological community, including any and all biotic and abiotic features of the area or areas occupied.
Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities. Key threatening processes are listed under the TSC Act, the FM Act and the EPBC Act.

Term / acronym	Meaning
Local population	The population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated.
Locality	The area within a 10 km of the Study Area.
Migratory species	Species listed as migratory under the EPBC Act relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals.
MNES	Matter of National Environmental Significance.
Noxious weed	An introduced species listed under the *Noxious Weeds Act 1993*. Under the Act, noxious weeds have specific control measure and reporting requirements.
NPW Act	*National Parks and Wildlife Act 1974.*
NPWS	National Parks and Wildlife Service (now included under OEH).
NSW	New South Wales.
OEH	NSW Office of Environment and Heritage.
Patch (vegetation), Patch size	Under the EPBC Act, a patch is defined as a discrete and continuous area of the ecological community. However, a patch may include small-scale disturbances, such as tracks or breaks or small-scale variations in vegetation that do not significantly alter its overall functionality (for instance the movement of wildlife or dispersal of plant propagules).
Proposal footprint	Refers to the area of bridge replacement and includes any ancillary locations or drainage structures.
Riparian	Transition zone between land and watercourse.
REF	Review of Environmental Factors.
Roads and Maritime	Roads and Maritime Services NSW.
RTA	Roads and Traffic Authority NSW (now known as the Roads and Maritime).
SEPP	State Environmental Planning Policy.
Significant, Significant Impact	Important, weighty or more than ordinary as defined by Department of Environment, Climate Change and Water. A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of the Environment 2013).
SIS	Species impact Statement.
Study area	Encompasses the proposal footprint and any adjoining or adjacent habitat where potential indirect impacts may occur.

Term / acronym	Meaning
TEC	Threatened Ecological Communities. For the purposes of this report this includes ecological communities listed or nominated under the EPBC Act and ecological communities listed or nominated under the TSC Act.
Threatened biodiversity	Threatened species, populations or ecological communities as listed under the TSC Act or the EPBC Act.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the TSC Act or the EPBC Act.
TSC Act	*Threatened Species Conservation Act 1995.*
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references.

Appendix A Flora and fauna species lists

Table A.1 Flora species list for the study area

Family	Scientific name	Common name	Native	Plot number					
				1	2	3	4	5	6
Acanthaceae	*Brunoniella australis*	Blue Trumpet	Y		✓	✓	✓		
Alismataceae	*Damasonium minus*	Starfruit	Y						✓
Amaranthaceae	*Gomphrena celosioides*	Gomphrena Weed	N					✓	
Anthericaceae	*Arthropodium milleflorum*	Vanilla Lily	Y	✓	✓	✓			
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery	N			✓			
Apocynaceae	*Araujia sericifera*	Moth Vine	N		✓				✓
Arecaceae	*Phoenix canariensis*	Canary Island Date Palm	N				✓		✓
Asclepiadaceae	*Araujia sericifera*	Moth Vine	N						
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	N				✓		✓
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	N			✓	✓	✓	
	Bidens tripartita	Burr Marigold	N						✓
	Calotis lappulacea	Yellow Burr-daisy	Y				✓		
	Cirsium vulgare	Spear Thistle	N	✓	✓	✓	✓	✓	
	Conyza bonariensis	Flaxleaf Fleabane	N			✓		✓	
	Gamochaeta americana	American Cudweed	N			✓			
	Hypochaeris radicata	Catsear	N		✓	✓	✓		
	Leontodon taraxacoides	Hairy Hawkbit	N			✓			
	Senecio madagascariensis	Fireweed	N	✓	✓	✓	✓		
	Sonchus oleraceus	Common Sow thistle	N				✓		
	Taraxacum officinale	Dandelion	N	✓	✓			✓	
	Xanthium strumarium		N						✓
Brassicaceae	*Brassica* sp.		N				✓		
Campanulaceae	*Wahlenbergia gracilis*	Sprawling or Australian Bluebell	Y			✓			
Caryophyllaceae	*Cerastium glomeratum*	Mouse-ear Chickweed	N					✓	
Casuarinaceae	*Casuarina glauca*	Swamp Oak	Y						✓
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	Y	✓					✓

Family	Scientific name	Common name	Native	Plot number					
	Einadia polygonoides		Y					✓	✓
Commelinaceae	*Commelina cyanea*		Y				✓		✓
Convolvulaceae	*Dichondra repens*	Kidney Weed	Y	✓	✓	✓	✓		
Crassulaceae	*Bryophyllum delagoense*	Mother of millions	N				✓		
Cyperaceae	*Cyperus eragrostis*		N						✓
	Cyperus gracilis		Y					✓	
Fabaceae (Caesalpinoideae)	*Senna pendula* var. *glabrata*	Cassia	N						✓
Fabaceae (Faboideae)	*Glycine clandestina*		Y				✓		
	Glycine tabacina		Y	✓	✓	✓		✓	
	Hardenbergia violacea	False Sarsaparilla	Y				✓		
	Lotus sp.	Trefoil	N	✓	✓		✓		
	Medicago polymorpha	Burr Medic	N		✓	✓			
	Trifolium repens	White Clover	N					✓	
Juncaceae	*Juncus usitatus*		Y	✓					
Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush	Y		✓	✓	✓		
Loranthaceae	*Muellerina eucalyptoides*		Y			✓			
Malvaceae	*Modiola caroliniana*	Red-flowered Mallow	N	✓				✓	✓
	Sida rhombifolia	Paddy's Lucerne	N	✓		✓	✓	✓	✓
Myrsinaceae	*Anagallis arvensis*	Scarlet Pimpernel	N	✓	✓	✓	✓		
Myrtaceae	*Eucalyptus amplifolia*	Cabbage Gum	Y						✓
	Eucalyptus crebra	Narrow-leaved Ironbark	Y				✓		
	Eucalyptus moluccana	Grey Box	Y	✓	✓				
	Eucalyptus tereticornis	Forest Red Gum	Y		✓		✓	✓	
	Melaleuca linariifolia	Flax-leaved Paperbark	Y						✓
Oleaceae	*Ligustrum sinense*	Small-leaved Privet	N						✓
	Olea europaea subsp. *cuspidata*	African Olive	N				✓		
Oxalidaceae	*Oxalis perennans*		Y	✓			✓	✓	
Pittosporaceae	*Bursaria spinosa*	Native Blackthorn	Y		✓		✓		

Family	Scientific name	Common name	Native	Plot number					
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	N		✓	✓	✓	✓	
Poaceae	*Aristida vagans*	Threeawn Speargrass	Y				✓	✓	
	Bothriochloa macra	Red Grass	Y		✓	✓		✓	
	Bromus catharticus	Prairie Grass	N			✓	✓	✓	✓
	Chloris gayana	Rhodes Grass	N			✓			✓
	Chloris ventricosa	Tall Chloris	Y			✓	✓		
	Cynodon dactylon	Common Couch	Y		✓		✓	✓	
	Echinochloa crus-galli	Barnyard Grass	N						✓
	Eleusine tristachya	Goose Grass	N					✓	
	Eragrostis curvula	African Lovegrass	N	✓	✓			✓	
	Eriochloa pseudoacrotricha	Early Spring Grass	Y					✓	
	Lachnagrostis filiformis	Blown Grass	Y		✓	✓			
	Lolium perenne	Perennial Ryegrass	N				✓		
	Oplismenus imbecillis	Basket Grass	Y						✓
	Paspalidium distans		Y					✓	
	Paspalum dilatatum	Paspalum	N			✓	✓	✓	✓
	Pennisetum clandestinum	Kikuyu Grass	N				✓	✓	
	Phragmites australis	Common Reed	Y						✓
	Poa annua	Winter Grass	N		✓				
	Setaria gracilis	Slender Pigeon Grass	N					✓	
	Sporobolus africanus	Parramatta Grass	N					✓	
	Themeda triandra	Kangaroo Grass	Y				✓		
	Vulpia myuros	Rat's Tail Fescue	N	✓					
Polygonaceae	*Persicaria hydropiper*	Water Pepper	Y						✓
	Persicaria strigosa	Spotted Knotweed	Y						✓
Rubiaceae	*Asperula conferta*	Common Woodruff	Y	✓		✓			
	Richardia stellaris		N		✓	✓			
Sapindaceae	*Cardiospermum grandiflorum*	Balloon Vine	N						✓

Family	Scientific name	Common name	Native	Plot number					
Solanaceae	*Solanum linnaeanum*	Apple of Sodom	N	✓					
	Solanum nigrum	Black-berry Nightshade	N	✓					
	Solanum pseudocapsicum	Jerusalem Cherry	N						✓
Typhaceae	*Typha orientalis*	Broad-leaved Cumbungi	Y				✓		✓

Table A.2 Fauna species list for the study area

Species	Common name	Native
REPTILES		
SCINCIDAE		
Lampropholis guichenoti	Grass Skink	Y
AMPHIBIANS		
MYOBATRACHIDAE		
Crinia signifera	Common Eastern Froglet	Y
Limnodynastes peronii	Striped Marsh Frog	Y
BIRDS		
ANATIDAE		
Chenonetta jubata	Australian Wood Duck	Y
Anas superciliosa	Black Duck	Y
ARDEIDAE		
Ardea ibis	Cattle Egret	Y
Egretta novaehollandiae	White-faced Heron	Y
FALCONIDAE		
Falco cenchroides	Nankeen Kestrel	Y
RALLIDAE		
Porphyrio porphyrio	Purple Swamphen	Y
CHARADRIIDAE		
Vanellus miles	Masked Lapwing	Y
CACATUIDAE		
Cacatua galerita	Sulphur-crested Cockatoo	Y
PSITTACIDAE		
Trichoglossus haematodus	Rainbow Lorikeet	Y
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	Y
Platycercus eximius	Eastern Rosella	Y

Species	Common name	Native
HALCYONIDAE		
Dacelo novaeguineae	Laughing Kookaburra	Y
MALURIDAE		
Malurus cyaneus	Superb Fairy-wren	Y
PARDALOTIDAE		
Pardalotus punctatus	Spotted Pardalote	Y
Acanthiza lineata	Striated Thornbill	Y
MELIPHAGIDAE		
Anthochaera carunculata	Red Wattlebird	Y
Philemon corniculatus	Noisy Friarbird	Y
Manorina melanocephala	Noisy Miner	Y
Lichenostomus chrysops	Yellow-faced Honeyeater	Y
DICRURIDAE		
Rhipidura leucophrys	Willie Wagtail	Y
Rhipidura fuliginosa	Grey Fantail	Y
Grallina cyanoleuca	Magpie-lark	Y
CAMPEPHAGIDAE		
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Y
ARTAMIDAE		
Cracticus torquatus	Grey Butcherbird	Y
Gymnorhina tibicen	Australian Magpie	Y
Strepera graculina	Pied Currawong	Y
CORVIDAE		
Corvus coronoides	Australian Raven	Y
PASSERIDAE		
Passer domesticus	House Sparrow	N
Neochmia temporalis	Red-browed Firetail	Y
HIRUNDINIDAE		
Hirundo neoxena	Welcome Swallow	Y
STURNIDAE		
Sturnus vulgaris	Common Starling	N

Appendix B Likelihood of occurrence assessment for threatened species

Likelihood of occurrence assessment for threatened species

The following assessment identifies the list of threatened flora and fauna species recorded from a 10 km radius of the proposal and compares the preferred habitat of these species with the habitats identified in the study area to assess the likelihood of the species being present in the proposal study area (ie subject species). The criteria used in the assessment are detailed below.

Table B.1 Criteria used in the likelihood of occurrence assessment

Likelihood of Occurrence	Criteria
Unlikely	Species not recorded during field surveys and fit one or more of the following criteria: • Species highly restricted to certain geographical areas not within the study area. • Species with specific habitat requirements that are not present in the study area.
Low	Species not recorded during field surveys and fit one or more of the following criteria: • Have not been recorded previously in the study area/locality and for which the study area is beyond the current distribution range. • Have been recorded sporadically in the locality in the past but are considered a low likelihood to use the study area as habitat due to the absence of any high quality habitat features upon which the species depends. • Use specific habitats or resources not present in the study area. • Are flora species that were specifically targeted by seasonal surveys and not recorded.
Moderate	Species not recorded during the field surveys that fit one or more of the following criteria: • Have frequently been recorded in the study area/locality and are known to be present in the locality. • Use specific habitats or resources that are present in the study area (eg for foraging or roosting/breeding). • Species that are unlikely to maintain sedentary populations however may seasonally use resources within the study area opportunistically or during migration if the habitat is good quality. • Are flora species that were not targeted by seasonal surveys but have suitable habitat in the study area.
High	Species recorded during the field surveys or species not recorded that fit one or more of the following criteria: • Have frequently been recorded previously in the study area/surrounds. • Use habitat types or resources that are present in the study area and/or the habitats in the study area are in good condition. • Are known or likely to maintain resident populations in the study area. • Are known or likely to visit the site during regular seasonal movements or migration due to the presence of high quality habitats.
Present	A species recorded in the study area during the field surveys.

Table B.2 Likelihood of occurrence assessment for threatened flora species

Species	Status		Distribution and habitat requirements*	Data source+	Likelihood of occurrence in the study area
	EPBC Act	TSC Act			
Bynoe's Wattles *Acacia bynoeana*	V	E	Found in central eastern NSW, from the Hunter District south to the Southern Highlands and west to the Blue Mountains. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood (*Corymbia gummifera),* Scribbly Gum *(Eucalyptus haemastoma),* Drooping Red Gum *(E. parramattensis),* Old Man Banksia *(Banksia serrata)* and Small-leaved Apple *(Angophora bakeri).*	21 PMST	Unlikely No suitable habitat for this species is present
Downy Wattle *Acacia pubescens*	V	V	Concentrated around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/ Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland. Occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravely soils, often with ironstone.	7 PMST	Low This species was not recorded during surveys
Allocasuarina glareicola	E	E	Primarily restricted to the Richmond (NW Cumberland Plain) district, but with an outlier population found at Voyager Point, Liverpool. Grows in Castlereagh woodland on lateritic soil. Found in open woodland with *Eucalyptus parramattensis, Eucalyptus fibrosa, Angophora bakeri, Eucalyptus sclerophylla* and *Melaleuca decora*. Common associated understorey species include *Melaleuca nodosa, Hakea dactyloides, Hakea sericea, Dillwynia tenuifolia, Micromyrtus minutiflora, Acacia elongata, Acacia brownei, Themeda australis* and *Xanthorrhoea minor.*	11 PMST	Unlikely No suitable habitat for this species is present
Asterolasia elegans	E	E	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby local government areas. Also likely to occur in the western part of Gosford local government area. Known from only seven populations, only one of which is wholly within a conservation reserve. Occurs on Hawkesbury sandstone. Found in sheltered forests on mid- to lower slopes and valleys, for example in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (*Syncarpia glomulifera subsp. glomulifera*), Smooth-barked Apple (*Angophora costata*), Sydney Peppermint (*Eucalyptus piperita*), Forest Oak (*Allocasuarina torulosa*) and Christmas Bush (*Ceratopetalum gummiferum*).	PMST	Unlikely No suitable habitat for this species is present

Species	Status		Distribution and habitat requirements*	Data	Likelihood of occurrence
White-flowered Wax Plant *Cynanchum elegans*	E	E	Occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree (*Leptospermum laevigatum*) – Coastal Banksia (*Banksia integrifolia subsp. integrifolia*) coastal scrub; Forest Red Gum (*Eucalyptus tereticornis*) aligned open forest and woodland; Spotted Gum (*Corymbia maculata*) aligned open forest and woodland; and Bracelet Honeymyrtle (*Melaleuca armillaris*) scrub to open scrub.	PMST	Low This species was not recorded during surveys
Dillwynia tenuifolia	–	V	Core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in Western Sydney are recorded at Voyger Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. Disjunct localities include the Bulga Mountains at Yengo in the north, and Kurrajong Heights and Woodford in the Lower Blue Mountains. In western Sydney, it may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone.	240	Low This species was not recorded during surveys
Black Gum *Eucalyptus aggregata*	V	V	Black Gum is found in the NSW Central and Southern Tablelands, with small isolated populations in Victoria and the ACT. In NSW, it occurs in the South Eastern Highlands Bioregion and on the western fringe of the Sydney Basin Bioregion. Black Gum has a moderately narrow distribution, occurring mainly in the wetter, cooler and higher parts of the tablelands, for example in the Blayney, Crookwell, Goulburn, Braidwood and Bungendore districts. Grows on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers	PMST	Unlikely No suitable habitat for this species is present
Camden White Gum *Eucalyptus benthamii*	V	V	Occurs on the alluvial flats of the Nepean River and its tributaries. There are two major subpopulations: in the Kedumba Valley of the Blue Mountains National Park and at Bents Basin State Recreation Area. A further 18 trees are scattered along the Nepean River, south to The Oaks. Requires a combination of deep alluvial sands and a flooding regime that permits seedling establishment. Occurs in open forest. Associated species at the Bents Basin site include *Eucalyptus elata, E. baueriana, E. amplifolia, E. deanei* and *Angophora subvelutina*. Understorey species include *Bursaria spinosa, Pteridium esculentum* and a wide variety of agricultural weeds. The Kedumba Valley site lists *E. crebra, E. deanei, E. punctata, Leptospermum flavescens, Acacia filicifolia* and *Pteridium esculentum* among its associated species.	25 PMST	Unlikely No suitable habitat for this species is present

Species	Status		Distribution and habitat requirements*	Data	Likelihood of occurrence
Bauer's Midge Orchid *Genoplesium baueri*	–	V	Recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. The species has been recorded at locations now likely to be within the several conservation reserves including Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Found in sparse sclerophyll forest and moss gardens over sandstone	PMST	Unlikely No suitable habitat for this species is present
Juniper-leaf Grevillea *Grevillea juniperina* subsp. *juniperina*	–	V	Endemic to Western Sydney centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kemps Creek and Pitt Town. Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium often with a shale influence, typically containing lateritic gravels. Recorded from Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest.	1018 PMST	Low This species was not recorded during surveys
Small-flower Grevillea *Grevillea parviflora subsp. parviflora*	V	V	Sporadically distributed throughout the Sydney Basin with the main occurrence centred on Picton, Appin and Bargo. Separate populations are also known further north from Putty to Wyong and Lake Macquarie on the Central Coast, and Cessnock and Kurri Kurri in the Lower Hunter. Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Often occurs in open, slightly disturbed sites such as along tracks.	2 PMST	Unlikely No suitable habitat for this species is present
Hibbertia puberula	–	E	Has not been seen for over 40 years. Early records of this species are from the Hawkesbury River area and Frenchs Forest in northern Sydney, South Coogee in eastern Sydney, the Hacking River area in southern Sydney, and the Blue Mountains. Occurs on sandy soil often associated with sandstone.	1	Unlikely No suitable habitat for this species is present
Hypsela sessiliflora	X	E	Currently known from only two adjacent sites on a single private property between Mamre Rd and Sarah Andrews Cl at Erskine Park. Thought to be extinct until recorded in 1999 and in 2002. Now recognised as a form of *Isotoma fluviatilis* subsp. *fluviatilis*.	7	Low Restricted to two sites in Erskine Park. No longer considered a distinct species
Marsdenia viridiflora subsp. *viridiflora* (endangered population)	–	E2	Endangered population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas. Grows in vine thickets and open shale woodland.	210	Low This species was not recorded during surveys

Species	Status		Distribution and habitat requirements*	Data	Likelihood of occurrence
Deane's Paperbark *Melaleuca deanei*	V	V	Deane's Paperbark occurs in two distinct areas, in the Ku-ring-gai, Berowra, Holsworthy and Wedderburn areas, and there are also more isolated occurrences at Springwood, Wollemi National Park, Yalwal and the Central Coast areas. The species grows in heath on sandstone	1 PMST	Unlikely No suitable habitat for this species is present
Micromyrtus minutiflora	V	E	Restricted between Richmond and Penrith of western Sydney. Grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest and open forest on tertiary alluvium.	34 PMST	Unlikely No suitable habitat for this species is present
Omeo Storksbill (*Pelargonium* sp. Striatellum G.W. Carr 10345)	E	E	Known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. A population at a fourth known site on the Monaro has not been seen in recent years. The only other known population is at Lake Omeo, Victoria. It occurs at altitudes between 680 to 1030 m. It is known to occur in the local government areas of Goulburn-Mulwaree, Cooma-Monaro, and Snowy River, but may occur in other areas with suitable habitat; these may include Bombala, Eurobodalla, Palerang, Tumbarumba, Tumut, Upper Lachlan, and Yass Valley local government areas. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities. It sometimes colonises exposed lake beds during dry periods.	PMST	Low This species is not known from Sydney
Hairy Geebung *Persoonia hirsuta*	E	E	The Hairy Geebung has been recorded in the Sydney coastal area, the Blue Mountains area and the Southern Highlands. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone.	6 PMST	Unlikely No suitable habitat for this species is present
Nodding Geebung *Persoonia nutans*	E	E	Restricted to the Cumberland Plain in western Sydney, between Richmond in the north and Macquarie Fields in the south. Core distribution occurs within the Penrith, and to a lesser extent, Hawkesbury LGAs, with isolated and relatively small populations also occurring in the Liverpool, Campbelltown, Bankstown and Blacktown LGAs. Confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities, with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland.	87 PMST	Low This species was not recorded during surveys
Slender Curved Rice Flowers *Pimelea curviflora* var. *curviflora*	V	V	Confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. Former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.	PMST	Unlikely No suitable habitat for this species is present

Species	Status		Distribution and habitat requirements*	Data	Likelihood of occurrence
Spiked-rice Flower *Pimelea spicata*	E	E	Broad distribution in western Sydney, occurring on the Cumberland Plain (Narellan, Marayong, Prospect Reservoir areas). Another smaller population is recorded in districts (Landsdowne to Shellharbour to northern Kiama) Illawarra. It grows on well-structured clay soils. On the inland Cumberland Plain sites it is associated with Grey Box and Ironbark. In the coastal Illawarra it occurs commonly in Coastal Banksia open woodland with a more well developed shrub and grass understorey.	8 PMST	Low This species was not recorded during surveys. Habitat is highly degraded and not optimal
Brown Pomaderris *Pomaderris brunnea*	V	V	Found in a very limited area around the Nepean and Hawkesbury Rivers, including the Bargo area. It also occurs at Walcha on the New England tablelands and in far eastern Gippsland in Victoria. Grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	PMST	Unlikely No suitable habitat for this species is present
Tall Rustyhood *Pterostylis chaetophora*	–	V	Occurs in Queensland and NSW. In NSW it is currently known from c. 18 scattered locations in a relatively small area. It occurs in an area between Taree and Kurri Kurri, extending to the south-east towards Tea Gardens and west into the Upper Hunter, with additional records near Denman and Wingen. There are also a few records from the Sydney region (Glenhaven (1949), Ingleburn (1987) and Picnic Point (1987)), but it is unclear if any of these populations still exist.	1	Unlikely No suitable habitat for this species is present
Illawarra Greenhood *Pterostylis gibbosa*	E	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Forest Red Gum (*Eucalyptus tereticornis*) and Black Cypress Pine (*Callitris endlicheri*).	PMST	Unlikely It is apparently extinct in western Sydney
Sydney Plains Greenhood *Pterostylis saxicola*	E	E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south. There are very few known populations and they are all very small and isolated. Only one population occurs within a conservation reserve at Georges River National Park. Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where it occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils.	1 PMST	Unlikely No suitable habitat for this species is present
Smooth Bush-pea (*Pultenaea glabra*)	V	V	Restricted to the higher Blue Mountains and has been recorded from the Katoomba-Hazelbrook and Mount Victoria areas, with unconfirmed sightings in the Mount Wilson and Mount Irvine areas. All known populations occur within the Blue Mountains Local Government Area. Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	PMST	Unlikely No suitable habitat for this species is present

Species	Status		Distribution and habitat requirements*	Data	Likelihood of occurrence
Sydney-bush Pea *Pultenaea parviflora*	E	E	Endemic to the Cumberland Plain the core distribution is from Windsor to Penrith and east to Dean Park. Outlier populations are recorded from Kemps Creek and Wilberforce. May be locally abundant, particularly within scrubby/dry heath areas of Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. *Eucalyptus fibrosa* is usually the dominant canopy species. *Eucalyptus globoidea, E. longifolia, E. parramattensis, E. sclerophylla* and *E. sideroxylon* may also be present or co-dominant, with *Melaleuca decora* frequently forming a secondary canopy layer. Associated species may include *Allocasuarina littoralis, Angophora bakeri, Aristida* spp. *Banksia spinulosa*, *Cryptandra* spp., *Daviesia ulicifolia*, *Entolasia stricta, Hakea sericea, Lissanthe strigosa, Melaleuca nodosa, Ozothamnus diosmifolius* and *Themeda australis*.	203 PMST	Low This species was not recorded during surveys.
Eastern Australian Underground Orchid *Rhizanthella slateri*	E	V	Occurs from south-east Queensland to south-east NSW. In NSW, currently known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest.	PMST	Low This species is not known from the study area
Kangaloon Sun Orchid *Thelymitra sp. Kangaloon*	CE	CE	Only known to occur on the southern tablelands of NSW in the Moss Vale / Kangaloon / Fitzroy Falls area at 550-700 m above sea level. It is known to occur at three swamps that are above the Kangaloon Aquifer. It is found in swamps in sedgelands over grey silty grey loam soils	PMST	Unlikely No suitable habitat for this species is present, restricted to Kangaloon
Austral Toad-flax (*Thesium australe*)	V	V	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (*Themeda australis*). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.	PMST	Low This species is not known from the study area

* Distribution and habitat requirement information adapted from:

- Australian Government Department of the Environment http://www.environment.gov.au/biodiversity/threatened/index.html
- NSW Office of Environment and Heritage http://www.environment.nsw.gov.au/threatenedspecies/

+ Data source includes

- Number of records from the NSW Office of Environment and Heritage Wildlife Atlas record data; and
- Identified from the Protected Matters Search Tool (PMST) http://www.environment.gov.au/epbc/pmst/index.html

Key:

- CE = critically endangered
- E = endangered
- V = vulnerable

Table B.3 Likelihood of occurrence assessment for threatened fauna species

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
	EPBC Act	TSC Act			
Mammals					
Brush-tailed Rock Wallaby (*Petrogale penicillata*)	E	E	Open forest habitats on steep terrain with exposed rocks, rock overhangs and platforms.	PMST	Unlikely No suitable habitat is present for this species
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	–	V	Occurs on east and north west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	41	Moderate Several records from urbanised areas of Penrith LGA and considered likely to forage in the study area. Potential seasonal roosting habitat in culverts under Glenmore Parkway
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	–	V	Occurs in a variety of open forest and woodland habitats with hollow-bearing trees. Requires hollows for roosting. May forage in re-growth and modified environments.	6	Low No suitable habitat is present in the study area, needs tall forests
Eastern Freetail-bat (*Mormopterus norfolkensis*)	–	V	Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in human-made structures.	24	Moderate Likely to forage in the study area, may potentially roost in hollow-bearing trees
Eastern Pygmy Possum (*Cercartetus nanus*)	–	V	Found in a broad range of habitats from rainforest through to wet and dry sclerophyll forest and woodland to heath, but in most areas woodlands and heath appear to be preferred.	1	Low No suitable habitat is present in the study area
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	–	V	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings.	13	Low Sensitive to urbanisation, not recorded in urbanised areas of Penrith LGA. Habitats not optimal. Considered low likelihood of occurrence.

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Forages on nectar and pollen in sclerophyll forests and on rainforest fruits and vines, orchards, gardens.	51 PMST	Moderate Likely to forage in the study area, no roosting habitat present
Koala (*Phascolarctos cinereus*)	V	V	The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. It was briefly historically abundant in the 1890s in the Bega District on the south coast of NSW, although not elsewhere, but it now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands. Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	24 PMST	Low No known Koala populations exist in the study area and this species was not recorded during surveys. Habitat for this species is poor quality
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	Forages over a broad range of open forest and woodland habitats, this species is a cave roosting bat which favours sandstone escarpment habitats for roosting, in the form of shallow overhangs, crevices and caves.	4 PMST	Low Unlikely to forage in the study area and no roosting habitat present
Little Bent-wing Bat (*Miniopterus australis*)	–	V	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest	2	Low Unlikely to forage in the study area and no roosting habitat present
New Holland Mouse (*Pseudomys novaehollandiae*)	V	–	Distribution is fragmented across all eastern states of Australia, where it inhabits open heath lands, open woodlands with heath understorey and vegetated sand dunes.	PMST	Unlikely No suitable habitat is present for this species
Southern Myotis (*Myotis macropus*)	–	V	Generally roost in groups close to water in caves, mine shafts, hollow-bearing trees, and storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools catching insects and small fish.	31	Moderate Some suitable forgaing habitat present in drainage line under Glenmore Parkway and farm dams. Potential roosting habitat in culverts under Glenmore Parkway.
Spotted-tailed Quoll (*Dasyurus maculatus*)	E	V	Wet and dry sclerophyll forests and rainforests, and adjacent open agricultural areas. Generally associated with large expansive areas of habitat to sustain territory size. Requires hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	15 PMST	Unlikely This species needs large expansive areas of high quality habitat. Old records from 1980s in Penrith no longer valid

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Squirrel Glider (*Petaurus norfolcensis*)	–	V	Forest and woodland habitats, particularly areas with a diversity of eucalypt species in the canopy and other suitable food resources (shrubs and small trees). Requires tree hollows for denning.	1	Low This species is not known from the study area and habitat is disturbed, no tree hollows are present
Yellow-bellied Glider (*Petaurus australis*)	–	V	Tall open forest habitats, favours mature wet sclerophyll forest and dense gullies.	8	Unlikely This species is not known from the study area and habitat is disturbed, all records are from lower Blue Mountains
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	–	V	Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Roost in tree hollows and buildings.	2	Low Not known from the area, nearest two records are from Eastern Creek and Llandilo
Birds					
Australasian Bittern (*Botaurus poiciloptilus*)	E	E	They are widespread but uncommon over south-eastern Australia. It extends mainly along the coasts of eastern Australia and is found all over NSW except for the far north west. It inhabits freshwater wetlands with tall dense vegetation where it feeds in shallow waters.	1 PMST	Low Wetland habitats generally in poor condition
Australian Painted Snipe (*Rostratula benghalensis australis*)	V, M	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	1 PMST	Unlikely Wetland habitats generally in poor condition
Barking Owl (*Ninox connivens*)	–	V	Forest and woodland habitats, particularly drier western slopes and riverine areas, hunts for birds and small mammals.	1	Low Study area generally lacks roosting habitat and prey species
Black Bittern (*Ixobrychus flavicollis*)	–	V	Occurs from south NSW to Cape York, and extends to the Kimberley region. Inhabits terrestrial and estuarine wetlands, preferring permanent water and dense vegetation.	1	Low Wetland habitats generally in poor condition

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Black-chinned Honeyeater (*Melithreptus gularis*)	–	V	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and logs.	4	Low Habitat is not suitable and rarely recorded east of the Great Dividing Range and tends to occur in the largest woodland patches in the landscape.
Black-necked Stork (*Ephippiorhynchus asiaticus*)	–	E	Open wetlands & adjoining agricultural areas.	3	Unlikely Wetland habitats generally in poor condition
Bush-stone Curlew (*Burhinus grallarius*)	V	E	Open forests and woodlands with a sparse grassy ground layer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feed on insects and small vertebrates, such as frogs, lizards and snakes. Nest on the ground in a scrape or small bare patch.	2	Low No recent records of this species have been made in the study area and no suitable habitat is present
Diamond Firetail (*Stagonopleura guttata*)	–	V	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum (*Eucalyptus pauciflora*) Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.	4	Low Needs high quality grassy woodland habitat, rarely found in western Sydney
Flame Robin (*Petroica phoenicea*)	–	V	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with an open understorey.	5	Low Dispersing non breeding birds prefer open grassy woodland habitat, no suitable habitat present
Freckled Duck (*Stictonetta naevosa*)	–	V	Open wetlands & adjoining agricultural areas.	2	Unlikely Wetland habitats generally in poor condition
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	–	V	Occurs within a variety of forest and woodland types. Usually frequents forested areas with old growth attributes required for nesting and roosting purposes.	13	Low Prefers forested areas with mature trees for foraging and roosting, all records from Lower Blue Mountains and Nepean River

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	–	V	Open forest habitats with She-oak species (*Allocasuarina* spp.) required for food.	16	Low Some potential foraging habitat is present in the south of the study area on the Penrith Golf Course but no evidence of this species was found during surveys. Records mostly form lower Blue Mountains
Hooded Robin (*Melanodryas c. cucullata*)	–	V	Woodland bird species, favour dry sclerophyll forests and woodlands, generally with a sparse understorey, grassy areas and logs.	1	Low Needs high quality grassy woodland habitat. Study area lacks appropriate habitat structure
Little Eagle (*Hieraaetus morphnoides*)	–	V	Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used.	5	Low This species may fly over the study area from time to time but foraging or breeding habitat is absent
Little Lorikeet (*Glossopsitta pusilla*)	–	V	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in apples (*Angophora* sp.), paperbarks (*Melaleuca* sp.) and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country (eg paddocks, roadside remnants) and urban trees also help sustain viable populations of the species.	4	Low All records of this species are from the north and the study area does not provide any high quality foraging resources of nesting sites
Masked Owl (*Tyto novaehollandiae*)	–	V	Dry eucalypt forests and woodland, typically prefers open forest with low shrub density. Requires old trees for roosting and nesting	14	Low Known from the Mulgoa Nature Reserve but unlikely to utilise habitat in the study area as it lacks hollows and/or prey
Painted Honeyeater *Grantiella picta*	V	V	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occur on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. The painted honeyeater is the most specialised of Australia's honeyeaters. Its diet mainly consists of mistletoe fruits.	1 PMST	Low Habitat is not optimal but vagrant individuals may utilise the study area on rare occasion
Powerful Owl (*Ninox strenua*)	–	V	Open forests with dense wet gullies and creek areas, requires large mature trees with hollows for breeding and dense areas of vegetation for prey and roosting	25	Low Unlikely to utilise habitat in the study area as it lacks hollows and/or prey

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Regent Honeyeater (*Anthochaera phrygia*)	E, M	E	A nomadic species typically associated with forest and woodland habitats with the presence of suitable foraging species such as Yellow Box (*Eucalyptus melliodora*) and Red Ironbark (*Eucalyptus sideroxylon*).	4 PMST	Low Dispersing individual non-breeding birds may visit the habitat in the study area from time to time when preferred foraging grounds are unproductive. Habitat is poor for this species
Scarlet Robin (*Petroica boodang*)	–	V	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and re-growth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps.	5	Low Dispersing non breeding birds prefer open grassy woodland habitat and study area is not optimal
Sooty Owl (*Tyto tenebricosa*)	–	V	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	2	Unlikely No suitable rainforest or wet forest habitat is present and unlikely to utilise habitat in the study area as it lacks hollows and/or prey
Speckled Warbler (*Chthonicola sagittatus*)	–	V	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt re-growth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area.	17	Low Large, relatively undisturbed remnants are required for the species to persist in an area so study area is not suitable
Spotted Harrier (*Circus assimilis*)	–	V	Occurs throughout the Australian mainland and disperses into NSW as one single population. It occurs on grassy open woodland, inland riparian woodlands, grasslands and shrub steppe.	1	Low May fly over the study area from time to time but no suitable foraging, roosting or breeding habitat is present for this species
Square-tailed Kite (*Lophoictinia isura*)	–	V	It is widely distributed to the coastal and sub-coastal area of Australia. Migrates to NSW in September for breeding. Occurs in dry woodlands and open forests, and timbered watercourses.	5	Low May fly over the study area from time to time but no suitable foraging, roosting or breeding habitat is present for this species

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Swift Parrot (*Lathamus discolor*)	E, M	E	On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculate)*, Red Bloodwood (*C. Gummifera),* Red Ironbark (*E. sideroxylon*), and White Box (*E. albens*).	22 PMST	Moderate Dispersing foraging individuals or small flocks may utilise the habitat in the study area in Winter and this species has been recorded on occasion in developed areas in Penrith
Turquoise Parrot (*Neophema pulchella*)	–	V	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	3	Unlikely Most recent records of this species are from 1977 and 1982 and this species has not been recorded in the locality since
Varied Sittella (*Daphoenositta chrysoptera)*	–	V	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and acacia woodland.	38	Low Habitat patches in the study area are small, fragmented and disturbed (not optimal)
Reptiles					
Broad-headed Snake (*Hoplocephalus bungaroides*)	V	V	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer.	1 PMST	Unlikely No suitable habitat is present for this species
Frogs					
Giant Burrowing Frog (*Heleioporus australiacus*)	V	V	Found in heath, woodland and open forest with sandy soils.	4 PMST	Unlikely No suitable habitat is present for this species
Green and Golden Bell Frog (*Litoria aurea*)	E	E	Ephemeral and permanent freshwater wetlands, ponds, dams with an open aspect and fringed by Typha and other aquatics, free from predatory fish.	14 PMST	Low Wetland habitats are generally unsuitable for this species and *Gambusia* is prevalent
Littlejohn's Tree Frog (*Litoria littlejohni*)	V	V	It occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops.	PMST	Unlikely No suitable habitat is present for this species

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Red-crowned Toadlet (*Pseudophryne australis*)	–	V	It has restricted distribution from Pokolbin to Nowra and west to Mt Victoria. Occurs in open forests and wet drainage lines below sandstone ridges that often have shale lenses or cappings in the Hawkesbury and Narrabeen Sandstones.	40	Unlikely No suitable habitat is present for this species
Stuttering Frog (*Mixophyes balbus*)	–	E	Permanent streams in moist and wet sclerophyll forests.	0 PMST	Unlikely No wet or rainforest habitat is present
Invertebrates					
Cumberland Land Snail (*Meridolum corneovirens*)	–	E	Primarily inhabits Cumberland Plain Woodland (an endangered ecological community). This community is grassy, open woodland with occasional dense patches of shrubs. Lives under litter of bark, leaves and logs, or shelters in loose soil around grass clumps. Occasionally shelters under rubbish.	178	Low Habitat is disturbed and unsuitable for this species, no snails found during the survey
Giant Dragonfly (*Petalura gigantea*)	–	E	Sedge swamps, freshwater wetlands and peat bogs.	1	Unlikely No suitable habitat is present for this species
Fish					
Australian Grayling (*Prototroctes maraena*)	V		The Australian Grayling has been recorded within the upper reaches of the Hawkesbury-Nepean River Catchment. It inhabits clear, flowing waters.	PMST	Unlikely Not known from the study area. Habitat in waterways is degraded
Macquarie Perch (*Macquaria australasica*)	E	E (FM Act)	Macquarie Perch has been recorded within the upper Reaches of the Hawkesbury –Nepean System.	PMST	Unlikely In NSW and they are now considered isolated to the upper reaches of the Lachlan and Murrumbidgee Rivers in southern NSW. A population exists in the Cataract Dam. No suitable habitat in the study area
Migratory birds					

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Fork-tailed Swift (*Apus pacificus*)	M	–	The species breeds in Asia and migrate to Australia in the summer from which they spend their entire life-cycle on the wing, hunting, resting and sleeping.	3 PMST	Moderate Likely to fly over the study area from October to March
Cattle Egret (*Ardea ibis*)	M	–	Grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Often seen with cattle.	32 PMST	Low The wetlands in the study area are considered too small and do not provide optimal foraging habitat for this species
Black-faced Monarch (*Monarcha melanopsis*)	M	–	Rainforests, moist eucalypt forests and coastal scrubs.	PMST	Low No preferred habitat present. Mainly occurs in rainforest ecosystems. Low chance of vagrant birds occurring in spring, summer and autumn
Rainbow Bee-eater (*Merops ornatus*)	M	–	Predominantly woodland and timbered plains.	PMST	Low Has not been recorded from the urbanised areas of the Penrith LGA and no suitable habitat is present in the study area.
Rufous Fantail (*Rhipidura rufifrons*)	M	–	Predominantly rainforests and wetter forests.	PMST	Low No preferred habitat present. May pass through the study area on migration to and from coastal lowlands and off-shore islands in south-east Queensland, north to Cape York Peninsula and Torres Strait Island
Satin Flycatcher (*Myiagra cyanoleuca*)	M	–	Predominantly forests, in particular thick vegetation in gullies.	PMST	Low No preferred habitat present. May utilise the study area from time to time during migration
White-bellied Sea-eagle (*Haliaeetus leucogaster*)	M	–	Predominantly ocean shores and estuaries, occasionally inland rivers and streams.	PMST	Low No preferred habitat present in the study area. The wetlands are not suitable.
White-throated Needletail (*Hirundapus caudacutus*)	M	–	An aerial foraging species which occupies a range of habitats from open modified landscapes to woodland and forest.	PMST	Moderate Likely to fly over the study area during October and November

Species	Status		Distribution and habitat requirements*	Source+	Likelihood of occurrence in the study area
Great Egret (*Ardea modesta*)	M	–	A wide range of wetland habitats including swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs.	PMST	Low The wetlands in the study area are considered too small and do not provide optimal foraging habitat for this species
Latham's snipe (*Gallinago hardwickii*)	M	–	Wetlands, wet meadows, flooded grassy paddocks, open grassland and drainage areas.	PMST	Moderate May occur in wetlands from July to November
Eastern Osprey (*Pandion haliaetus*)	M	V	Favour coastal areas, especially the mouths of large rivers, lagoons and lakes	PMST	Unlikely No suitable habitat is present for this species

* Distribution and habitat requirement information adapted from:

- Australian Government Department of the Environment http://www.environment.gov.au/biodiversity/threatened/index.html
- NSW Office of Environment and Heritage http://www.environment.nsw.gov.au/threatenedspecies/
- Department of Primary Industries – Threatened Fish and Marine Vegetation http://pas.dpi.nsw.gov.au/Species/All_Species.aspx

+ Data source includes

- Number of records from the NSW Office of Environment and Heritage Wildlife Atlas record data; and
- Identified from the Protected Matters Search Tool (PMST) http://www.environment.gov.au/epbc/pmst/index.html

Key:

- E = endangered species
- E2 = endangered population
- V = vulnerable species
- M = migratory species

Appendix C Assessments of significance

Assessments of significance

Assessments of significance have been conducted for species, populations and communities that were recorded in the study area during field surveys or were identified as having a moderate or higher potential to occur in the study area based on the presence of habitat (see Appendix B).

The proposed works will be assessed under Part 5 of the EP&A Act. Section 5A of the EP&A Act requires that a '7 part test' is undertaken to assess the likelihood of significant impact upon threat-listed species, populations or ecological communities listed under the TSC Act. These assessments have been undertaken in accordance with the *Threatened Species Assessment Guidelines: The Assessment of Significance* (Department of Environment and Climate Change 2007) which outlines a set of guidelines to help applicants/proponents of a development or activity with interpreting and applying the factors of assessment in the 'seven-part test'. The guidance provided by the Department of Environment and Climate Change (2007) has been used here in preparing these 'seven-part tests' and in determining whether there is likely to be a significant effect to a threatened species, population or ecological community listed under the TSC Act.

For threatened biodiversity listed under the EPBC Act, significance assessments have been completed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment 2013). Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment that is affected, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of the Environment 2013). Importantly, for a 'significant impact' to be 'likely', it is not necessary for a significant impact to have a greater than 50 per cent chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility (Department of the Environment 2013).

The ecological communities and species subject to this assessment are outlined in **Table C.1** along with the predicted impact from the proposal.

Table C.1 Threatened biodiversity subject to this assessment

Species	Status		Predicted impact (habitat in ha)
	EPBC Act	TSC Act	
Cumberland Plain Woodland in the Sydney Basin Bioregion (including M4 Motorway revegetation)	–	CE	1.9 (excludes M4 revegetation)
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	–	E	0.4
Eastern Bentwing-bat	–	V	6.3
Eastern Freetail-bat	–	V	6.3
Southern Myotis	–	V	6.3
Grey-headed Flying-fox	V	V	6.3
Swift Parrot	E	E	6.3

Environmental Planning & Assessment Act 1979 assessment

Threatened ecological communities

The threatened ecological communities that are present in the study area and are subject to this assessment include:

- Cumberland Plain Woodland in the Sydney basin Bioregion (excluding M4 revegetation)
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened ecological communities or their habitats are outlined below:

1. **in the case of a Threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

   Not applicable.

2. **in the case of an Endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

   Not applicable.

3. **in the case of an Endangered ecological community or Critically Endangered ecological community, whether the action proposed:**

   i) **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   ii) **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   In addressing this question, the local occurrence of these threatened ecological communities is taken to be the community that occurs within the study area and all contiguous vegetation (as defined in the *Threatened Species Assessment Guidelines: The Assessment of Significance* (Department of Environment and Climate Change 2007)). Risk of extinction is used here as the likelihood that the local occurrence of the ecological community will become extinct either in the short-term or in the long-term as a result of direct or indirect impacts on the threatened ecological community from the proposal. Composition refers to the assemblage of species and the physical structure of the community.

   Cumberland Plain Woodland in the Sydney basin Bioregion is listed as a critically endangered ecological community and is considered to be facing an extremely high risk of extinction in New South Wales in the immediate future. The River-Flat Eucalypt Forest TEC is considered likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

   The threatened ecological communities subject to this assessment are already at risk of extinction and the proposal would exacerbate this risk. However, the proposal is considered unlikely to result in the extinction of the local occurrence of any TECs. The proposal is predicted to remove around

1.9 hectares of the Cumberland Plain Woodland TEC and a smaller extent of the River-Flat Eucalypt Forest TEC (0.4 hectares) (see **Table C.2**).

When the impacts outlined below (and in **Table C.2**) are considered in the local context, the impacts in terms of hectares removed are relatively small but the proportional impacts are large. The study area has been extensively cleared of native vegetation in the past. Few patches of native vegetation remain in the study area and the areas immediately adjacent. The vegetation that does remain is directly bordering the existing roadways. Due to the nature of the proposal, the study area is narrow and linear and follows existing roadways closely. The existing vegetation is along the roadways. The proposal involves road widening and the proposal footprint follows the roadways and occupies a large proportion of the study area.

Table C.2 Impact on the extent of each threatened ecological community

Threatened ecological community (TSC Act)	Status	Extent in the study area (ha)	Extent of local occurrence (ha)	Potential impact (ha)	Impact as % of local occurrence	Impact in the context of the locality (within 10 km)
Cumberland Plain Woodland in the Sydney Basin Bioregion	Critically endangered	4.8	8.4 (includes extent in study area and 3.6 ha of contiguous vegetation)	1.9	23%	0.18% (3,190 ha mapped in the locality
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	1.1	1.1	0.4	36%	0.02% (1,703 ha mapped in the locality)

The proposal is considered unlikely to substantially and adversely modify the composition of the two TECs so that their local occurrences are placed at risk of extinction. The local occurrences of these TECs have already been substantially and adversely modified by past land use practices.. All TECs subject to this assessment are currently suffering from altered composition caused by a very large reduction in ecological function, as indicated by:

- altered community structure (ie missing structural layers)
- altered species composition (ie lack of native species)
- disruption of ecological processes (ie altered drainage, mowing preventing natural regeneration)
- invasion and establishment of exotic species resulting in weed dominance
- degradation of habitat
- fragmentation.

The proposal is not considered likely to further modify the composition of any of the TECs within the study area such that the local occurrence is placed at risk of extinction. The composition of the threatened ecological communities within the study area is predicted to remain intact after the implementation of the proposal. However, the remaining patches would be smaller.

4. in relation to the habitat of a Threatened species, population or ecological community:

i) the extent to which habitat is likely to be removed or modified as a result of the action proposed

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The extent of each threatened ecological community to be removed because of the proposal is outlined in **Table C.2**. Overall, the proposal is considered to have a large proportional impact on the local occurrence of all three TECs subject to this assessment of over 30 percent.

Fragmentation is unlikely to occur from the proposal as the work would largely involve removing vegetation from patch edges rather than breaking apart of large blocks of vegetation into many smaller patches. Importantly, the proposal would not result in the breaking apart of large blocks of high quality examples of threatened ecological communities. No further habitat fragmentation on a landscape scale would occur because of the proposal. Isolation of habitats is likely to increase by a small extent as the distance between patches on either side of The Northern Road would be increased.

Due to the conservation significance of these TECs (particularly the critically endangered Cumberland Plain Woodland in the Sydney basin Bioregion), the remaining patches of these TECs within NSW are likely to be important for their survival. However, the patches within the study area are small, are largely degraded and in moderate to poor condition and in many cases are the result of human intervention (ie Cumberland Plain Woodland TEC because of revegetation works associated with the construction of the M4 Motorway). Furthermore, no patches of vegetation in the study area have been recognised as priority conservation land or as part of core habitats or regional corridors by the OEH. As such, the TEC patches within the study area can be considered less important than larger high quality examples of these TECs in the locality that retain high levels of ecological integrity and function (ie the important patches of TECs in the Mulgoa Nature Reserve or Defence Establishment Orchard Hills).

5. whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable, as no critical habitat has been listed for the threatened ecological communities subject to this assessment.

6. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The Cumberland Plain Recovery Plan (Department of Environment Climate Change and Water 2011) has been prepared with the overall objective provide for the long-term survival of the threatened biodiversity of the Cumberland Plain. The recovery objectives include:

- To build a protected area network, comprising public and private lands, focused on the priority conservation lands.
- To deliver best practice management for threatened biodiversity across the Cumberland Plain, with a specific focus on the priority conservation lands and public lands where the primary management objectives are compatible with biodiversity conservation.

- To develop an understanding and enhanced awareness in the community of the Cumberland Plain's threatened biodiversity, the best practice standards for its management, and the recovery program.
- To increase knowledge of the threats to the survival of the Cumberland Plain's threatened biodiversity, and thereby improve capacity to manage these in a strategic and effective manner.

The OEH action statements for the management of the Cumberland Plain Woodland and River-Flat Eucalypt Forest TECs under the Saving Our Species Program focus on actions for the OEH to complete and have a large focus on identified priority conservation lands. An action also states that in circumstances where impacts are unavoidable, as part of any consent, approval or license that is issued, ensure that offset measures are undertaken within the priority conservation lands where practicable. Any offsets provided by Roads and Maritime will be done in accordance with the OEH.

The proposal is considered unlikely to interfere with any actions or objectives planned for recovery of these TECs.

7. whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

A Key Threatening Process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs (see **Table C.3**).

Of the 38 listed KTPs under the TSC Act, 11 are applicable to the TECs subject to this assessment (see **Table C.3**). However, hygiene and weed control measures would reduce or avoid the impact of most KTPs with the exception of clearing of native vegetation and removal of dead wood and dead trees.

Table C.3 Key threatening processes that may result from the proposal that may affect threatened ecological communities

Clear threatening process	Relevance to the proposal
Clearing of native vegetation	Yes. The proposal would result in clearing of native vegetation.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	Yes. The proposal may result in the introduction or spread of amphibian chytrid. However, hygiene measures would be followed to prevent spread of this fungus.
Infection of native plants by *Phytophthora cinnamomi*	Yes. The proposal may result in the introduction or spread of *Phytophthora cinnamomi*. However, hygiene measures would be followed to prevent spread of *Phytophthora cinnamomi*.
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	Yes. The proposal may result in the introduction or spread of Exotic Rust Fungi. However, hygiene measures would be followed to prevent spread of Exotic Rust Fungi.
Invasion and establishment of exotic vines and scramblers	Yes. The proposal may result in the invasion and establishment of exotic vines and scramblers. However, weed control measures would be followed to prevent invasion and establishment of exotic vines and scramblers.
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	Yes. The proposal may result in the invasion and establishment of Scotch broom (*Cytisus scoparius*). However, weed control measures would be followed to prevent invasion and establishment of Scotch broom (*Cytisus scoparius*).

Clear threatening process	Relevance to the proposal
Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*	Yes. The proposal may result in the invasion and establishment of African Olive *Olea europaea* L. subsp. *cuspidata*. However, weed control measures would be followed to prevent invasion and establishment of African Olive *Olea europaea* L. subsp. *Cuspidata.*
Invasion, establishment and spread of *Lantana camara*	Yes. The proposal may result in the invasion and establishment of *Lantana camara*. However, weed control measures would be followed to prevent invasion and establishment of *Lantana camara.*
Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed)	Yes. The proposal may result in the invasion and establishment of *Chrysanthemoides monilifera* (bitou bush and boneseed). However, weed control measures would be followed to prevent invasion and establishment of *Chrysanthemoides monilifera*.
Invasion of native plant communities by exotic perennial grasses	Yes. The proposal may result in the invasion and establishment of exotic perennial grasses. However, weed control measures would be followed to prevent invasion and establishment of exotic perennial grasses.
Removal of dead wood and dead trees	Yes. Some dead wood and dead trees would be removed as part of the proposal.

Conclusion

In summary, the proposal is considered unlikely to have an adverse effect on the extent of the two TECs such that the local occurrence of each is likely to be placed at further risk of extinction. The large proportional impact on the local occurrence of each TEC is due largely to a small study area to impact footprint ratio. The impact is small when considered in the context of the actual impact in hectares and the extent of the TECs within the broader locality. The proposal is considered unlikely to substantially and adversely modify the composition of any of the TECs as the current composition of the TECs is highly modified.

There is unlikely to be any further increase in fragmentation from the proposal. However, an increase in isolation of habitat patches is expected as The Northern Road is widened resulting in increased distance between patches on either side of the roadway. The TECs within the study area are not recognised as important to the long-term survival of the TECs in the locality as the patches are small, in poor to moderate condition, and in many cases are man-made (ie M4 Motorway revegetation). Furthermore, none of the TEC patches to be impacted is identified as important under the Cumberland Plain Recovery Plan. No critical habitat will be impacted.

The proposal is not inconsistent with the objectives or actions of the Cumberland Plain Recovery Plan and the proposal is not considered likely to interfere with any of the identified recovery objectives or actions for any of the TECs subject to this assessment. The proposal would contribute to some KTPs that cannot be mitigated against including clearing of native vegetation and removal of dead wood and dead trees.

Considering the context of the TECs and intensity of the potential impacts to these TECs from the proposal, an overall conclusion has been made that the proposal is unlikely to result in a significant effect to these TECs.

Grey-headed Flying-fox (*Pteropus poliocephalus*)

While the Grey-headed Flying-fox was not recorded in the study area during the field survey it is considered likely to occur based on the presence of suitable foraging habitat and the nearby location of a roosting camp at Emu Plains.

The factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species or their habitats are outlined below:

1. **in the case of a Threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Annual mating commences in January and conception occurs in April or May; a single young is born in October or November.

There are no roost camps located in the study area and at the time of this assessment the proposal would not directly impact on any known breeding / maternity site. As such, the impacts of the proposal to the Grey-headed Flying-fox would be limited to loss of feeding habitat caused by direct clearing or damage to native vegetation during the construction phase.

The proposal would remove around 6.3 hectares of potential foraging habitat (although not this entire habitat is likely to be used) however, removal of vegetation would be avoided where possible. Foraging habitat mainly comprises nectar resources from planted native trees and shrubs as well as fruit resources from planted fig trees and some exotic trees. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within the locality. Given the relative widespread nature of similar planted vegetation in the locality and abundance of higher quality foraging habitat within the feeding range of the camps located near the study area, the proposal is not expected to significantly affect the life cycle of the species.

The proposal is unlikely to reduce the population size of the Grey-headed Flying-fox or decrease the reproductive success of this species.

2. **in the case of an Endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

Not applicable.

3. **in the case of an Endangered ecological community or Critically Endangered ecological community, whether the action proposed:**

   i) **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   ii) **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

4. **in relation to the habitat of a Threatened species, population or ecological community:**

   i) **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The potential habitat of the Grey-headed Flying-fox within the study area is limited to foraging habitat and includes all vegetation where fruiting and flowering trees and shrubs are present. The extent of potential foraging habitat for the Grey-headed Flying-fox would be reduced by around 6.3 ha (however not all of this habitat is represented by preferred flowering or fruiting plants), for example smaller trees in replanting / revegetation areas of the M4 corridor. This amount of habitat removal is small when the amount of available foraging habitat in the locality is considered.

Importantly, the proposal would not result in fragmentation of habitat for the Grey-headed Flying-fox. This species is highly mobile and will freely fly long distances (up to 50 km) over open areas including urbanised city centres to move between roost camps and foraging sites. The proposal would not affect the movement of the Grey-headed Flying-fox between habitat patches.

Importantly, the proposal would not affect the most important habitats for Grey-headed Flying-fox within the locality. The most important habitats for the local Grey-headed Flying-fox sub-populations are the roosting camps at Parramatta Park, Clyde (Duck River), Wetherill Park, Ropes Creek, and Emu Plains. These camps would not be affected by the proposal. Foraging habitat within the study area is likely to form part of an overall foraging range of these sub-populations and would only form a small proportion of available habitat for this species. As such, the foraging habitat within the study area is unlikely to be of critical importance for the survival of the Grey-headed Flying-fox within the locality.

5. whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Grey-headed Flying-fox.

6. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The *Draft National Recovery Plan for the Grey-headed Flying-fox* (Department of Environment Climate Change and Water 2009) outlines the following actions:

- Identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes across their range
- Enhance winter and spring foraging habitat for Grey-headed Flying-foxes
- Identify, protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes
- Significantly reduce levels of deliberate Grey-headed Flying-fox destruction associated with commercial horticulture
- Provide information and advice to managers, community groups and members of the public that are involved with controversial flying-fox camps
- Produce and circulate educational resources to improve public attitudes toward Grey-headed Flying-foxes, promote the recovery program to the wider community and encourage participation in recovery actions
- Monitor population trends for the Grey-headed Flying-fox
- Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts

- Oversee a program of research to improve knowledge of the demographics and population structure of the Grey-headed Flying-fox
- Maintain a National Recovery Team to oversee the implementation of the Grey-headed Flying-fox National Recovery Plan

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. The Grey-headed Flying-fox has been assigned to the Landscape species management stream under the OEH Saving our Species program and the following actions for recovery have been identified for this species:

- Increase the extent and viability of foraging habitat for the Grey-headed Flying-fox that is productive during winter and spring through dedicated habitat creation and restoration using guides published by OEH (in preparation).
- Negotiate agreements with landholders, particularly in-perpetuity covenants or stewardship agreements that promote the protection and retention of high quality foraging habitat and roost sites for Grey-headed Flying-foxes.
- Rehabilitate degraded flying-fox roost sites through weed management, planting new roost trees, managing understorey vegetation to maintain suitable microclimate conditions, establishing buffers between roost camps and nearby human settlements to minimise conflict.
- Conduct dedicated engagement programs in communities affected by flying-fox roost sites, building the capacity of all stakeholders to engage in the process of decision-making and developing camp management plans. Provide information about mitigating the impacts of flying-foxes on nearby residences and businesses such as strategic vegetation management, and structural modifications like double-glazing, air conditioning and shade cloths.
- Distribute public education materials to land managers and local community groups working with contentious flying-fox roost sites highlighting species status, reasons for being in urban areas, reasons for decline etc.
- Develop site-based heat stress response protocols for camps likely to be affected by heat stress events. Protocols should be based on best practice guidelines, and should be implemented by licensed fauna rehabilitators. Data should be recorded to inform future management of heat stress events.
- Increase the extent and viability of foraging habitat for the Grey-headed Flying-fox that is productive during winter and spring through dedicated habitat creation and restoration using guides published by OEH (in preparation).
- Negotiate agreements with landholders, particularly in-perpetuity covenants or stewardship agreements that promote the protection and retention of high quality foraging habitat and roost sites for Grey-headed Flying-foxes.
- Rehabilitate degraded flying-fox roost sites through weed management, planting new roost trees, managing understorey vegetation to maintain suitable microclimate conditions, establishing buffers between roost camps and nearby human settlements to minimise conflict.
- Conduct dedicated engagement programs in communities affected by flying-fox roost sites, building the capacity of all stakeholders to engage in the process of decision-making and developing camp management plans. Provide information about mitigating the impacts of flying-foxes on nearby residences and businesses such as strategic vegetation management, and structural modifications like double-glazing, air conditioning and shade cloths.
- Distribute public education materials to land managers and local community groups working with contentious flying-fox roost sites highlighting species status, reasons for being in urban areas, reasons for decline etc.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Grey-headed Flying-fox are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area.

The proposal would not interfere with the recovery of the Grey-headed Flying-fox.

7. **whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.**

A KTP is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Grey-headed Flying-fox that would be increased by the proposal is clearing of native vegetation.

The main threats to the Grey-headed Flying-fox include:

- Loss and disturbance of roosting sites.
- Unregulated shooting.
- Electrocution on powerlines, entanglement in netting and on barbed-wire.
- Competition with Black Flying-foxes.
- Negative public attitudes and conflict with humans.
- Impacts from climate change.
- Disease.

The proposal would not increase any of the above threats.

Conclusion

The Grey-headed Flying-fox would suffer a small reduction in extent of suitable foraging habitat from the proposal of around 6.3 ha (although not all of this vegetation would be fruiting or flowering plants suitable for foraging). No roosting camps or other important habitat would be impacted. As such, the proposal is considered unlikely to reduce the population size of the Grey-headed Flying-fox or decrease the reproductive success of this species. The proposal would not interfere with the recovery of the Grey-headed Flying-fox and would not contribute to any of the key threats to this species. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant effect to the Grey-headed Flying-fox.

Swift Parrot (*Lathamus discolor*)

While the Swift Parrot was not recorded in the study area during the field survey it is considered likely to occur based on the presence of suitable foraging habitat and nearby records.

The factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species or their habitats are outlined below:

1. **in the case of a Threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

The Swift Parrot is endemic to south-eastern Australia and breeds only in Tasmania. It migrates to mainland Australia in autumn. As such, the proposal would not affect breeding habitat for this species. Additionally, the study area does not contain any important winter foraging grounds so none would be impacted. No impacts to the life cycle of the Swift Parrot species are anticipated. The study area contains some potential foraging habitat for the Swift Parrot. While the habitat in the study area is not optimal, the loss of potential feed trees would directly affect the species opportunity to feed in the area. However, the study area is not considered a critical area for the Swift Parrot. The Swift Parrot may utilise trees in the study area for foraging intermittently when no other suitable inland (ie box ironbark woodlands) or coastal resources (ie Spotted Gum and Swamp Mahogany forests) are available.

2. **in the case of an Endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

   Not applicable.

3. **in the case of an Endangered ecological community or Critically Endangered ecological community, whether the action proposed:**

   i) **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   ii) **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   Not applicable.

4. **in relation to the habitat of a Threatened species, population or ecological community:**

   i) **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

   ii) **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

   iii) **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

   As a specialist nectarivore dependent on flowering eucalypts, Swift Parrots are vulnerable to the loss of quantity and quality of key forage tree species. As a large-scale migrant, it has the ability to cover vast areas of its winter range, seeking suitable flowering eucalypt habitat. The species is an occasional visitor to the region and may utilise trees in the study area for foraging intermittently when no other suitable resources are available. The Swift Parrot would suffer a small reduction in extent of suitable foraging habitat from the proposal of around 6.3 ha (although not all of this vegetation would be flowering plants suitable for foraging).

   The proposal would contribute to the loss of potential foraging habitat that would reduce the area of habitat available. However, the proposal would not increase fragmentation of habitat for this species and the area of occupancy of this species, which is estimated at 4,000 km².

5. **whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)**

   Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable, as no critical habitat has been listed for the Swift Parrot.

6. **whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan**

   The National Recovery Plan for the Swift Parrot (Swift Parrot Recovery Team 2001) identifies the following actions for recovery of this species:

   - Identify the extent and quality of habitat.
   - Manage and protect Swift Parrot habitat at the landscape scale.

- Monitor and manage the impact of collisions, competition and disease.
- Monitor population and habitat.

A targeted strategy for managing threatened species is also being developed under the OEH Saving Our Species program. The Swift Parrot has been assigned to the Landscape species management stream under the OEH Saving our Species program and the following actions for recovery have been identified for this species:

- Raise public awareness of the importance of large old trees of species that provide important food resources. Protect large old trees, including from the effects of fire. Ensure the recruitment of large old trees by retaining medium-sized trees, facilitating regeneration, and undertaking replanting.
- Within a region, increase the extent and quality of habitat to increase food supply and improve foraging efficiency. Focus on sites that may better function as drought refuges. Include locally occurring species that provide important food resources in revegetation programs where appropriate. Ensure that fuel reduction burns do not result in canopy scorch, which can reduce flowering in subsequent years. Manage aggressive honeyeater impacts through habitat modification (e.g. reduce the amount of edge and establish a structurally complex understorey.
- Engage the community in the identification and enhanced management of priority sites. Priority sites are those that (1) have been used by a large proportion of the population, or (2) have been used in multiple seasons, or (3) have been used for an extended period of time within a season. Engage stakeholders in the identification and development of site-based management projects for priority areas, being areas containing a high proportion of priority sites, or areas that contribute to the overall diversity and distribution of resources available to swift parrots under a range of environmental conditions.
- With the assistance of the community, monitor swift parrot distribution, abundance, and habitat use. Investigate knowledge gaps to improve the effectiveness of management actions, including understanding the phenology of key food species, determining movement strategies, patterns and pathways between regions, and modelling the impacts of climate change projections on the distribution and abundance of foraging habitat and resources.
- Raise public awareness on collision risks and how these can be minimised. At priority sites and movement pathways assessed as having a high risk of collision, develop and implement mitigation strategies.
- Establish the Beak and Feather Disease Virus (BFDV) status of rehabilitated parrots proposed to be released using appropriate tests and quarantine procedures. Parrots carrying BFDV should not be released into the wild.

The recovery actions listed above, and those identified in the Saving Our Species program, that have been identified by the OEH to help recover the Swift Parrot are largely not applicable to the proposal. The proposal would not interfere with the recovery of the Swift Parrot.

7. whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

A KTP is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTP relevant to the Swift Parrot that would be increased by the proposal is clearing of native vegetation.

Conclusion

The Swift Parrot would suffer a small reduction in extent of suitable foraging habitat from the proposal of around 6.3 ha (although not all of this vegetation would be flowering plants suitable for foraging). The lifecycle of this species will not be affected. No important habitat would be impacted. As such, the proposal is considered unlikely to reduce the population size of the Swift Parrot or

decrease the reproductive success of this species. The proposal would not interfere with the recovery of the Swift Parrot and would not contribute to any of the key threats to this species. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant effect to the Swift Parrot.

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Southern Myotis (*Myotis macropus*)

This assessment concerns the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Southern Myotis (*Myotis macropus*) which are two species of bat that are known to roost in caves, derelict mines, storm-water tunnels, culverts, bridges, buildings and other man-made structures. These two species have been recorded in the locality and suitable foraging habitat is present. The culverts under the Glenmore Parkway may also provide roosting habitat for these two species. The bridge over the M4 Motorway is considered to have a low likelihood as roosting habitat for these species (see Section 3.2.4).

The factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species or their habitats are outlined below:

1. **in the case of a Threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

The Eastern Bentwing-bat primarily roosts in caves, but will also use derelict mines, storm-water tunnels, buildings and other man-made structures. The Eastern Bentwing-bat forms populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. At other times of the year, populations disperse within about 300 km range of maternity caves. The Eastern Bentwing-bat hunts in forested areas.

The Southern Myotis generally roosts close to water in caves, mine shafts, hollow-bearing trees, storm-water channels, buildings, under bridges and in dense foliage. The Southern Myotis forages over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW, females have one young each year usually in November or December.

The Eastern Bentwing-bat and the Southern Myotis are known from the locality and are commonly recorded. These two species are known to roost together in culverts under the M4 Motorway and other roadways in Sydney. The populations of the Eastern Bentwing-bat and the Southern Myotis that are considered likely to be present in the study area may utilise the box culverts under the Glenmore Parkway as roosting habitat. The Eastern Bentwing-bat does not breed in the study area but the Southern Myotis may use the culverts as breeding habitat. The populations of the Eastern Bentwing-bat and the Southern Myotis that may utilise the habitats in the study area are considered viable.

All vegetation within the study area is likely to provide foraging habitat for these two bat species. The Southern Myotis will preferentially forage in the riparian zones and open water surfaces of drainage lines and dams. Riparian zones are also likely to be a focal point for foraging of the Eastern Bentwing-bat. As such, the riparian vegetation opposite the Glenmore Parkway is likely to provide the most suitable foraging habitat in the study area for these two species.

The proposal would result in damage to the culverts that may be used as a roost by the Eastern Bentwing-bat and the Southern Myotis. However, these culverts were identified as marginal as roosting habitat and no bats were observed during the survey.
The proposal would remove around 6.3 ha of potential foraging for these species. The current potential for these species to occur based on the presence of potential foraging habitat is expected to remain after completion of the proposal. Foraging, movement and other life-cycle attributes would not be impacted.

Overall, the proposal is unlikely to reduce the population size of these two bat species or decrease their reproductive success.

2. **in the case of an Endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

   Not applicable.

3. **in the case of an Endangered ecological community or Critically Endangered ecological community, whether the action proposed:**

   i) **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   ii) **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   Not applicable.

4. **in relation to the habitat of a Threatened species, population or ecological community:**

   i) **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

   ii) **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

   iii) **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

   The proposal would remove around 6.3 ha of potential foraging habitat for the Eastern Bentwing-bat and the Southern Myotis. This amount of habitat removal is small when the amount of available foraging habitat in the locality is considered. The proposal would remove the culverts, however no evidence of bats roosting was identified and these structures are considered sub-optimal as roosting habitat.

   Importantly, the proposal would not result in fragmentation of habitat for these species. These bats are highly mobile and will freely fly long distances over open areas to move between habitats. The proposal would not affect the movement of these species between habitat patches.

   The vegetation in the study area would form a small component of a larger foraging range for these two bat species. Riparian vegetation is likely to be a focal point of foraging activity as are the edges of vegetation patches. The loss of native vegetation from the study area would reduce the amount of foraging habitat available for these species by a small amount. However, when compared to the larger and higher quality vegetation remnants in the locality (ie The vegetation on Defence Establishment Orchard Hills, Mulgoa Nature Reserve, South Creek and Ropes Creek, and the Wianamatta Nature reserve), the vegetation within the study area is not considered as important for the long-term survival of these species in the locality.

5. **whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)**

   Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for these two bat species.

6. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan does not exist for the Eastern Bentwing-bat or the Southern Myotis. However, the following actions have been identified by the OEH for recovery of these species under the Saving Our Species program.

Eastern Bentwing-bat:

- Prevent human access to roost and maternity caves and the areas immediately around cave entrances during winter and the breeding season, through the erection of signage, or the removal of access tracks and paths.
- Remove vegetation encroaching on cave entrances, with a minimum of disturbance.
- Initiate a caver education program promoting awareness of the threat of pathogens to microbats, and providing information on appropriate hygiene, and where appropriate decontamination, protocols. Program should particularly target people likely to come into contact with pathogens overseas and who may introduce them to Australia.
- Protect and maintain high quality foraging habitat in the vicinity of maternity caves. Target high productivity habitats, primarily riparian areas, wetlands, and other areas of native vegetation associated with high moisture status and fertility. Where possible negotiate conservation agreements with landholders; agreements should preferably be funded and in perpetuity.
- Undertake revegetation, using a diverse mix of locally appropriate native species. Revegetation should focus on areas of good moisture and fertility, particularly riparian areas and wetlands. Priority should be given to expanding existing small habitat patches.
- Restrict physical cave entrance closures to situations where there is a real hazard to public health and safety, and where the risk cannot be dealt with by other means (for example removing access tracks). Where closures are required, closures should be undertaken in a manner that continues to allow safe access for bats, and that does not influence the cave's microclimate.

Southern Myotis:

- Retain and protect live and standing dead trees likely to contain suitably sized hollows, or that have the potential to develop these in the future (eg through the loss of limbs) particularly in riparian zones. Ensure the largest hollow-bearing trees, including dead trees, are given highest priority for retention in property vegetation plan assessments. Offsets should include remnants in high productivity and riparian zones. Raise public awareness of the importance of hollow-bearing trees and promote strategies for retaining these in the landscape.
- Identify sites, particularly in riparian zones, where hollows are limiting due to exotic species inhibiting recruitment and changing the vegetation structure. Ensure the future replacement of large old trees by facilitating regeneration or undertaking replanting at sites where they presently occur. Protect recruit trees that will be able to provide hollows in the future.
- Liaise with Roads and Maritime Services and other relevant authorities and land managers regarding wooden bridges, wharves, tunnels, aqueducts and other structures acting as bat habitat. When undertaking any major works, replacing wooden bridges with concrete bridges or upgrading wharves, this be done at a time outside of the breeding (October-February) and overwintering period. A wooden structure should be placed under new bridges or wharves where bats are known to provide a roost.
- Encourage land managers to enter into land management agreements that protect and restore key areas such as riparian habitat and including the retention of suitable hollow-bearing trees and recruitment trees in these areas.
- Check that in caves utilised by bats, entrances are not blocked in a way that prevents easy continual access by bats. Monitor the density of vegetation (native or exotic) at the entrance to any active or potential maternity or hibernation roost cave and manually remove (do not use chemicals) as necessary to ensure bats have ready access year-round.

- Discourage recreational users from roosting areas such as caves, culverts, and storm water drains by erecting signs or blocking preventing human access whilst still allowing access to bats. In caves where public access is permitted, restrict access during breeding season (November-March) and winter to approved management and scientific research only. Provide information to users in the form of brochures and signage about appropriate care and behaviour whilst at the site. Provide this information to caving, climbing, abseiling and bushwalking groups.
- Promote roosting habitat in new artificial structures within the species' range and monitor their use.
- Raise awareness amongst landholders in close proximity (around 15km radius) to maternity or roost sites, of the potential impacts of using harmful pesticides and other chemicals and discourage their use in or adjacent to foraging habitat, particularly in riparian zones around waterways such as rivers, creeks, lakes and dams.
- Liaise with agricultural landholders to promote land management that minimises disturbance to waterways likely to be foraging habitat (eg restore riparian vegetation and carefully manage stormwater and polluted run-off). Monitor and maintain adequate water quality in water systems known to be used for foraging. Liaise with relevant authorities with respect to limiting the impacts of waste disposal and runoff in these systems.
- Control or remove exotic weeds, particularly in riparian zones, that degrade habitat and alter the structure of the vegetation community in areas of the species' distribution. Ensure that such weed control work be undertaken in a staged manner and minimises disturbance to the habitat of the species. Develop and implement a bush regeneration strategy (which includes monitoring and reporting requirements) targeting the removal of weeds significantly compromising habitat values such as the repression of future hollow-bearing trees. Care should be taken to avoid widespread removal of vegetation without replacement. Manual weed removal is preferable and the use of herbicides should avoid non-target impacts. Leave dead trees standing. Encourage land managers and bushcare groups to undertake weed control.
- Undertake restoration and augmentation planting and/or direct seeding, including species from the ground layer and understorey in areas of degraded and/or potentially suitable habitat particularly in riparian zones. Revegetation should focus on expanding existing smaller areas of suitable habitat and connecting areas of suitable habitat to create corridors for movement. A diversity of local native species should be planted. Dead trees should not be removed.
- Manually remove and appropriately dispose of invasive aquatic weeds in waterways in foraging areas (weeds inhibit the species' ability to forage over water).
- Liaise with relevant authorities and/or land managers to discourage the destruction of caves. If mine sites are to be closed or previously abandoned mines reopened, they should first be checked for the presence of bats (during summer) and access should still be provided for the bats to safely enter and leave. Closure technique should be discussed with relevant microbat experts to ensure that possible habitat for bats is maintained. If gates are used, they should be bat friendly with horizontal bars at least 15cm apart and preferably with a larger gap across the top. Bats should be excluded prior to closure (and this should not occur during the breeding season from October to February or in winter). The impact of closure on bat usage should be monitored for several seasons.

The recovery actions listed above identified in the Saving Our Species program that have been identified by the OEH to help recover these two bat species are largely not applicable to the proposal. However, the proposal would result in the removal of some hollow-bearing trees and some dead trees. The recovery actions for the Southern Myotis state that when undertaking works to replace structures that act as bat habitat, the works must be done at a time outside of the breeding (October-February) and overwintering period. The mitigation measures for the proposal would ensure this occurs.

7. whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

A KTP is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTPs relevant to the Eastern Bentwing-bat and Southern Myotis that would be increased by the proposal is clearing of native vegetation and removal of dead wood and dead trees. The main threats to the Eastern Bentwing-bat and Southern Myotis include:

- loss or disturbance of roosting sites
- clearing adjacent to foraging areas
- application of pesticides in or adjacent to foraging areas
- reduction in stream water quality affecting food resources
- Disturbance by recreational cavers and general public accessing caves and adjacent areas particularly during winter or breeding
- loss of high productivity foraging habitat
- introduction of exotic pathogens, particularly white-nose fungus
- cave entrances being blocked for human health and safety reasons, or vegetation (particularly blackberries) encroaching on and blocking cave entrances
- hazard reduction and wildfire fires during the breeding season.

The proposal may involve the loss or disturbance of a roosting site in the culverts under the Glenmore Parkway.

Conclusion

The Eastern Bentwing-bat and Southern Myotis would suffer a small reduction in extent of foraging habitat from the proposal. The proposal would remove the culverts, however no evidence of bats roosting was identified and these structures are considered sub-optimal as roosting habitat.. The proposal is unlikely to reduce the population size of the Eastern Bentwing-bat and Southern Myotis or decrease the reproductive success of this species. The proposal would not interfere with the recovery of the Eastern Bentwing-bat and Southern Myotis and would not contribute to the key threats to these species. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant impact to threatened cave roosting microchiropteran bats.

Eastern Freetail-bat (*Mormopterus norfolkensis*)

This assessment concerns the Eastern Freetail-bat (*Mormopterus norfolkensis*) which is a bat species that is known to roost in tree hollows, under bark, or sometimes in man-made structures. The Eastern Freetail-bat is considered moderately likely to occur within the study area based on the presence of suitable habitat (particularly the vegetated riparian zone opposite the Glenmore Parkway) and the presence of records in the locality. The Eastern Freetail-bat is a species that is recorded with moderate frequency in western Sydney and it is a powerful flyer capable of fast long distance travel for foraging.

The factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species or their habitats are outlined below:

1. **in the case of a Threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

The Eastern Freetail-bat inhabits dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. It roosts mainly in tree hollows but will also roost under bark or in man-made structures.

The study area is likely to provide foraging habitat for the Eastern Freetail-bat and roosting habitat may be present in hollow-bearing trees. Suitable foraging habitat is present throughout the study area where vegetation is present. Riparian zones are likely to be a focal point for foraging due to the higher productivity of these areas (ie more insect prey available around creek lines). The Eastern Freetail-bat is a fast flyer and will exploit the edges of vegetation and open treeless areas for foraging. As such, potential foraging habitat for this species is widespread in the study area. It is unknown whether the study area contains a roost site for this species. However, the six hollow bearing trees that were recorded in the study area contained small hollows that may provide some suitable roosting habitat for this species. Breeding may potentially occur in these trees or these trees may form part of the home range of breeding bats. Alternatively, the trees may be used intermittently as day or night shelters. Other trees and vegetation in the study area, including dead trees, may also be suitable for roosting under loose bark or in foliage.

The proposal would result in the removal of around 6.3 hectares of potential foraging habitat for the Eastern Freetail-bat. Five hollow-bearing trees that may provide suitable roosting and breeding habitat would be removed by the proposal. The local population of the Eastern Freetail-bat is likely to use the habitat resources within the study area as part of a larger habitat matrix. The vegetation in the study area is likely to form part of a larger foraging range for this species. The Eastern Freetail-bat has been found to travel up to 10 kilometres away from roost sites to forage and can have a home range of over 4,000 hectares (McConville 2014). The core habitats that are critical for the local population of the Eastern Freetail-bat to complete its lifecycle are likely to be the riparian zones of Ropes Creek and South Creek and the larger patches of vegetation in the Mulgoa Nature Reserve, Wianamatta Nature Reserve, Castlereagh Nature Reserve and Defence Establishment Orchard Hills.

As such, the local population of the Eastern Freetail-bat is considered unlikely to be reliant on the habitat features in the study area. The removal of five hollow-bearing trees and 6.3 hectares of potential foraging habitat (which is mostly composed of suboptimal revegetation along the M4 Motorway) would have an adverse effect on the lifecycle of the species such that a viable local population is likely to be placed at risk of extinction.

2. **in the case of an Endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

   Not applicable.

3. **in the case of an Endangered ecological community or Critically Endangered ecological community, whether the action proposed:**

   i) **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   ii) **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

   Not applicable.

4. **in relation to the habitat of a Threatened species, population or ecological community:**

   i) **the extent to which habitat is likely to be removed or modified as a result of the action proposed**

   ii) **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The proposal would remove around 6.3 ha of potential foraging habitat for the Eastern Freetail-bat. However, 3.9 hectares of this foraging habitat is considered suboptimal, as it is revegetation along the heavily used M4 Motorway. The habitat along the M4 Motorway is considered suboptimal as bats are known to exhibit avoidance behaviours around major roadways with marked decreases in bat activity and diversity seen in proximity to major roads (Berthinussen & Altringham 2012; Zurcher *et al.* 2010). The proposed removal of foraging habitat is small when the amount of available foraging habitat within foraging range of the Eastern Freetail-bat is considered.

Importantly, the proposal would not result in fragmentation of habitat for the Eastern Freetail-bat. This species is a fast and highly mobile flyer that will freely fly long distances (up to 10 kilometres) over open areas to move between habitats. The proposal would not affect the movement of Eastern Freetail-bat between habitat patches, as no barriers to the movement of this species would be created.

The core habitats that are critical for the local population of the Eastern Freetail-bat to complete its lifecycle are likely to be the riparian zones of Ropes Creek and South Creek and the larger patches of vegetation in the Mulgoa Nature Reserve, Wianamatta Nature Reserve, Castlereagh Nature Reserve and Defence Establishment Orchard Hills. The habitats within the study area are likely to be supplementary to these core habitats.

5. whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Critical habitat refers only to those areas of land listed in the Register of Critical Habitat kept by the NSW Office of Environment and Heritage (OEH). This question is not applicable as no critical habitat has been listed for the Eastern Freetail-bat.

6. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

A recovery plan does not exist for the Eastern Freetail-bat. However, the OEH has developed a targeted strategy for managing threatened species the Saving Our Species program. The Eastern Freetail-bat has been assigned to the Landscape species management stream under the OEH Saving our Species program. The actions identified for recovery of this species by the OEH include:

- Raise public awareness of the importance of hollow-bearing trees and promote strategies for retaining these in the landscape. Facilitate regeneration or undertaking replanting at sites where they presently occur. Protect recruit trees that will be able to provide hollows in the future.
- Negotiate agreements with relevant landholders (particularly in-perpetuity covenants or stewardship agreements) that promote the retention, connectivity, restoration and sensitive management of suitable habitat including remnant vegetation and forested areas with hollow-bearing trees, especially in productive landscapes, as well as vegetation buffers around wetlands, estuaries, alluvial flats along creeklines and coastal lagoons.
- Raise public awareness of the damage that can be caused to habitat by slashing, underscrubbing, thinning, weed encroachment and inappropriate grazing. Encourage land managers to retain natural tree density and a floristically and structurally diverse and spatially variable mid and understorey.
- Identify sites where exotic species are inhibiting native tree recruitment or changing the vegetation structure. Implement a bush regeneration strategy targeting the removal of weeds significantly compromising habitat values, especially in riparian zones, and restore native

vegetation. Care should be taken to avoid widespread removal of beneficial exotic woody vegetation without replacement and avoid non-target impacts of herbicides.
- Liaise with relevant landholders or land managers responsible for artificial light sources close to key roosting or foraging areas, to encourage reduction or modification of light impacting on known habitat to reduce levels of disturbance.
- Liaise with relevant authorities or land managers to ensure that the location and sensitivity of key foraging or roosting habitat areas are known prior to any hazard reduction burns. Where maternity roost sites are known to occur, burning should not take place during breeding (November to January). Fire in suitable habitat areas should be managed to promote a mosaic of vegetation structures and high intensity fires that remove hollow-bearing trees should be avoided where possible.
- Where maternity or other roost site locations are known to occur, raise awareness amongst landholders in close proximity (around 15km radius) of the potential impacts of using harmful pesticides and other chemicals; discourage their use in or adjacent to suitable habitat and monitor and maintain water quality in systems known to be used for foraging. In other high quality foraging habitat areas, particularly in low-elevation productive landscapes, raise public awareness of the potential impacts of pesticide and chemical use and discourage their use in riparian zones around waterways such as wetlands, swamps, estuaries, rivers, creeks, lakes and dams.
- Conduct targeted research into the species biology, particularly in relation to habitat use in various densities of urbanisation and in agricultural landscapes. For example, investigation of prey availability and disturbance (noise and lighting) in productive floodplain areas over a gradient of urbanisation, and research that investigates what key elements make agricultural landscapes suitable for the species.

The recovery actions identified in the Saving Our Species program are largely not applicable to the proposal as they are actions for the OEH or landholders to complete. The proposal would not interfere with any of the recovery actions posed for the Eastern Freetail-bat.

7. whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

A KTP is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. Key threatening processes are listed under the TSC Act and at the present, there are currently 38 listed KTPs. Of the 38 listed KTPs under the TSC Act, the only KTPs relevant to the Eastern Freetail-bat that would be increased by the proposal is clearing of native vegetation and removal of dead wood and dead trees.

The main threats to the Eastern Freetail-bat include:

- loss of hollow-bearing trees
- loss of foraging habitat
- application of pesticides in or adjacent to foraging areas
- artificial light sources spilling onto foraging and/or roosting habitat
- large scale wildfire or hazard reduction burns on foraging and/or roosting habitat.

The proposal would result in the loss of some potential foraging habitat and the loss of hollow-bearing trees.

Conclusion

The proposal would remove around 6.3 ha of potential foraging habitat for the Eastern Freetail-bat. However, 3.9 hectares of this foraging habitat is considered suboptimal, as it is revegetation along the heavily used M4 Motorway. Five hollow-bearing trees that may provide suitable roosting and breeding habitat would be removed by the proposal. The extent of potential habitat removal is not

considered likely to result in an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of extinction.

The study area is considered likely to form part of a larger home range for a local population of the Eastern Freetail-bat. However, the study area is not considered to form any core high quality habitat. No critical habitat will be impacted.

The proposal is considered unlikely to reduce the local population size of the Eastern Freetail-bat or decrease the reproductive success of this species. The proposal would not interfere with the planned recovery actions for the Eastern Freetail-bat. The proposal would however contribute to some KTPs that are known to affect this species.

After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant effect to the Eastern Freetail-bat.

Environment Protection and Biodiversity Conservation Act 1999 assessment

Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox is considered likely to occur based on the presence of suitable foraging habitat. The Grey-headed Flying-fox exists as a single interconnected population in Australia. As such, it is considered an important population.

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

1. lead to a long-term decrease in the size of an important population of a species

There are no roost camps in the study area and the action would not affect any known permanent roosting, breeding / maternity site. Therefore, it is likely that the impacts of construction and operation of the action would be confined to loss of feeding habitat caused by direct clearing or damage to native vegetation during the construction phase. There is also a low risk of vehicle strike during operation.

The proposal would directly remove up to 6.3 hectares of potential foraging habitat. The affected area of foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the study area. Given the relative widespread nature of similar native vegetation and planted vegetation in the locality and abundance of higher quality foraging habitat within the feeding range of regional populations, the proposal is not expected to lead to a long-term decrease in the size of an important population.

2. reduce the area of occupancy of an important population

The area of occupancy of the Grey-headed Flying-fox is not known but the species exists as one interconnected population along the eastern Australian coastal belt from Rockhampton in central Queensland to Melbourne in Victoria. The area occupied by this species would remain the same after the action. No impact to area of occupancy is expected.

3. fragment an existing important population into two or more populations

Highly mobile species such as bats are expected to be less impacted by fragmentation and the Grey-headed Flying-fox is particularly well adapted to accessing widely spaced habitat resources given its mobility and preference for seasonal fruits and blossom in differing parts of the landscape. The proposal would not fragment an important population of the Grey-headed Flying-fox. Individuals would still be able to disperse between roosts along the east Australian coast.

4. adversely affect habitat critical to the survival of a species

This species typically exhibits very large home range and Grey-headed Flying-fox is known to travel distances of at least 50 kilometres from roost sites to access seasonal foraging resources. There are no known roost camps within the study area and the site does not provide critical roosting habitat. However, there are a number of known roost camps with a 50km radius of the proposal, including Parramatta, Emu Plains, Cabramatta, Clyde and Brownlow Hill. The draft recovery plan for the Grey-headed Flying-fox identifies critical foraging habitat for this species as:

- Productive during winter and spring, when food bottlenecks have been identified
- Known to support populations of >30,000 individuals, within an area of 50 kilometre radius of a camp site

- Productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (September-May)
- Productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes
- Known to be continuously occupied as a camp site.

Native vegetation within the study area would constitute critical foraging habitat. The affected area of critical foraging habitat would represent a small percentage of the total extent of important foraging vegetation types present within a 50 kilometre radius of the camp sites described. Given the relative widespread nature of similar vegetation in the locality and abundance of higher quality foraging habitat within the feeding range of regional populations, the proposal is not expected to adversely affect foraging habitat critical to the survival of this species in this region.

5. disrupt the breeding cycle of an important population

As stated above there would be a minor impact on foraging habitat identified as important during the breeding cycle of the species. The upgrade would not directly impact on a known roost camp / breeding or maternity site.

6. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

No evidence of a roost camp has been identified from the study area. Further, there would be a relatively minor impact on critical foraging habitat. This impact is not expected to lead to a decline in the species in this region.

7. result in invasive species that are harmful to a vulnerable species becoming established in the Vulnerable species' habitat

The action is unlikely to result in an invasive species harmful to the Grey-headed Flying-fox becoming established in the habitat. The potential for weed invasion was considered possible with a proposal of this nature and appropriate controls are required during construction and operation of the road to reduce this threat. The management of invasive species would be managed under the construction environmental management plan and during operation of the highway using best practice methods.

8. introduce disease that may cause the species to decline, or

There are no known disease issues affecting this species in relation to the action. The action would be unlikely to increase the potential for significant disease vectors to affect local populations.

9. interfere substantially with the recovery of the species.

The *Draft National Recovery Plan for the Grey-headed Flying-fox (Pteropus poliocephalus)* (Department of Environment Climate Change and Water 2009) outlines the following actions:

- Identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes across their range
- Enhance winter and spring foraging habitat for Grey-headed Flying-foxes
- Identify, protect and enhance roosting habitat critical to the survival of Grey-headed Flying-foxes
- Significantly reduce levels of deliberate Grey-headed Flying-fox destruction associated with commercial horticulture
- Provide information and advice to managers, community groups and members of the public that are involved with controversial flying-fox camps

- Produce and circulate educational resources to improve public attitudes toward Grey-headed Flying-foxes, promote the recovery program to the wider community and encourage participation in recovery actions
- Monitor population trends for the Grey-headed Flying-fox
- Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire, and implement strategies to reduce these impacts
- Oversee a program of research to improve knowledge of the demographics and population structure of the Grey-headed Flying-fox
- Maintain a National Recovery Team to oversee the implementation of the Grey-headed Flying-fox National Recovery Plan

The recovery actions listed above are largely not applicable to the proposal and the proposal is not expected to interfere substantially with the recovery of the species.

Conclusion

The Grey-headed Flying-fox would suffer a small reduction in extent of suitable foraging habitat from the action. No breeding camps or other important habitat would be impacted. The action is unlikely to reduce the population size of the Grey-headed Flying-fox or decrease the reproductive success of this species. The action would not interfere with the recovery of the Grey-headed Flying-fox and would not contribute to the key threats to this species. After consideration of the factors above, an overall conclusion has been made that the action is unlikely to result in a significant impact to the Grey-headed Flying-fox.

Swift Parrot (*Lathamus discolor*)

While the Swift Parrot was not recorded in the study area during the field survey it is considered likely to occur based on the presence of suitable winter foraging habitat.

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

1. lead to a long-term decrease in the size of a population

The study area contains some potential foraging habitat for the Swift Parrot. While the habitat in the study area is not optimal, the loss of potential feed trees would directly affect the species opportunity to feed in the area. However, the study area is not considered a critical area for the Swift Parrot. The Swift Parrot may utilise trees in the study area for foraging intermittently when no other suitable inland (ie box ironbark woodlands) or coastal resources (ie Spotted Gum and Swamp Mahogany forests) are available. The action would remove around 6.3 ha of potential foraging habitat.

The Swift Parrot does not breed in the study area and the extent of habitat remaining in the study area would provide sufficient resources to sustain future visitation, such that the action is unlikely to lead to a long-term decrease in the size of the Australian population.

2. reduce the area of occupancy of the species

As a specialist nectarivore dependent on flowering eucalypts, Swift Parrots are vulnerable to the loss of quantity and quality of key forage tree species. As a large-scale migrant, it has the ability to cover vast areas of its winter range, seeking suitable flowering eucalypt habitat. The species is an occasional visitor to the region and may utilise trees in the study area for foraging intermittently when no other suitable resources are available.

The proposal would contribute to the loss of potential foraging habitat that would reduce the area of habitat available. However, the proposal would not reduce the area of occupancy of this species, which is estimated at 4,000 km².

3. fragment an existing population into two or more populations

Importantly, the proposal would not result in fragmentation of habitat for the Swift Parrot. This species is highly mobile and will freely fly long distances over open areas to move between habitats. The proposal would not affect the movement of the Swift Parrot between habitat patches.

4. adversely affect habitat critical to the survival of a species

Key habitats for this species on the coast and coastal plains of New South Wales include large stands of *Corymbia maculata, E. robusta, Eucalyptus gummifera* and *E. tereticornis* forests. The study area supports stands of *E. tereticornis*, hence why suitable habitat for this species is considered present. The habitat within the study area is considered to be secondary habitat for the Swift Parrot as this species is not regularly recorded from the area and it is not known as critical habitat.

5. disrupt the breeding cycle of a population

The Swift Parrot is endemic to south-eastern Australia and breeds only in Tasmania, and migrates to mainland Australia in autumn. As such, the proposal would not affect breeding habitat for this species. Important winter foraging grounds would not be impacted.

6. modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Foraging habitat for this species would be reduced by around 6.3 ha. As a large-scale migrant, it has the ability to cover vast areas of its winter range, seeking suitable flowering eucalypt habitat. The species is an occasional visitor to the region and may utilise trees in the study area for foraging intermittently when no other suitable resources are available. The action is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

7. result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat

The main invasive species harmful to the habitat for the swift parrot are weeds. Noisy Miners and Bell Miners are abundant in the habitat that may make the habitat less suitable for the Swift Parrot due to competitive exclusion. The action may result in weed invasion and the removal of habitat may concentrate local miner populations increasing competition. The management of invasive species would be managed under the construction environmental management plan and during operation.

8. introduce disease that may cause the species to decline, or

Infection of native plants by Phytophthora cinnamomi has been identified as being spread by construction machinery. This water-borne mould infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of 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 and is unlikely to have a significant impact. It is the intention to use current best practice hygiene protocols on this proposal as part of the CEMP to prevent the introduction or spread of pathogens.

9. interfere with the recovery of the species.

The National Recovery Plan for the Swift Parrot (Swift Parrot Recovery Team 2001) identifies the following actions for recovery of this species:

- Identify the extent and quality of habitat.
- Manage and protect Swift Parrot habitat at the landscape scale.
- Monitor and manage the impact of collisions, competition and disease.
- Monitor population and habitat.

The recovery actions listed above to help recover the Swift Parrot are largely not applicable to the proposal as they are actions for the OEH to complete and focus on priority conservation lands which are outside of the study area. The proposal would not interfere with the recovery of the Swift Parrot.

Conclusion

The Swift Parrot would suffer a small reduction in extent of foraging habitat from the action. The action is unlikely to reduce the population size of the Swift Parrot or decrease the reproductive success of this species. The action would not interfere with the recovery of the Swift Parrot. After consideration of the factors above, an overall conclusion has been made that the action is unlikely to result in a significant impact to the Swift Parrot.

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